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Appendix A

North Butte Section 106 Plan

November 30, 2011

Proposal from Power Resources, Inc. dba Cameco Resources
To the U.S. Nuclear Regulatory Commission

A plan for gathering information about properties of religious and cultural significance to Federally-recognized Indian tribes that may be affected by its proposed undertakings at the North Butte satellite facility

Power Resources Inc., dba Cameco Resources (Cameco), proposes to carry out a phased program of information gathering with concerned Indian tribes, as described below, in order to identify places of religious and cultural significance to those tribal nations that may be affected by the Smith Ranch Source and Byproduct Materials License SUA-1548 renewal application (LRA), which includes Smith Ranch-Highland and related satellite facilities (Reynolds, North Butte, Ruth, and Gas Hills). These efforts will be carried out in response to U.S. Nuclear Regulatory Commission's (NRC) Meeting Report referencing a meeting on September 19-20, 2011, at which the NRC staff reviewed the LRA prior to submission. The meeting report was an enclosure of a NRC staff memorandum of October 28, 2011.

The meeting report stated that "The LRA does not clearly describe the status of any tribal consultation activities related to North Butte, namely with respect to the Pumpkin Buttes." In response to this observation, Cameco plans to gather information relative to the North Butte Remote Satellite, in anticipation of Section 106 consultations between NRC and Indian tribes once the LRA is submitted for review.
Cameco has secured the services of the SRI Foundation (SRIF) of Rio Rancho, NM to assist them in this effort. Unless otherwise indicated, all tasks below will be carried out by SRIF under the direction of Cameco.

Phase 1

- Obtain review and comments from the NRC, Bureau of Land Management (BLM), and the Wyoming State Historic Preservation Officer (WSHPO) of this plan. This may include meetings with these agencies.
- Define a specific study area involving the North Butte satellite. The study area will take into account the presence of known places of religious and cultural significance, including the Pumpkin Buttes, and the potential sensitivity of such places to visual effects.
- Review NRC documentation concerning previous consultations with representatives of Indian tribes and any NRC policies or protocols for Native American consultation.
- Revise the plan to reflect NRC, WSHPO, and BLM comments.

Phase 2

- Develop a brief overview of Native American use and practices in the study area to serve as a context for subsequent Section 106 decisions; this overview will include information on types of traditional cultural properties typically encountered in this region.
- Develop draft letters for contacting Indian tribes concerning the information-gathering project, and prepare supporting materials to be included with the letters. The supporting materials may include maps of the project and surrounding area, photographs of what operating ISR projects look like, an animation of the ISR process, copies of the NRC request to Cameco for additional information on traditional cultural properties, etc.

  Parameters: Information provided will be brief, clear, and nontechnical. Indian tribes will be asked how they wish to proceed with identification of places of traditional significance to them (carry out their own research with facilitation by SRIF, work with an ethnographer or ethnohistorian, etc.). The letters will offer a choice among several possible levels of future participation ranging from "not interested in being consulted about these projects" through "would like to be informed about results of efforts to identify archaeological sites and traditional cultural places" through "wish to participate in field visits and interviews."
- Obtain NRC and BLM review of draft letters and materials.
- Revise letters and materials per NRC and BLM comments.

Phase 3

- If responding Indian tribes request a round table meeting with NRC and SRIF to develop a process for the information gathering, and at the request of NRC, help NRC convene and facilitate the meeting.
- Make initial contacts with all Indian tribes on the tribal contact list (see below).
- Follow up with the Indian tribes as needed to secure responses to the letter and decisions about the nature and extent of participation in the projects from as many tribes on the list as possible.
- Maintain a detailed record of tribal contacts and responses.
- Provide information to Cameco and NRC about those Indian tribes wishing to participate in field visits and interviews, tribes wishing to participate at lesser levels of consultation, and tribes not wishing to participate.
- If responding Indian tribes request the services of an ethnographer or ethnohistorian, assist Cameco in securing the services of appropriate ethnographers or ethnohistorians to complete identification of properties of religious and cultural significance. Assistance may include identifying potential consultants, developing scopes of work, and reviewing and commenting on proposals received.

Phase 4

- Provide assistance to Cameco in all areas of managing the identification process: facilitate and review work carried out by Indian tribes as well as work carried out under any ethnographic or ethnohistoric contracts; monitor schedules, recordkeeping, and results; assist tribes and contractors with any problems; review reports; ensure that contractors are gathering, or tribes are providing, the needed information about identification, eligibility, effects, and potential measures to resolve any adverse effects.
- Communicate with those Indian tribes who asked to be kept informed as the project proceeds.
- Cameco will provide regular updates on the progress of the project to NRC and BLM.

Phase 5

- Coordinate with NRC, BLM, and WSHPO to adjust the Area of Potential Effects (APE) boundaries (36 CFR §800.4(a)) if discussions with Indian tribes indicate that properties outside project boundaries may be affected.
- Assemble information from tribes and contractors and prepare eligibility recommendations (36 CFR §800.4(c)) for traditional cultural properties in the project APE.
- Cameco will then submit these eligibility recommendations to NRC for consultation with WSHPO and tribes (and BLM if any properties are on BLM-managed lands).
- Assemble information from tribes and contractors, apply the criteria of adverse effect (36 CFR §800.5(a)), and prepare recommendations concerning the effects of in situ recovery (ISR) development activities on eligible or listed historic properties within the APE.
- Cameco will then submit these effect recommendations to NRC for consultation with WSHPO and tribes (and BLM if any properties are on BLM-managed lands).

Optional Phase 6

- If any adverse effects are identified during Phase 5, assist Cameco and the NRC to complete consultations with BLM, the WSHPO and Indian tribe consulting parties (and the Advisory Council on Historic Presrvation, if they choose to participate) to identify measures to resolve the adverse effects (36 CFR §800.6).
- Provide recommendations concerning "whereas" declarations and stipulations to be included in the Section 106 agreement document (36 CFR §800.6(c) or §800.14(b)(3)) and submit through Cameco to NRC for possible inclusion in the agreement document.

November 30, 2011

Preliminary List of Tribes Whose Aboriginal Territory May Include Campbell County, WY

Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
Crow Tribe of Montana
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
Oglala Sioux Tribe of the Pine Ridge Reservation, South Dakota
Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
Santee Sioux Nation, Nebraska
Standing Rock Sioux Tribe of North & South Dakota
Three Affiliated Tribes of the Fort Berthold Reservation, North Dakota

Appendix B

North Butte Wellfield Modeling Study

SECTION 16.12

SPACING OF ORE SAND MONITORING WELLS ADJACENT TO THE NORTH BUTTE INSITU WELL FIELD

FOR:
URANERZ U.S.A., INC.

BY:
HYDRO-ENGINEERING
JANUARY, 1990

GEORGE L. HOFFMAN, P.E.
HYDROLOGIST

Revised Feb. 1, 1990

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1.0 INTRODUCTION

This report presents the recommended ore sand monitor well spacing for the North Butte insitu well field. It is recommended that horizontal excursion monitoring wells be located within the zone in the aquifer where the well field controls the ground-water movement. The zone of control or gradient reversal is created by the bleed rate from the well field. The procedure presented in Hydro-Engineering (1989) that predicts the drawdowns from the bleed rate was used, with an adjustment for the natural ground-water gradient to determine if the well field controls the flow. The well field controls the flow within the zone of ground-water reversal. Recommendations on the selection of monitoring well spacing concludes this report.

2.0 ZONE OF CONTROL FOR MINING UNIT #1

The placement of monitoring wells in the ore sand aquifer needs to be within the zone where the ground-water flow is controlled by the operation of the mining unit. The bleed from the mining unit creates a zone around the mine where the head is lower than outside of this zone. This reversal zone causes ground water in this area to flow to the mining unit and for purposes of this report is called the zone of control. The zone of control is the area of ground-water reversal in the two downgradient sides of the well field and also includes the two upgradient sides. The ground-water flow direction at the North Butte mining unit #1 well field is north 34.5 degrees west. Therefore this site has two upgradient and two downgradient sides. Flow from the upgradient sides of the well field enters the well field area prior to the operation. The bleed rate will only increase the gradient in the two upgradient sides toward the well field. Therefore, the flow on these two sides of the well field is controlled by the well field also. Figure 2-1 of Hydro-Engineering (1989), presents a cross section of the hydraulic gradient adjacent to a well field. The zone of reversal is shown downgradient of the well field where the ground-water is flowing back to the well field. Beyond the zone of reversal the ground-water flow continues downgradient. The zone of control includes the two reversal (downgradient) sides and the two upgradient sides.

The following presents our evaluation of the zone of control around the eastern half of mining unit #1. Only the eastern half

of mining unit #1 was simulated because this area is the initial start-up region. Drawdowns at distances from the mining unit are first estimated by summing the individual drawdowns. The drawdowns are adjusted for the natural ground-water gradient to estimate the changes in the piezometric surface with distance from mining unit #1.

2.1 DRAWDOWN ESTIMATES

The appropriate ground-water flow model for the North Butte site is the Hantush modified leaky model. The Theis (1935), non-leaky confined aquifer model was used in this analysis because the modified Hantush is not available in Walton's (1989) program. The leaky drawdowns would be slightly less than the Theis predictions but the water-level changes should be very similar. The use of a partially penetrating well model is not necessary due to the length of time and distances where the drawdowns are needed. The following procedures are the same as those outlined in Hydro-Engineering (1989).

The WELFLO program presented in Walton (1989) was used to compute drawdowns from the Theis equation. This program has the advantage that it computes drawdowns along grid lines and therefore several lines of drawdowns are developed with one execution.

2.1.1 WELL FIELD SIMULATION

The total production from the recovery wells is slightly higher than the total injection rate. This difference is called

the bleed rate and is planned to be one percent of the total recovery rate for the North Butte site. The bleed rate, not the recovery and injection rates, becomes the important rate with time. The zone of reversal was simulated with only the bleed rate for the eastern half of mining unit #1. Figure 2-1 shows the outer limits (dashed line) of mining unit #1. The eastern half of this area is being simulated by 85 nodes that are 100 feet on each side. The modelled area is shown on Figure 2-1 as a solid line. Average total bleed rate of one percent for the 85 nodes is 0.35 gpm per node for a total recovery rate for this mining unit of 3000 gpm. The total bleed rate of 30 gpm for this simulation is applied uniformly over the well field area but could be applied unevenly if the well field was planned to be operated with a non-uniform bleed.

The drawdown calculations for the example consists of 85 pumping (bleed) sites with drawdowns simulated over a 25 by 23 grid. Table 2-1 presents the list of input parameters that are initially listed with the output from the WELFLO program. The output listing does not list the first three inputs: enter 1 for printer, enter 1 for non leaky condition and enter 1 for fully penetrating wells. Table 2-1 presents the remainder of the input data. Table 2-2 presents the listing of the simulated drawdowns from the program output. The well field bleed locations are presented in Table 2-1 for each of the 85 stresses. The drawdowns west of the southwest corner of the well field are presented in the number 1 I nodes from 13 through 1 J nodes. Figure 2-1 shows the

grid used to calculate the drawdown adjacent to the North Butte mining unit #1.

2.1.2 AQUIFER PROPERTIES

Average aquifer properties (transmissivity and storage coefficient) from the multi-well pump test are found in Volume III of Uranerz (1989). Properties that are thought best representative of the area along the line of drawdowns used for the reversal determination should be used. A transmissivity of 750 gal/day/ft and a storage coefficient of 0.00015 are thought to best represent the B aquifer in this area.

2.2 GRADIENT REVERSAL

The pre-mine hydraulic gradient in the ore sand aquifer is integrated with the drawdown calculations to determine the zone that the bleed has caused the gradient to be towards the well field. This zone is where the gradient has been reversed on the down gradient sides of the well field. Monitoring in the ore sand aquifer is recommended within the zone of control where the bleed controls the flow in the aquifer. The zone of control includes the upgradient sides of the well field because ground-water flow in this area moves to the well field.

A pre-mine gradient of 0.0057 ft/ft means that more than 0.57 feet of additional drawdown is needed in the next closest drawdown node (100 foot spacing) for reversal to exist along drawdown lines that are downgradient to the ground-water flow direction. The ground-water flow direction at the North Butte mining unit #1 is

north 34.5 degrees west. Therefore, the drawdown difference required for lines of drawdown to the north of the well field is 0.47 feet (0.57 x cosine 34.5 degrees). The angle between the lines of drawdowns on the west side of the well field and the flow direction is 55.5 degrees. The drawdown change required for a reversal on the west side is therefore 0.32 (0.57 x cosine 55.5). Figure 2-2 presents the drawdown changes along five lines extending from this well field. The change in drawdown in the two northern lines between 100 foot node points needs to be 0.47 feet for the gradient to be reversed. Therefore, the reversal in this area extends greater than 1200 feet from the northern edge of the well field. The reversal extends a greater distance to the west of the well field because a drawdown change of 0.32 feet is needed in this direction to obtain a ground-water reversal.

The western half of mining unit #1 was not simulated but the zone of reversal will be very similar to the eastern half reversal because the area of withdrawal is very similar and the bleed rate will be the same. Therefore, a zone of reversal of greater than 1200 feet should exist as well field development progresses from the eastern to the western half of mining unit #1.

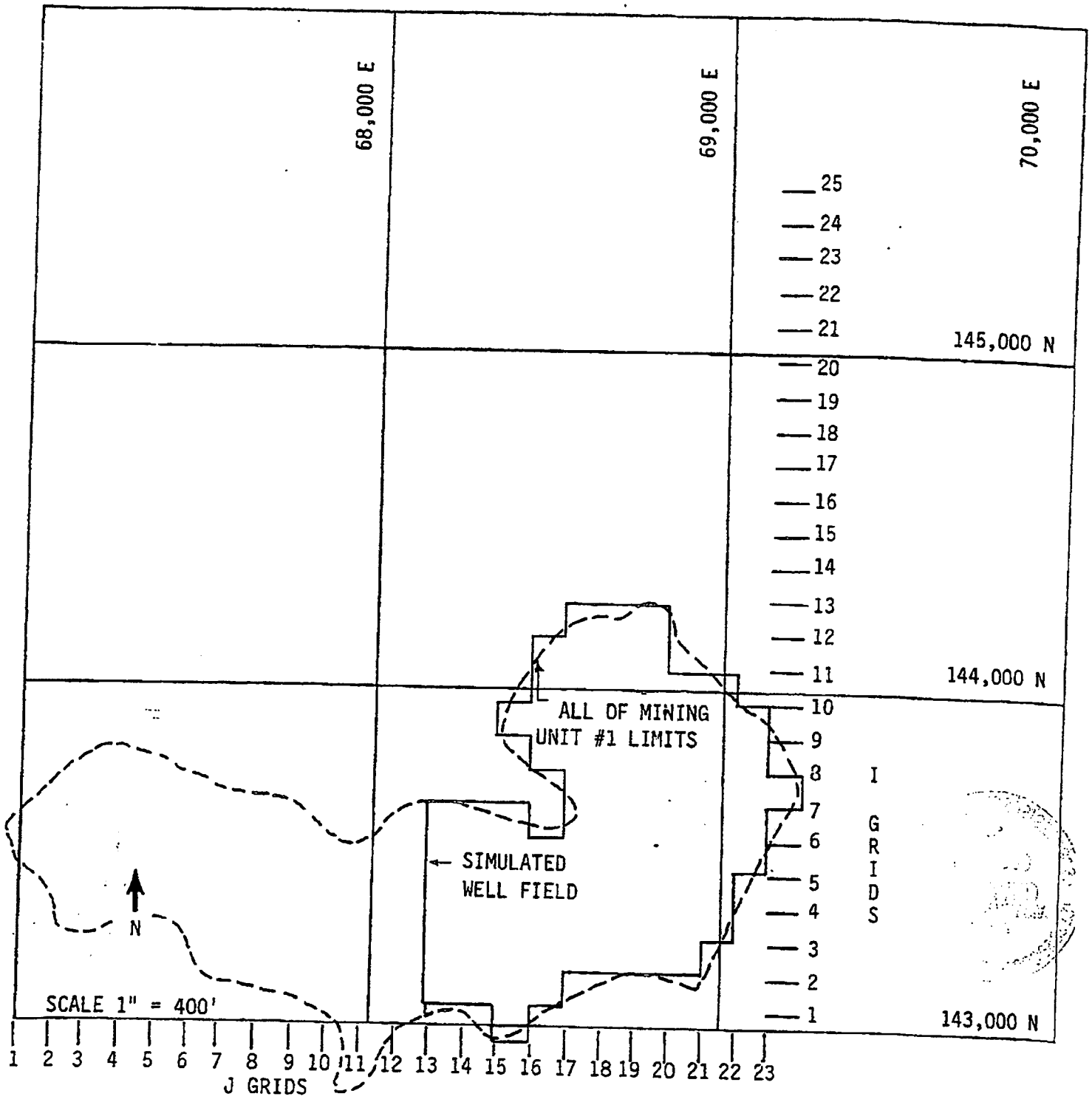


FIGURE 2-1. LOCATION OF WELL FIELD AND SIMULATED DRAWDOWN GRID

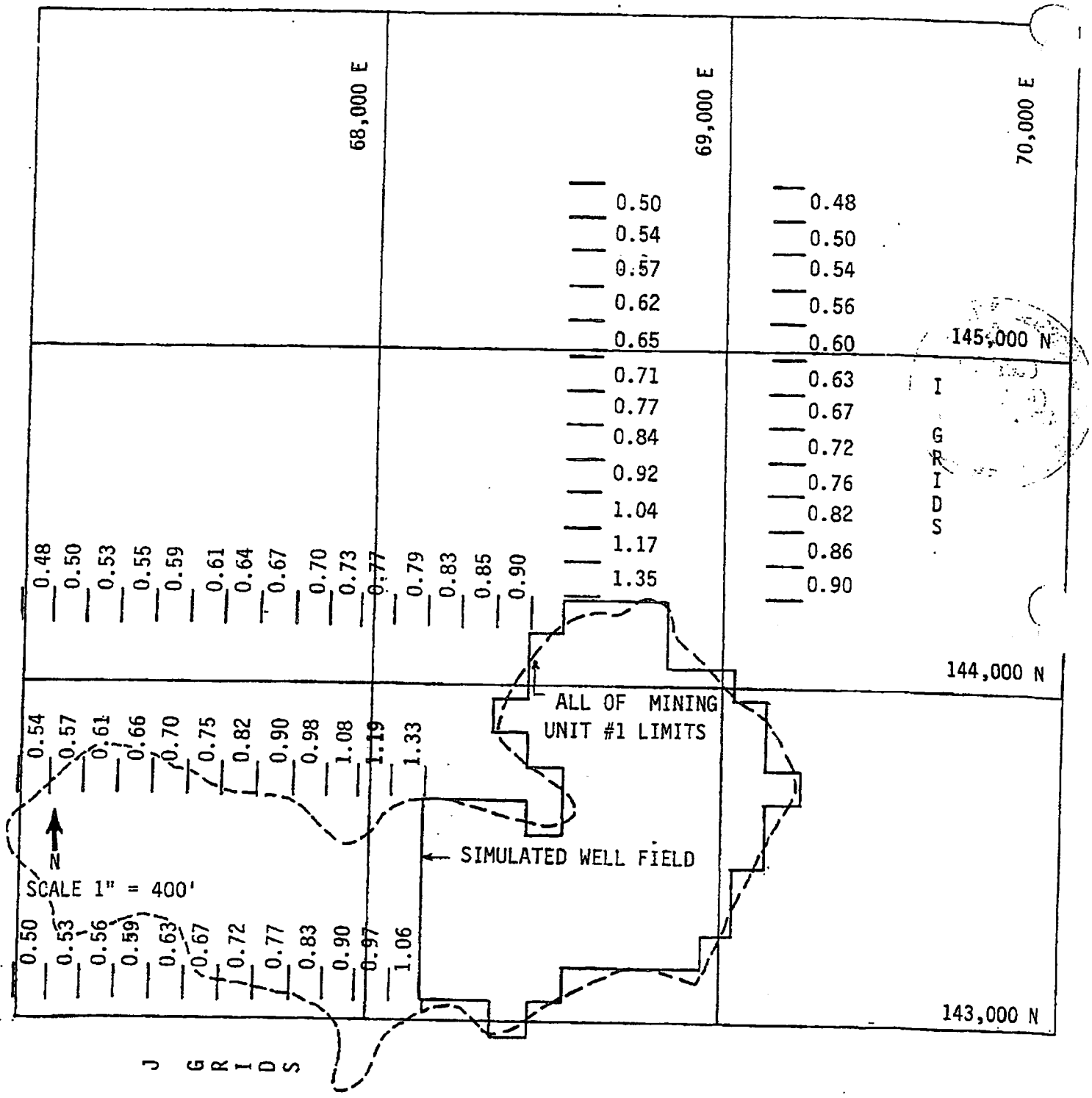


FIGURE 2-2. DRAWDOWN CHANGES ADJACENT TO EASTERN HALF OF MINING UNIT #1

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION

DATA INPUT FOR NORTH BUTTE FIRST HALF MINING UNIT 1 30GPM BLEED

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days= 365.000

DATA INPUT FOR NORTH BUTTE FIRST HALF MINING UNIT 1 30GPM BLEED

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days= 365.000

DATA INPUT FOR NORTH BUTTE FIRST HALF MINING UNIT 1 30GPM BLEED

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days= 365.000

DATA INPUT FOR NORTH BUTTE FIRST HALF MINING UNIT 1 30GPM BLEED

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days= 365.000
Number of grid columns= 25
Number of grid rows= 23
Grid spacing in ft= 100.00
X-coordinate of upper-left grid node in ft= 0.00
Y-coordinate of upper-left grid node in ft= -1200.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 1
X-coordinate of well in ft= -50.00
Y-coordinate of well in ft= 250.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 2
X-coordinate of well in ft= 50.00
Y-coordinate of well in ft= 50.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 3

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
X-coordinate of well in ft=    50.00
Y-coordinate of well in ft=   150.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 4
X-coordinate of well in ft=    50.00
Y-coordinate of well in ft=   250.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 5
X-coordinate of well in ft=    50.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 6
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=    50.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 7
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   150.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 8
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   250.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 9
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
```

(continued)

```
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 10
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 11
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 12
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 13
X-coordinate of well in ft=   150.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 14
X-coordinate of well in ft=   250.00
Y-coordinate of well in ft=    50.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 15
X-coordinate of well in ft=   250.00
Y-coordinate of well in ft=   150.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 16
X-coordinate of well in ft=   250.00
Y-coordinate of well in ft=   250.00
```

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 17
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    350.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 18
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    450.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 19
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    550.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 20
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    650.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 21
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    750.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 22
X-coordinate of well in ft=    250.00
Y-coordinate of well in ft=    850.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
```

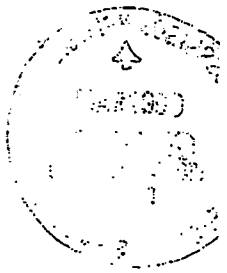
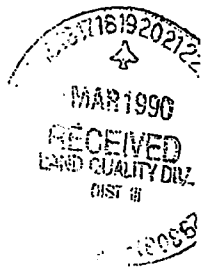


TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
Well number= 23
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=    50.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 24
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   150.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 25
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   250.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 26
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 27
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 28
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 29
X-coordinate of well in ft=   350.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
```



Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 30
X-coordinate of well in ft= 350.00
Y-coordinate of well in ft= 750.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 31
X-coordinate of well in ft= 350.00
Y-coordinate of well in ft= 850.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 32
X-coordinate of well in ft= 450.00
Y-coordinate of well in ft= 50.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 33
X-coordinate of well in ft= 450.00
Y-coordinate of well in ft= 150.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 34
X-coordinate of well in ft= 450.00
Y-coordinate of well in ft= 250.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 35
X-coordinate of well in ft= 450.00
Y-coordinate of well in ft= 350.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 36
X-coordinate of well in ft= 450.00
Y-coordinate of well in ft= 450.00
Well discharge in gpm= 0.35

```
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 37
X-coordinate of well in ft=   450.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 38
X-coordinate of well in ft=   450.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 39
X-coordinate of well in ft=   450.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 40
X-coordinate of well in ft=   450.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 41
X-coordinate of well in ft=   450.00
Y-coordinate of well in ft=   950.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 42
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=    50.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 43
```

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   150.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 44
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   250.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 45
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 46
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 47
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 48
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 49
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
```

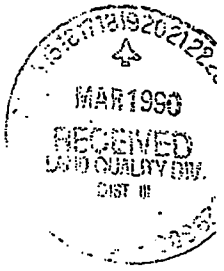


TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
Number of production, injection, and image wells
active during simulation period= 85
Well number= 50
X-coordinate of well in ft=   550.00
Y-coordinate of well in ft=   950.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 51
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 52
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 53
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 54
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 55
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 56
X-coordinate of well in ft=   650.00
Y-coordinate of well in ft=   950.00
Well discharge in gpm=    0.35
```

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION
(continued)

Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 57
X-coordinate of well in ft= 650.00
Y-coordinate of well in ft= 1050.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 58
X-coordinate of well in ft= 750.00
Y-coordinate of well in ft= 350.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 59
X-coordinate of well in ft= 750.00
Y-coordinate of well in ft= 450.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 60
X-coordinate of well in ft= 750.00
Y-coordinate of well in ft= 550.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 61
X-coordinate of well in ft= 750.00
Y-coordinate of well in ft= 650.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 62
X-coordinate of well in ft= 750.00
Y-coordinate of well in ft= 750.00
Well discharge in gpm= 0.35
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION
(continued)

```
Well number= 63
X-coordinate of well in ft=   750.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 64
X-coordinate of well in ft=   750.00
Y-coordinate of well in ft=   950.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 65
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   250.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 66
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 67
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 68
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 69
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
```

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 70
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 71
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 72
X-coordinate of well in ft=   850.00
Y-coordinate of well in ft=   950.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 73
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 74
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 75
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 76
```

```
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 77
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   750.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 78
X-coordinate of well in ft=   950.00
Y-coordinate of well in ft=   850.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 79
X-coordinate of well in ft=  1050.00
Y-coordinate of well in ft=   350.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 80
X-coordinate of well in ft=  1050.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 81
X-coordinate of well in ft=  1050.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 82
X-coordinate of well in ft=  1050.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=    0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
```

TABLE 2-1. INPUT PARAMETERS FOR THE NORTH BUTTE MINING UNIT #1 SIMULATION (continued)

```
Number of production, injection, and image wells
active during simulation period= 85
Well number= 83
X-coordinate of well in ft=  1150.00
Y-coordinate of well in ft=   450.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 84
X-coordinate of well in ft=  1150.00
Y-coordinate of well in ft=   550.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 85
Well number= 85
X-coordinate of well in ft=  1150.00
Y-coordinate of well in ft=   650.00
Well discharge in gpm=     0.35
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=      750.00
Aquifer storativity as a decimal= 0.000150
```

TABLE 2-2. DRAWDOWN CHANGES ADJACENT TO NORTH BUTTE MINING UNIT #1

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN 1	2	3	4	5	6	7	8	9	10
1	23.55	23.68	23.78	23.86	23.91	23.92	23.91	23.87	23.79	23.70
2	24.05	24.20	24.31	24.40	24.45	24.46	24.45	24.40	24.32	24.21
3	24.58	24.74	24.87	24.97	25.02	25.04	25.02	24.97	24.87	24.75
4	25.14	25.32	25.47	25.57	25.64	25.66	25.63	25.57	25.46	25.32
5	25.73	25.94	26.10	26.22	26.29	26.32	26.29	26.21	26.09	25.92
6	26.36	26.60	26.79	26.92	27.00	27.02	26.99	26.90	26.75	26.57
7	27.03	27.31	27.53	27.68	27.77	27.79	27.74	27.63	27.47	27.25
8	27.75	28.07	28.33	28.51	28.61	28.62	28.56	28.43	28.23	27.97
9	28.52	28.90	29.20	29.41	29.53	29.54	29.46	29.29	29.05	28.74
10	29.35	29.81	30.17	30.42	30.55	30.55	30.44	30.22	29.93	29.57
11	30.25	30.81	31.26	31.55	31.70	31.68	31.52	31.24	30.87	30.44
12	31.22	31.93	32.49	32.85	33.00	32.95	32.71	32.34	31.88	31.37
13	32.28	33.22	33.91	34.34	34.52	34.42	34.04	33.50	32.95	32.36
14	33.26	34.42	35.25	35.76	35.97	35.84	35.34	34.69	34.08	33.40
15	34.03	35.28	36.21	36.81	37.07	36.96	36.46	35.83	35.27	34.55
16	34.43	35.79	36.83	37.53	37.85	37.77	37.37	36.92	36.45	35.72
17	34.45	35.92	37.13	37.94	38.37	38.40	38.17	37.85	37.38	36.63
18	34.29	35.80	37.14	38.06	38.60	38.80	38.72	38.42	37.90	37.12
19	34.01	35.51	36.89	37.87	38.50	38.79	38.80	38.53	38.00	37.20
20	33.57	35.00	36.35	37.36	38.04	38.41	38.47	38.23	37.70	36.86
21	32.96	34.22	35.48	36.51	37.23	37.65	37.76	37.55	37.02	36.17
22	32.23	33.28	34.34	35.29	36.04	36.53	36.69	36.50	35.99	35.13
23	31.45	32.32	33.16	33.93	34.59	35.07	35.27	35.12	34.61	33.85

J-ROW	I-COLUMN 11	12	13	14	15	16	17	18	19	20
1	23.57	23.43	23.26	23.07	22.87	22.65	22.43	22.19	21.94	21.69
2	24.07	23.91	23.72	23.52	23.30	23.06	22.81	22.55	22.29	22.02
3	24.59	24.41	24.21	23.98	23.73	23.48	23.21	22.93	22.64	22.35
4	25.15	24.94	24.71	24.46	24.19	23.90	23.61	23.30	22.99	22.68
5	25.73	25.49	25.24	24.96	24.66	24.34	24.02	23.69	23.35	23.02
6	26.34	26.08	25.79	25.47	25.14	24.79	24.44	24.08	23.71	23.35
7	26.98	26.69	26.36	26.01	25.64	25.25	24.86	24.47	24.08	23.68
8	27.67	27.33	26.95	26.56	26.14	25.72	25.29	24.86	24.44	24.01
9	28.39	28.00	27.57	27.13	26.66	26.19	25.72	25.25	24.79	24.34
10	29.15	28.70	28.22	27.71	27.19	26.67	26.15	25.64	25.14	24.65
11	29.96	29.43	28.88	28.30	27.72	27.14	26.57	26.01	25.47	24.95
12	30.81	30.20	29.56	28.91	28.25	27.61	26.98	26.37	25.79	25.23
13	31.70	30.99	30.25	29.51	28.77	28.05	27.36	26.71	26.08	25.48
14	32.64	31.82	30.96	30.10	29.27	28.47	27.72	27.01	26.34	25.71
15	33.65	32.67	31.66	30.67	29.73	28.85	28.03	27.27	26.56	25.90
16	34.72	33.57	32.34	31.19	30.13	29.16	28.28	27.48	26.74	26.05
17	35.63	34.37	32.95	31.60	30.43	29.39	28.47	27.63	26.86	26.15
18	36.10	34.83	33.32	31.84	30.59	29.52	28.56	27.70	26.92	26.20
19	36.13	34.84	33.33	31.84	30.60	29.52	28.56	27.70	26.92	26.20
20	35.71	34.37	32.97	31.62	30.44	29.40	28.47	27.62	26.85	26.14
21	34.97	33.64	32.39	31.22	30.15	29.17	28.29	27.47	26.73	26.04
22	34.00	32.84	31.75	30.72	29.75	28.86	28.03	27.26	26.55	25.88
23	32.92	31.98	31.05	30.15	29.29	28.47	27.71	26.99	26.32	25.69

TABLE 2-2. DRAWDOWN CHANGES ADJACENT TO NORTH BUTTE MINING UNIT #1

J-ROW	I-COLUMN									
	21	22	23	24	25	26	27	28	29	30
1	21.44	21.18	20.92	20.66	20.39					
2	21.74	21.47	21.19	20.91	20.64					
3	22.05	21.76	21.47	21.17	20.88					
4	22.37	22.05	21.74	21.43	21.12					
5	22.68	22.34	22.01	21.68	21.36					
6	22.99	22.63	22.28	21.93	21.59					
7	23.30	22.91	22.54	22.17	21.81					
8	23.60	23.19	22.79	22.40	22.02					
9	23.89	23.46	23.04	22.63	22.23					
10	24.17	23.71	23.27	22.84	22.42					
11	24.44	23.95	23.49	23.04	22.60					
12	24.69	24.18	23.69	23.22	22.77					
13	24.92	24.38	23.86	23.38	22.91					
14	25.11	24.55	24.02	23.51	23.03					
15	25.28	24.70	24.15	23.63	23.14					
16	25.41	24.81	24.25	23.72	23.21					
17	25.50	24.88	24.31	23.77	23.27					
18	25.54	24.92	24.34	23.80	23.29					
19	25.54	24.92	24.34	23.80	23.29					
20	25.49	24.88	24.30	23.77	23.26					
21	25.40	24.80	24.23	23.70	23.20					
22	25.26	24.68	24.13	23.61	23.12					
23	25.09	24.53	23.99	23.49	23.01					

3.0 RECOMMENDED SPACING FOR THE NORTH BUTTE WELL FIELD

Horizontal excursion monitoring wells are recommended to be placed within the area where the well field controls the groundwater flow (zone of control). The spacing of the monitoring wells from the North Butte mining unit #1 well field could be near 1200 feet in all directions of the well field and still be within the zone of control. A recommended spacing of approximately 400 feet on all sides places the monitoring wells significantly inside the reversal zone. This spacing is close enough for early detection of excursions and well within the zone of control.

This analysis shows that horizontal containment is going to be easier on the west side than the north side. Containment will also be even easier on the east and south sides (upgradient) due to the aid of the natural gradient. Recommendation for spacing between monitoring wells is based on the areas most likely to have an excursion. Figure 3-1 shows the recommended spacing and the limits of the spacing on each side of the well field depending on the flow direction. A spacing between monitoring wells of 400 feet is recommended on the north and northwest downgradient sides of the well field. Spacing on the north side of the well field which has an angle of 34.5 degrees is recommended to be 600 feet. Spacing between monitoring wells on the northeast side of the well field is recommended to be 600 feet. Spacing between monitoring wells on the upgradient sides of the well field is recommended to be 1000 feet. These recommended spacings between monitoring wells are

based on the fact that certain sides of the well field are much less likely to have an excursion as can be seen by the simulation of gradients.

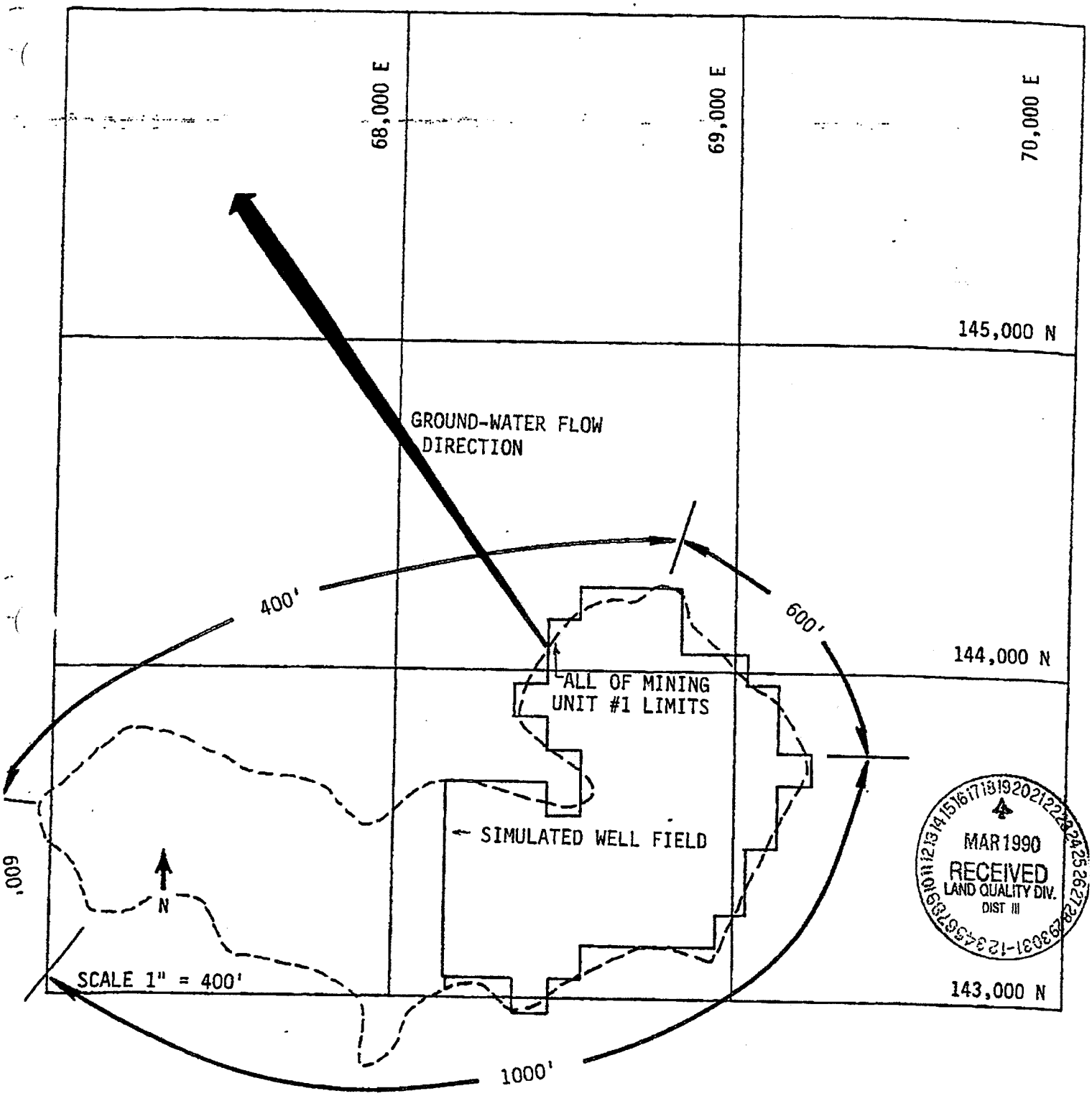


FIGURE 3-1. RECOMMENDED SPACING BETWEEN MONITORING WELLS FOR NORTH BUTTE MINING UNIT #1

4.0 EXCURSION RETRIEVAL

The well field simulated in section 2 was re-simulated at an increased bleed rate of 45 gpm (1.5 percent) and 60 gpm (2 percent). The additional one-half and one percent increase in the bleed rates were simulated to occur in the west six nodes. Wells 2, 6, 14, 23, 32 and 42 in Table 2-1 were the six bleed rates to be increased to 2.85 and 5.35 gpm for the two simulations. The following changes in drawdowns were predicted from the two simulations:

CHANGES IN DRAWDOWNS WEST OF NORTH BUTTE (FT)

DISTANCE FROM WELL FIELD (FT)	1.5% BLEED TIME (DAYS) 20	1.5% BLEED TIME (DAYS) 60	2% BLEED TIME (DAYS) 20	2% BLEED TIME (DAYS) 60
1150	0.88	.90	1.24	1.28
1050	0.94	0.97	1.34	1.37
950	1.02	1.04	1.46	1.48
850	1.11	1.13	1.60	1.63
750	1.23	1.24	1.76	1.78
650	1.35	1.37	1.96	1.99
550	1.51	1.53	2.22	2.24
450	1.72	1.73	2.54	2.56
350	1.97	1.99	2.96	2.97
250	2.33	2.34	3.53	3.54
150	2.79	2.79	4.30	4.31
50	3.37	3.38	5.25	5.26

A correction of 0.32 ft. per 100 feet for the gradient is needed to obtain the change in head between two 100 foot nodes. Therefore the predicted gradients toward the well field at the proposed monitoring well location (400 feet) after 20 and 60 days of increased rate are .015 and 0.015 ft/ft for the 1.5 percent bleed rate. The two percent bleed rate produced gradients of 0.024 and 0.024 ft/ft at the monitoring well proposed location. This analysis shows that one simulation would be adequate instead of the simulations for 20 and 60 days. The average ground-water movement rates back to the well field are estimated to be 0.15 ft/day and 0.24 ft/day for the 1.5 and two percent bleeds respectively (based on permeability of 1 ft/day and effective porosity of 0.1). These movement rates will require travel times of 67 and 42 days, respectively for the water to move ten feet back to the well field. The excursion is "controlled" at the beginning of the period because contaminated water is moving back toward the well field. The well on excursion status will most likely be off excursion prior to the end of the above stated periods due to the hydro-chemical nature of an excursion.

5.0 REFERENCES

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Appendix C

Gas Hills Groundwater Modeling

TABLE OF CONTENTS
ADDENDUM 2
GROUND WATER MODELING

FIGURES

TABLES

ADDENDUM 2
GROUND WATER MODELING

1. GROUND WATER MODEL DESCRIPTION

1.1 General Background for Model

There are two primary concerns in the design and operation of ISL wellfields: (1) that the fewest wells possible are drilled, completed and operated to achieve a required U_3O_8 production, and later to restore the wellfield, and (2) that the U_3O_8 production is realized with minimum impact to ground water outside of the pattern areas (minimum "flare"). Thus, the lixiviant flowpath in the aquifer and the velocity of the lixiviant are critical items of interest. The path that a particle of fluid takes as it proceeds through the reservoir is called a "pathline".

Since every flow rate from every well will affect the reservoir pressures and flow rates at every other well, computer models are used for the large number of calculations required to trace the pathlines and to help in the design and operation of a wellfield. Generally, computer models fall into two categories: (1) analytical models, and (2) numerical models. Analytical models allow calculation of the pressures or particle velocities directly, but require homogeneity of the reservoir. Numerical models (e.g. MODLFOW), on the other hand, allow for discrete spatial variation in reservoir and fluid properties (permeability, thickness, porosity, etc.), but require special mathematical techniques for solutions and do not determine velocities directly (Bartels, 1996).

1.2 Program Description

The computer model chosen by PRI to simulate the design and operations of the various mine units is PATH v. 5.0 (PATH), an analytical, solute transport model of a saturated, horizontally confined system. The model is based upon Darcy's Law and allows for horizontal anisotropy, for multiple zones or layers, and multi-completions of wells. Particle velocities for pathlines (and lixiviant fronts) are determined directly as steady-state, while pressure calculations are made as time-dependent, unsteady-state. Superposition is used to simulate the additive effects of the varying flow rates from multiple wells. The final predicted flow rate is based upon the available injection or production pressure, the aquifer characteristics and fluid properties, and the geometry of the patterns. The estimated flow rates are used to design surface facilities for production and restoration and are used as input data for the simulation of ground water flowpaths.

The PATH model is a family of programs, used in the design and operation of ISL wellfields. Ore outlines and other CADD information can be input into the model. The injection and/or production wells can then be added/deleted individually, or as part of a specific 5-spot or

7-spot pattern. Connection lines can be drawn between wells, and then the flowrates for the wells can be balanced well by well, with any desired percentage bleed rate. Aquifer characteristics for each zone are also input. Individual well flowrates for any particular day are input into separate files, or the flow rate data may be brought from a PC as multiple ASCII files (one for each day) and converted in a batch process. For multiple zones or multi-completed wells, the flowrates are then "split" into separate zones using differential pressures in an iterative process to determine the splits by zone. As mentioned above, permeability and thickness can be varied for each zone.

The pathline and/or lixiviant front calculations are made by the program after choosing the dates for pathline calculation and the zone of interest. Pathlines, lixiviant fronts changing with time, or both, may be chosen to be visually displayed by the program. Average flowrates and standard deviations of those rates are determined by the program across the dates chosen. Pathlines for any portion of the model domain can be calculated and output. Efficiency of lixiviant coverage across the ore, or potential problems with excursions may then be determined by using actual, measured flowrates. Since flowrates tend to vary in actual operations, as compared to the constant rates used in wellfield design, pathlines can be re-started after they are "captured" by a well to ensure that potential problems are not missed after a major flow rate change, rebalancing of flowrates across a mine unit or header house, or well reversal. Also, since the effect on pressure throughout the aquifer by an operating well varies inversely with log of the distance, but directly with flow rate, the flowrates for every well (regardless of the size of the area) is used for each step of all pathline calculations (Bartels, 1996).

1.3 Model Validation

The PATH model has been used extensively in the ISL industry for several years, with the flowpath and flow rate estimates validated against substantial operating history. The model has been used at the Highland Uranium Project, operated by Power Resources, to model pattern flow paths and the extent of flare beyond the operating patterns. The model predictions at Highland are consistent with known operating conditions.

2. FLOW RATE SIMULATION METHOD

2.1 General

The PATH model was used to predict maximum flow rates for the Gas Hills Project. A total of five areas of differing geology and hydrogeologic conditions were identified for analysis: Mine Unit No. 1, Mine Unit No. 2, Mine Unit No. 3 - South, Mine Unit No. 3 - North, and Mine Unit No. 4 (See Figure OP 5-3). Mine Unit No. 5 is not currently adequately defined for hydrologic modeling. Three geometric patterns were used to analyze each area:

1. "single row 5 spot" - single row of connected 5-spot patterns with the injectors located on the outside and the producers located on the pattern interior.

2. "double row 5 spot" - two connected rows of single row 5-spots. This pattern can be extended to a "block 5 spot pattern by adding rows of 5-spots.

3. "ground water sweep" - single or double row of production wells

The single row 5-spot pattern and the double row (and block) 5-spot pattern are the likely producing patterns based on the ore configuration. The single or double row of producers for ground water sweep was chosen because this pattern most efficiently pulls impacted ground water back within the perimeter of the wellfield. Figure OP 5-2 shows these three pattern configurations.

Initially, the pattern was built and well number and injection or production status was assigned to each well. A maximum producing or injection flow rate and a bleed was then input along with the aquifer and fluid properties. The model then generated balanced flow rates given these limits. The balanced flow rates are used by the program to generate the required injection and production pressures for each maximum flow rate. These model generated pressures are compared to the actual available pressures as calculated from the static water level (SWL) and surface injection pressure data. The maximum flow rates are iteratively adjusted until the model generated pressures match the calculated pressures. The pressures decrease slightly with time, dependent on the bleed rate. The rates reported for the single row 5-spot, and the double row 5-spot, are for a pressure match at approximately one year of production. The rates for ground water sweep (GWS) phase of ground water restoration are reported twice; for a pressure match at one month and for a pressure match at one year. The RO phase of ground water restoration is predicted using either the single row 5-spot or the double row 5-spot pattern but with a higher bleed. In these cases, a bleed of 10% was used for the RO phase of restoration.

2.2 Input Data

The model requires the following input data:

Permeability
Formation Thickness
Porosity
Total System Compressibility
Fluid Viscosity
Injection Well Efficiency
Production Well Efficiency
Ground Water Velocity
Direction of Ground Water Movement
Well Locations (X and Y coordinates)

The following model input data were constant for all of the five analyzed areas.

Porosity	0.27
Viscosity	1.0 cp
Compressibility	2.8 E-5
Ore thickness	20 ft
Spacing between like wells	80 ft

The porosity was obtained from a review of log and core data in the Project vicinity. The rock compressibility was determined from a review of correlations for friable and unconsolidated sands. The average ore thickness was estimated from geologic cross-sections. The depth to the SWL and the depth from the SWL to the center of the ore were obtained from the potentiometric surface map (Plate D6-3) and geologic cross-sections of the five analyzed areas (Appendix D-5). These two parameters are used to calculate pressures as described below.

The injection and production well efficiencies of 20% and 85%, respectively, were obtained from a comparison of actual to theoretical flow rates at the Highland Uranium Project where similar well construction techniques are used. To obtain the maximum double row 5-spot rate shown on Table ADD2- 1, production efficiencies were allowed to range from 85% to 100% and injection efficiencies were allowed to range from 20% to 40%. These ranges of efficiencies are considered reasonable given current drilling and well completion practices.

The surface injection pressure will be limited by the existing hydrogeologic conditions of the wellfield, because a fractured formation could potentially result in smaller swept areas, less ore contact by the lixiviant, and lixiviant migration outside of the pattern area. Therefore injection pressures will be maintained below the formation fracture pressure. A commonly reported formation fracture pressure gradient is 1.0 psi or less for every 1.0 foot of depth or

overburden (Driscoll, 1989 and Campbell, 1973). For modeling and forecasting purposes, a very conservative gradient of 0.6 psi/ft has been used to calculate the maximum surface injection pressure for these flow estimates. This is conservatively below the 0.87 psi per foot discussed in Section 6.1.4 of the Operations Plan, resulting in conservative injection pressures and conservative flow estimates. Further pressure transient testing may be required to determine the actual formation fracture pressure. The depth to the SWL and the depth from the SWL to the center of the ore zone for each of the five analyzed areas is shown in Table ADD2-1. The calculated differential pressure available for injection (ΔP_I) and the calculated differential pressure required for production (ΔP_P) were calculated from the SWL data, the surface injection pressure and the ore zone depth using the following equations:

ΔP_I (ft) = (Surface Injection Pressure (psi) / .433 (psi/ft)) + Depth to SWL (ft)
ΔP_P (ft) = SWL to Ore (ft)

Transmissivities were obtained from pump tests (See Table D6-3-2, Appendix D6 of this Permit Application) and converted to permeabilities for each area. These values reflect reasonable estimates of the anticipated hydrogeologic conditions within each mine unit. Subsequent model sensitivity analysis to permeability supports the selection of aquifer values within the observed range of pump test data. Transmissivities were converted to permeabilities using the following equation and assuming a water viscosity of 1 centipoise:

Permeability (md) = transmissivity (gal/day/ft) / saturated thickness (ft) * 48.823

The permeability for Mine Unit No. 1 is based on the average of the conductivities for wells P-1 (early time) and MP-1. The permeability for Mine Unit No.2 is based on the average conductivity of wells BSPW-1, BSMP-1, and BSMP-2. The permeability for Mine Unit No.3 is based on the conductivity of well Peach MP-1 using a saturated thickness of 100 feet. The permeability determined from wells in Mine Unit No.4 ranges widely from 5 md to 1300 md. Eliminating the high and low values decreases the range to 50 to 700 md. A permeability of 300 md was used to model Mine Unit No.4. This value is slightly below the range median.

2.3 Flow Rate Results

The flow rates that result in a pressure differential match for each analyzed area and pattern configuration are summarized in Table ADD2-1. In each area, the single row 5-spot pattern results in the highest flow rate and the ground water sweep pattern results in the lowest flow rate. The estimated flow rates during production and ground water restoration have been used to determine the project schedule, summarized in Section 1.5 of the Operations Plan, and to design the water treatment facilities described in Section 3.5 of the Operations Plan.

As can be seen from Table ADD2-1, maximum production flow rates range from 4 to 20 gpm per production well. These values are acceptable for economic recovery of the uranium reserves. Due to the limited SWL in the Gas Hills, pumping rates during GWS are limited to

2 to 10 gpm per pumped well after one year because there is no re-injection. During the RO phase of ground water restoration, when 90% of the produced fluids are re-injected into the ore zone, sustainable flow rates are estimated to be from 4 to 20 gpm per pumped well. These flow rates represent the ability of the aquifer, given the existing available heads, to yield water. These flow rates are the physical limitation on both the rate of mining and the rate of ground water restoration which can be achieved at the Gas Hills Project. The following section describes how these flow rates are used to predict pathlines of ground water movement.

3. MINE UNIT SIMULATIONS OF GROUND WATER FLOWPATHS

3.1 Simulation Method

PATH was used to simulate flow rates and pathlines in areas of interest at the Gas Hills Project. Simulations were conducted for five areas:

1. Mine Unit No. 1
2. Mine Unit No. 2
3. Mine Unit No. 3, South, south of the Atlas underground mine workings
4. Mine Unit No. 3, North, located north of the Atlas underground mine workings and South of the Pathfinder Mines Corp (PMC) reclaimed pit
5. Mine Unit No. 4 near the reclaimed Buss pit

The movement of ground water near previously mined areas, both reclaimed open pit mines and underground mines, was investigated to determine the impact of the mined out areas on the proposed ISL mining operations, to improve pattern design, and to account for the hydrologic gradient.

The simulation areas are shown on the Simulation Index Map, Figure OP 5-3. The purpose of the simulation was to estimate injection and production rates which will control flow at the margins of the mine area, and to prevent the migration of high TDS water associated with previously mined areas from migrating toward the ISL mining operation.

The planned wellfield geometry, geology, and hydrology were used to estimate the achievable flow rates for the areas to be developed by ISL mining. These estimated flow rates are based on a calibration of injection and production pressures as discussed in Section 2.2 above. Pathlines showing the direction of ground water flow were modeled based on these estimated flow rates, the wellfield pattern, the sand thickness, porosity and permeability, and the potentiometric surface elevations.

Output from the model is displayed as pathlines of ground water movement in two modes. The Injection Mode shows the pathline of a particle of water that was injected through an injection well into the aquifer. The Extraction Mode shows the pathline that a particle of water in the aquifer would travel to reach and be produced from a production well. The Injection Mode is important in tracking the flow of lixiviant and preventing migration of lixiviant away from the pattern area. The Extraction Mode indicates the dilution that can be expected during production and is important in tracking the migration of ground water from previously mined areas toward the pattern area. If an initial simulation showed migration to or from an area of concern such as a previously mined area, then the wellfield pattern and/or the injection and production rates were adjusted to reduce the outward migration of lixiviant (flare) or the inward migration of ground water (sweep).

3.2 Simulation Results

The simulation cases for the five areas are summarized below. The model input data and the results for each simulation case are summarized in Table ADD2-2. A Production Plot (Injection Mode), a Production Plot (Extraction Mode), a Ground Water Sweep Plot (Extraction mode), the input formation data, and the final adjusted production and injection rates for each simulation case are attached as Figures ADD2-1 through ADD2-15 and Tables ADD2-3 through ADD2-12. On Figures ADD2-1 through ADD2-17, the pattern configurations are the same as those shown on Figure OP 5-2, for "typical" patterns. The flowpaths on these figures are from the injectors to the producers, as indicated by the arrows on the flowpaths. The results in each Mine Unit which have been modeled demonstrate that the injection and production rates can be modified to meet the site specific hydrologic conditions such that lixiviant control is assured. The results for each mine unit follows:

Mine Unit No. 1 - There are no previously mined areas in the vicinity of Mine Unit No. 1; therefore a general case was simulated for this area. The design flow rate was 20 gpm. Based on the shape of the ore bodies, the pattern type for this area is a double row 5-spot (see Figure ADD2-1). The ground water gradient ranges from 0.0033 to 0.014 throughout the area. A conservative gradient of 0.017, was used in the simulation. The potentiometric surface slopes to the southwest.

The ground water gradient in this area is high enough to distort the flowpaths resulting in lixiviant migration in the downgradient direction. To compensate for the hydrologic gradient, the lixiviant injection was shifted by increasing the injection rates in upgradient wells and decreasing the injection rates in downgradient wells. The combined bleed for the simulated patterns remained constant at 1%. Once the rates were adjusted, the Injection Mode Production Plot (Figure ADD2-1) shows increased lixiviant flare at the ends of the double 5-spot rows, but all of the pathlines are captured. The Extraction Mode Production Plot (Figure ADD2-2) shows ground water migration into the pattern area from distances of approximately 200 feet upgradient. The Extraction Mode Production Plot shows ten pathlines originating from ground water both upgradient and downgradient of the wellfield patterns. Since each pathline represents 5% of the flow into a producer, and there are 20 production wells producing at a rate of 20 gpm, the dilution is 2.5 %. Since there are no previously mined areas upgradient from Mine Unit No. 1, the migration of ground water into the pattern area is not a concern. The Ground Water Sweep Plot (Figure ADD2-3) shows that by continuing to produce only the downgradient row of producers once injection is halted, the effects of the ground water velocity result in a sweep pattern that captures all of the affected ground water within the influence of the wellfield patterns.

Mine Unit No. 2 - There are no previously mined areas in the vicinity of Mine Unit No. 2; therefore a general case was simulated for this area. The design flow rate was 13 gpm. Based on the shape of the ore bodies, large blocks of 5-spots are the planned producing pattern (see Figure ADD2-4). The simulation was run using a block 5-spot pattern that was

5 X 4 in dimension and utilized 20 producing wells. A ground water gradient of 0.042 ft/ft was used in the model. This is conservative compared to the current potentiometric surface map that shows a gradient of 0.0024 ft/ft. The potentiometric surface slopes to the southwest.

The ground water gradient in this area is high enough to distort the flowpaths resulting in lixiviant migration in the downgradient direction. To compensate for the hydrologic gradient, the lixiviant injection was shifted by increasing the injection rates in upgradient wells and decreasing the injection rates in downgradient wells. The combined bleed for the simulated patterns remained constant at 1%. Once the rates were adjusted, the Injection Mode Production Plot (Figure ADD2-4) shows slightly increased lixiviant flare at the ends of the block 5-spot rows but all of the pathlines are captured. The Extraction Mode Production Plot (Figure ADD2-5) shows ground water migration into the pattern area from distances of approximately 150 feet upgradient along 7 pathlines, and along one pathline downgradient. Since each pathline represents 5% of the flow into a producer, and there are 20 production wells producing at a rate of 13.0 gpm, the dilution is 2.0 %. Since there are no previously mined areas upgradient from Mine Unit No. 2, the migration of ground water into the pattern area is not a concern. The GWS pattern that resulted in the most complete coverage of the block 5-spot pattern is shown on the Ground Water Sweep Plot (Figure ADD2-6). Approximately ten various ground water sweep patterns were simulated, and this pattern resulted in the smallest volume of ground water production to completely sweep the block 5-spot area.

Mine Unit No. 3 South Area - The South Area of Mine Unit No. 3 is located south of the Atlas Mine underground workings. These underground mine workings are located approximately 300 feet northeast of Wellfield 3 in Mine Unit No. 3 South Area (see Figure OP 5-3). The model hydraulic gradient is very flat at 0.0013 ft/ft. (Revised potentiometric surface interpretation indicates that this area may be more similar to the Mine Unit No. 3 North Area as the current map shows a gradient of 0.01 ft/ft rather than the modeled value of 0.0013 ft/ft.) The ground water is flowing north and the ore is trending from the southwest to the northeast. Therefore, the ground water is flowing at an angle of approximately 45° to the block 5-spot pattern in this area.

To assure that the flowpaths of lixiviant did not travel toward the Atlas mine underground workings, the downgradient injection well rates were decreased by approximately 15% and the upgradient injection well rates were increased by approximately 15%. This kept the bleed constant at 1%. The Injection Mode Production Plot (Figure ADD2-7) shows less than approximately 80 feet of lixiviant flare toward the Atlas mine on the northeast side of the plot. The Extraction Mode Production Plot (Figure ADD2-8) shows less than 120 feet of sweep of ground water into the pattern area during the three years of production. The Ground Water Sweep Plot (Figure ADD2-9) shows sweep into the pattern area from approximately 160 feet to the northeast. This is approximately half the distance to the Atlas mine from the northern extent of the Mine Unit No. 3 South Area wellfields.

Mine Unit No. 3 North Area - The Mine Unit No. 3 North Area is located north of the Atlas Mine workings (see Figure OP 5-3). The underground workings are located approximately 300 feet southeast of Wellfields 4 and 5 in the Mine Unit No. 3 North Area, while the Pathfinder Mines Corp. (PMC) reclaimed pit area is located approximately 1000 feet northeast of Wellfields 9 and 10 in Mine Unit No. 3 North Area. The hydraulic gradient used in the model is 0.029 ft/ft which is conservatively higher than the currently measured gradient of 0.01 ft/ft. The ground water velocity is 62 ft/yr. The ground water is flowing to the northeast and the ore is trending from the southwest to the northeast. Therefore, the ground water is flowing at an angle of approximately 90° to the block 5-spot pattern in this area.

To assure that the flowpaths of lixiviant did not travel toward the underground workings or the PMC reclaimed area, the downgradient injection well rates were decreased by approximately 25% and the upgradient injection well rates were increased by approximately 25%. This kept the bleed constant at 1%. The Injection Mode Production Plot (Figure ADD2-10) shows less than approximately 50 feet of lixiviant flare toward the Atlas or the PMC mine areas located southeast and northeast of the pattern area respectively. The Extraction Mode Production Plot (Figure ADD2-11) shows approximately 160 feet of ground water sweep into the pattern area from the southwest and approximately 100 feet of sweep from the northeast during the three years of production. These distances appear to be adequate to prevent high TDS ground water from the Atlas mine underground workings or the PMC reclaimed area from being drawn into the pattern area. The Ground Water Sweep Plot (Figure ADD2-12) shows sweep into the pattern area from approximately 80 feet to the southwest and approximately 120 feet to the northeast. These distances appear to be adequate to prevent drawing high TDS ground water from the historic mine areas into the ISL pattern area during the ground water sweep phase of restoration.

Mine Unit No. 4 - The Buss Pit is located north, northeast and east of portions of Mine Unit No. 4. At its nearest point, the Buss Pit is approximately 1000 feet north of Mine Unit No. 4. The ground water flows southwest at a gradient of 0.025 ft/ft in this area. Based on the shape of the ore bodies, the planned production pattern is block 5-spots and a bleed of 1% is planned for this area. A gradient of 0.054 was used in the model. The ground water flow in this area is strong enough to distort the pathlines, indicating potential lixiviant migration towards the Buss Pit. Once the injection rates have been adjusted, the Injection Mode Production Plot (Figure ADD2-13) shows no migration of lixiviant toward the Buss Pit towards the north. Additionally, the Extraction Mode Production Plot (Figure ADD2-14) shows only 1.5% dilution, all of which sweeps into the patterns from the south and southwest. Therefore, migration to or from the Buss Pit appears to be controlled by adjusting the injection rates. The Ground Water Sweep Plot (Figure ADD2-15) shows approximately 100 feet of sweep from the northeast which appears to be adequate to prevent migration of high TDS ground water from the Buss Pit toward Mine Unit No. 4 area during ground water restoration.

In most of the modeled cases, a model gradient higher than the gradient calculated from the revised potentiometric surface map has been utilized. Under operating conditions, as gradients increase, it becomes increasingly more difficult to control excessive flare or sweep by adjusting the injection rates of upgradient and/or downgradient wells. The "worst case" scenario has been modeled. The models show that sweep and flare can be adequately controlled near high TDS waters, even under higher than anticipated gradients.

For permitting purposes, the models are utilized as a planning tool. Following hydrologic testing of each mine unit, the models will be rerun utilizing the actual pattern configurations and more accurate gradients for the mine units established from the water level data obtained from the monitor well rings.

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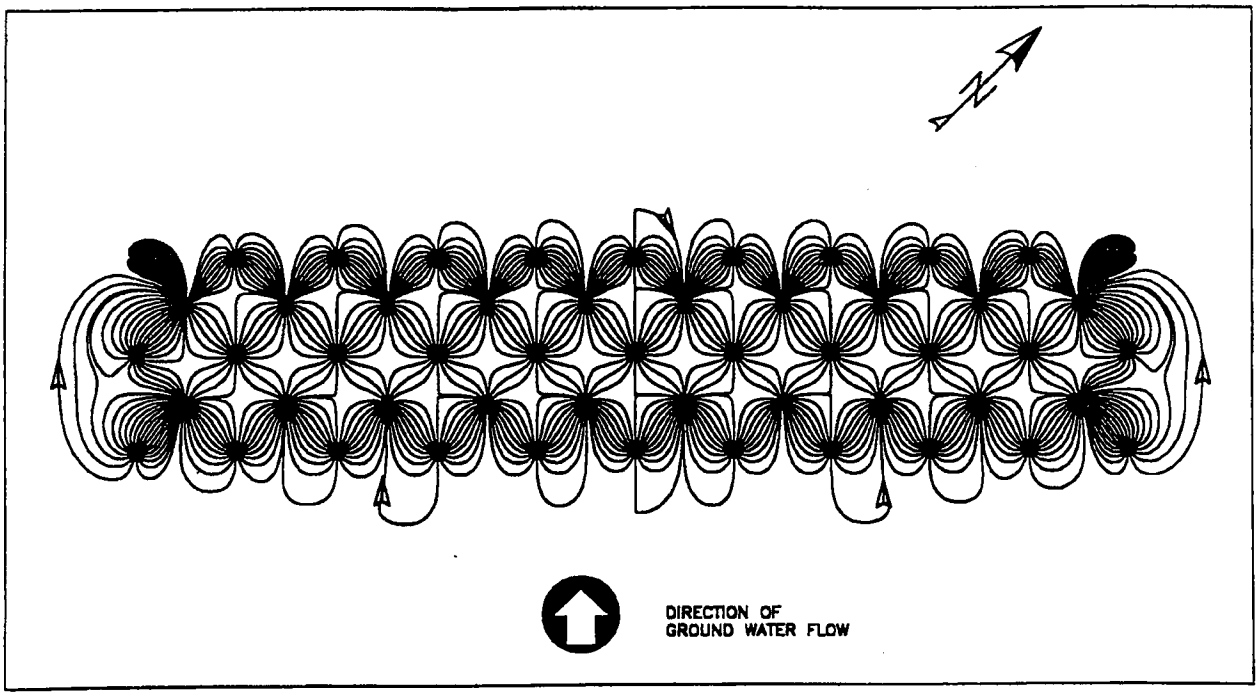
MINE UNIT #1 – GAS HILLS PROJECT

1000 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Injection Well
Each Pathline Represents 5% of the Flow
DAYS: 933.0 Mgal/PV: 12.032
TOTAL EXTRACTION: 537.429 Mgal TOTAL INJECTION: 530.979 Mgal

Approximate Scale: 1/2" = 80'



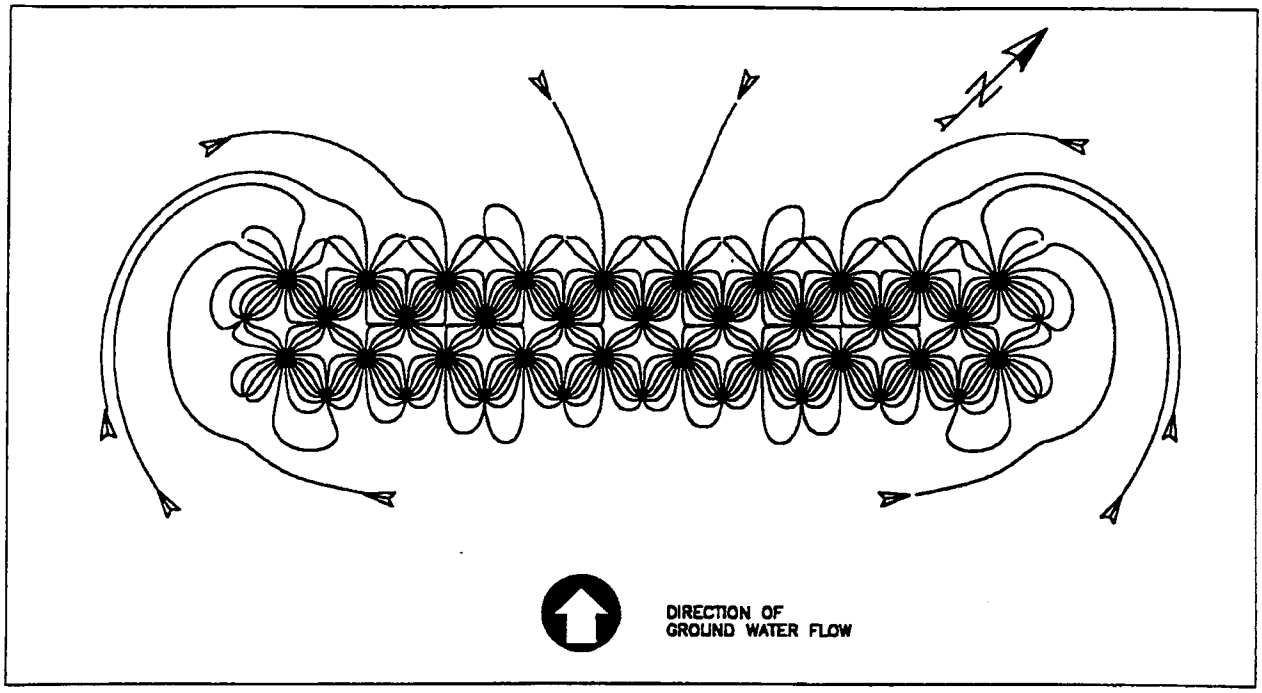
INJECTION MODE PRODUCTION PLOT
MINE UNIT #1

FIGURE ADD2-1

MINE UNIT #1 – GAS HILLS PROJECT

1000 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 25.386
TOTAL EXTRACTION: 630.720 Mgal TOTAL INJECTION: 623.151 Mgal

Approximate Scale: 1/2" = 80'



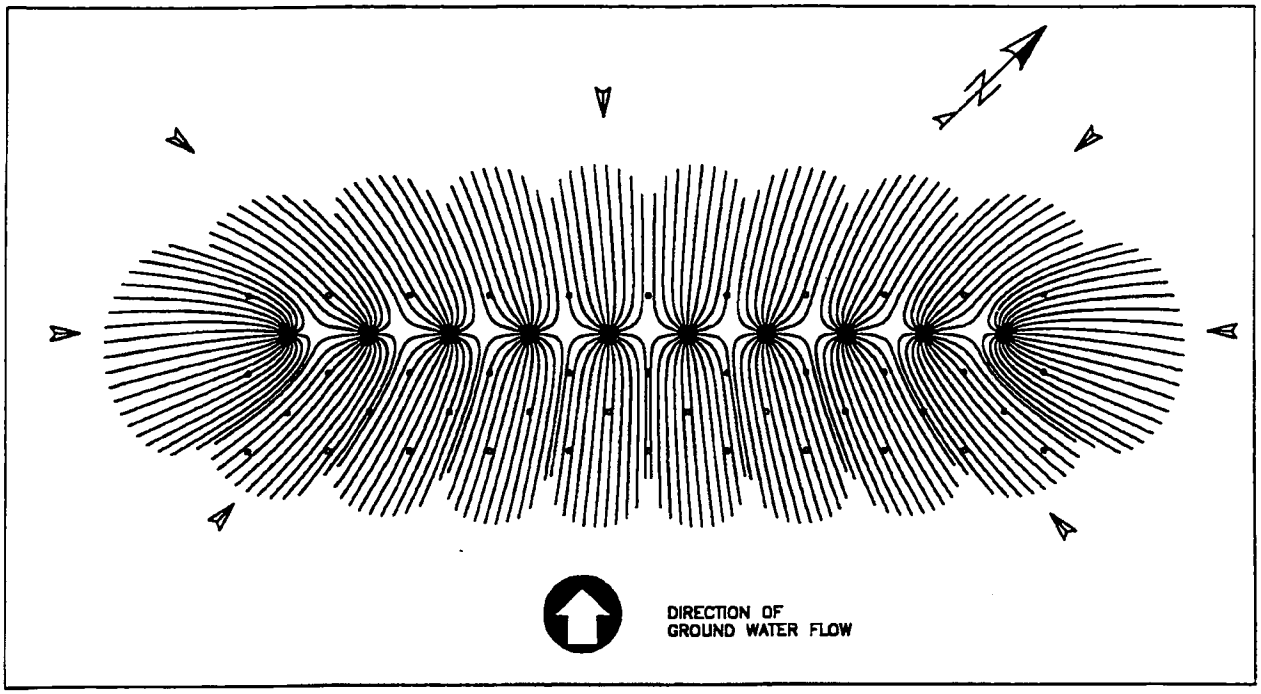
EXTRACTION MODE PRODUCTION PLOT
MINE UNIT #1

FIGURE ADD2-2

MINE UNIT #1 – GAS HILLS PROJECT

1000 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 90.0 Mgal/PV: 12.960
TOTAL EXTRACTION: 12.960 Mgal TOTAL INJECTION: 0.000 Mgal

Approximate Scale: 1/2" = 80'



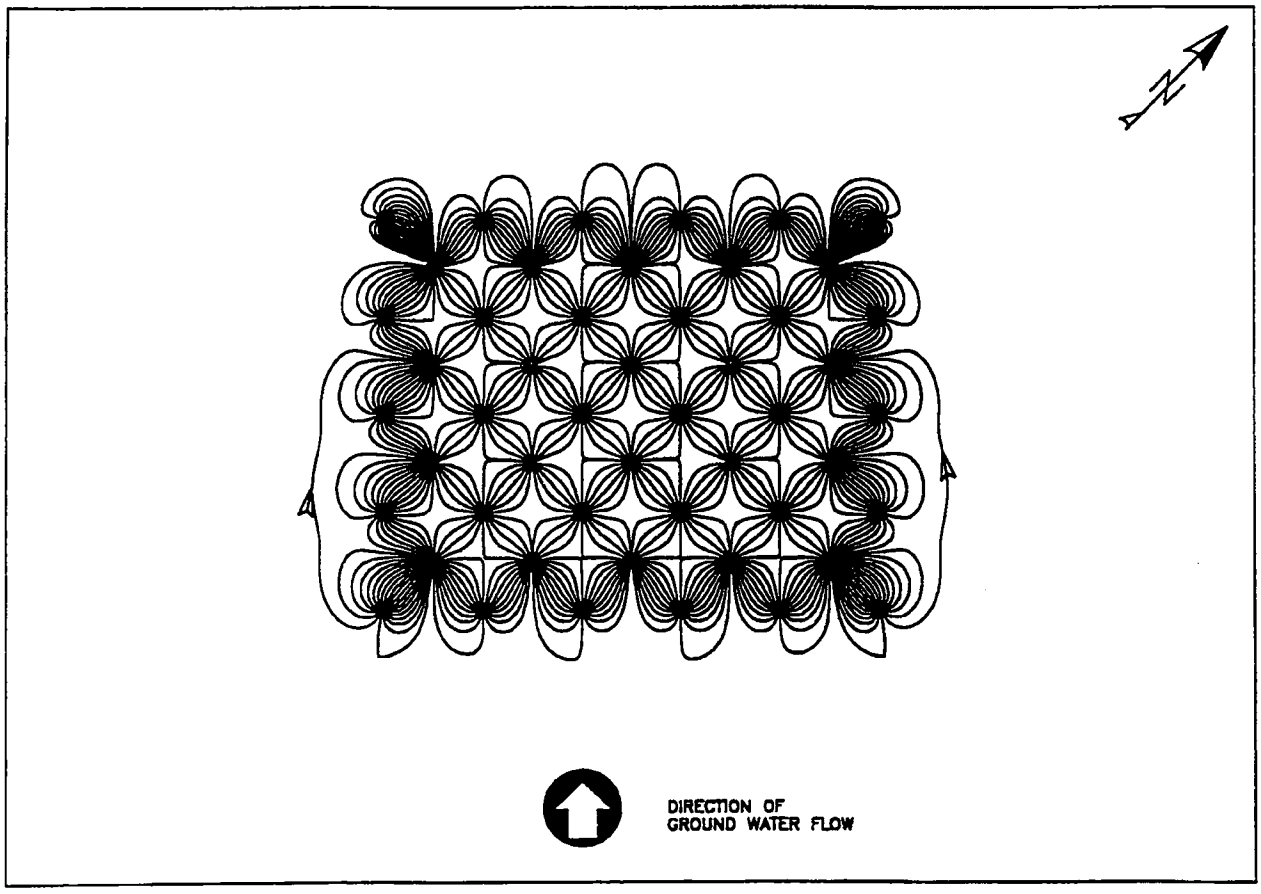
GROUND WATER SWEEP PLOT
MINE UNIT #1

FIGURE ADD2-3

MINE UNIT #2 – GAS HILLS PROJECT

400 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Injection Well
Each Pathline Represents 5% of the Flow
DAYS: 974.0 Mgal/PV: 9.419
TOTAL EXTRACTION: 364.661 Mgal TOTAL INJECTION: 360.972 Mgal

Approximate Scale: 1/2" = 80'



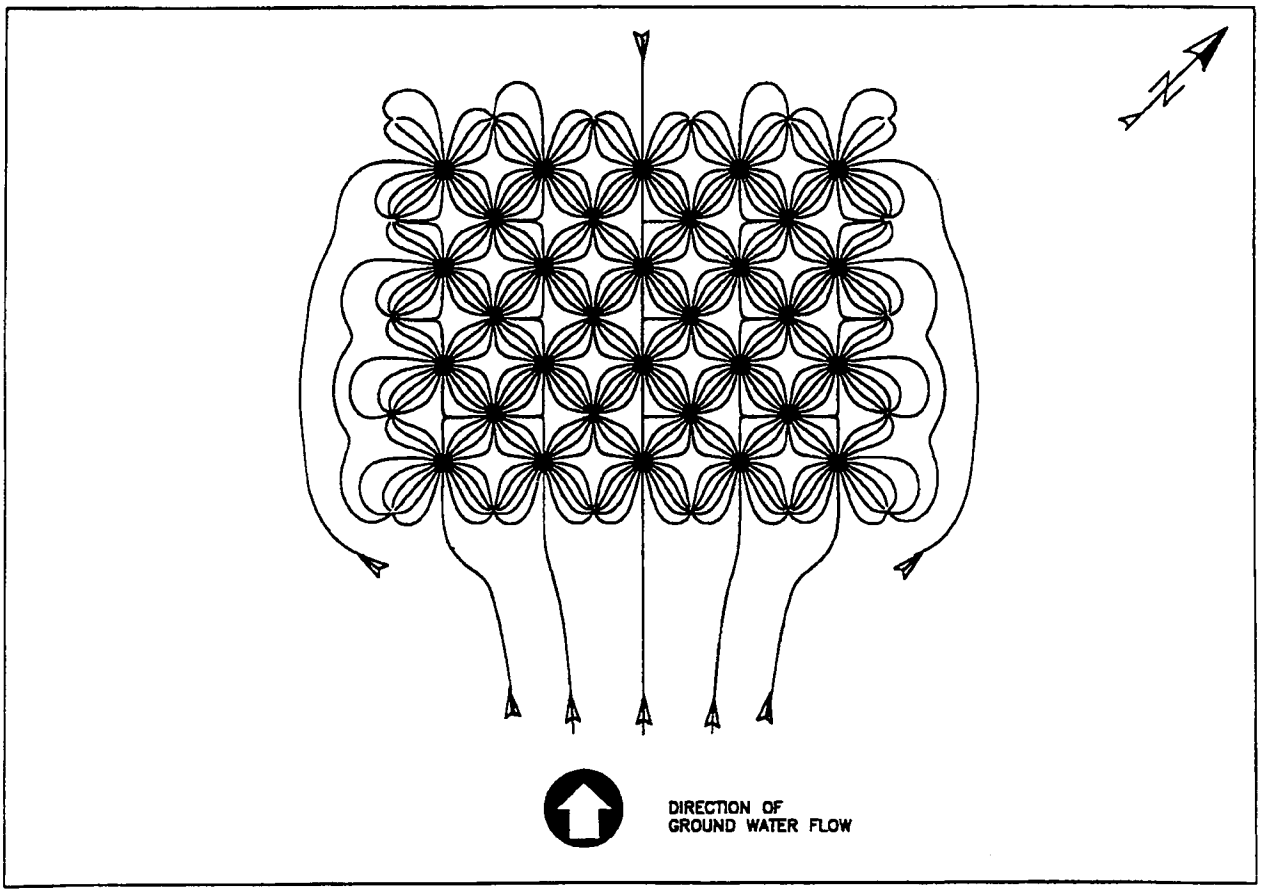
INJECTION MODE PRODUCTION PLOT
MINE UNIT #2

FIGURE ADD2-4

MINE UNIT #2 – GAS HILLS PROJECT

400 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 16.796
TOTAL EXTRACTION: 409.968 Mgal TOTAL INJECTION: 405.821 Mgal

Approximate Scale: 1/2" = 80'



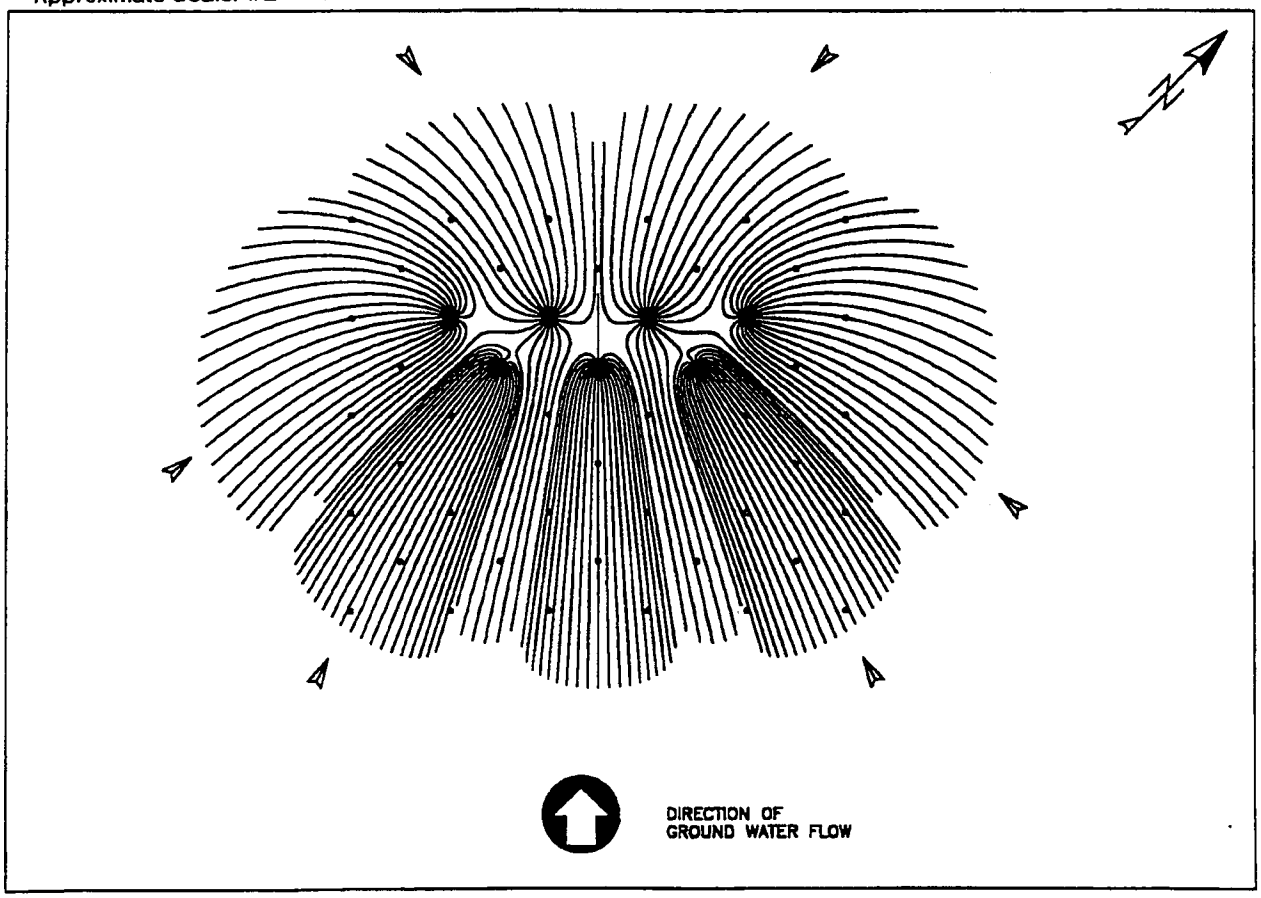
EXTRACTION MODE PRODUCTION PLOT
MINE UNIT #2

FIGURE ADD2-5

MINE UNIT #2 – GAS HILLS PROJECT

400 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 364.0 Mgal/PV: 9.435
TOTAL EXTRACTION: 9.435 Mgal TOTAL INJECTION: 0.000 Mgal

Approximate Scale: 1/2" = 80'



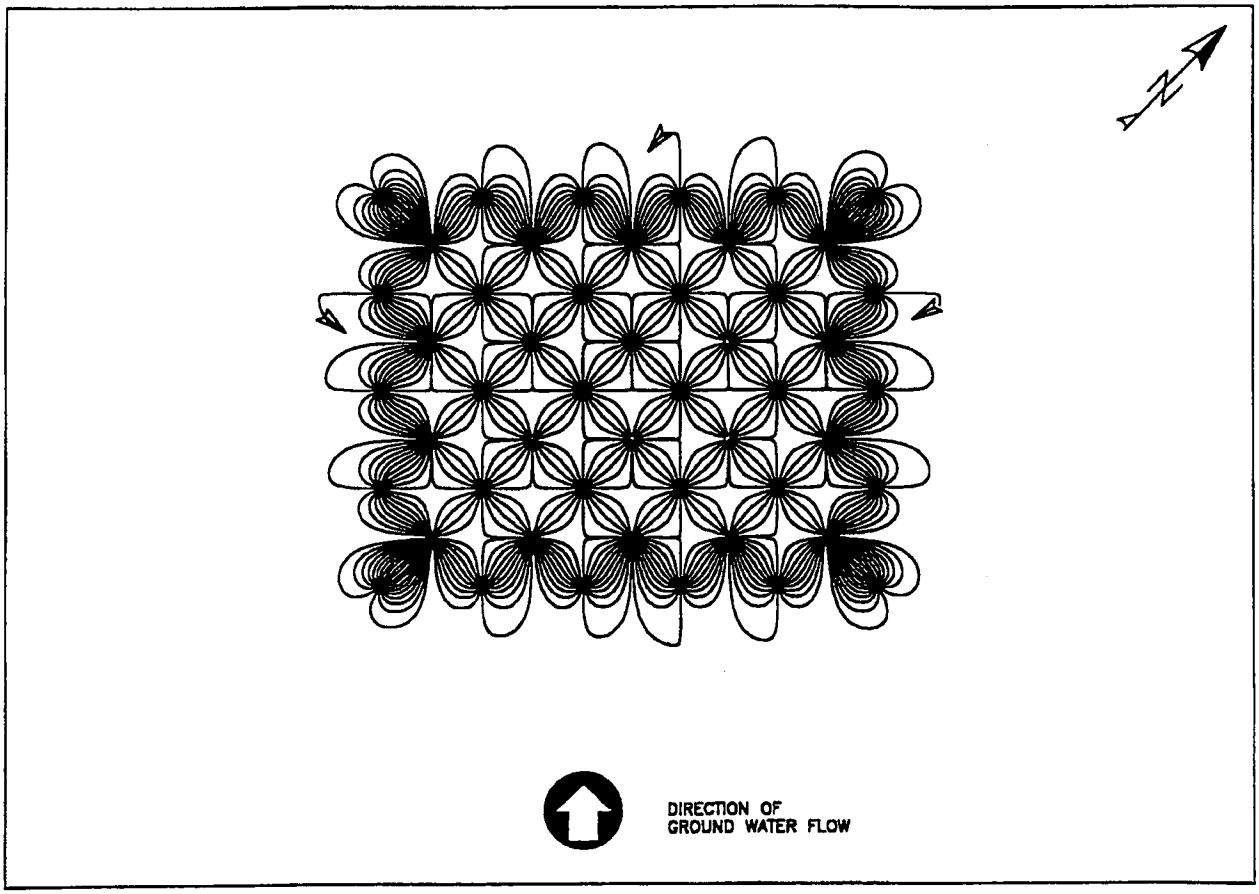
GROUND WATER SWEEP PLOT
MINE UNIT #2

FIGURE ADD2-6

MINE UNIT #3 (SOUTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 3 Ft/Yr Ground Water Velocity
20 Pathlines per Injection Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 11.001
TOTAL EXTRACTION: 346.896 Mgal TOTAL INJECTION: 343.427 Mgal

Approximate Scale: 1/2" = 80'



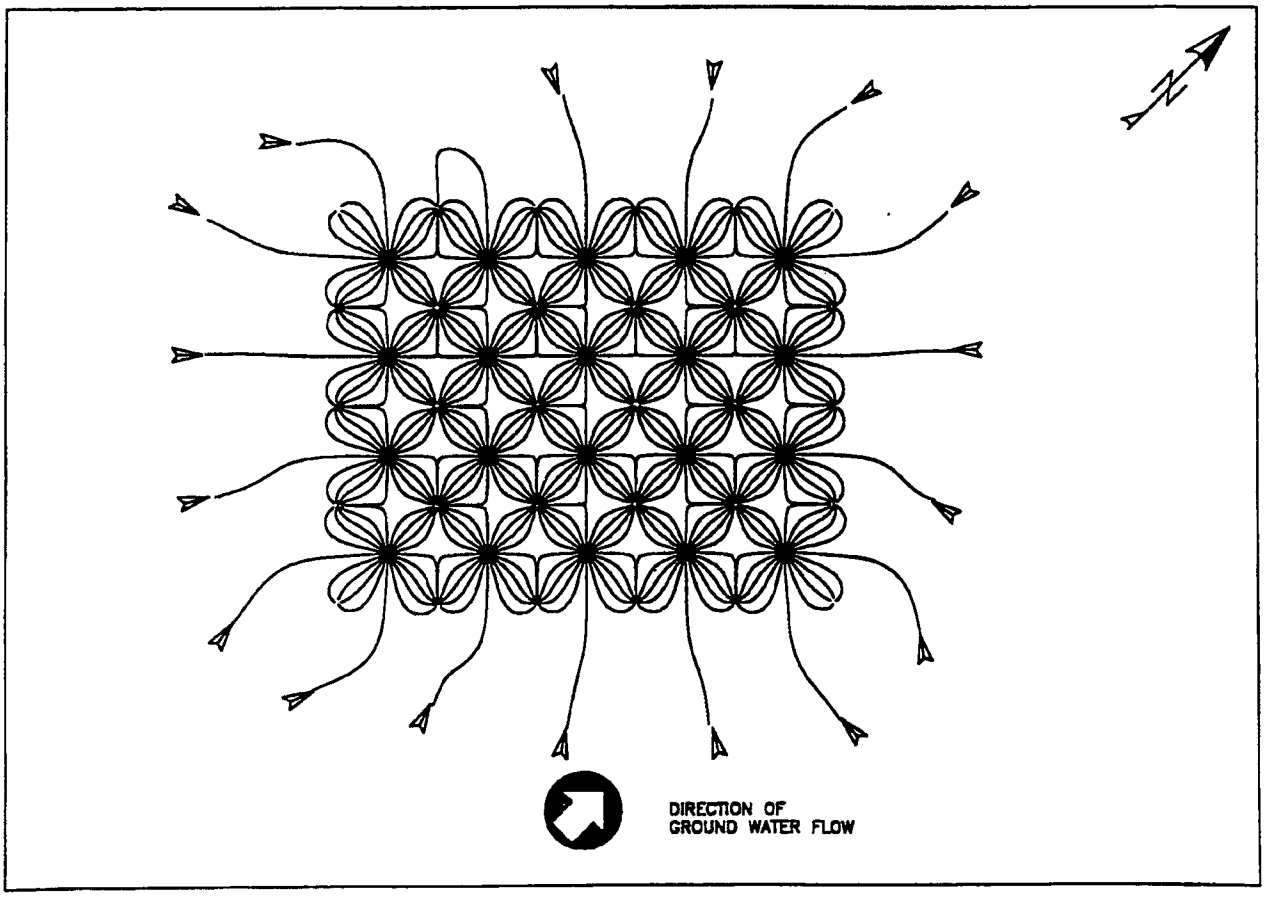
INJECTION MODE PRODUCTION PLOT
MINE UNIT #3 (SOUTH AREA)

FIGURE ADD2-7

MINE UNIT #3 (SOUTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 3 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 21.872
TOTAL EXTRACTION: 346.896 Mgal TOTAL INJECTION: 343.427 Mgal

Approximate Scale: 1/2" = 80'



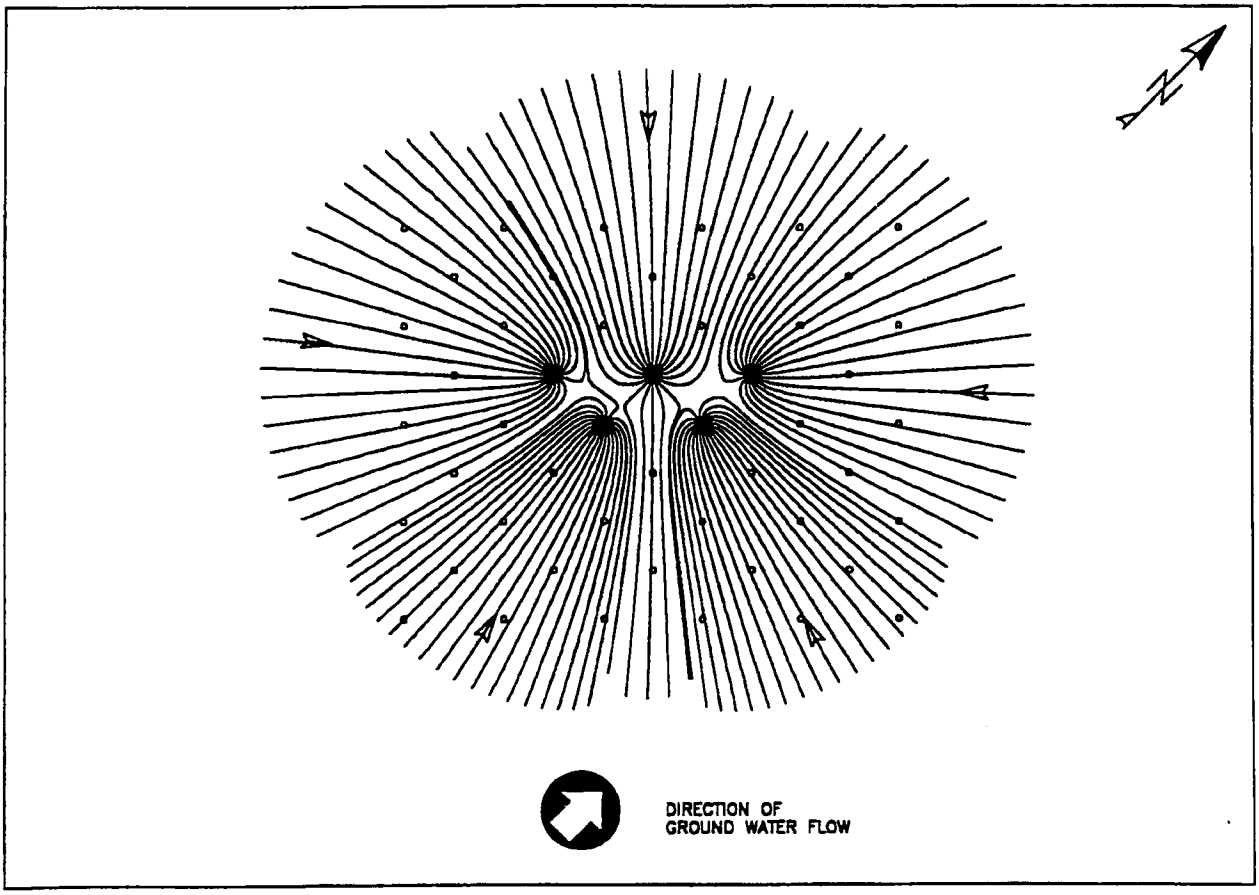
EXTRACTION MODE PRODUCTION PLOT
MINE UNIT #3 (SOUTH AREA)

FIGURE ADD2-8

MINE UNIT #3 (SOUTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 3 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 546.0 Mgal/PV: 11.794
TOTAL EXTRACTION: 11.794 Mgal TOTAL INJECTION: 0.000 Mgal

Approximate Scale: 1/2" = 80'



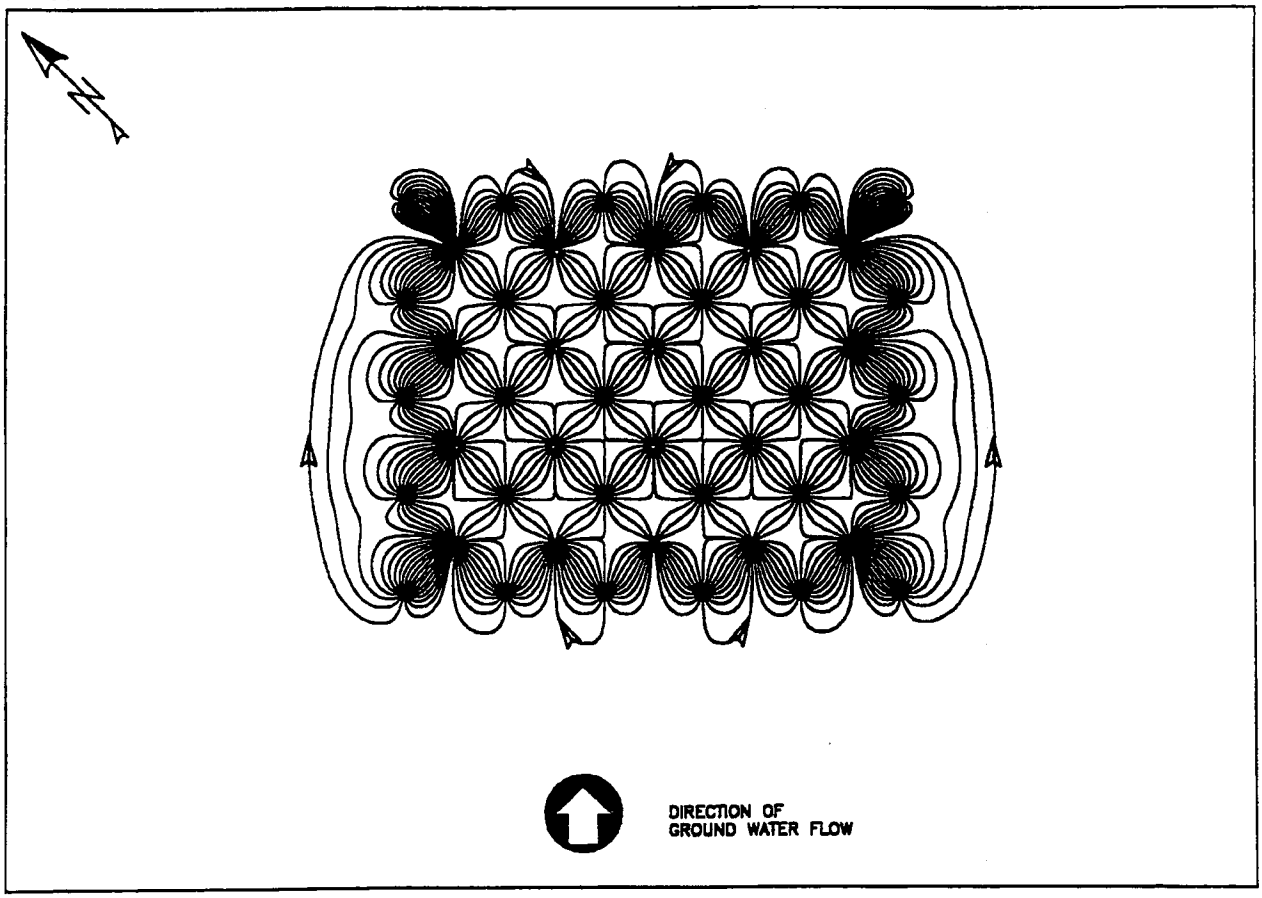
GROUND WATER SWEEP PLOT
MINE UNIT #3 (SOUTH AREA)

FIGURE ADD2-9

MINE UNIT #3 (NORTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Injection Well
Each Pathline Represents 5% of the Flow
DAYS: 1036.3 Mgal/PV: 9.166
TOTAL EXTRACTION: 328.294 Mgal TOTAL INJECTION: 325.056 Mgal

Approximate Scale: 1/2" = 80'



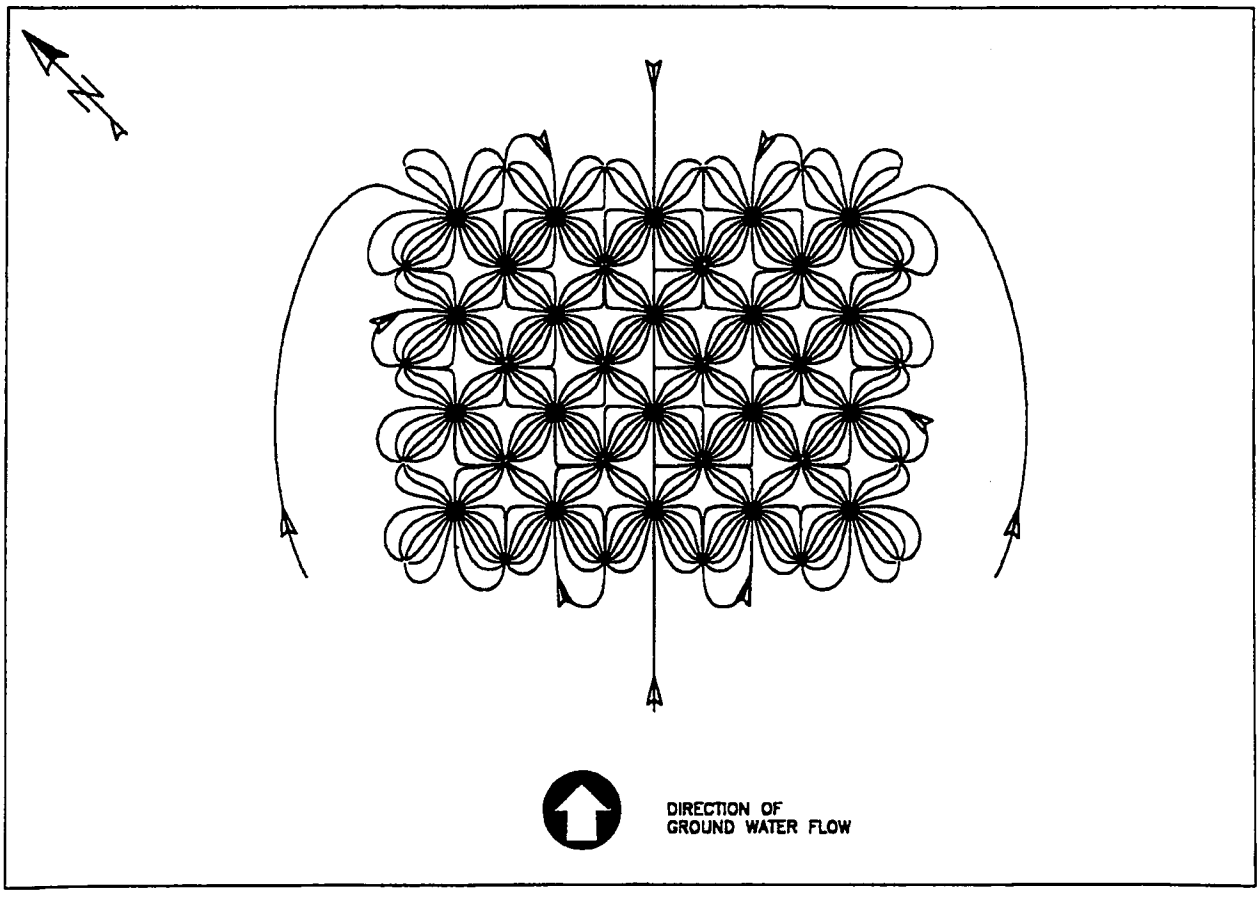
INJECTION MODE PRODUCTION PLOT
MINE UNIT #3 (NORTH AREA)

FIGURE ADD2-10

MINE UNIT #3 (NORTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 11.385
TOTAL EXTRACTION: 346.896 Mgal TOTAL INJECTION: 343.474 Mgal

Approximate Scale: 1/2" = 80'



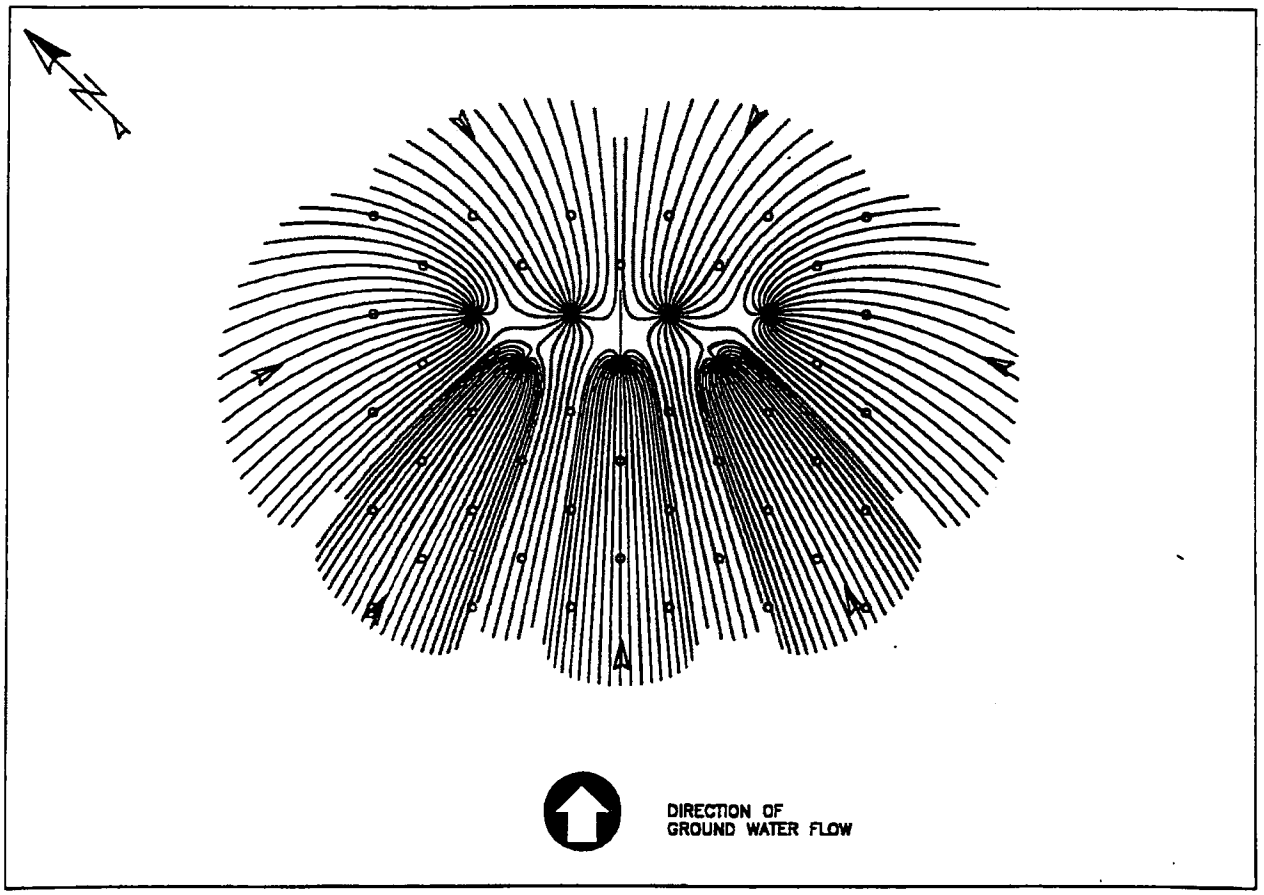
EXTRACTION MODE PRODUCTION PLOT
MINE UNIT #3 (NORTH AREA)

FIGURE ADD2-11

MINE UNIT #3 (NORTH AREA) – GAS HILLS PROJECT

600 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 364.0 Mgal/PV: 9.435
TOTAL EXTRACTION: 9.435 Mgal TOTAL INJECTION: 0.000 Mgal

Approximate Scale: 1/2" = 80'



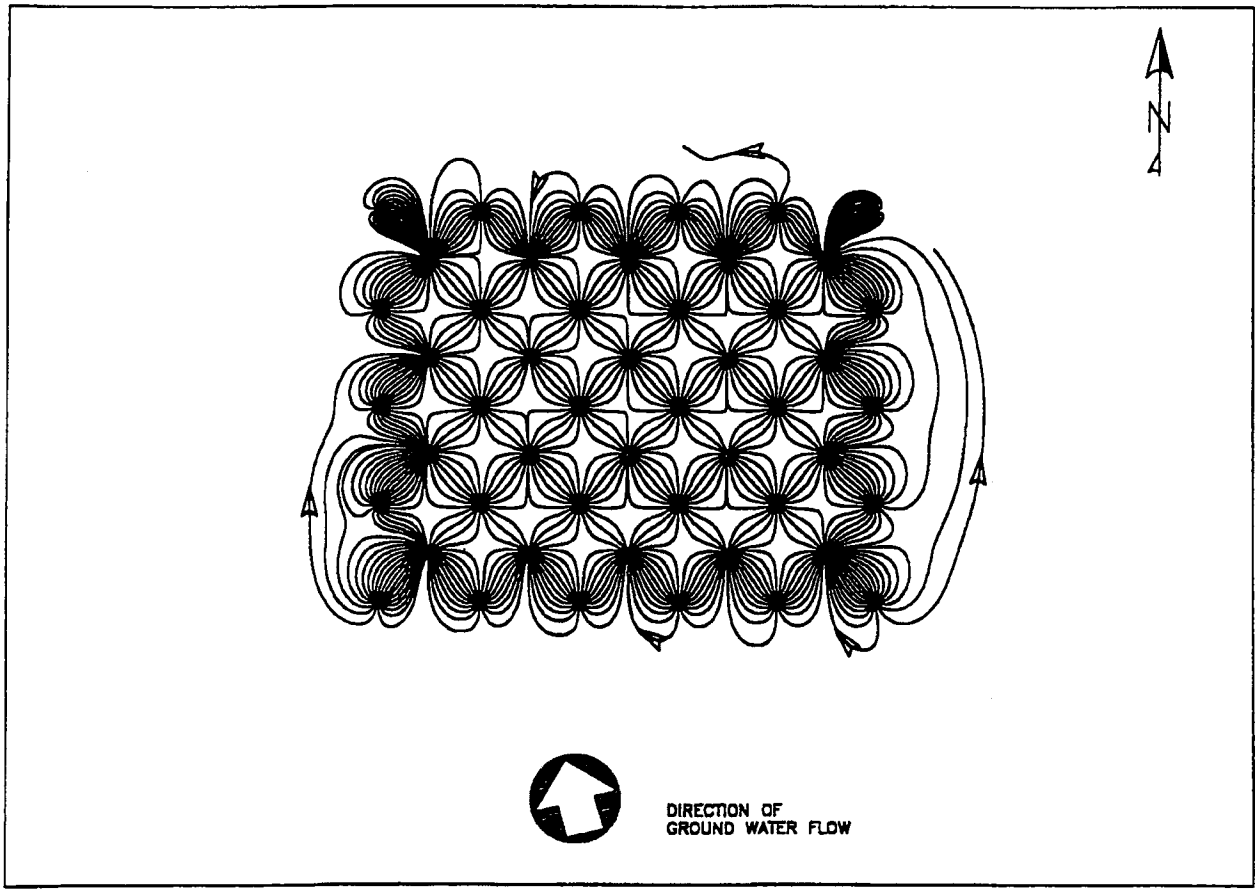
GROUND WATER SWEEP PLOT
MINE UNIT #3 (NORTH AREA)

FIGURE ADD2-12

MINE UNIT #4 – GAS HILLS PROJECT

300 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Injection Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 8.606
TOTAL EXTRACTION: 283.824 Mgal TOTAL INJECTION: 280.907 Mgal

Approximate Scale: 1/2" = 80'



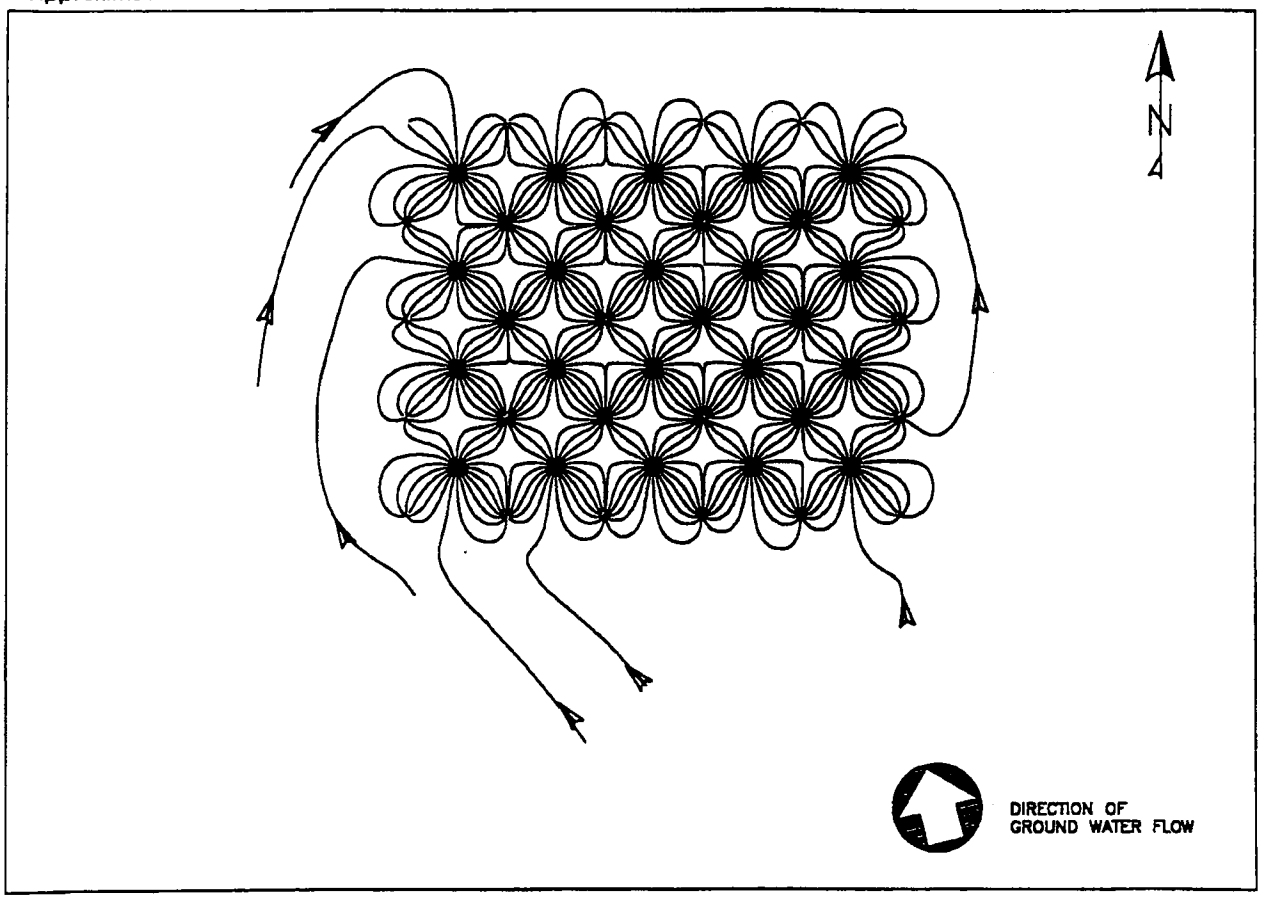
INJECTION MODE PRODUCTION PLOT
MINE UNIT #4

FIGURE ADD2-13

MINE UNIT #4 – GAS HILLS PROJECT

300 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 1095.0 Mgal/PV: 11.576
TOTAL EXTRACTION: 283.824 Mgal TOTAL INJECTION: 280.907 Mgal

Approximate Scale: 1/2" = 80'



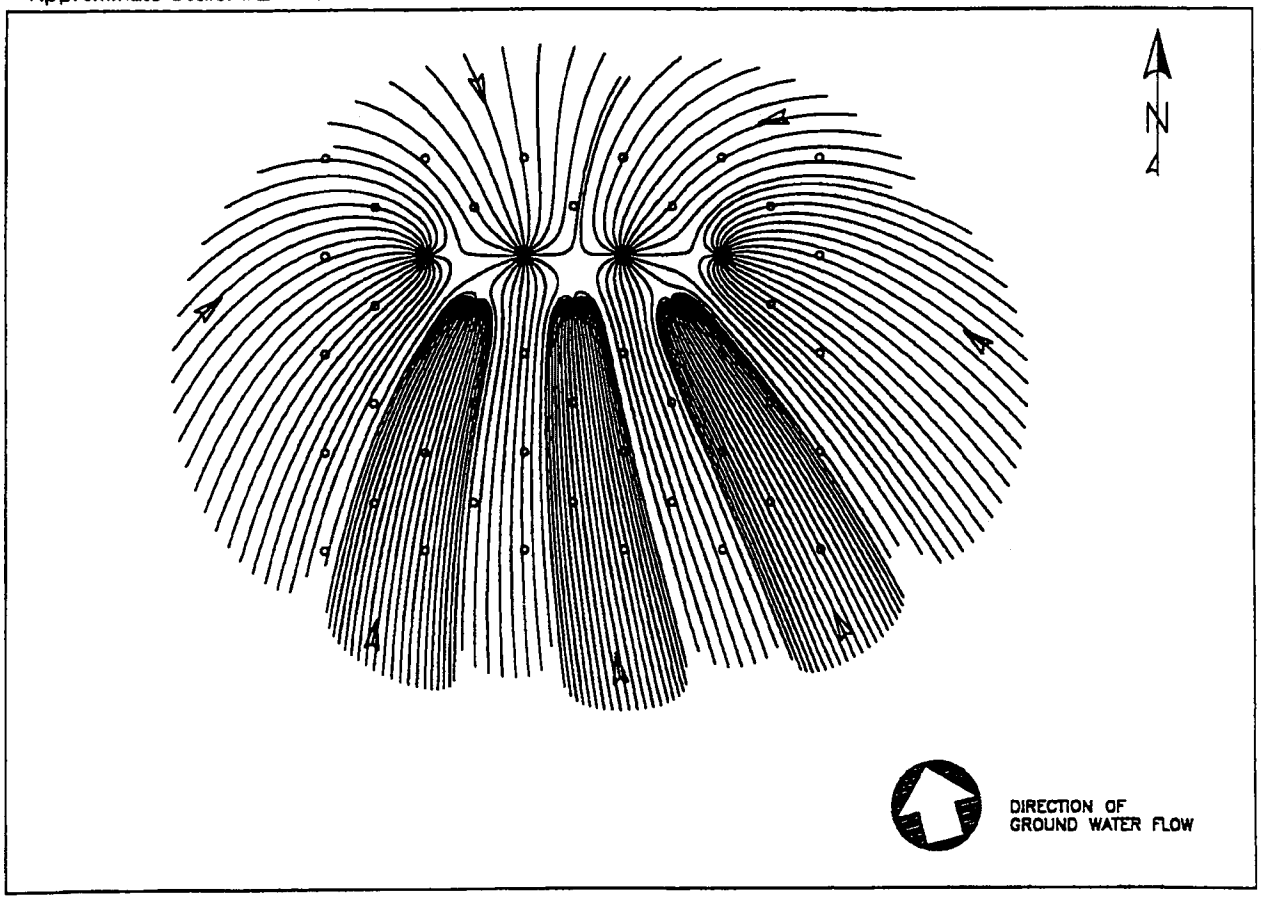
EXTRACTION MODE PRODUCTION PLOT
MINE UNIT #4

FIGURE ADD2-14

MINE UNIT #4 – GAS HILLS PROJECT

300 MD Permeability: 62 Ft/Yr Ground Water Velocity
20 Pathlines per Extraction Well
Each Pathline Represents 5% of the Flow
DAYS: 728.0 Mgal/PV: 11.531
TOTAL EXTRACTION: 11.532 Mgal TOTAL INJECTION: 0.000 Mgal

Approximate Scale: 1/2" = 80'



GROUND WATER SWEEP PLOT
MINE UNIT #4

FIGURE ADD2-15

TABLE ADD 2-1
FLOW RATE ESTIMATES
PATH 5.0 MODEL RESULTS
GAS HILLS PROJECT

	Mine Unit #1	Mine Unit #2	Mine Unit #3 North	Mine Unit #3 South	Mine Unit #4
Depth to SWL (ft)	265	230	250	415	150
SWL to Ore (ft)	180	120	60	187	100
Surface Injection Pressure (psia)	74	58	52	101	42
Delta P - Inj. (ft)	436	365	370	647	246
Delta P - Prod. (ft)	180	120	60	187	100
Permeability (md)	1000	400	600	600	300
Single Row 5-spot Rate (gpm)[1]	41.0	13.0	10.0	28.0	7.5
Double Row 5-spot Rate (gpm)[1]	20.0	7.0	10.0	19.0	4.0
Double Row 5-spot Max Rate (gpm)[2]	20.0 Ei=20% Ep=45%	13.0 Ei=32% Ep=90%	11.0 Ei=20% Ep=100%	19.0 Ei=20% Ep=70%	9.0 Ei=40% Ep=100%
Groundwater Sweep Max Rate (gpm) at one month	12.0	3.5	3.0	8.0	2.0
Groundwater Sweep Max Rate (gpm) at one year	10.0	2.5	2.0	6.0	1.8
RO Max Rate (gpm) at one year [3]	20.0	6.0	4.5	13.0	4.0

Ei - Injection Efficiency
Ep - Production Efficiency
1 - Ei = 20%, Ep = 85%, Bleed = 1%
2 - Bleed = 1%
3 - Bleed = 10%

TABLE ADD 2-2
SUMMARY OF GROUND WATER FLOWPATH SIMULATION
GAS HILLS PROJECT

Simulation Area	Mine Unit #1	Mine Unit #2	Mine Unit #3 South	Mine Unit #3 North	Mine Unit #4
Permeability (md)	1000	400	600	600	300
Hydraulic Gradient (ft/ft)	0.017	0.042	0.0013	0.029	0.054
Ground Water Velocity (ft/yr)	62	62	3	62	62
Direction of Ground Water Flow	Northwest	Northwest	North	Northeast	North to Northwest
Well Pattern and Orientation	Double-Row 5-Spot at 90°	Block 5-Spot at 90°	Block 5-Spot at 45°	Block 5-Spot at 90°	Block 5-Spot at 30°
Max. Design Rate (gpm)	20	13	19	11	9
Contacted Volume using Adjusted Rates (Mgal)	12.032	9.419	11.001	9.166	8.606
Max Ground Water Sweep Rate (gpm)	10	3	7	3	2
Ground Water Sweep Volume (Mgal)	12.960	9.435	11.794	9.435	11.531

Mgal = million gallons

TABLE ADD2-3
PRODUCTION UNIT #1
FORMATION CHARACTERISTICS AND
PROGRAM CALCULATION CONSTRAINTS

Description	Value
Average Permeability (md)	1000.0
Formation Thickness (feet)	20.0
Porosity (fraction)	0.270
Total Compressibility (vol/vol/psi)	0.00002800
Viscosity (cp)	1.000
Transmissivity (gpd/ft)	410
Storage Coefficient (dimensionless)	0.000066
Efficiency of INJECTION Well (frac.)	0.200
Efficiency of EXTRACTION Well (frac.)	0.850
Groundwater Velocity (ft/yr)	62.0
Angle of Groundwater Movement (degrees)	90.0
Maximum Time Between Calculation (hours)	12.0
Max Dist Betw Calc (feet) [MUST <= Cap Dist]	2.0
Dist. from Well for Streamline Capture (feet)	2.0

TABLE ADD2-4
PRODUCTION UNIT #1
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
1	i1			-6.60	11.000
2	i2	80.0		-13.60	11.000
3	i3	160.0		-13.60	11.000
4	i4	240.0		-13.60	11.000
5	i5	320.0		-13.60	11.000
6	i6	400.0		-12.40	11.000
7	i7	480.0		-13.60	11.000
8	i8	560.0		-13.60	11.000
9	i9	640.0		-13.60	11.000
10	i10	720.0		-13.60	11.000
11	i11	800.0		-6.60	11.000
12	e12	40.0	40.0	20.00	11.000
13	e13	120.0	40.0	20.00	11.000
14	e14	200.0	40.0	20.00	11.000
15	e15	280.0	40.0	20.00	11.000
16	e16	360.0	40.0	20.00	11.000
17	e17	440.0	40.0	20.00	11.000
18	e18	520.0	40.0	20.00	11.000
19	e19	600.0	40.0	20.00	11.000
20	e20	680.0	40.0	20.00	11.000
21	e21	760.0	40.0	20.00	11.000
22	i22		80.0	-9.90	11.000
23	i23	80.0	80.0	-21.50	11.000
24	i24	160.0	80.0	-21.50	11.000
25	i25	240.0	80.0	-21.50	11.000
26	i26	320.0	80.0	-21.50	11.000
27	i27	400.0	80.0	-21.50	11.000
28	i28	480.0	80.0	-21.50	11.000
29	i29	560.0	80.0	-21.50	11.000
30	i30	640.0	80.0	-21.50	11.000
31	i31	720.0	80.0	-21.50	11.000
32	i32	800.0	80.0	-9.90	11.000
33	e33	40.0	120.0	20.00	11.000
34	e34	120.0	120.0	20.00	11.000
35	e35	200.0	120.0	20.00	11.000
36	e36	280.0	120.0	20.00	11.000
37	e37	360.0	120.0	20.00	11.000
38	e38	440.0	120.0	20.00	11.000

TABLE ADD2-4 (cont'd)
PRODUCITON UNIT #1
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
39	e39	520.0	120.0	20.00	11.000
40	e40	600.0	120.0	20.00	11.000
41	e41	680.0	120.0	20.00	11.000
42	e42	760.0	120.0	20.00	11.000
43	i43		160.0	-2.00	11.000
44	i44	80.0	160.0	-4.70	11.000
45	i45	160.0	160.0	-5.00	11.000
46	i46	240.0	160.0	-5.00	11.000
47	i47	320.0	160.0	-4.80	11.000
48	i48	400.0	160.0	-4.80	11.000
49	i49	480.0	160.0	-4.80	11.000
50	i50	560.0	160.0	-5.00	11.000
51	i51	640.0	160.0	-5.00	11.000
52	i52	720.0	160.0	-4.70	11.000
53	i53	800.0	160.0	-2.00	11.000

TABLE ADD2-5
PRODUCTION UNIT #2
Formation Characteristics
and
Program Calculation Constraints

Description	Value
Average Permeability (md)	400.0
Formation Thickness (feet)	20.0
Porosity (fraction)	0.270
Total Compressibility (vol/vol/psi)	0.00002800
Viscosity (cp)	1.000
Transmissivity (gpd/ft)	164
Storage Coefficient (dimensionless)	0.000066
Efficiency of INJECTION Well (frac.)	0.320
Efficiency of EXTRACTION Well (frac.)	0.900
Groundwater Velocity (ft/yr)	62.0
Angle of Groundwater Movement (degrees)	90.0
Maximum Time Between Calculation (hours)	12.0
Max Dist Betw Calc (feet) [MUST <= Cap Dist]	2.0
Dist. from Well for Streamline Capture (feet)	2.0

TABLE ADD2-6
PRODUCTION UNIT #2
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
1	i1			-4.22	11.000
2	i2	80.0		-7.43	11.000
3	i3	160.0		-7.43	11.000
4	i4	240.0		-7.43	11.000
5	i5	320.0		-7.43	11.000
6	i6	400.0		-4.22	11.000
7	e7	40.0	40.0	13.00	11.000
8	e8	120.0	40.0	13.00	11.000
9	e9	200.0	40.0	13.00	11.000
10	e10	280.0	40.0	13.00	11.000
11	e11	360.0	40.0	13.00	11.000
12	i12		80.0	-6.43	11.000
13	i13	80.0	80.0	-12.87	11.000
14	i14	160.0	80.0	-12.87	11.000
15	i15	240.0	80.0	-12.87	11.000
16	i16	320.0	80.0	-12.87	11.000
17	i17	400.0	80.0	-6.43	11.000
18	e18	40.0	120.0	13.00	11.000
19	e19	120.0	120.0	13.00	11.000
20	e20	200.0	120.0	13.00	11.000
21	e21	280.0	120.0	13.00	11.000
22	e22	360.0	120.0	13.00	11.000
23	i23		160.0	-6.43	11.000
24	i24	80.0	160.0	-12.87	11.000
25	i25	160.0	160.0	-12.87	11.000
26	i26	240.0	160.0	-12.87	11.000
27	i27	320.0	160.0	-12.87	11.000
28	i28	400.0	160.0	-6.43	11.000
29	e29	40.0	200.0	13.00	11.000
30	e30	120.0	200.0	13.00	11.000
31	e31	200.0	200.0	13.00	11.000
32	e32	280.0	200.0	13.00	11.000
33	e33	360.0	200.0	13.00	11.000
34	i34		240.0	-6.43	11.000
35	i35	80.0	240.0	-12.87	11.000
36	i36	160.0	240.0	-12.87	11.000
37	i37	240.0	240.0	-12.87	11.000
38	i38	320.0	240.0	-12.87	11.000

TABLE ADD2-6 (cont'd)
PRODUCTION UNIT #2
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
39	i39	400.0	240.0	-6.43	11.000
40	e40	40.0	280.0	13.00	11.000
41	e41	120.0	280.0	13.00	11.000
42	e42	200.0	280.0	13.00	11.000
43	e43	280.0	280.0	13.00	11.000
44	e44	360.0	280.0	13.00	11.000
45	i45		320.0	-2.22	11.000
46	i46	80.0	320.0	-5.43	11.000
47	i47	160.0	320.0	-5.43	11.000
48	i48	240.0	320.0	-5.43	11.000
49	i49	320.0	320.0	-5.43	11.000
50	i50	400.0	320.0	-2.22	11.000

TABLE ADD2-7
PRODUCTION UNIT #3 - SOUTH
FORMATION CHARACTERISTICS AND
PROGRAM CALCULATION CONSTRAINTS

Description	Value
Average Permeability (md)	600.0
Formation Thickness (feet)	20.0
Porosity (fraction)	0.270
Total Compressibility (vol/vol/psi)	0.00002800
Viscosity (cp)	1.000
Transmissivity (gpd/ft)	246
Storage Coefficient (dimensionless)	0.000066
Efficiency of INJECTION Well (frac.)	0.200
Efficiency of EXTRACTION Well (frac.)	1.000
Groundwater Velocity (ft/yr)	3.0
Angle of Groundwater Movement (degrees)	45.0
Maximum Time Between Calculation (hours)	12.0
Max Dist Betw Calc (feet) [MUST <= Cap Dist]	2.0
Dist. from Well for Streamline Capture (feet)	2.0

TABLE ADD2-8
PRODUCTION UNIT #3 - SOUTH
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
1	i1			-2.72	11.000
2	i2	80.0		-5.45	11.000
3	i3	160.0		-5.45	11.000
4	i4	240.0		-5.45	11.000
5	i5	320.0		-5.45	11.000
6	i6	400.0		-2.72	11.000
7	e7	40.0	40.0	11.00	11.000
8	e8	120.0	40.0	11.00	11.000
9	e9	200.0	40.0	11.00	11.000
10	e10	280.0	40.0	11.00	11.000
11	e11	360.0	40.0	11.00	11.000
12	i12		80.0	-5.45	11.000
13	i13	80.0	80.0	-10.89	11.000
14	i14	160.0	80.0	-10.89	11.000
15	i15	240.0	80.0	-10.89	11.000
16	i16	320.0	80.0	-10.89	11.000
17	i17	400.0	80.0	-5.45	11.000
18	e18	40.0	120.0	11.00	11.000
19	e19	120.0	120.0	11.00	11.000
20	e20	200.0	120.0	11.00	11.000
21	e21	280.0	120.0	11.00	11.000
22	e22	360.0	120.0	11.00	11.000
23	i23		160.0	-5.45	11.000
24	i24	80.0	160.0	-10.89	11.000
25	i25	160.0	160.0	-10.89	11.000
26	i26	240.0	160.0	-10.89	11.000
27	i27	320.0	160.0	-10.89	11.000
28	i28	400.0	160.0	-5.45	11.000
29	e29	40.0	200.0	11.00	11.000
30	e30	120.0	200.0	11.00	11.000
31	e31	200.0	200.0	11.00	11.000
32	e32	280.0	200.0	11.00	11.000
33	e33	360.0	200.0	11.00	11.000
34	i34		240.0	-5.45	11.000
35	i35	80.0	240.0	-10.89	11.000
36	i36	160.0	240.0	-10.89	11.000
37	i37	240.0	240.0	-10.89	11.000
38	i38	320.0	240.0	-10.89	11.000

TABLE ADD2-8 (cont'd)
PRODUCTION UNIT #3 - SOUTH
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
39	i39	400.0	240.0	-5.45	11.000
40	e40	40.0	280.0	11.00	11.000
41	e41	120.0	280.0	11.00	11.000
42	e42	200.0	280.0	11.00	11.000
43	e43	280.0	280.0	11.00	11.000
44	e44	360.0	280.0	11.00	11.000
45	i45		320.0	-2.72	11.000
46	i46	80.0	320.0	-5.45	11.000
47	i47	160.0	320.0	-5.45	11.000
48	i48	240.0	320.0	-5.45	11.000
49	i49	320.0	320.0	-5.45	11.000
50	i50	400.0	320.0	-2.72	11.000

TABLE ADD2-9
PRODUCTION UNIT #3 - NORTH
FORMATION CHARACTERISTICS AND
PROGRAM CALCULATION CONSTRAINTS

Description	Value
Average Permeability (md)	600.0
Formation Thickness (feet)	20.0
Porosity (fraction)	0.270
Total Compressibility (vol/vol/psi)	0.00002800
Viscosity (cp)	1.000
Transmissivity (gpd/ft)	246
Storage Coefficient (dimensionless)	0.000066
Efficiency of INJECTION Well (frac.)	0.200
Efficiency of EXTRACTION Well (frac.)	1.000
Groundwater Velocity (ft/yr)	62.0
Angle of Groundwater Movement (degrees)	90.0
Maximum Time Between Calculation (hours)	12.0
Max Dist Betw Calc (feet) [MUST <= Cap Dist]	2.0
Dist. from Well for Streamline Capture (feet)	2.0

TABLE ADD2-10
PRODUCTION UNIT #3 - NORTH
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
1	i1			-3.72	11.000
2	i2	80.0		-6.90	11.000
3	i3	160.0		-6.90	11.000
4	i4	240.0		-6.90	11.000
5	i5	320.0		-6.90	11.000
6	i6	400.0		-3.72	11.000
7	e7	40.0	40.0	11.00	11.000
8	e8	120.0	40.0	11.00	11.000
9	e9	200.0	40.0	11.00	11.000
10	e10	280.0	40.0	11.00	11.000
11	e11	360.0	40.0	11.00	11.000
12	i12		80.0	-5.45	11.000
13	i13	80.0	80.0	-10.89	11.000
14	i14	160.0	80.0	-10.89	11.000
15	i15	240.0	80.0	-10.89	11.000
16	i16	320.0	80.0	-10.89	11.000
17	i17	400.0	80.0	-5.45	11.000
18	e18	40.0	120.0	11.00	11.000
19	e19	120.0	120.0	11.00	11.000
20	e20	200.0	120.0	11.00	11.000
21	e21	280.0	120.0	11.00	11.000
22	e22	360.0	120.0	11.00	11.000
23	i23		160.0	-5.45	11.000
24	i24	80.0	160.0	-10.89	11.000
25	i25	160.0	160.0	-10.89	11.000
26	i26	240.0	160.0	-10.89	11.000
27	i27	320.0	160.0	-10.89	11.000
28	i28	400.0	160.0	-5.45	11.000
29	e29	40.0	200.0	11.00	11.000
30	e30	120.0	200.0	11.00	11.000
31	e31	200.0	200.0	11.00	11.000
32	e32	280.0	200.0	11.00	11.000
33	e33	360.0	200.0	11.00	11.000
34	i34		240.0	-5.45	11.000
35	i35	80.0	240.0	-10.89	11.000
36	i36	160.0	240.0	-10.89	11.000
37	i37	240.0	240.0	-10.89	11.000
38	i38	320.0	240.0	-10.89	11.000

TABLE ADD2-10 (cont'd)
PRODUCTION UNIT #3 - NORTH
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
39	i39	400.0	240.0	-5.45	11.000
40	e40	40.0	280.0	11.00	11.000
41	e41	120.0	280.0	11.00	11.000
42	e42	200.0	280.0	11.00	11.000
43	e43	280.0	280.0	11.00	11.000
44	e44	360.0	280.0	11.00	11.000
45	i45		320.0	-1.72	11.000
46	i46	80.0	320.0	-4.00	11.000
47	i47	160.0	320.0	-4.00	11.000
48	i48	240.0	320.0	-4.00	11.000
49	i49	320.0	320.0	-4.00	11.000
50	i50	400.0	320.0	-1.72	11.000

TABLE ADD2-11
PRODUCTION UNIT #4
FORMATION CHARACTERISTICS AND
PROGRAM CALCULATION CONSTRAINTS

Description	Value
Average Permeability (md)	300.0
Formation Thickness (feet)	20.0
Porosity (fraction)	0.270
Total Compressibility (vol/vol/psi)	0.00002800
Viscosity (cp)	1.000
Transmissivity (gpd/ft)	123
Storage Coefficient (dimensionless)	0.000066
Efficiency of INJECTION Well (frac.)	0.400
Efficiency of EXTRACTION Well (frac.)	1.000
Groundwater Velocity (ft/yr)	62.0
Angle of Groundwater Movement (degrees)	105.0
Maximum Time Between Calculation (hours)	12.0
Max Dist Betw Calc (feet) [MUST <= Cap Dist]	2.0
Dist. from Well for Streamline Capture (feet)	2.0

TABLE ADD2-12
PRODUCTION UNIT #3
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
1	i1			-3.23	11.000
2	i2	80.0		-5.45	11.000
3	i3	160.0		-5.65	11.000
4	i4	240.0		-5.65	11.000
5	i5	320.0		-5.45	11.000
6	i6	400.0		-3.23	11.000
7	e7	40.0	40.0	9.00	11.000
8	e8	120.0	40.0	9.00	11.000
9	e9	200.0	40.0	9.00	11.000
10	e10	280.0	40.0	9.00	11.000
11	e11	360.0	40.0	9.00	11.000
12	i12		80.0	-3.45	11.000
13	i13	80.0	80.0	-8.91	11.000
14	i14	160.0	80.0	-8.91	11.000
15	i15	240.0	80.0	-8.91	11.000
16	i16	320.0	80.0	-8.91	11.000
17	i17	400.0	80.0	-5.45	11.000
18	e18	40.0	120.0	9.00	11.000
19	e19	120.0	120.0	9.00	11.000
20	e20	200.0	120.0	9.00	11.000
21	e21	280.0	120.0	9.00	11.000
22	e22	360.0	120.0	9.00	11.000
23	i23		160.0	-3.45	11.000
24	i24	80.0	160.0	-8.91	11.000
25	i25	160.0	160.0	-8.91	11.000
26	i26	240.0	160.0	-8.91	11.000
27	i27	320.0	160.0	-8.91	11.000
28	i28	400.0	160.0	-5.45	11.000
29	e29	40.0	200.0	9.00	11.000
30	e30	120.0	200.0	9.00	11.000
31	e31	200.0	200.0	9.00	11.000
32	e32	280.0	200.0	9.00	11.000
33	e33	360.0	200.0	9.00	11.000
34	i34		240.0	-4.45	11.000
35	i35	80.0	240.0	-8.91	11.000
36	i36	160.0	240.0	-8.91	11.000
37	i37	240.0	240.0	-8.91	11.000
38	i38	320.0	240.0	-8.91	11.000

TABLE ADD2-12 (cont'd)
PRODUCTION UNIT #3
WELL DATA

Row	Well Number	X Location (feet)	Y Location (feet)	Flowrate (gpm)	Well Dia. (in)
39	i39	400.0	240.0	-4.45	11.000
40	e40	40.0	280.0	9.00	11.000
41	e41	120.0	280.0	9.00	11.000
42	e42	200.0	280.0	9.00	11.000
43	e43	280.0	280.0	9.00	11.000
44	e44	360.0	280.0	9.00	11.000
45	i45		320.0	-1.23	11.000
46	i46	80.0	320.0	-3.45	11.000
47	i47	160.0	320.0	-3.45	11.000
48	i48	240.0	320.0	-3.45	11.000
49	i49	320.0	320.0	-3.25	11.000
50	i50	400.0	320.0	-1.03	11.000

Appendix D

North Butte Surge Pond Design

TECHNICAL CONSTRUCTION SPECIFICATIONS AND CONSTRUCTION DRAWINGS

Surge Pond
North Butte Satellite Facility
Campbell County, Wyoming

For

Cameco

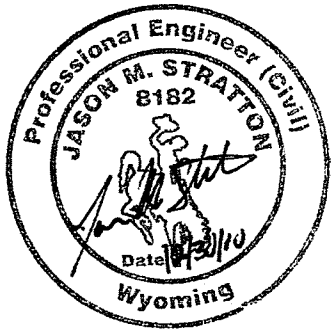
550 North Poplar, Suite 100
Casper, Wyoming 82601

Prepared by:

TETRA TECH

605 N. Warehouse Road
Casper, Wyoming 82601

Contact:
Mr. Jason Stratton, P.E.
307.234.2126
jason.stratton@tetratech.com



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DIVISION 1: GENERAL REQUIREMENTS

SECTION 01009

GENERAL INFORMATION AND REQUIREMENTS

PART 1: GENERAL

1.1 SUMMARY

A. Purpose of Project: The purpose of this project is to construct a surge pond to be located at Cameco Resources North Butte ISR Satellite located in Campbell County, Wyoming. The project includes the construction of a surface storage facility with a capacity on the order of 4.43 ac-ft. The facility will consist of a double geomembraned lined pond with a leak detection and collection system. Borrow material for construction of the homogeneous embankments will come from within the impoundment footprint. All disturbed areas will be revegetation upon completion of construction.

B. Location: The surge pond is located in Section 24, Township 44 North, Range 76 West. The pond will be located adjacent to and south of the proposed North Butte ISR Satellite plant building. The project site work locations are shown on the drawings.

C. Drawings: Detail the work required at each project location.

D. Work provided by Contractor for construction of ponds:

1. Clearing and Grubbing of Pond Construction Area.
2. Stripping of topsoil.
3. Excavation of drainage features and pond cells.
4. Overexcavation for clay liner.
5. Earth fill for embankments.
6. Earth fill for clay liner.
7. Smooth finishing of liner area.
8. Installation of a 40-mil and a 60-mil HDPE liner.
9. Installation of a leak detection system between the liners include two wells.
10. Installation of a 100-mil wear liner as noted.
11. Crest surfacing
12. Topsoil placement, fertilization, mulching, and seeding.
13. Perimeter Fence.

E. Work provided by others:

1. Water delivery and pumping systems.
2. Access roads to the exterior of the pond perimeter fence.

1.2 REFERENCES

A. Referenced Specifications/Standards with Abbreviations and/or Acronyms: Wherever the following acronyms are used in these specifications or on the drawings, they are to be construed the same as the respective expressions represented. Copies of the referenced specifications/ standards referred to herein may be procured by the Contractor, from the following:

AASHTO American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249
Washington, DC 20001

ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken PA 19428-2959
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol St. between G and H St., NW Washington, DC 20402
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173
DOT	Department of Transportation 400 Seventh St., SW Washington, DC 2059
EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460
OSHA	Occupational Safety and Health Administration US Department of Labor 200 Constitution Ave., NW Washington DC 20210
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
WYDOT	Wyoming Department of Transportation 5300 Bishop Blvd. Cheyenne, WY 82009

1.3 DEFINITIONS

A. Approvals: Approval of submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After approval of an item, Contractor shall submit a substitute for approval when the approved item cannot be purchased or delivered in time to avoid delay in completion of the project.

1.4 SUBMITTALS

A. Scope: Submittals include design computations, shop drawings, manufacturers' literature, as-built drawings, samples, and maintenance manuals.

B. Requirements: Refer to specifications for submittals required. Allow at least 10 working days for review. Submittals shall be delivered to the Owner as designated in Section 01330, Submittal Procedures.

C. Identification of Submittals: Completely identify each submittal by showing at least the following information:
   1. Name and address of submitter, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number, and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.
   6. Submittal sequence number.

1.5 CERTIFICATES OF CONFORMANCE

A. Requirements: The Owner may permit use, prior to sampling and testing, of materials when accompanied by Certificates of Conformance. Materials used on the basis of a Certificate of Conformance may be sampled and tested. Installation of materials on the basis of Certificates of Conformance shall not relieve the Contractor of responsibility for incorporating materials which conform to the requirements of the drawings and specifications. Material not conforming to those requirements will be subject to rejection, whether in place or not.

B. Related Sections:
   1. Section 01331 – Certificates.

1.6 QUALITY ASSURANCE/QUALITY CONTROL

A. Codes and Standards: The work shall comply with codes and standards applicable to each type of work and as listed in the individual sections of these specifications. This Contract incorporates materials, applications, and tests by reference, with the same force and effect as when they were given in full text.

B. Requirements: Quality Control will be the responsibility of the Owner to assure that Contractor is performing adequate construction and quality control.

C. Conflict: Where a conflict occurs between reference documents and project specifications, the project specifications shall govern. Specifications on project drawings govern over specifications herein.

D. Measurements: Where approved shop drawings give specific measurements or rough-in dimensions, these dimensions shall take precedence over dimensions indicated on the drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Protect products incorporated into the work from damage while in transit to the site. Products must be delivered in original unopened containers with manufacturer's name, brand designation, and contents legibly indicated.

B. Storage: Provide temporary storage facilities for products. Storage shall comply with the manufacturer's instructions. The storage area shall permit access for inspection and handling.

C. Handling: Load and unload products protecting them from damage.

1.8 PROJECT SITE ISSUES

A. Access to the Work: Strict conformance with Cameco Resources access policies to be detailed by the Owner.

B. Remote location: The work area is in a remote location with no access to public telephone, and potable water source.

E. Site Investigation and Conditions Affecting the Work: The contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and location of the work, and that it has investigated and satisfied itself as to the general local conditions which can affect the work or its costs, including but not limited to:

1. Conditions bearing upon transportation, disposal, handling and storage of materials;
2. The available of labor, water, electric power and roads;
3. Uncertainties of weather conditions at the site;
4. The conformation and conditions of the ground, and;
5. The character of equipment and facilities needed preliminary to and during work performance.

The Contractor also acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Owner, as well as from the drawings and specifications made a part of this contract. Any failure of the Contractor to take the actions described and acknowledged in this paragraph will not relieve the Contractor from responsibility for estimating properly the difficulty and cost of successfully performing the work, or for proceeding to successfully perform the work without additional expense to the Owner.

Percent shrinkage/swell shall not be the basis for extra work claim. Contractor shall have fill risk for percent shrinkage/swell determination.

The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor based on the information made available by the Owner. Nor does the Owner assume responsibility for any understanding reached or representation made concerning conditions which can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in this contractor.

1.9 SEQUENCING AND SCHEDULING

A. Work Schedule: The schedule shall be submitted for each task after 14 days following the pre-work conference. When requested, submit an updated schedule within 3 calendar days. As a minimum, the estimated start and completion dates shall be shown in the estimate.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 PROJECT MEETINGS

A. Pre-Work Conference:

1. Will be held prior to the start of work. The Contractor will be notified in advance of meeting time, date and place. The purpose will be to review required work, project

drawings and specifications, site-specific construction related issues, construction schedules, payroll and payments, administrative provisions of the Contract, and other matters pertinent to the Work.

2. The Contractor, subcontractors and the persons responsible for coordination of the work shall be present at the meeting.
3. Be prepared to summarize and explain procedures planned for the project and present a plant for the submittals requested in the specifications.

B. Progress Meetings:
   1. To be held at the project site or by telephone conferencing, or as determined by the Owner.
   2. May be called by either the Owner or the Contractor. Request shall state who should attend and include an agenda.

C. Final Inspection:
   1. To be held at the project site, or as determined by the Owner.
   2. Notify the Owner in writing at least 30 working days before the completion date so the Owner can schedule final inspection.
   3. The Contractor's superintendent shall be present during this inspection.

3.2 PREPARATION

A. Work Layout: The Owner will provide a construction survey control monument map noting all primary control and control coordinates for locating the principal components of the Work with a suitable number of benchmarks adjacent to the Work to give the Contractor measurements, lines and grades necessary for the work executed under the Contract. Baseline monuments or benchmarks disturbed or removed during construction shall be reset by the Contractor at the Contractor's expense. Control points located within areas that must be disturbed can be removed without replacement with prior approval by the Owner.

B. Work Limits and Control Points: Will be established by the Owner.

C. Construction Staking and Surveying: Survey, calculate, furnish and set construction stakes and marks necessary to control the project to the line and grades as shown on the drawings, specifications or as established by the Owner. Make all supporting computations and field notes required for control of the work and as necessary to establish the exact position of the work from control points. Perform surveying, staking and recording of data. The cost for construction staking and surveying shall be considered incidental and no additional compensation will be allowed. Costs incurred as a result of survey errors will be borne by the Contractor.

D. Measurement and Calculations for Pay Quantities: In the event of any design changes or changes of conditions, Contractor shall have a third party licensed professional surveyor perform surveying for final grade and cross-sections, finish grade elevations, perform measurements and calculations for pay quantities, and perform "as constructed" measurements for record drawings.

   Contractor shall submit to Owner all calculations, field notes and survey drawings for layout, control and final payment as necessary to construct the project as specified.

3.3 HEALTH AND SAFETY PLAN

A. Requirements: Contractor shall submit a site specific Health and Safety Plan as outlined in Section 01330 – Submittal Procedures. Owner may have additional Health and Safety requirements separate of these specifications.

3.4. ACCESS TO THE WORK

A. Requirements: Access to the project work area shall be maintained throughout construction. Posted speed limits shall be observed on all the roads. Haul vehicles and all other vehicles used in the work shall strictly comply with these limits. Legal weight limits for public roadways and bridges shall also be observed in all hauling activities.

B. Use of the Premises: Shall be in strict conformance to the following:
   1. Contractor shall confine his equipment, storage of materials, and construction operations to the areas shown on the Drawings or as set forth in the Contract. Only authorized personnel shall be on site during construction activities. Contractor shall not unreasonably encumber the site with his materials and construction equipment. Should Contractor deem it necessary to work outside of the general construction areas shown, Contractor shall obtain written approval from the Owner prior to performing such work.
   2. Contractor shall comply with all reasonable instructions of regarding signs, traffic, fires, explosives, danger signals and barricades.
   3. Contractor shall notify the Owner of the need to temporarily remove or relocate fences for access to the work and shall coordinate such activities with Owner in regards to removal, relocation, prior to commencing work, and restoration of fences upon completion.

3.5 STAGING AREA

A. Staging Area: An equipment and materials staging area shall be located in an area south of the proposed pond or otherwise approved by the Owner. This area shall include an equipment fueling and maintenance area. Any additional space needed or modifications to the boundaries of the staging area shall be subject to approval by the Owner. Contractor shall limit equipment and materials storage to the staging area, unless specifically approved by the Owner. Contractor will be responsible for security of the staging area, hazardous material containment and cleanup (for all materials including motor oil, hydraulic and transmission fluid, antifreeze, brake fluid, and all other materials and chemicals used in the maintenance of equipment and machinery), weed control, and drainage and erosion control. Immediately following completion of construction, the staging area shall be thoroughly cleaned of all trash and debris, scarified, seeded and mulched.

3.6 SITE CLEAN UP

A. Requirements: Shall periodically, or as directed by Owner, during the course of the work remove and dispose of all surplus construction materials and debris and keep the work area and public rights-of-way reasonably clean. Upon completion of the work, Contractor shall remove all temporary construction facilities, debris, and unused materials provided for the project, leaving the project in a neat and clean condition.

3.7 DECONTAMINATION:

A. Requirements: Contractor shall provide for vehicle and equipment decontamination, which includes preparing an area where vehicles and equipment shall be decontaminated as specified. Only vehicles that come in contact with contaminated soil or other solid or liquid hazardous waste shall require decontamination. Design and construction of the decontamination area, including wastewater collection and storage facilities, will be approved by the Owner prior to use. Contractor shall be liable and responsible for any release of wastewater or hazardous substances from the work area. Contractor shall also provide procedures to prevent the uncontrolled spread of wastes on site. The procedures should provide means for minimizing or preventing "tracking" of wastes from excavation areas onto access and haul roads. Accidental spills of materials on haul roads shall be removed immediately.

3.8 MAINTENANCE OF FENCES

A. Requirements: Maintain all fences adjacent to work areas to the satisfaction of the abutting property owners. Any fence removed or destroyed during the course of Work shall be reinstalled or reconstructed in like kind at no cost to Owner or landowner.

3.9 RESTORATION OF DISTURBED AREAS

A. Requirements: All areas disturbed by Contractor's operations such as, but not limited, to, access roads, staging areas, haul roads, loading operations and disposal operations shall be restored by grading to the original contours as set forth in the Contract Documents. Seed mixture shall be as called for in Section 02923 - Seeding or as approved by the Owner.

3.10 SALVAGEABLE ITEMS

A. Requirements: Salvageable items shall be stockpiled at locations approved in writing by the Owner.

3.11 DISPOSAL OF DEBRIS

A. Requirements: Items or debris not designated as salvage for the Owner shall become the property of the Contractor. Disposal of materials in a legal manner and payment of fees required is the Contractor's responsibility.

3.12 PROJECT IDENTIFICATION

A. Requirements: As needed for access and delivery of Contractor's Equipment and Materials.

3.13 AS-BUILT DRAWINGS

A. General Requirements: A complete set of full-sized prints, furnished by the Contractor for this purpose only, shall be kept at the site. As the job progresses, continuously maintain as-built drawings of the work. The changes shall be noted legibly in red pencil or red ink. These drawings shall be submitted to the Owner prior to final inspection. Should final inspection reveal changes in the project not so noted on the as-built drawings, record these changes on the as-built drawings within 5 working days of final inspection and deliver completed as-built drawings to the Owner. Owner's Engineer will prepare final record copy of all drawings.

B. Installation Changes: Records shall be maintained of actual installations where at variance with the work shown, where changed, or where not otherwise located by dimension, elevation or other reference on the Contract drawings. Actual locations and elevations of equipment and components (such as pipe, conduits and ducts) occurring within concealed areas shall be recorded by actual dimensions referenced from readily accessible and permanent structures or monuments.

3.14 WARRANTY

A. Requirements: Materials and equipment furnished under this Contract shall be covered by the most favorable commercial warranties given to customers for such materials or equipment. The rights or remedies provided herein are in addition to and do not limit rights afforded to the Owner by other clauses of this Contract. With respect to warranties, expressed or implied, from manufacturers or suppliers for materials or equipment furnished under the Contract the Contractor shall:
   1. Obtain warranties that would be given in normal commercial practices.
   2. Require warranties to be executed, in writing, for the benefit of the Owner.
   3. Submit warranties to the Owner prior to the final inspection.

3.15 OWNER PROVIDED PERMITS

A. The facility is permitted through the following agencies:
   1. State of Wyoming, State Engineer's Office, Herschler Building, 4th East, Cheyenne, Wyoming 82002; (307) 777-7354. Permit No. pending at the time of publication.
   2. State of Wyoming, Department of Environmental Quality, Water Quality Division, Southwest District, 250 Lincoln Street, Lander, Wyoming 82520; (307) 332-3144; FAX (307) 332-3183. Permit No. pending at the time of publication.

All other permits are the responsibility of the Contractor.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01011

DRAWINGS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes: List of drawings for construction of the Surge Pond.

1.2 QUALITY ASSURANCE

A. Inform the Owner of any discrepancies, errors, or omissions discovered on drawings in accordance Section 01009.

1.3 PROJECT CONDITIONS

A. Where there are minor differences as determined by the Owner between details and dimensions shown on drawings and details and dimensions of existing features at jobsite, use details and dimensions of existing features at jobsite.

1.4 COPIES OF DRAWINGS

A. The Contractor will furnish additional copies of drawings for performing work.

1.5 LIST OF DRAWINGS

A. Drawings listed in Table 01011A - List of Drawings, are made a part of these specifications.

Table 01011A - List of Drawings

Sequence No.	Drawing No.	Title
1	1 of 4	Cover Sheet
2	2 of 4	Site Map
3	3 of 4	Special Foundation Preparation and Leak Detection Grading
4	4 of 4	Groundwater Drain System

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

There are no applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01016

MATERIAL SAFETY DATA SHEETS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for Material Safety Data Sheets.

B. *"Hazardous material"* includes any material defined as hazardous under the latest version of Federal Standard No. 313 (including revisions adopted during the term of the contract).

1.2 SUBMITTALS

A. Submit in accordance with Section 01330 – Submittals.

B. Submit updated List of Hazardous Materials (LHM) and Material Safety Data Sheets (MSDS) for any hazardous material, as defined in paragraph 1.1 SUMMARY. B., to be delivered under this contract. The hazardous material shall be properly identified and include any applicable identification number, such as National Stock Number or Special Item Number. This information shall also be included on the Material Safety Data Sheet submitted under this contract. This list must be updated during performance of the contract whenever the Contractor determines that any other material to be delivered under this contract is hazardous.

1.3 DELIVERY

A. Do not deliver any hazardous material to jobsite which was not included on the original LHM before acceptance of MSDS by Owner.

PART 2: PRODUCTS

There are not applicable requirements.

PART 3: EXECUTION

There are not applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01330

SUBMITTAL PROCEDURES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for submittals of the work schedules, earned value schedules, design computations, shop drawings, design drawings, scope of supply summaries, technical data, manufacturer's literature, and samples.

B. Requirements: Refer to specifications for submittals required. Allow 10 working days for Owner's review. Review time commences upon receipt by the Owner. Submittals shall be delivered to the Owner.

1.2 SUBMITTALS

A. Requirements: All shop drawings, samples and other submittals shall be submitted as required by the Contract. At a minimum, the following submittals shall be received and approved by the Owner prior to issuing a Notice to Proceed. As an aid to the Contractor the following submittals will be required. This list is not considered to be exhaustive and additional submittals may be requested by the Owner.
   1. Permits, by Contractor
   2. Health and Safety Plan
   3. Erosion Control Plan
   4. Dust Control Plan
   5. Traffic Control Plan
   6. Construction Plan
   7. Water Management Plan
   8. Water Pollution Prevention Plan
   9. Spill Prevention Control and Countermeasure Plan (SPCC)
   10. First Aid Plan
   11. Plan of Temporary Facilities

1.3 QUALITY ASSURANCE

A. Approval: Written approval of the submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Installation of material on the basis of written approval of submittals shall not relieve the Contractor of the responsibility for incorporating material which conforms to the requirements of the drawings and specifications. Written approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After written approval of an item, the Contractor may submit a substitution for approval, if the approved item cannot be purchased or delivered in time to avoid delay in completion of the project

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 WORK SCHEDULE:

A. Requirements: The schedule shall be submitted 14 days after the pre-work conference. When requested, the Contractor shall submit an updated schedule within three working days. As a minimum, the estimated start and completion dates should be shown in the schedule.

3.2 VALUE SCHEDULE

A. Requirements: The Contractor shall prepare a value schedule for presentation 14 days after the pre-work conference.

3.3 DESIGN COMPUTATIONS

A. Requirements: The Contractor shall deliver to the Owner all of his complete design effort, including computations, quantities, specifications and working drawings necessary to construct, design, and bid all items required by the specification sections in this Contract. The Contractor shall provide enough time for reviews, revisions, and resubmittals so as to not delay the work. When submittals have received final written approval, the Contractor shall make distribution to the parties concerned.

3.4 SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

A. General: The Contractor shall deliver to the Owner the shop drawings and manufacturer's literature required by the specification sections in this Contract to the Owner.

B. Identification: When full catalogs or pages and tables are submitted, the specific items to be used on this project shall be circled, blocked in or underlined. Completely identify each submittal by showing the following information:
   1. Name and address of preparer, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.

C. Substitutions: The Contractor shall present requests for substitutions to the Owner according to the following:
   1. Deliver sufficient calculations and data to justify selection of the proposed item and permit comparison with the original item.
   2. Show complete layout of system, except that which is identical to Contract documents, unless unchanged portion must be shown to indicate clearances.
   3. Include drawings, same (or larger) scale as Contract drawings, marked to show differences.
   4. Submit complete technical data including test data, drawings, manufacturer's literature, samples, and complete performance specifications.
   5. The Contractor is responsible for the cost of redesign and modifications to this or other parts of the project caused by the substitutions.

3.5 SAMPLES

A. Requirements:
   1. The Contractor shall deliver samples required by the specification sections in this contract. Submit samples with shop drawings when both are required.
   2. Each item shall clearly note the manufacturer, trade name, product, lot, style, color, model, locations of use and contract document reference.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01331

CERTIFICATES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: The requirements for Certificates of Conformance.

B. Requirements: Refer to specifications for Certificates of Conformance required. Allow three working days for review. Review time commences upon receipt by the Owner. Certificates of Conformance shall be delivered to the Owner.

1.2 QUALITY ASSURANCE

A. Authorization: The Owner may permit use, prior to sampling and testing, of material when accompanied by Certificates of Conformance. Material used on the basis of a Certificate of Conformance may be sampled and tested. Installation of material on the basis of a Certificate of Conformance shall not relieve the Contractor of responsibility for incorporating material which conforms to the requirements of the drawings and specifications. Material not conforming to those requirements will be subject to rejection, whether in place or not.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 PREPARATION

A. Format: The form of the Certificate of Conformance provided by the supplier shall be as follows:
   1. The certificate shall state that the named product conforms to the Contract requirements.
   2. The certificate shall either be accompanied with a certified copy of the test results, or certify that such test results are on file with the manufacturer and will be furnished to the Owner upon request.
   3. The certificate shall provide the name and address of the manufacturer, the testing agency, and the date of tests.
   4. The certificate shall set forth the means of identification which will permit field determination of the product delivered as being the product covered by the certification.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01458

TESTING LABORATORY SERVICES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: The Owner will retain a qualified, Independent Testing Laboratory to conduct specific on-site tests including soil compaction testing for quality assurance purposes. The Contractor will be responsible for all other testing including that for geomembrane testing.

1.2 SUBMITTALS

A. Test Reports: The Independent Testing Laboratory will provide 3 copies of test reports to the Owner. Reports will include testing facility name, address, telephone number, and names of responsible field technicians and field supervisor. Contractor shall submit test results of all Contractors' tests to Owner. Owner may witness Contractor's tests.

1.3 QUALITY ASSURANCE

A. Approval of Laboratory: The qualified, independent testing laboratory will have authority or be licensed to operate in the State in which the project is located. The testing laboratory will be retained by the Owner prior to the Contractor beginning work.

B. Responsibilities of Laboratory:
   1. Test samples of mixes submitted by the Contractor.
   2. Provide qualified personnel at project site. Cooperate with the Owner and Contractor in performance of services.
   3. Perform specified sampling and testing of products and materials in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of specifications.
   5. Promptly notify the Owner and Contractor of observed irregularities or non-conformance of work, products, or materials.
   6. Perform additional tests required by the Owner.
   7. Attend preconstruction meetings and progress meetings.

C. Limitations on Laboratory:
   1. Laboratory may not release, revoke, alter, or enlarge on requirements of specifications.
   2. Laboratory may not approve or accept partial portions of the work.
   3. Laboratory may not assume duties of the Contractor unless approved in writing by the Owner.

1.4 SEQUENCING AND SCHEDULING

A. Establishing Testing Schedule:
   1. By advance discussion with the testing laboratory, the Owner and Contractor will determine the time required for the laboratory to perform its test and to issue its findings.
   2. Contractor shall provide required time within the construction schedule.

B. Revising Testing Schedule: When construction schedule changes are necessary during construction, Contractor shall coordinate such changes with the testing laboratory as required.

PART 2: PRODUCTS

2.1 REPORTS

A. Reports: Will include:
1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and specification sections.
6. Location in the Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

B. Interpretation: When requested by the Owner, provide interpretation of test results.

PART 3: EXECUTION

3.1 FIELD QUALITY CONTROL

A. Contractor Requirements: See individual specifications "Field Quality Control" paragraph for specific testing requirements. When applicable, the Contractor shall:
1. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel, and provide access to the Work.
3. Provide incidental labor and facilities:
   a. To obtain, handle, and label or identify samples at the site or at source of products and materials to be tested.
   b. To facilitate tests.
   c. To provide storage and curing of test samples.
4. Ensure samples are taken by qualified personnel.
5. Coordinate the laboratory test frequency and timing with the Owner.
6. Ensure Contractor supplied tests are completed according to the testing schedule.
7. For Contractor supplied testing furnish verbal test reports prior to leaving the project site and submit written reports within 5 working days after tests have been completed.

B. Field Testing:

Item	Location	Reference	Frequency	Remarks
Subgrade	Embankment Foundation	ASTM D2922	1,500 square ft	Field Density and Moisture Content
Embankment Fill	Embankment	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Any Other Fill	Pipe Bedding, Site Grading, Crest Surfacing, Etc.	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Clay Liner	Embankment/Pond Bottom	ASTM D2922	250 cubic yards	Field Density and Moisture Content.
Embankment Fill	Source	ASTM D422, D4318, D698	5,000 cubic yards	Gradation, Plasticity Index, Standard Proctor
Clay Liner	Source	ASTM D422, D4318, D698	5,000 cubic yards	Gradation, Plasticity Index, Standard Proctor

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for temporary utilities for construction, temporary field office, first aid, sanitary facilities, vehicular access, temporary barriers and controls, and project identification.

1.2 DEFINITIONS

A. Landscape Preservation: The term "injury" includes, without limitation, bruising, scarring, tearing, and breaking of roots, trunks, or branches.

B. Pesticides: Include herbicides, insecticides, fungicides, rodenticides, piscicides, avicides, surface disinfectants, animal repellents, and insect repellents.

C. Security: "Restricted Area" means an area where entry will not be allowed unless authorized by the Owner.
   1. "Security Measures" means those measures contained in regulations or as may be established by the Owner and carried out by an Owner's guard system to provide continuous and effective security of restricted areas.

1.3 SUBMITTALS

A. Temporary Utilities: Submit three copies of the implementation and termination schedule for each utility; and three reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Air Quality: Submit three copies of Air Quality Permit, 10 days prior to commencing for any activity for which an Air Quality Permit is required. Air Quality Permits are required for certain construction-related activities including, but not limited to, earthmoving, or other processes which discharge pollutants into the open air.

C. Water Management Plan: Submit three copies of a detailed Water Quality Management Plan to the Owner for review, approval, and use, at least 30 days prior to commencing construction activities that involve less than 5 acres of land in the vicinity of any stream, flowing or dry watercourse, lake, wetland, reservoir, or underground water source.

D. Water Pollution Prevention Plan: Submit three copies of a Water Pollution Prevention Plan to the Owner not less than 30 days prior to the start of onsite construction work. Prepare a Pollution Prevention Plan as required by the stormwater permit for discharges from construction sites.

E. Spill Prevention Control and Countermeasure Plan (SPCC): Submit an SPCC Plan where the location of a construction site is such that oil from an accidental spillage could reasonably be expected to enter into or upon the navigable waters of the United States or adjoining shorelines, and the aggregate storage of oil at the site is over 1,320 gallons or a single container has a capacity in excess of 660 gallons. Submit the SPCC Plan to the Owner at least 30 days prior to delivery or storage of oil at the site. The Plan must have been reviewed and certified by a

registered professional engineer in accordance with 40 CFR, part 112, as required by section 311 of the Clean Water Act (Public Law 92-500 as amended).

F. First Aid Plans: Submit three copies of plans [and facilities] for providing medical attention for injured or disabled employees, including onsite emergency facilities and ambulance service, before start of operations.

G. Health and Safety Plan: Contractor shall submit three copies of a site specific Health and Safety Plan. The plan shall be written in accordance with the following U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standard practices: Safety and Health Standards 29 Code of Federal Regulations (CFR) 1926 (General Industry), OSHA 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response, Safety and Health Standards 29 CFR 1926 (Construction Industry).

At a minimum, the plan shall address the following elements: staff organization, responsibilities, and authorities; site description; hazard analysis for each project task and operation; general and site-specific training; personal protective equipment; medical surveillance; personal and environmental exposure monitoring; standard operating safety procedures, engineering controls, and work practices; communications; illumination; site control measures; personnel hygiene and decontamination; equipment decontamination; emergency equipment and first aid; emergency response and contingency procedures; and logs, reports, and record keeping.

If applicable to a specific work item, Contractor shall provide written documentation that all employees engaged in the work have received the OSHA 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training required under 29 CFR 1910.120.

H. Sediment Control and Erosion Control Plan: Sediment control provisions shall be used to control silt in runoff whenever work is conducted adjacent to water courses. The purpose of these controls is to prevent pollution of waters of the state that may be caused by this project. If prevention is not possible, Contractor must implement best management practices (BMP) that minimize pollution from Contractor's operations.

Properly installed silt fences, sediment basins, and other approved sediment traps (staked straw bales, etc.) shall be used to implement these BMPs for all work, both during and after working hours. Contractor shall install all construction sediment control measures required by the Technical Specifications and Drawings. Contractor shall also comply with the substance of any permit requirements applicable to this work under state and federal law. If during construction Owner deems it necessary to install additional erosion control measures, these shall be installed by Contractor and paid for at the unit price(s) bid. Erosion control mat and straw or wood mulch shall be incorporated in site reclamation as specified.

Contractor shall submit an Erosion Control Plan for construction activities in accordance with the Submittals Section 01330. The plan shall be prepared to identify the general types of work and the types of BMPs anticipated for the entire project area. The plan shall be site specific and detail the locations and types of BMPs to be used during this project's construction activities. Information required in the plan includes, but is not limited to:

- A brief description of the project, types of work activities to be performed, and anticipated sources of sediment and erosion.
- BMPs for each work area to prevent erosion and provide sediment control. This information shall be accompanied by site sketches showing types and locations of BMPs.

- Erosion control practices for each type of work activity (i.e., stream reconstruction, Repository excavation, cover material placement, etc.). Practices shall be specific and appropriate for each activity.

I. Dust Control: Contractor shall be responsible for dust control during the Work. Contractor shall water or otherwise treat dust-generating surfaces as often as necessary to comply with all federal and state standards for airborne particulates. Prior to commencing any work, Contractor shall submit a written plan for dust control/abatement procedures, identifying at a minimum the following:

- Times and nature of dust generating activity on roads or at the project site;
- Nature of dust abatement measures to be used (i.e., watering or application of chemical treatment, etc.);
- Methods of application of dust control measures;
- Time schedule for application of dust control measures; and
- Procedures/availability of equipment to address dust control at other than scheduled times, if necessary.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with applicable local regulations for haul routes over public highways, roads, or bridges. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to the following:
   1. Building code requirements.
   2. Health and safety regulations.
   3. Utility company regulations.
   4. Police, fire department, and rescue squad rules.
   5. Environmental protection regulations.
   6. Prevention and control of air pollution.
   7. Prevention and control of water pollution.

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
   1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."

D. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 EXPLOSIVES

A. Explosives: Shall not be permitted.

1.6 PROJECT CONDITIONS

A. Access Routes: Rights-of-way for access to work from existing roads will be established by the Owner. Use only established roadways, areas, and haul routes, or temporary roadways, areas, or haul routes constructed by the Contractor when and as authorized by the Owner.

PART 2: PRODUCTS

2.1 UTILITIES

A. General: Telephone, internet service, sanitation, heat, electricity, and potable water are not available on the site and will be provided by the Contractor as needed.

2.2 MATERIALS

A. Plastic Safety Fencing: Orange plastic fencing, 4 ft minimum height.

B. Water: Provide potable water approved by local health authorities.

2.3 TOILET UNITS

A. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

2.4 PROJECT IDENTIFICATION

A. Project Site Sign: Within 30 days after Notice to Proceed, furnish and install a project sign which shall be located at the main construction entrance to the site. The size, mounting, construction, paint colors and lettering shall be as detailed on the drawings.

B. Construction Signs: Only signs to expedite deliveries, maintain traffic flow, promote safety, and caution against danger shall be erected, as necessary.

PART 3: EXECUTION

3.1 INSTALLATION

A. Toilets: Install self-contained toilet units specified in Part 2 of this specification section. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
   1. Provide separate facilities for male and female personnel.
   2. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

B. First-Aid Facilities: Make first-aid facilities and services obvious and easily available for providing emergency aid to personnel on the site.

3.2 HAUL ROUTES, ROADWAYS, PARKING AREAS, AND STORAGE/STAGING AREAS

A. Examination: Investigate the condition of available public or private roads for clearances, restrictions, bridge-load limits, bond requirements, and other limitations that affect or may affect access and transportation operations to and from the jobsite.

B. Established Roadways as Haul Routes: Use existing roads as haul routes subject to the applicable local regulations and approval of the Owner. Tracked or heavy vehicles are allowed on dirt surfaced roads. Contractor is responsible for damage caused by construction traffic.
   1. Provide and use means of removing mud from vehicle tires before entering existing paved roads. Road repair and cleanup shall be at no cost to the Owner.
   2. Minimize interference with or congestion of local traffic.
   3. Provide barricades, flagpersons, lighting, signs, and other necessary precautions for safety of the public where haul routes cross public roads.

C. Temporary Roadways and Haul Routes: Construct and maintain temporary roadways, bridges, culverts, and drainage structures required for access to serve construction areas, of a width and load-bearing capacity to provide unimpeded traffic for construction purposes and to allow unimpeded surface drainage.

1. After their completion, the roadways constructed under the contract will be reclaimed as directed by the Owner.
2. Temporary roadways and detours may be constructed, as approved by the Owner or as indicated on the drawings.

D. Temporary Parking Areas: Construct temporary parking areas for construction operations personnel. Provide additional offsite parking when site space is not adequate. Locate as approved by the Owner.

E. Storage/Staging Areas: The Contractor may construct a temporary area for trailers, equipment, and materials, located as approved by the Owner. Fencing of materials or equipment shall not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Trailers, materials, or equipment shall not be placed or stored outside the area.

F. Maintenance: Maintain haul routes, roadways, parking and storage areas, in a sound, smooth condition. Maintain the surfacing of roads and areas until completion and acceptance of all the work under this contract. Maintain the surfacing of gravel-surfaced roads and areas in a smooth condition until completion and acceptance of all work under this contract. Snow removal for convenience of the Contractor or to facilitate work operations of the Contractor is considered to be normal required maintenance and at contractor's expense.

G. Repair: Promptly repair ruts, potholes, low areas with standing water, and other deficiencies to maintain road and parking area surfaces and drainage in original or specified condition.

H. Removal: Remove materials used to construct temporary roadways, areas, and haul routes prior to contract completion.

3.3 AIR POLLUTION CONTROL

A. Air Quality Permits: Information concerning the requirements in addition to requirements for earthwork operations will be available from the Owner.

B. Responsibility: Contractor shall be responsible for damages resulting from dust originating from Contractor operations.
1. Owner may stop any construction activity contributing to air pollutant levels which are excessive or in violation of Federal, State, or local laws and additional expenses resulting from work stoppage will be responsibility of Contractor.

C. Requirements: Utilize such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.

1. Do not operate equipment and vehicles that show excessive emissions of exhaust gases until corrective repairs or adjustments reduce such emissions to acceptable levels.

2. Provide dust control and abatement during construction. Prevent, control, and abate dust pollution on rights-of-way provided by Owner or elsewhere during performance of work. Provide labor, equipment, and materials, and use efficient methods wherever and whenever required to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic, and similar conditions.

3. Provide means for eliminating atmospheric discharges of dust during mixing, handling, and storing of cement, pozzolan, and concrete aggregate.

4. Burning shall not be allowed.

3.4 WATER POLLUTION CONTROL

A. Contractor Water Pollution Violations: If noncompliance should occur, report the noncompliance to the Owner immediately (orally), with the specific information submitted in writing within 2 calendar days. Consistent violations of applicable Federal, State, or local laws, orders, regulations, or Water Quality Standards may result in the Owner stopping all site activity until compliance is ensured. The Contractor shall not be entitled to any extension of time, claim for damage, or additional compensation by reason of such a work stoppage. Corrective measures required to bring activities into compliance shall be at the Contractor's expense.

B. Intentionally left blank.

C. Intentionally left blank.

D. Stormwater Discharge Permit Associated With a Construction Site:
   1. Notice of Intent: Both the Owner and the Contractor shall sign the Notice of Intent (NOI) to obtain coverage under a stormwater general permit to control stormwater discharges from the construction site as required under section 402 of the Clean Water Act (Public Law 92-500, as amended). Contractor shall prepare and submit permit application and have responsibility to obtain permit. Costs associated with permit are incidental to the work and at the Contractor's expense.
   2. Pollution Prevention Plan: The Contractor shall prepare a Pollution Prevention Plan as required by the permit. The Contractor shall comply with all terms and conditions to obtain and maintain this stormwater discharge permit.

   3. Monitoring and Water Treatment: Contractor shall provide all monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards, and provide the recordkeeping required by the stormwater discharge permit associated with construction activity.

E. Intentionally left blank.

F. Pollution Controls: Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including State and local control requirements.
   1. Sediment and Erosion Controls: Establish methods for controlling sediment and erosion which address vegetative practices, structural control, silt fences, straw dikes, sediment controls, and operator controls as appropriate. Institute stormwater management measures as required, including velocity dissipaters, and solid waste controls which address controls for building materials and offsite tracking of sediment.

   2. Wastewater and Stormwater Management Controls: Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and erosion, and which will intercept and settle any runoff of sediment-ladened waters. Prevent wastewater from general construction activities such as drainwater collection, aggregate processing concrete batching, drilling grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods. Divert stormwater runoff from upslope areas away from disturbed areas.
      a. Turbidity prevention measures: Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life. All such wastewaters discharged into surface waters shall contain the least concentration of settleable material possible and shall meet all conditions of section 402, the National Pollutant Discharge Elimination System (NPDES) permit. Do not operate

mechanized equipment in waterbodies without having first obtained a section 404 permit, and then only as necessary to construct crossings or perform the required construction.

3. Construction Site Management: Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources. Such pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, mineral salts, and thermal pollution.
   a. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff, or can in any way encroach upon the watercourse.
   b. Place all oil or other petroleum product (hereinafter referred to collectively as oil) storage tanks at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.
   c. Diked storage areas shall be at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to the capacity of all tanks and/or containers located in each area plus a sufficient amount of freeboard to contain the 25-year rainstorm.
   d. Provide diked areas with an impermeable barrier at least 10 mils thick. Provide areas used for refueling operations with an impermeable liner at least 10 mils thick buried under 2 to 4 inches of soil.
   e. Do not use underground storage tanks.

3.5 PEST CONTROL

A. Requirements: Comply with manufacturer's labeling as to handling and application.

B. Records: Keep records of types and amounts of pesticides purchased, delivered, stored, mixed, and actually used and means of disposal of excess pesticide. Keep records current and accurate and make available for review by Owner.

3.6 SECURITY MEASURES

A. Requirements: Protect the site, materials, and operations from theft, vandalism, and unauthorized entry. Initiate program in coordination with Owner's existing program at project site. Maintain program throughout construction period until Owner's acceptance.

B. Entry Control: Restrict entrance of persons and vehicles into the project site and existing facilities. These restricted areas are designated and may be modified or changed by the Owner. Allow entrance only to authorized persons with proper identification.
   1. Maintain log of workers and visitors, make available on request.
   2. Restricted Areas: Construction personnel will not be permitted to enter established or designated restricted areas unless so authorized by the Owner. It shall be the Contractor's responsibility to ensure by appropriate and effective means that contractor's personnel shall not enter these areas unless authorized.

3.7 MAINTENANCE AND REMOVAL

A. Maintenance: Maintain temporary structures, facilities, and controls as long as needed for safe and proper completion of the work and as directed by the Owner.

B. Removal: Remove temporary structures, facilities, and controls as rapidly as progress of the work will permit and as approved by the Owner.

3.8 PROTECTION

A. Barriers: Provide earthen embankments and similar barriers around excavation and subgrade construction, sufficient to prevent flooding by runoff from heavy rains.

3.9 WASTE

A. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately form other waste by containerizing properly. Dispose of material lawfully.

3.10 CLEANUP

A. Requirements: Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

B. Restoration of Storage Area: Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used by the Contractor for the storage of equipment or material, or other use, to the original or better condition. Remove gravel used for surfacing and restore the area to its original condition, including top soil and seeding as necessary.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01505

MOBILIZATION

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Preparatory work and operations, including those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

There are no applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for record drawings.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 RECORD DRAWINGS

A. General Requirements: A complete set of full-sized prints, furnished by the Contractor for this purpose only, shall be kept at the site. As the job progresses, the Contractor shall continuously maintain record drawings of the work. The changes shall be noted legibly in red pencil or red ink. These drawings shall be submitted to the Owner for review prior to the final inspection. Should the final inspection reveal changes in the project not so noted on the record drawings, the Contractor shall record these changes on the record drawings within 5 working days of final inspection and submit the completed record drawings to the Owner. The Owner's Engineer will then prepare final record drawings in DWG and PDF electronic formats.

B. Installation Changes: Records shall be maintained by the Contractor of actual installations where at variance with the work shown, where changed, or where not otherwise located by dimension, elevation or other reference on the Contract drawings. Actual locations and elevations of equipment and components occurring within concealed areas shall be recorded by actual dimensions referenced from readily accessible and permanent building lines or monuments.

3.2 WARRANTY

A. Requirements: Materials and equipment furnished under this Contract shall be covered by the most-favorable commercial warranties the Contractor gives to any customer for such materials or equipment. The rights or remedies provided shall be in addition to, and shall not limit any rights afforded to the Government by any other clause of this Contract. With respect to all warranties, expressed or implied, from manufacturers or suppliers for materials or equipment furnished under the Contract, the Contractor shall:
   1. Obtain all warranties that would be given in normal, commercial practices.
   2. Require all warranties to be executed, in writing, for the benefit of the Government.
   3. Submit all warranties to the Owner, prior to the final inspection.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02231

CLEARING AND GRUBBING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Clearing of vegetation, and grubbing of stumps, roots, and debris; disposal of unutilized materials; and other incidental work related to preparing the site for later use.

1.2 DEFINITIONS

A. Clearing: Clearing shall consist of the trimming and cutting of obstructions and the satisfactory disposal of surface vegetation designated for removal including brush and rubbish occurring in the areas to be cleared.

B. Grubbing: Grubbing shall consist of the removal and disposal of below-surface stumps, roots larger than 3-inches in diameter, and matted roots from the designated grubbing areas.

C. Hazardous Waste: Substance likely to cause death or injury by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful; and includes, but is not limited to flammable dust, flammable fiber, combustible liquid, dangerous chemical, flammable gas, liquified flammable gas, and flammable liquid.

1.3 PROJECT/SITE CONDITIONS

A. Work Limits: As indicated on Project Drawings.

B. Burning: Shall not be permitted.

C. Landscape Preservation: Protect vegetation outside the work limits from injury. Existing brush and shrubs shall not be disturbed or damaged.

1.4 SUBMITTALS

A. None

PART 2: PRODUCTS

2.1 PREPARED PRODUCTS

A. No products, as such, are listed in this section of the specifications. It is however, the responsibility of the Contractor to supply all products to comply with this section of the specifications.

PART 3: EXECUTION

3.1 PROTECTION

A. Roads: Keep roads free of dirt and debris at all times.

B. Trees, Shrubs, and Existing Facilities: Protection shall be according to Section 01500 - Temporary Facilities and Controls.

C. Utility Lines: Protect existing utility lines that are indicated to remain from damage. Notify the Owner immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to the start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Owner at least 72 hours prior to interruption of the service.

3.2 CLEARING

A. Requirements: Contractor shall remove only those trees, large shrubs and bushes designated by the Owner for removal. Clear stumps, roots, brush, and other vegetation in areas to be graded, cut off flush with or below the original ground surface, except such vegetation indicated or directed to be left standing. Vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of existing obstructions that obtrude, encroach upon, or otherwise obstruct the work.

B. Road Improvements and Construction: The existing vegetation that is cleared and grubbed for road improvement and construction shall be windrowed close to the road for later salvage. For permanent roads, salvaged material shall be placed back onto cut/fill slopes outside the traveled roadway. For reclaimed roadways, salvaged material shall be spread evenly over the reclaimed area.

3.3 GRUBBING

A. Requirements: Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

3.4 EXPLOSIVES

A. Requirements: The use of explosives is prohibited.

3.5 DISPOSAL

A. Requirements: Material that is not to be salvaged shall be deposited as directed by the Owner.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02310

SITE GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Stripping and storage of topsoil, excavating, filling, grading, and other related work to prepare the site.

1.2 DEFINITIONS

A. Unclassified Excavation: Shall consist of the material excavation and placement regardless of its nature.

B. Rock Excavation: Removal of material shall be considered rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of 145 kW (195 net horsepower), with a rear-mounted, heavy-duty, single-tooth, ripping attachment.

C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 145 kW (195 net horsepower) or less shall be considered common excavation.

D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

E. Fill Material: Shall be mineral soil free from peat, frozen material, brush, trees, roots over 2 inches in diameter and rocks over 6 inches in greatest diameter obtained from site during excavation.

F. Topsoil: Surface soil approximately 6 inches in depth that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch in diameter.

1.3 QUALITY ASSURANCE

A. Failure Criteria: Not limited to the following:
   1. Formation of pools of moisture where positive drainage is indicated on the drawings.
   2. Settlement of fill.
   3. Flow of moisture toward, or entrapment against, structures and working surfaces.

1.4 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Do not attempt to grade frozen or saturated material. Water dry material to prevent dust.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: See definitions.
   1. Silt Barrier: A silt barrier shall be constructed to prevent silt from polluting existing streams. The silt barrier shall consist of straw bales or a geosynthetic silt fence.

PART 3: EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify the grade elevations existing on the site. Notify the Owner immediately when adjustments are required to provide finish elevations indicated. Site drainage shall be considered of prime importance.

3.2 PREPARATION

A. Clearing: Section 02231 - Clearing and Grubbing.

B. Stripping Topsoil: Strip and stockpile topsoil in the location designated by the Owner.

C. Scarifying: Sod and vegetation shall be removed from the surface upon which the fill shall be placed. The cleared surface shall be completely broken up by scarifying to a minimum depth of 6 inches. Scarifying furrows shall be a maximum of 3 feet apart and shall be parallel to the center line of the fill. No fill materials shall be placed upon unapproved surface.

3.3 INSTALLATION

A. Excavation: Section 02315 - Excavation and Fill.

B. Grades: When not otherwise indicated shall be level, or uniform slopes between points where elevations are given, or between such points and existing finished grades. Abrupt change in slopes shall be rounded.

C. Compaction Methods: Fill material shall be spread over the full area of the cross section of the fill to a maximum loose layer thickness of 9 inches. Compact according to Section 02315 - Excavation and Fill before the next layer is spread. During placing and compacting of the fill material, the optimum moisture content shall be maintained by wetting or drying as required.

D. Frozen Material: Fill shall not be placed when either the material or the surface on which it is to be placed is frozen.

E. Homogeneous Mass: Successive loads of material shall be dumped on the earthfill to produce the best practicable distribution of the material. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.

F. Topsoil: Topsoil to be used for reclamation shall be spread uniformly over compacted material to grades at the depth shown on the drawings and compacted firmly in place. Upon completion of grading operations, spread topsoil from the stockpile onto areas disturbed by grading operations.

3.4 FIELD QUALITY CONTROL

A. Testing: Owner will arrange for a certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Compaction: Fill material shall be compacted to a minimum density of 95 percent of the maximum dry density obtained by ASTM D698. Fill material shall be placed to within plus or minus 2% of optimum moisture content as determined by ASTM D698.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02315

EXCAVATION AND FILL

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, borrow excavation, embankment construction, placement, and disposal of materials as shown on the drawings.

B. Related Sections

1. General Information and Requirements	Section 01009
2. Testing Laboratory Services	Section 01458
3. Clearing and Grubbing	Section 02231
4. Borrow Excavation	Section 02317
5. Watering	Section 02339

1.2 DEFINITIONS

A. Unclassified Excavation: Consists of the material excavation and placement regardless of its nature.

B. Rock Excavation: Removal of material is rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of [195] net horsepower, with a rear-mounted, heavy-duty, single-tooth, ripping attachment.

C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 195 net horsepower or less shall be considered common excavation.

D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

E. Fill Material: Shall be mineral soil free from peat, frozen material, brush, trees, roots over 2 inches in diameter and rocks over 6 inches in greatest diameter obtained from site during excavation.

F. Topsoil: Surface soil approximately 6 inches in depth, unless otherwise specified, that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch in diameter.

1.3 PROJECT/SITE CONDITIONS

A. Excess Material: Usable excess material excavated shall be used in the embankment construction before the use of borrow is allowed. Borrow wasting is not permitted.

B. Borrow Material Source: Obtain borrow material from the source or sources shown on the drawings, subject to use restrictions or requirements as noted.

C. Fencing: When fencing is removed, replace the fencing to the same condition as it was before removal. The Contractor shall be responsible for the livestock confinement when a portion of a fence is removed.

D. Drainage of Borrow Pits: Borrow pits and waste or disposal areas shall be excavated so that water will not collect and stand.

E. Calculation of percent shrinkage/swell to be established by Contactor at Contractor's risk and shall not be the basis of any extra work claim.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: See definitions.

B. Fill Material: Shall be obtained from the common excavation or from designated borrow areas. Material from excavation shall be used unless it contains ice or frozen earth, debris, high moisture content, or is specified in other sections to be replaced. Materials removed in clearing and grubbing shall not be used for backfill or embankment.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing and Grubbing: Section 02231 - Clearing and Grubbing.

B. Borrow Area: Notify the Owner sufficiently in advance of opening borrow areas. This allows cross section determination of elevations and measurements of the ground surface after stripping. Also, the borrow material can be tested before being used. Allow sufficient time for testing the borrow. Borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavation has been completed. Do not excavate beyond the dimensions and elevations established, and no material shall be removed prior to staking out and cross-sectioning of the site. The finished borrow areas shall be approximately true to the line and grade established.

C. Prewatering: Excavation areas and borrow pits may be prewatered before excavating the material. The area to be excavated shall be moistened to the full depth from the surface to the bottom of the excavation. The application of water shall be controlled so that the excavated material will be near the optimum moisture content as specified in paragraph 3.3A Testing, below. When necessary, prewatering shall be supplemented to assure that embankment material and backfill material moisture content comply with paragraph 3.3A Testing, below.

D. Preparation for Grading: Prior to beginning embankment operations in an area, necessary clearing and grubbing in that area shall have been completed and accepted by the Owner. No embankment materials shall be placed upon an unapproved surface.
   1. Embankments: When embankments are to be constructed, the cleared surface shall be completely broken up by plowing or scarifying to a minimum depth of 6 inches. Scarifying or furrows shall be a maximum of 3 feet apart, and shall be parallel to the centerline of the embankment. This area shall then be compacted beginning with the first lift, as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction.

3.2 INSTALLATION

A. Explosives: The use of explosives is prohibited.

B. Excavation: Excavate where shown on the drawings and typical sections, unless staked otherwise. Excavate on a straight grade between the control points shown on the drawings unless staked otherwise. Existing structures which are disturbed or damaged by construction activity shall be reset, repaired, or replaced at the Contractor's expense.

C. Subgrade Compaction: In areas where earthfill, or embankments are to be constructed and in areas where excavation exposes the subgrade surface upon which fill is placed will be constructed, the subgrade shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before embankment construction begins.

D. Disposal of Materials: Excess and unsuitable material, including rock and boulders that cannot be used in embankments, shall be disposed of as directed by Owner.

E. Use of Borrow Material: Do not use borrow material until after the materials obtained from required excavation have been placed in the fill, unless otherwise directed by the Owner. When more borrow is placed than is required, and required excavation is wasted, the waste shall be replaced in the borrow area at the Contractor's expense.

F. Overburden: Overburden shall be stripped from borrow pits and stockpiled for later use. The pit shall be neatly sloped and trimmed. Side slopes shall be flattened to a 4:1 slope. Stockpiled overburden material shall then be spread uniformly over the sides and bottom of the pit area, and vegetation established.

G. Imported Borrow: Section 02317 - Borrow Excavation.

H. Fill Material: Shall be spread over the full width of the cross section of the embankment or fill section to a maximum compacted thickness of 9 inches, and shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before the next layer is spread. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.

I. Frozen Material: Shall not be placed, nor be placed upon a frozen surface.

3.3 FIELD QUALITY CONTROL

A. Testing: The Owner will arrange for a certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Moisture Content:
   1. During placing and compacting of fill material, the optimum moisture content (-2 percent to +2 percent) as determined by ASTM D698, unless otherwise noted on the project drawings, and shall be maintained by wetting or drying.

C. Compaction:
   1. The fill material shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by ASTM D698 unless otherwise noted on the project drawings.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02316

DEWATERING

PART 1: GENERAL

1. SUMMARY

A. Section includes: All work associated with required dewatering activities for all components of work.

1.2 WORK INCLUDES

A. Maintain the foundations, excavations and other parts of the work free from water as required for constructing each part of the work.

B. Remove all components of dewatering system, if required, after dewatering is complete.

PART 2: PRODUCTS

There are no requirements

PART 3: EXECUTION

3.1 GENERAL

A. It shall be the Contractor's responsibility to evaluate the subsurface conditions at the project site with respect to required dewatering.

B. The Contractor shall, at all times during construction, provide ample means and devices to remove promptly and dispose of properly all water entering excavations and keep the bottoms of the excavations firm and free of standing water until the structures to be built therein are completed and/or the backfill to be placed therein has been placed. The pumping and dewatering operations shall be carried out in such a manner that no disturbance to the bearing soil or rock or to soil or rock supporting any other work will result from the dewatering operations. The dewatering discharge shall not cause siltation or other negative environmental impact on natural waterways or other property; such discharge shall be in accordance with applicable Federal, state, and local regulations. At dewatering discharge locations, hay-bales, silt barriers or other control measures, as approved by the Owner, shall be installed to control and prevent siltation.

C. The dewatering system shall be operated continuously, as necessary, to prevent flotation of partially completed structures or other work.

3.2 DEWATERING REQUIREMENTS

A. Design, furnish, install, maintain, and operate a dewatering system which shall prevent loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottoms of excavations so that every phase of the work can be performed in the dry. The dewatering operations shall be such that the bottoms of all excavations shall be kept at all times firm, and in all respects acceptable to the Owner as good foundation.

3.3 INSTALLATION AND OPERATION

A. The location of every element of the dewatering system shall be such that interference with excavation and construction activity is minimized. Locations shall be subject to approval by the Owner's Representative.

B. When the dewatering system does not meet the specified requirements, and as a consequence loosening or disturbance of the foundations strata, instability of the slopes or damage to foundations or structures occurs, the Contractor shall supply all materials, labor, and perform all work for restoration of foundation soil, fill soil, slopes, foundations, or structures, to the satisfaction of the Owner's Representative, at no cost to the Owner.

3.4 REMOVAL

A. All elements of the dewatering system(s) shall be removed from the site at the completion of the dewatering work.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02317

BORROW EXCAVATION

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, loading, hauling, and stockpiling imported borrow materials for the fill.

B. Related Sections

1.	General Information and Requirements	Section 01009
2.	Excavation and Fill	Section 02315
3.	Watering	Section 02339

1.2 PROJECT/SITE CONDITIONS

A. Excess Material: Useable excess material excavated as a result of other section work shall be used in embankment construction as approved by the Owner. Wasting borrow is not permitted.

B. Borrow Material Source: Obtain borrow material from the source or sources shown on the drawings, subject to use restrictions or requirements as noted.

PART 2: PRODUCTS

2.1 MATERIALS

A. Borrow: Borrow shall be selected to meet the requirements and conditions for which the particular fill is intended. The borrow material shall be free of roots, trash, and other objectionable materials. Borrow shall be approved by the Owner in writing.

B. Topsoil for Reclaimed Areas: Material excavated from the designated borrow sources can be used for topsoil for reclaimed areas if approved by the Owner if produced to meet the requirements as specification in Section 02726 – Topsoil for Reclaimed Areas.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing and Grubbing: Strip from the borrow area all brush, stumps, roots, and harmful or undesirable materials.

B. Borrow Areas: The borrow excavation slope shall not exceed 2:1. Vertical slopes are not allowed.

3.2 RECLAMATION

A. Borrow areas shall be reclaimed such that surface water will drain.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02319

MULCH

PART 1: GENERAL

1.1 SUMMARY

A. Description: This work shall consist of covering and processing specified seeded areas with a mulch of the stipulated materials.

1.2 SUBMITTALS

A. The following submittals are required:

1. Manufacturer's specifications and material content for mulch products.
2. Manufacturer's recommended application methods and rate.

PART 2: PRODUCTS

2.1 GENERAL

A. Materials: Mulching materials used on the project shall be those described hereafter.

1. Grass Hay: This type of mulch material shall be composed primarily of perennial grasses at least 10 inches. The grass hay mulch shall contain greater than 70% grass by weight and shall not contain a total greater than 5% alfalfa, crested wheatgrass or yellow sweet clover. Grass hay is subject to the Owner's approval and must be certified "Noxious Weed Seed Free" hay provided by a certified supplier. Chopped or ground material is not acceptable. The mulch material is not acceptable if it is musty, moldy or rotted, or if it contains seedbearing stalks of noxious weeds. It shall be free of stones, dirt, roots, stumps or other foreign material.

PART 3: EXECUTION

3.1 GENERAL

A. General: Mulch must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. If the Contractor does not mulch within 24 hours after seeding, the Contractor may be required to re-seed the project at no additional cost to the Owner. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground as long as it doesn't compact the surface. Mulch shall not be applied to snow-covered ground surfaces.

Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Areas not to be mulched shall be determined by the Owner. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the Contractor, to the satisfaction of the Owner.

Additional mulching may be required in accordance with summer erosion control procedures.

The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow or other acceptable means to remove the tracks.

B. Application of Native Hay Mulch: Native hay shall be uniformly spread at a rate approved by the Owner for the intended purpose. Unless otherwise specified by the Owner, hay shall be anchored into the seedbed by using a mulch crimper. Hay shall have a minimum length of 10 inches shall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.

The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions: 1/4-inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done along the contour of the slope.

C. Finishing: Prior to final acceptance of the project, the Contractor shall immediately remulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before remulching. The operations described in this paragraph shall be at the Contractor's expense if the damage is due to his negligence.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02339

WATERING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Distributing and applying water required for excavation, compaction of fill, backfilling, dust control, roadways, parking areas and watering of seeded areas.

1.2 PROJECT/SITE CONDITIONS

A. Water Source: The Owner will designate a source of water.

PART 2: PRODUCTS

2.1 MATERIALS

A. Water: Water shall be obtained from the Owner supplied source.

2.2 EQUIPMENT

A. Requirements: Provide necessary pumping equipment, piping, tanks, water trucks, and measuring devices. Water trucks shall be equipped with a spray bar of adequate capacity and design to ensure uniform application of water in the amounts designated. Measuring devices shall be approved by the Owner.

PART 3: EXECUTION

3.1 APPLICATION

A. Compaction: Water may be applied by sprinkling to either the borrow area or the fill. Water shall be applied uniformly to each layer of fill, as needed, to obtain the optimum moisture content determined by ASTM D698. The final moisture content shall be as specified.

B. Seeding and Dust Control: Water shall be applied to those areas identified by the Owner as dust control or seeded areas.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02726

TOPSOIL FOR RECLAIMED AREAS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes:

1. Strip and stockpile topsoil from areas within the work site and from other areas designated by the Owner.
2. Spread stockpiled topsoil on prepared reclaimed disturbed areas as designated by the Owner.

1.2 RELATED WORK

A. Section 02923: Seeding

PART 2: PRODUCT

2.1 TOPSOIL

A. Topsoil for reclaiming disturbed areas shall be developed from stripping of topsoil in the work areas or as designated by the Owner.

2.2 UNACCEPTABLE TOPSOIL MATERIALS

A. Subsoils (no B or C horizon soils)

B. Coarse sand and gravel

C. Stiff clay, hard clods or hard pan soils

D. Rock larger than 3-inch in any dimension

E. Trash, litter or refuse

F. Topsoil containing greater than 5 percent rock.

PART 3: EXECUTION

3.1 GENERAL REQUIREMENTS

A. Place topsoil just before seeding if it can be seeded within the upcoming fall seeding window.

B. Do not strip or handle topsoil when it is wet or frozen.

C. Work topsoil only when it can be left in a friable, loose and crumbly state.

D. On steep cut slopes requiring the placement of topsoil, it may be necessary to place the topsoil as the slope is constructed.

3.2 TOPSOIL STRIPPING

A. Strip the topsoil only from areas identified on the plans or approved by Owner.

B. Remove and dispose of any roots larger than 2-inches in diameter or 12-inches in length.

C. Stockpile stripped topsoil at locations acceptable to the Owner and so that placement or activity around the stockpile does not damage any existing trees or shrubs.

D. Grade to minimize erosion on and around the stockpiles.

3.3 SPREAD STOCKPILED TOPSOIL

A. Clear area to receive topsoil of all trash, debris, weeds, and rock 3-inch or larger, and dispose of objectionable material in an approved manner.

B. Place and spread the stockpiled topsoil over the prepared slopes to the plan depths. A minimum of 6-inches is required in all disturbed areas unless otherwise indicated on the Drawings.

C. Disc or harrow the prepared areas following topsoil placement. When discing or harrowing slopes, follow the contour to help prevent erosion.

D. Provide a crumbly soil texture.

3.4 COMPCATION

A. Cover soil has no compaction requirement.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02726

TOPSOIL FOR RECLAIMED AREAS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes:

1. Strip and stockpile topsoil from areas within the work site and from other areas designated by the Owner.
2. Spread stockpiled topsoil on prepared reclaimed disturbed areas as designated by the Owner.

1.2 RELATED WORK

A. Section 02923: Seeding

PART 2: PRODUCT

2.1 TOPSOIL

A. Topsoil for reclaiming disturbed areas shall be developed from stripping of topsoil in the work areas or as designated by the Owner.

2.2 UNACCEPTABLE TOPSOIL MATERIALS

A. Subsoils (no B or C horizon soils)

B. Coarse sand and gravel

C. Stiff clay, hard clods or hard pan soils

D. Rock larger than 3-inch in any dimension

E. Trash, litter or refuse

F. Topsoil containing greater than 5 percent rock.

PART 3: EXECUTION

3.1 GENERAL REQUIREMENTS

A. Place topsoil just before seeding if it can be seeded within the upcoming fall seeding window.

B. Do not strip or handle topsoil when it is wet or frozen.

C. Work topsoil only when it can be left in a friable, loose and crumbly state.

D. On steep cut slopes requiring the placement of topsoil, it may be necessary to place the topsoil as the slope is constructed.

3.2 TOPSOIL STRIPPING

A. Strip the topsoil only from areas identified on the plans or approved by Owner.

B. Remove and dispose of any roots larger than 2-inches in diameter or 12-inches in length.

C. Stockpile stripped topsoil at locations acceptable to the Owner and so that placement or activity around the stockpile does not damage any existing trees or shrubs.

D. Grade to minimize erosion on and around the stockpiles.

3.3 SPREAD STOCKPILED TOPSOIL

A. Clear area to receive topsoil of all trash, debris, weeds, and rock 3-inch or larger, and dispose of objectionable material in an approved manner.

B. Place and spread the stockpiled topsoil over the prepared slopes to the plan depths. A minimum of 6-inches is required in all disturbed areas unless otherwise indicated on the Drawings.

C. Disc or harrow the prepared areas following topsoil placement. When discing or harrowing slopes, follow the contour to help prevent erosion.

D. Provide a crumbly soil texture.

3.4 COMPCATION

A. Cover soil has no compaction requirement.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02821

CHAIN-LINK FENCES AND GATES

PART 1: GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Galvanized steel chain-link fabric
2. Galvanized steel framework

1.2 SUBMITTALS

A. Product Data: Material descriptions, construction details, and dimensions of individual components and profiles.

B. Shop Drawings: Show locations of fence, each gate, posts, rails, and gate swing. Indicate materials, dimensions, size, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and detail of post anchorage and attachment and bracing.

C. Product Certificates: Signed by manufacturers of chain-link fences and gates certifying that products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fence and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of success in-service performance.

B. Source Limitations for Chain-Link Fences and Gates: Obtain each color, grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2: PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. Steel Chain-Link Fence Fabric: Height of 6 feet unless otherwise indicated on Drawings. Provide fabric fabricated in one-piece widths. Comply with CLFMI's "Product Manual" and with requirements indicated below:

1. Mesh and Wire Size: 2-inch mesh, 0.148-inch (nominal 9 gage) diameter.

2. Zinc-Coated Fabric: ASTM A 392, with zinc coating applied to steel wire mesh fabric after weaving with following minimum coating weight.
   a. Class 2: Not less than 2 oz./sq. ft. of uncoated wire surface.

2.2 INDUSTRIAL FENCE FRAMING

A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F 1083. Comply with ASTM F1043, Material Design Group 1A, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. zinc; and the requirements for heavy industrial fence.

B. End, Corner, and Pull Posts: 2.875 inch actual OD, Type I or II steel pipe.

C. Line and Intermediate Rails: 2.375 inch actual OD, Type I or II steel pipe.

D. Bottom Rails: 1.660 inch actual OD, Type I or II steel pipe. Fabricated in longest practical lengths available, with swedged-end or fabricated for expansion-type coupling, forming continuous rail along chain-link fabric.

E. Post Brace Rails: 1.660 inch actual OD, Type I or II steel pipe. Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.

2.3 TENSION WIRE

A. General: Provide horizontal tension wire extended along the top of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire complying with ASTM A 824 and the following.

1. Coating: Type II, zinc coated (galvanized) with the following minimum coating weight:
   a. Class 2: Not less than 1.2 oz./sq. ft. of uncoated wire surface.

2.4 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F900 for the swing-gate types indicated on the Drawings.

B. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1083 and ASTM F1043 for materials and protective coatings.

C. Frames: Fabricate members from either round galvanized steel tubing having minimum 1.90 inch actual OD, or 2 inch square steel tubing weighing 2.52 lb. per sq. ft.

1. Corner Construction: Welded

D. Braces: Diagonal cross-bracing of 5/16-inch-diameter, adjustable truss rods for panels 5 feet wide or wider.

E. Gate Posts: Fabricate members from round galvanized steel pipe with actual outside dimension and minimum weight for the following leaf widths:

1. Up to And Including 6 Feet: 2.875 inches, 4.64 lbs. per ft.
2. Over 6 Feet, Up To and Including 12 Feet: 4.0 inches, 8.65 lbs. per ft.
3. Over 12 Feet, Up To and Including 18 Feet: 6.625 inches, 18.02 lbs. per ft.
4. Over 18 Feet, Up To And Including 24 Feet: 8.625 inches, 27.12 lbs per ft.

F. Hardware: Provide galvanized hardware accessories for each gate according to the following:

1. Latches permitting operation from both sides of the gate, hinges, and, for each gate leaf more than 5 feet wide, keepers. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
2. Hinges: Size and material to suit gate size, offset to permit 180-degree gate opening. Provide 1-½ pair of hinges for each leaf over 6-foot nominal height.
3. Keeper: Provide a keeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.
4. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete and designed to engage a center drop rod or plunger bar. Include a locking device and padlock eyes as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

2.5 FITTINGS

A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

B. Post and Line Caps: Hot-Dip galvanized pressed steel or hot-dip galvanized cast iron. Provide weather tight closure for each post. Provide line post caps with loop to receive tension wire.

C. Rail and Brace Ends: Hot-Dip galvanized pressed steel or hot-dip galvanized cast iron. Provide rail ends or other means for attaching rails securely to each gate, corner, pull, and end post.

D. Rail Fittings: Rail Clamps: Hot-dip galvanized pressed steel. Provide line and corner boulevard clamps for connecting intermediate or bottom rails in the fence line to line posts.

E. Tension and Brace Bands: Hot-dip galvanized pressed steel.

F. Tension Bars: Hot-dip galvanized steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F 626:

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
   a. Hot-Dip Galvanized Steel: 0.106-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

2.6 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C150 Type II modified or Type V, aggregates complying with ASTM C 33, and potable water for ready-mixed concrete complying with ASTM C 94. Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94.

1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

PART 3: EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance. Do not begin installation before final grading is completed, unless otherwise permitted by Architect/Engineer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. General: Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soils.

C. Post Setting: Drill or hand excavate holes for post foundations in firm, undisturbed or compacted soil. Set terminal posts, corner posts, pull posts (bracing post), gate posts and line posts in concrete footings to required depths. Protect the portion of the post above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Verify placement and finishing operations until concrete is sufficiently cured.

D. Dimension and Profile: As indicated on Drawings.

E. Exposed Concrete and Footings: Extend concrete 1 inch above grade, smooth and shape to shed water.

3.4 CHAIN-LINK INSTALLATION

A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

B. Line Posts: Space line posts uniformly a 10 feet o.c., unless otherwise directed.

C. Post Bracing Assemblies: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate post and at both sides of corner and pull posts. Locate horizontal braces at mid-height of fabric on fences with top rail at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

D. Tension Wire: Install according to ASTM D 567, maintaining plumb position and alignment of fencing. Pull wire taught, without sags. Fasten fabric to tension wire with 0.120-inch hog rings of same material and finish as fabric wire, spaced at a maximum of 24-inches o.c. Install tension in wire in locations indicated before stretching fabric. Install tension wire through post cap loops.

E. Intermediate Rails: Install in one piece at post-height center span, spanning between posts, using fittings, special offset fittings, and accessories.

F. Bottom Rails: Install, spanning between posts, using fittings and accessories.

G. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taught and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15-inches o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing. Tie fabric to line posts 12 inches o.c. and to the braces 24 inches o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. General: Install Gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using temper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02923

SEEDING

PART 1: GENERAL

1.1 SUMMARY

A. This work shall consist of ground surface preparation; furnishing, applying and incorporating fertilizer into the soil; furnishing and planting seed; mowing; tracking; and cleanup. The work includes permanent seeding.

1.2 SUBMITTALS

A. Certificate of Indigenous Seed: Indigenous seeds are the seeds of those plants that are naturally adapted to an area where the intended use is for revegetation of disturbed sites. These species include grasses, forbs, shrubs and legumes. The Contractor must supply the Owner with all seed tags and a certification from the supplier stating that the seed complies with all Wyoming and federal seed laws.

1.3 DELIVERY AND STORAGE

A. Seed: Deliver seed in original sealed, labeled, undamaged containers.

PART 2: PRODUCTS

A. Indigenous Seed. All seed shall comply with and be labeled in accordance with the Wyoming and federal seed laws. Each container of indigenous seeds sold in this state for sowing purposes must bear a conspicuous, unaltered label or tag, plainly written or printed in English. Bulk sales must be accompanied by the required label information which must be given to the seed purchaser. The following information must be included on a label:

a. name and address of seed labeler;
b. lot number identification;
c. germination rate and date of germination test or a notation of the year for which the seed was packaged for sale;
d. state or country of origin; and,
e. seed kind or variety.

In addition to the required label information listed above, and any information required by rule established by the Department of Agriculture, the following information shall either be included on the label or provided to the Owner:

a. the statement "Labeled only for reclamation purposes":
b. the common name, genus, species and subspecies, when applicable, including the name of each kind of seed present in excess of 5%. When two or more kinds of seed are named on the label the label shall specify the percentage of each. When only one kind of seed is present in excess of 5% and no variety name or type designation is shown, the percentage must apply to seed of the kind named. If the name of the variety is given, the name may be associated with the name of the kind. The percentage in this case may be shown as "pure seed" and must apply only to the seed of the variety named;

c. the approximate percentage of viable seed, together with the date of test. When labeling mixtures, the percentage viability of each kind shall be stated;
d. the approximate percentage by weight of pure seed, meaning the freedom of seed from inert matter and from other seeds;
e. the approximate percentage by weight of sand, dirt, broken seeds, sticks, chaff and other inert matter;
f. the approximate total percentage by weight of other seeds;
g. the name and approximate number of each kind of species of prohibited and restricted noxious weed seeds occurring per pound of seed;
h. the full name and address of the person, firm or corporation selling the seed;

Seed shall contain no prohibited noxious weed seed. The seed shall contain no restricted noxious weed seed in excess of the maximum numbers per pound as specified by Wyoming statute or the appropriate County Weed Board, whichever is more stringent. The number of seed allowed per pound, for all other noxious weed seeds shown on the "restricted list" will be zero.

Seed shall be grown in the North American continent above 41 degrees north latitude. Known varieties whose origin is above the 41st parallel but grown below are acceptable. All seed shall be a standard grade adapted to Wyoming conditions. Seed which has become wet, moldy or otherwise damaged will not be accepted.

Calculations of pure live seed may be made on the basis of either a germination test or a tertrazolium test in addition to the purity analysis. Seed shall be applied on a pure live seed basis. The quantity of pure live seed in a 100 lb. container shall be determined by the formula: 100 multiplied by germination percentage and this product multiplied by the purity percentage. (For example, if the seed is 85% pure and test 90% germination, then a 100 lb. container would contain 76.5 lbs. of pure live seed.

When legumes are seeded, inoculants specified by the Special Provisions shall be used.

B. Water. Water used for seeding shall be of irrigation quality and free of impurities that would be detrimental to plant growth. Water shall be obtained in accordance with section 02339 -- WATERING.

PART 3: EXECUTION

A. General. Areas to be seeded shall be completed, in reasonable conformity, to specified line and grade prior to seeding and fertilizing and approved by the Owner.

Slopes and areas finished during the period of October 15 through April 30, depending on seeding zone, shall be topsoiled and permanently seeded within this time period. The Contractor must obtain Owner's permission to commence topsoil placement and seeding operations. Slopes and areas finished during the period May 1 through October 14 shall be topsoiled, and mulched or otherwise treated as specified. The permanent seeding of these areas shall then commence during the fall at a time approved by the Owner. The Contractor shall be required to mulch all permanently seeded topsoil area within 15 days of topsoil placement.

Application rates for permanent seeding are shown in the following table.

Pure Live Seed Kind	PLS (Pounds per Acre)
Western wheatgrass	4.0
Pubescent wheatgrass	3.2
Bozoisky Russian Wild Rye	3.2
Revenue Slender Wheatgrass	2.8
Intermediate Wheatgrass	2.8
Total	16.0

Seeding of the finished slopes shall require repeated seeding operations until approved by the Owner, and shall not be construed to mean that the required finishing, topsoiling, and seeding may be done only once at the convenience of the Contractor. Any additional move-in required will not be paid for separately as the cost thereof shall be absorbed in the Contract unit price for seeding.

It is necessary, insofar as practicable and feasible, as determined by the Owner, that the seedbed surface, at the time of application of seeds, not be excessively wet, snow-covered, or frozen. The soil surface should be prepared to provide an acceptable seedbed to a depth of 6" that is not compacted and reasonably free of large aggregates and surface crusts. The seedbed should be left in a relatively rough condition to reduce overland flow and promote the infiltration of water. All seedbed preparation operations shall be oriented across slope (i.e. along the contour). The Contractor shall treat such areas, as required by the Owner, to attain, as nearly as practicable, the condition described.

If seeding is hampered due to standing vegetation, the vegetation shall then be mowed and left lay after seeding. Mowing shall be done, where terrain permits, with equipment using a cutting blade which rotates in a plane parallel to the ground. Whether alive or dead, the vegetation shall be removed if it will prevent good seeding practice.

Excessively tight or compacted soils shall be loosened to the minimum depth of 6 inches. Discing, harrowing, or tilling shall be done along the contour, unless otherwise approved by the Owner. Compaction of the soil, when required, shall be performed by equipment which will produce a uniform rough textured surface ready for seeding and mulching. Compacting of loose soils may be required by the Owner.

Existing structures and facilities shall be adequately protected and any damage done by the Contractor shall be repaired or adjusted to the satisfaction of the Owner.

B. Seed Distribution

1. General. Seed shall be applied to the conditioned seedbed no longer than 48 hours after the seedbed has been conditioned. The preferred method of seeding will be by drill seeding with a rangeland drill. Custom seeders modified to handle native seed may also be appropriate, but must be approved by Owner. Alternative seeding methods (e.g. broadcast seeding) may be necessary for cover materials that have high content of rock fragments or on steep slopes.

   Broadcast or hydraulic seeding methods shall not be used during adverse weather as determined by the Owner.

   The applied seed, regardless of the method of application, shall not be covered by a soil thickness greater than ¼ inch in depth.

2. Seeding by Drill. Seeding equipment used for applying grass seed must be designed, modified or equipped to regulate the application rate and planting depth of grass seed. If equipment for sowing cover crop seed is not equipped with press wheels, the seed shall be compacted with a cultipacker immediately after the ground has been drilled. Seed must be uniformly distributed in the drill hopper during the drilling operation. Acceptable drills are: custom seeders, furrow drills, disc drills, no till drills or other drills approved by the Owner. All grass establishment equipment shall be operated normal to the slope drainage.

   Planting depth shall be regulated by depth bands or coulters. The drill box shall be partitioned by dividers no more than 24 inches apart, in order to provide for more even distribution on sloping areas. A drill shall be no wider than the width of the area over which it is to operate.

   The rows of planted seed shall be a maximum of 8 inches apart and shall run along the contour of the slope.

   The application rate may be reduced to half the broadcast seeding rate specified herein.

3. Broadcast Seeding. Seeding by hand or mechanical broadcasting will be permitted on areas inaccessible to drills or impractical to seed by other prescribed methods. Broadcast seeding requires the approval of the Owner. Broadcast seeding should be followed by a dragging operation (cyclone fence, chain, tires, etc.) to lightly cover seed with soil.

4. Hydraulic Seeding. When using the hydraulic seeding method, the Contractor must provide 1 pound of wood fiber or organic mulch per each 3 gallons of water in the hydraulic seeder as a cushion against seed damage. The mulch used as a cushion may be part of the total required mulch with the remainder applied after the seed is in place.

   When hydraulically applying mulch in a separate operation, the Contractor may mix the seed with the fertilizer if his hydraulic seeding equipment is capable of uniformly mixing water, fertilizer and seed – in that order – and power blowing or spraying the mixture uniformly over the seedbed. THIS OPTION MAY ONLY BE APPLIED ON SLOPES STEEPER THAN 2:1. After blending, the slurry shall be applied to the seedbed within 45 minutes after the seed has been added to the water/fertilizer mixture. If the slurry cannot be applied within the specified 45 minutes, it shall be fortified, at no cost to the Owner, with the correct ratio of seed to the remaining slurry and a new 45-minute time frame established for applying the fortified mixture.

   The Contractor will be required to use extension hoses to reach the extremities of slopes.

   The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow, or other acceptable means to remove the tracks.

C. Tracking. Tracking shall be accomplished using a tracked vehicle equipped with grousers sufficient to groove the surface to at least ½ inch. The tracking vehicle shall be operated so as to completely cover the surface with grouser marks. All grouser's marks shall run perpendicular to the natural slopes. The tracking vehicle shall be operated alternatively between forward and reverse on each pass to eliminate damage to the seedbed resulting from 180 degree skid turns.

   If the area is seeded by hydraulic methods, tracking of the slopes shall be done at such time when the surface has had sufficient time to dry. The length of time established will be at the discretion of the Owner.

D. Owner Acceptance: The Contractor shall maintain and protect all planted areas until final acceptance. Final acceptance will not be made until an acceptable uniform stand of vegetation is

established. Upon acceptance by the Owner, the Owner will assume responsibility for maintenance.

Any portion of the areas of planting which fail to show a uniform stand of vegetation shall be replanted as before, except commercial fertilizer shall be applied at one-half the original rate. Planting shall be repeated until an acceptable stand of vegetation is provided.

Contractor shall guarantee all work and materials for a period of one year after completion of the seeding work. During the guarantee period, vegetation which dies shall be replaced by and at the expense of the Contractor. Replacement made under the Contractor's guarantee shall be covered by a like guarantee for a period of one year after completion of the replacement.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02372

GEOMEMBRANE LINER

PART 1: GENERAL

1.1 SUMMARY

A. This specification includes furnishing and installing HDPE geomembranes with a formulated sheet density of 0.940 g/cm or greater. Geomembranes with both smooth and textured surfaces are included.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 638, Standard Test Method for Tensile Properties of Plastics.
   2. D 751, Standard Test Methods for Coated Fabrics.
   3. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   4. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
   5. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
   6. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   7. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
   8. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
   9. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
   10. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
   11. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
   12. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
   13. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
   14. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
   15. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
   16. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
   17. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
   18. D 5820, Test Method for Air Testing.
   19. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
   20. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
   21. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

B. Geosynthetic Research Institute (GRI):
   1. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
   2. GRI GM 9, Cold Weather Seaming of Geomembranes
   3. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet

4. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
5. GRI GM 14, Test Frequencies for Destructive Seam Testing

1.3 SUBMITTALS

A. Submit under provisions of Section 01300, Submittals.

B. Submit the following to the Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:
   1. Documentation of manufacturer's qualifications as specified in subsection 1.4A of this Section.
   2. Manufacturer's Quality Control program manual or descriptive documentation.
   3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.
   4. Sample of the material.
   5. Documentation of Installer's qualifications, as specified below and in subsection 1.04B of this Section.
      a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
      b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
      c. Quality Control Program.
   6. Example Material Warranty and Liner Installation Warranty complying with subsections 1.07 and 1.08 of this Section.
   7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements for the project.

C. Shop Drawings
   1. Submit copies of shop drawings for Owner's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner. Butt seams on a slope, if allowed, should be staggered.
   2. Placement of geomembrane will not be allowed to proceed until Owner has received and approved the shop drawings.

D. Additional Submittals (In-Progress and at Completion)
   1. Manufacturer's warranty (refer to subsection 1.7).
   2. Geomembrane installation warranty (refer to subsection 1.8).
   3. Daily written acceptance of subgrade surface (refer to subsection 3.1.C).
   4. Low-temperature seaming procedures if applicable (refer to subsection 3.3.A).
   5. Prequalification test seam samples (refer to subsection 3.5.A.6).
   6. Field seam non-destructive test results (refer to subsection 3.5.B.1).
   7. Field seam destructive test results (refer to subsection 3.5.C.6).
   8. Daily field installation reports (refer to subsection 3.5.G).
   9. Installation record drawing, as discussed in subsection 3.5.

1.4 QUALITY CONTROL

A. Manufacturer's Qualifications: The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such

geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 square feet of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications

1. The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner to install the geomembrane.

2. The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 square feet of the specified type of geomembrane or similar during the last three years.

3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 square feet of geomembrane of the type specified or similar product.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 square feet of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.6 PROJECT CONDITIONS

A. Geomembrane should not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.7 MATERIAL WARRANTY

As required by specification, or as required in GRI GM 13 (attachment A)

1.8 GEOMEMBRANE INSTALLATION WARRANTY

A. The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.9 Geomembrane Pre-Construction Meeting

A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the Earthwork Contractor.

B. Topics for this meeting shall include:
   1. Responsibilities of each party.
   2. Lines of authority and communication. Resolution of any project document ambiguity.
   3. Methods for documenting, reporting and distributing documents and reports.
   4. Procedures for packaging and storing archive samples.
   5. Review of time schedule for all installation and testing.
   6. Review of panel layout and numbering systems for panels and seams including details or marking on geomembrane.
   7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
   8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation. Installation limitations under specific wind conditions shall be discussed.
   9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
   10. Deployment techniques including allowable subgrade for the geomembrane.
   11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
   12. Covering of the geomembrane and cover soil placement.
   13. Health and safety.
   14. Testing program.

C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

PART 2: PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Manufacturing Quality Control

1. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM 13, or modified as required for project specific conditions.

2. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.1.A.3 of this Section, must be supplied to the Owner to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

3. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.2 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE- Density >0.94g/cm) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane will meet the property requirements as shown in Table A. (GRI GM 13)

B. Material conformance testing by the Owner, if required, will be conducted in accordance with the project specifications.

C. The geomembrane seams shall meet the property requirements as shown in Table 2, (Attachment B) or as required by project specifications

PART 3: EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with the project specifications. The geomembrane subgrade shall be uniform and free of all sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.

B. The Geomembrane Installer and Owner shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.

C. The Geomembrane Installer and Owner shall provide daily written acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be approved by the Owner and the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.2 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.3 of this Section are submitted to and approved by the Owner. Should geomembrane material be deployed prior to approval by the Owner it will be at the sole risk of the Geomembrane Installer and/or Contractor. If the material does not meet project specifications it shall be removed from the work area at no cost to the Owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owner. The

specified minimum temperature for material deployment may be adjusted by the Owner' based on recommendations by the manufacturer. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations should be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be regraded to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.9.B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Owner.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.3 SEAMING PROCEDURES

A. Cold weather installations should follow guidelines as outlined in GRI GM9.

B. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperatures below 0 degrees C (32 degrees F) is allowed if the Geomembrane Installer can demonstrate to the Owner, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at sub-freezing temperatures.

2. The Geomembrane Installer shall submit to the Owner for approval, detailed procedures for seaming at low temperatures, possibly including the following:
   a. Preheating of the geomembrane
   b. The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming.
   c. Number of test welds to determine appropriate seaming parameters

C. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Owner. This approval will be based on recommendations by the manufacturer and on a field demonstration by the Geomembrane Installer using prequalification test seams to demonstrate that seams comply with the specification.

D. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

E. Fishmouths or excessive wrinkles at the seam overlaps, shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.4 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.5.B. Alternatively, where field non destructive testing can not be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.

2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.

3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.

4. Care should be taken if flammable gases are present in the area to be tested.

3.5 FIELD QUALITY CONTROL

The Owner shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.

2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.D. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.

4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.5.C.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.

5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.

6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner' for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner.

2. Testing should be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Owner. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.

3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.

4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner all test methods to verify the test procedures are valid.

5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.
   b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).
   c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.
   d. All areas where soap bubbles appear shall be marked, repaired and then retested.
   e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.
   f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:
   a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
   b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.
   c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.
   d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner as an archive sample; one section given to the Owner for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.2 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Owner, typically 3 m (10 ft) on either side of the failed sample and laboratory seem tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects

Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.5.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.

2. Defective seams, tears or holes shall be repaired by reseaming or applying an extrusion welded cap strip.

3. Reseaming may consist of either:
   a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.

4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.

5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams

Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

G. Daily Field Installation Reports

At the beginning of each day's work, the Installer shall provide the Owner with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.6 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Owner when:
   1. The entire installation is finished or an agreed upon subsection of the installation is finished;
   2. All Installer's QC documentation is completed and submitted to the Owner.
   3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.7 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.8 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in an EPA approved landfill, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4: GRI GM13 SPECIFICATION

Attachment A: Minimum Average Weld Properties for HDPE Geomembranes

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	**Test Method**	**30 mil**	**40 mil**	**50 mil**	**60 mil**	**80 mil**	**100 mil**	**120 mil**
Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in.	ASTM 4437	60	80	100	120	160	200	239

Attachment B: GRI GM13 Specification (14 pages attached)

END OF SECTION

ATTACHMENT B

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Rev. 6: June 23, 2003
Revision schedule on pg. 14

GRI Test Method GM13*

Standard Specification for

"Test Properties, Testing Frequency and Recommended Warranty for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

1.5 This specification also presents a recommended warrant which is focused on the geomembrane material itself.

1.6 The recommended warrant attached to this specification does not cover installation considerations which is independent of the manufacturing of the geomembrane.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device

GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet

Note 6: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 7: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

11. Warranty

11.1 Upon request of the purchaser in the contract or order, a manufacturer's warrant of the quality of the material shall be furnished at the completion of the terms of the contract.

11.2 A recommended warranty for smooth and textured HDPE geomembranes manufactured and tested in accordance with this specification is given in Appendix A.

11.3 The warranty in Appendix A is for the geomembrane itself. It does not cover subgrade preparation, installation, seaming, or backfilling. These are separate

operations that are often beyond the control, or sphere of influence, of the geomembrane manufacturer.

Note 9: If a warrant is required for installation, it is to be developed between the installation contractor and the party requesting such a document.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,00 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength	Type IV	63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	GM 11								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 20kN/m 12% 700%	 15 kN/m 27 kN/m 12% 700%	 18 kN/m 33 kN/m 12% 700%	 22 kN/m 40 kN/m 12% 700%	 29 kN/m 53 kN/m 12% 700%	 37 kN/m 67 kN/m 12% 700%	 44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	 D 3895 D 5885	 N. R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 45 lb/in. 12% 100%	 84 lb/in. 60 lb/in. 12% 100%	 105 lb/in. 75 lb/in. 12% 100%	 126 lb/in. 90 lb/in. 12% 100%	 168 lb/in. 120 lb/in. 12% 100%	 210 lb/in. 150 lb/in. 12% 100%	 252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 8 kN/m 12% 100%	 15 kN/m 10 kN/m 12% 100%	 18 kN/m 13 kN/m 12% 100%	 22 kN/m 16 kN/m 12% 100%	 29 kN/m 21 kN/m 12% 100%	 37 kN/m 26 kN/m 12% 100%	 44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Appendix "A"

Typical HDPE Geomembrane Warranty

Reviewed by: Donald J. Weiss, Esq. General Council for GSI

ABC GEOMEMBRANE COMPANY
LIMITED WARRANTY

Warranty No: _____
Project No: _____
Effective Date: _____

PURCHASER NAME: _____ PROJECT NAME: _____

ADDRESS: _____ ADDRESS/LOCATION: _____

CITY, STATE, ZIP, COUNTRY _____ CITY, STATE, ZIP, COUNTRY _____

GEOMEMBRANE TYPE/DESCRIPTION _____

ABC Geomembrane Company warrants each ABC geomembrane to be free from manufacturing defects (as defined by the contract's material specifications) and to be able to withstand normal weathering for a period of 5 years from the above effective date for normal use in approved applications.

This Limited Warranty does not include damages or defects in the ABC geomembrane resulting from acts of God, casualty or catastrophe including but not limited to: earthquakes, floods, piercing hail, tornadoes or force majeure. The term "normal use" as used herein does not include, among other things the exposure of ABC geomembranes to harmful chemicals, abuse of ABC geomembranes by machinery, equipment or people; improper site preparation or covering materials, excessive pressures or stresses from any source or improper application or installation. ABC geomembrane material warranty is intended for commercial use only and is not in effect for the consumer as defined in the Magnuson Moss Warranty or any similar federal, state, or local statues. The parties expressly agree that the sale hereunder is for commercial or industrial use only.

Should defects or premature loss of use within the scope of the above Limited Warranty occur, ABC Geomembrane Company will, at its option, repair or replace the ABC geomembrane on a pro-rata basis at the then current price in such manner as to charge the Purchaser/User only for that portion of the warranted life which has elapsed since purchase of the material. ABC Geomembrane Company will have the right to inspect and determine the cause of any alleged defect in the ABC geomembrane and to take appropriate steps to repair or replace the ABC geomembrane if a defect exists which is covered under this warranty. This Limited Warranty extends only to ABC's geomembrane, and does not extend to the installation service of ABC Geomembrane Company or third parties.

Any claim for any alleged breach of this warranty must be made in writing, by certified mail, to the President of ABC Geomembrane within ten (10) days of becoming aware of the alleged defect. Should the required notice not be given, the defect and all warranties are waived by the Purchaser, and Purchaser shall not have any rights under this warranty. ABC Geomembrane Company shall not be obligated to perform repairs or replacements under this warranty unless and until the area to be repaired or replaced is clean, dry, and unencumbered. This includes, but is not limited to, the area made available for repair and/or replacement of ABC geomembrane to be free from all water, dirt, sludge, residuals and liquids of any kind. If after inspection it is determined that there is no claim under this Limited Warranty, Purchaser shall reimburse ABC Geomembrane Company for its costs associated with the site inspection.

In the event the exclusive remedy provided herein fails in its essential purpose, and in that event only, the Purchaser shall be entitled to a return of the purchase price for so much of the material as ABC Geomembrane Company determines to have violated the warranty provided herein. ABC Geomembrane Company shall not be liable for direct, indirect, special, consequential or incidental damages resulting from a breach of this warranty including, but not limited to, damages for loss of production, lost profits, personal injury or property damage. ABC Geomembrane Company shall not be obligated to reimburse Purchaser for any repairs, replacement, modifications or alterations made by Purchaser unless ABC Geomembrane Company specifically authorized, in writing, said repairs, replacements, modifications or alteration in advance of them having been made. ABC Geomembrane Company's liability under this warranty shall in no event exceed the replacement cost of the material sold to the Purchaser for the particular installation in which it failed.

ABC Geomembrane Company neither assumes nor authorizes any person other than the undersigned of ABC Geomembrane Company to assume for it any other or additional liability in connection with the ABC geomembrane made on the basis of the Limited Warranty. The Limited Warranty on the ABC geomembrane herein is given in lieu of all other possible material warranties, either expressed or implied, and by accepting delivery of the material, Purchaser waives all other possible warranties, except those specifically given.

Limited Warranty is extended to the purchaser/owner and is non-transferable and non-assignable; i.e., there are no third-party beneficiaries to this warranty.

Purchaser acknowledges by acceptance that the Limited Warranty given herein is accepted in preference to any and other possible materials warranties.

ABC GEOMEMBRANE COMPANY MAKES NO WARRANTY OF ANY KIND OTHER THAN THAT GIVEN ABOVE AND HEREBY DISCLAIMS ALL WARRANTIES, BOTH EXPRESSED OR IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS IS THE ONLY WARRANTY THAT APPLIES TO THE MATERIALS REFERRED TO HEREIN AND ABC DISCLAIMS ANY LIABILITY FOR ANY WARRANTIES GIVEN BY ANY OTHER PERSON OR ENTITY, EITHER WRITTEN OR ORAL.

ABC GEOMEMBRANE COMPANY'S WARRANTY BECOMES AN OBLIGATION OF ABC GEOMEMBRANE COMPANY TO PERFORM UNDER THE WARRANTY ONLY UPON RECEIPT OF FINAL

I hereby state that I have read and understand the above and foregoing Limited Warranty and agree to such by signing hereunder.

DATE: _____

PURCHASER NAME: _____ ABC GEOMEMBRANE COMPANY: _____
(President or Authorized Representative)

SIGNATURE: _____ DATE _____ SIGNATURE: _____ DATE _____

TITLE: _____ Sworn before me this _____ day of _____ 200___

Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Properties, Testing Frequency and Recommended Warrant for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.

Attachment A

Geotechnical Engineering Report

TETRA TECH

Geotechnical Engineering Study

New Surge Pond Located at the North Butte Satellite Facility Campbell County, Wyoming

Prepared for:

Cameco Resources

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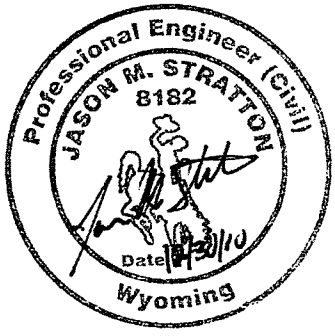
Tetra Tech Project No. 114-510340

December 30, 2010



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PURPOSE AND SCOPE OF STUDY

This report presents the results of our geotechnical engineering study for the proposed new surge pond to be located at the Cameco Resources North Butte Satellite Facility in Campbell County, Wyoming. The site vicinity is shown on Figure 1. The study was conducted to explore the subsurface profile beneath the proposed pond footprint and to perform stability analyses of the proposed pond slopes using the geometric design Tetra Tech is also performing. The design drawings and specifications will be submitted under separate cover. This study was conducted in accordance with Cameco Resource's Standard Agreement with Tetra Tech and Tetra Tech's proposal to Cameco Resources dated September 8, 2010.

Tetra Tech conducted a field exploration program for the surge pond which consisted of two exploratory borings drilled near the pond footprint to obtain information on the subsurface conditions. The exploratory borings were located as shown on Figure 2. Samples obtained during the field exploration were tested in our laboratory to determine physical and engineering characteristics. We analyzed results of the field exploration and laboratory testing to evaluate suitability of soils and bedrock for use in the planned construction, and to develop soil properties for use in the stability analyses. The results of the field exploration and laboratory testing are presented herein.

We have prepared this report to summarize the data obtained during this study, and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. A discussion of geotechnical engineering considerations related to construction is included in the report.

PROPOSED CONSTRUCTION

The proposed project consists of the construction of a new surge pond for storing process water located at the North Butte Satellite Facility. The overall pond dimensions will be approximately 280 ft by 340 ft and will be divided into two cells. The cell bottoms will have approximate dimensions of 50 ft by 120 ft. The pond sides will be constructed at 3 horizontal to 1 vertical slopes. The majority of the pond volume will be below grade. Embankments, ranging from 2 to 6 ft in height,

will be constructed around the pond to promote surface drainage away from the pond. The embankments constructed above grade will have crest widths of 12 ft and interior and exterior side slopes of 3 horizontal to 1 vertical. The total pond depths will be approximately 14 ft with 5 ft of freeboard and a total water depth of approximately 9 ft. The crest elevation will be at 5077.0 and the high water line will be at elevation 5072.0. As required by the Nuclear Regulatory Commission (NRC) Regulatory Guide 3.11, a double geomembrane liner with a leak detection system will be constructed. The double geomembrane liner will be installed over a 3 ft thick compacted clay liner. The compacted clay liner is required to have a hydraulic conductivity of no more than $1x10^{-7}$ cm/sec. The soil excavated for the below grade portion of the pond will be used for the above grade embankments and the compacted clay liner.

SITE CONDITIONS

The site is located southeast of North Butte at the North Butte Satellite Facility in Campbell County, Wyoming. The proposed pond will be located south and approximately 100 ft from the proposed new building for the North Butte Satellite Facility. Vegetation on the site consisted of sagebrush, cactus, natural grasses and weeds. The topography of the site sloped slightly downward to the south with an elevation difference of approximately 11 ft across the pond footprint. A relatively large drainage is located to the east of the site and a small drainage is located to the west of the site with both drainages sloping to the south.

FIELD EXPLORATION

Tetra Tech conducted the field exploration on October 15 and 18, 2010. Two exploratory borings were drilled near the pond footprint at the approximate locations shown on Figure 2 to explore the subsurface conditions. The boring locations were determined by Tetra Tech which were referenced from the pond corners which were staked in the field by Cameco representatives. Boring B-9 was originally located within the proposed pond footprint. However, the proposed pond configuration changed after the exploratory drilling was completed.

The drill crew used a CME-55 truck-mounted drill rig to advance the borings. The borings were advanced through the subsurface soils using 4 inch diameter solid-stem auger. A Tetra Tech field

engineer logged the borings. The borings were drilled to depths of 50.5 and 51.5 ft. Auger refusal was not encountered within either of the exploratory borings.

Samples of the subsurface materials were obtained using either a 1⅜-inch inside diameter split barrel sampler or a 2-inch inside diameter California sampler equipped with brass liners. The samplers were driven into the various strata using a 140 lb hammer falling 30 inches. The number of blows required to advance the sampler one 12 inch increment is recorded as the penetration resistance value or N value. This test, when using the California sampler, is similar to the standard penetration test described by ASTM D1586, Split Barrel Sampling of Soils. Penetration resistance values provide an indication of the relative density of granular soils, or consistency of fine-grained soils. Depths at which the samples were obtained and the penetration resistance values are shown on the exploratory boring logs.

Disturbed bulk samples were obtained from the upper portions of the borings. Depths at which the samples were obtained are shown on the Logs of Exploratory Borings.

Groundwater levels were measured in each boring during and upon completion of drilling. The borings were backfilled with hydrated bentonite chips immediately after completion of drilling.

LABORATORY TESTING

A Tetra Tech geotechnical engineer observed the soil samples obtained from the field exploration and visually classified them according to ASTM D2487, which is based on the Unified Soil Classification System. The engineer selected representative samples for testing to determine the engineering and physical properties in general accordance with ASTM standards. Laboratory tests performed for this project include:

Test	ASTM Designation
Natural Moisture Content and Dry Density	D2937
Natural moisture Content	D2216
Particle Size Analysis	D422/1140
Atterberg Limits	D4318
Standard Moisture-Density Relation	D698
Fixed Wall Falling Head Permeability (Remolded and Undisturbed)	

The laboratory test results, along with visual field logging information, were used to prepare the exploratory boring logs. Results of geotechnical laboratory testing are included on the boring logs, presented graphically on the figures following the boring logs, and summarized on Table I.

SUBSURFACE CONDITIONS

The subsurface profile within the proposed pond footprint generally consisted of 6 inches of topsoil and 30.5 to 38 ft of sandy lean clay, clayey sand, and silty sand overlying sandstone and claystone bedrock. The exploratory boring logs should be referenced for soil descriptions and classifications, strata thicknesses, N values, and laboratory test results. A brief description of each soil type encountered follows:

Sandy Lean Clay (CL) to Clayey Sand (SC)

Sandy lean clay to clayey sand was encountered below the topsoil in borings B-8 and B-9. The clay stratum extended to depths of 30.5 ft in boring B-8 and 23 ft in boring B-9. The consistency of the clay stratum was stiff to very stiff as indicated by the N values ranging from 12 to 26. Laboratory test results indicate that the clays have natural moisture contents ranging from 4 to 9%. Laboratory testing indicates that the clay has maximum dry densities ranging from 108.1 pcf to 109.9 pcf and optimum moisture contents ranging from 15.2% to 16.9% when tested in accordance with ASTM D698, Standard Proctor. The in-situ clays have hydraulic conductivities ranging from $1x10^{-7}$ cm/sec to $6x10^{-8}$ cm/sec and remolded hydraulic conductivities ranging from $1x10^{-7}$ cm/sec to $3x10^{-8}$ cm/sec when remolded to 95% of the maximum dry density and near the optimum moisture content as determined by ASTM D698. Graphical laboratory test results are presented on Figures 4, 5, 7, and 8.

Silty Sand (SM)

Silty sand was encountered below the clay in boring B-9 and extended to a depth of 38 ft below the ground surface. The relative density of the silty sand was medium dense to dense as indicated by the n values ranging from 24 to 40. The silty sand was light brown in color and slightly moist.

Sandstone Bedrock

Sandstone bedrock was encountered below the clay in boring B-8 and below the silty sand in boring B-9. The sandstone extended to depths of 49 ft in boring B-8 and 48 ft in boring B-9. The sandstone was medium hard to very hard as indicated by the N values ranging from 33 to greater than 50. The sandstone was pinkish gray in color and slightly moist.

Claystone Bedrock

Claystone bedrock was encountered below the sandstone in both borings and extended to the depths explored, 50.5 ft and 51.5 ft, respectively. The claystone bedrock was hard to very hard as indicated by the N values ranging from 58 to greater than 50. The claystone was reddish gray to light gray in color and slightly moist to moist.

Groundwater

Groundwater was not encountered within borings B-8 and B-9 at the time of drilling. Numerous factors contribute to fluctuations of groundwater levels; evaluation of these factors is beyond the scope of this report.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

The recommended design and construction criteria presented in the following sections should be observed for the geotechnical engineering aspects of the project. The details that we recommend should be considered when preparing the project documents.

Site Grading

All topsoil, vegetation, and organic matter should be stripped in all cut and fill areas within the pond footprint. The topsoil thickness was approximately 6 inches.

Site grading will consist of cuts of up to 8 ft on the northern portion of the site to achieve the planned crest elevation of 5074.0. Site grading will also include the construction of a drainage trench along the north side of the pond to route surface run-off away from the pond.

Excavation

The proposed pond will be constructed mostly below existing grade. In general, excavations to total depths of approximately 16 ft will be required. The final pond depths will be on the order of 13 ft and a 3 ft over-excavation will be required for the construction of the 3 ft thick compacted clay liner. Due to the site topography which slopes downward to the south, additional excavations will be required on the north side of the pond to achieve the crest elevation and to provide surface water drainage away from the pond.

The excavations will be made within the sandy lean clay stratum and can be accomplished with conventional heavy-duty excavation equipment. The quantity of soil excavated will be greater than the quantity required to construct the embankments along the tops of the cells and for the compacted clay liner. The excess soil will require disposal in an off-site area.

Embankment Construction

Embankments will be constructed along all sides of both cells. The embankment heights will range from 2 ft to 6 ft, will have crest widths of 12 ft, and will be constructed at 3 horizontal to 1 vertical slopes. The on-site sandy lean clay is suitable for use as embankment fill. Prior to placing embankment fill, the subgrade of all areas to receive new fill should be scarified to a minimum depth of 9 inches, moisture conditioned, and proof-rolled with a heavy-duty sheepsfoot compactor.

All soils used for the construction of the earthen embankment should be processed by scarifying, mixing, or discing and applying moisture to achieve a uniform moisture content within ±2% of the optimum moisture content as determined by ASTM D698, Standard Proctor. All fill should be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698. A sheepsfoot compactor must be used to compact all clay soils to help break up clods and to reduce the potential for laminations between lifts.

The on-site clay encountered within the borings have natural moisture contents ranging from 4 to 9%. Laboratory test results indicate that the clay will have an optimum moisture contents ranging from 15.2% to 16.9%. The natural moisture contents of the clay soil ranges from 6 to 13% below optimum moisture content. Therefore, moisture will need to be added to the clay soil to be used for embankment fill and the compacted clay liner.

Compacted Clay Liner

As required by the NRC regulations, a 3 ft thick compacted clay liner is required to be constructed below the double geomembrane liner system. Based on the results of the laboratory permeability testing, the on-site clay soils are suitable for the construction of the clay liner. The remolded clay specimens had hydraulic conductivities ranging from $1x10^{-7}$ cm/sec to $3x10^{-8}$ cm/sec when remolded to 95% of the maximum dry density and near the optimum moisture content as determined by ASTM D698.

The clay liner should be constructed of the on-site clay soils. The clay should be moisture conditioned to within -2% to +2% of the optimum moisture content and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698, Standard Proctor. The natural moisture contents of the clay soil ranges from 6 to 13% below optimum moisture content. Therefore, moisture will need to be added to the clay soil to be used for the compacted clay liner. The addition of moisture must be performed prior to the placement of the lifts of fill and a sheepsfoot compactor must be used to compact each lift.

Slope Stability

As required by the NRC regulations, slope stability analyses were performed. We modeled the north interior pond slope for our slope stability analyses which will have an overall greater height than the other sides. The soil strength values used in our analyses were estimated based on the soil type and our experience with soil strengths of similar soil types. The shear strength parameters used in the analyses are presented on the slope stability figure attached in Appendix A. The post-construction model was the only one performed. Analyses for the partial pool and maximum pool with steady seepage models were not performed due to the triple liner construction and the low potential for any seepage or phreatic surface to develop. These analyses are typically conducted

on external slopes which are low in height in comparison to the interior slopes for this project. The earthquake or pseudo-static model for external slopes also was not performed due to the low seismic potential project area.

Our slope stability analyses indicates that the pond slopes will be stable in the post-construction condition. The slope stability analyses summary is shown graphically for the post-construction condition in Appendix A. We used the slope stability software STABL6 for our analyses. Our analyses indicates a factor of safety on the order of 2.5 for the post-construction case. The minimum factors of safety required by the NRC for this condition is 1.3.

Settlement

Laboratory testing to determine the compressibility of the clay soils was not performed. Based on the type of construction proposed, the majority of the pond volume will be below the existing ground surface grade. This will result in a net decrease of loads and, therefore, no settlements of embankments or the cell bottoms. In addition, based on the liner system consisting of a double geomembrane and a 3 ft thick compacted clay liner, the infiltration of water into the soils beneath the pond is highly unlikely, further reducing any potential for settlement.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the design data submitted to Tetra Tech, data obtained from the exploratory borings drilled at the locations indicated on Figure 2 and the proposed construction discussed in this report. The nature and extent of subsurface variations across the site may not become evident until construction. During construction, if fill, soil, rock or water conditions appear to be different from those described herein, this office should be advised at once so that we may re-evaluate the recommendations made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our exploratory information which has not been

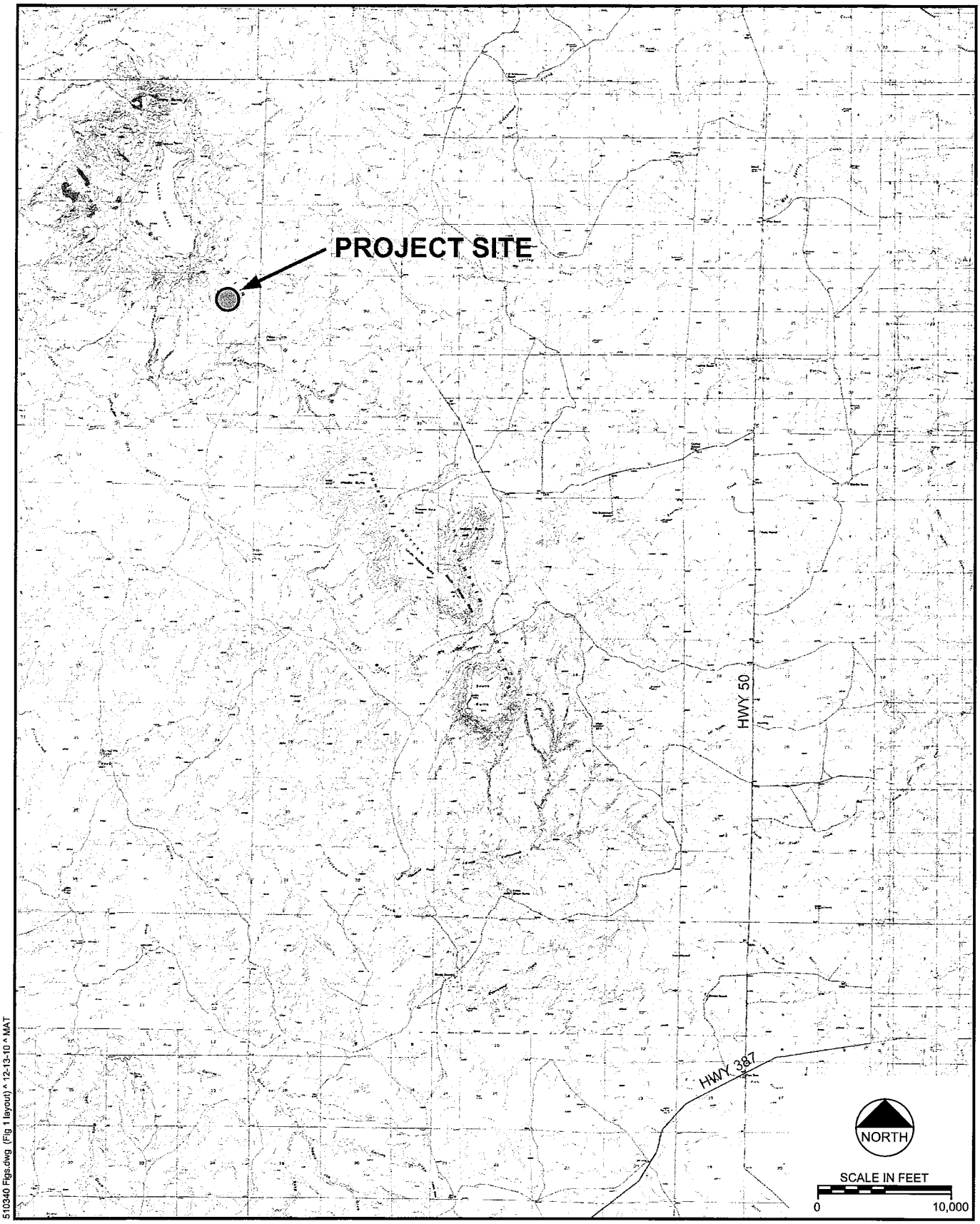
described or documented in this report. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analyses or modifications of the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of fill by a representative of the geotechnical engineer.

Any conclusions by a construction contractor or bidder, relating to construction means, methods, techniques, sequences or costs based upon the information provided in this report are independent conclusions by the contractor or bidder and are not the responsibility of Tetra Tech.

TETRA TECH

Brian L. Chandler, P.E.
Sr. Geotechnical Engineer

Jason M. Stratton, P.E.
Sr. Geotechnical Engineer

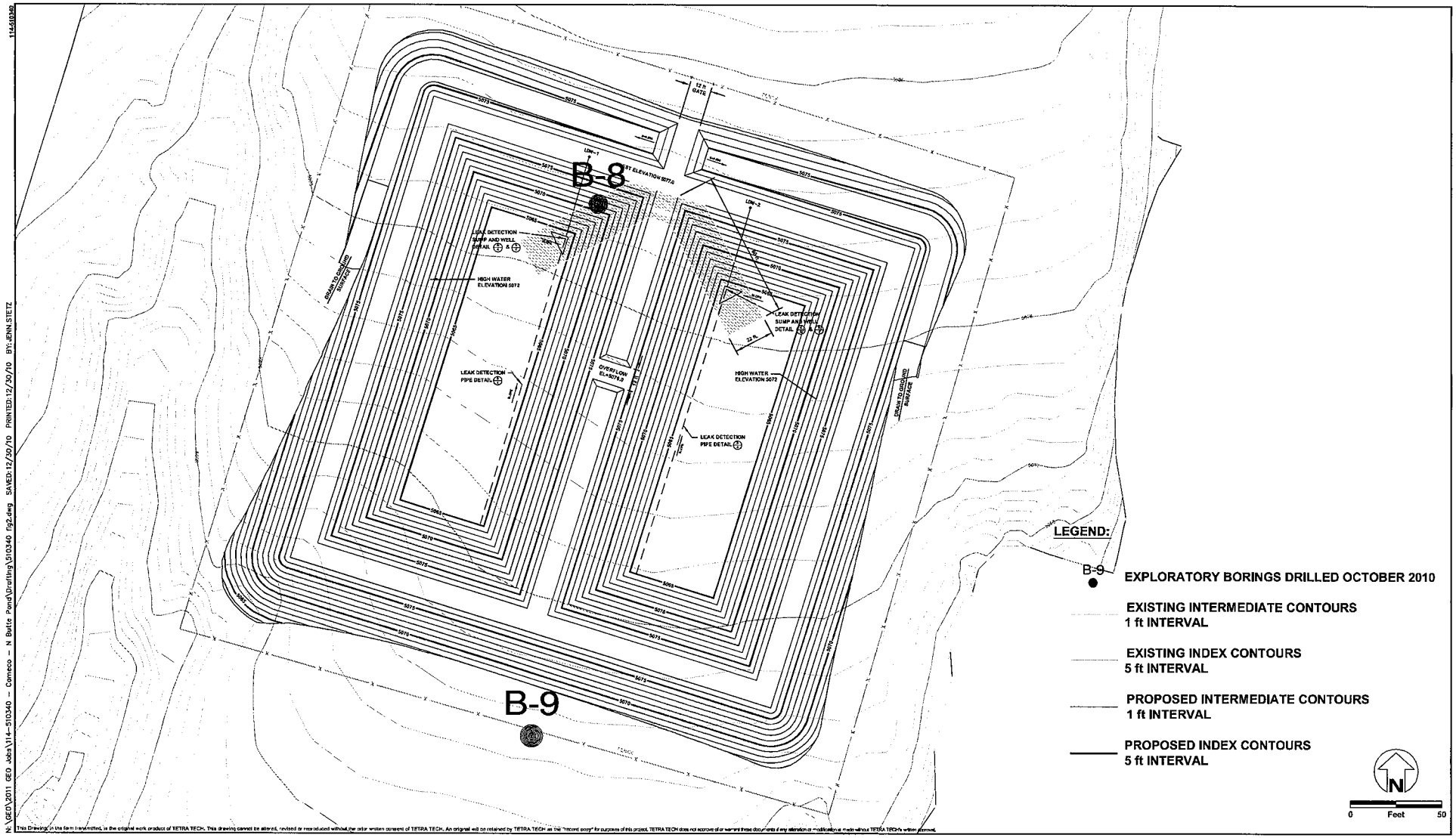


510340 Figs.dwg (Fig 1 layout) ^ 12-13-10 ^ MAT

Project Number: 114-510340

December 2010

Figure 1
SITE VICINITY MAP
North Butte Satellite Surge Pond - Campbell County, Wyoming



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Location of Exploratory Borings
North Butte Satellite Surge Ponds

FIGURE 2

Project Name: North Butte Satellite Surge Pond - Campbell County, Wyoming

Borehole Location: North Portion of West Cell, Refer to Site Map

Borehole Number: B-8	Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-15-10	Date Finished: 10-15-10

Elevation and Datum: Ground: Existing Grade

Notes: N 43°46'25.5"
W 105°56'08.6"

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				4		38	23	65		TOPSOIL (6 in. thick).	0.5
			13	9						Clayey SAND (SC), medium dense, light brown, slightly moist, layers of silty sand and layers of sandy lean clay throughout.	
			15								6
			16							Sandy lean CLAY (CL), very stiff, light brown, slightly moist.	
10			18			38	20	59			
			19								
			23							A lense of Silty Sand (medium dense, light brown, slightly moist) was encountered from 14 to 17 ft.	
											17
										Sandy lean CLAY (CL), very stiff, brown, slightly moist, medium plasticity.	
20			26								
			25								
30			34								30.5
										SANDSTONE BEDROCK, fine grained, very hard, pink, slightly moist.	
			50/0.7								
40			50/0.3								
			88/0.75								
											49
50			50/0.5							CLAYSTONE BEDROCK, very hard, light gray, slightly moist.	50.5

Bottom of Boring at 50.5 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

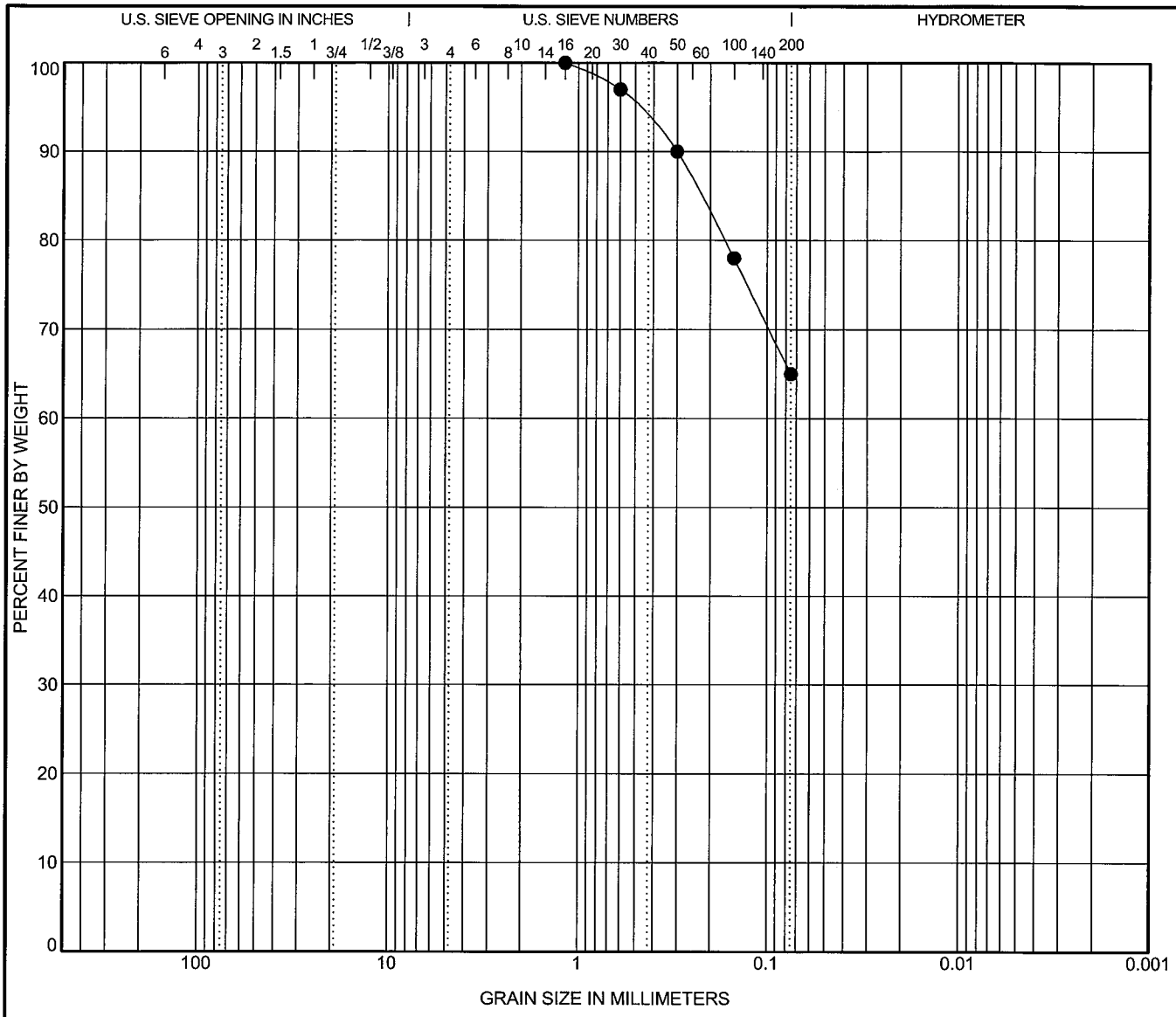
Depth To Water (ft)

Remarks:

114-510340 | TETRA TECH | LOG OF EXPLORATORY BORING B-8 | Fig. 3

510340 LOGS.GPJ ` 12-13-10 ` MAT ` CASPER ENGLISH (BOR) ` TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-8 - (0.5 - 6 ft)	**SANDY LEAN CLAY(CL)**	**38**	**15**	**23**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-8 - (0.5 - 6 ft)	**1.18**				**0**	**35**	**65**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

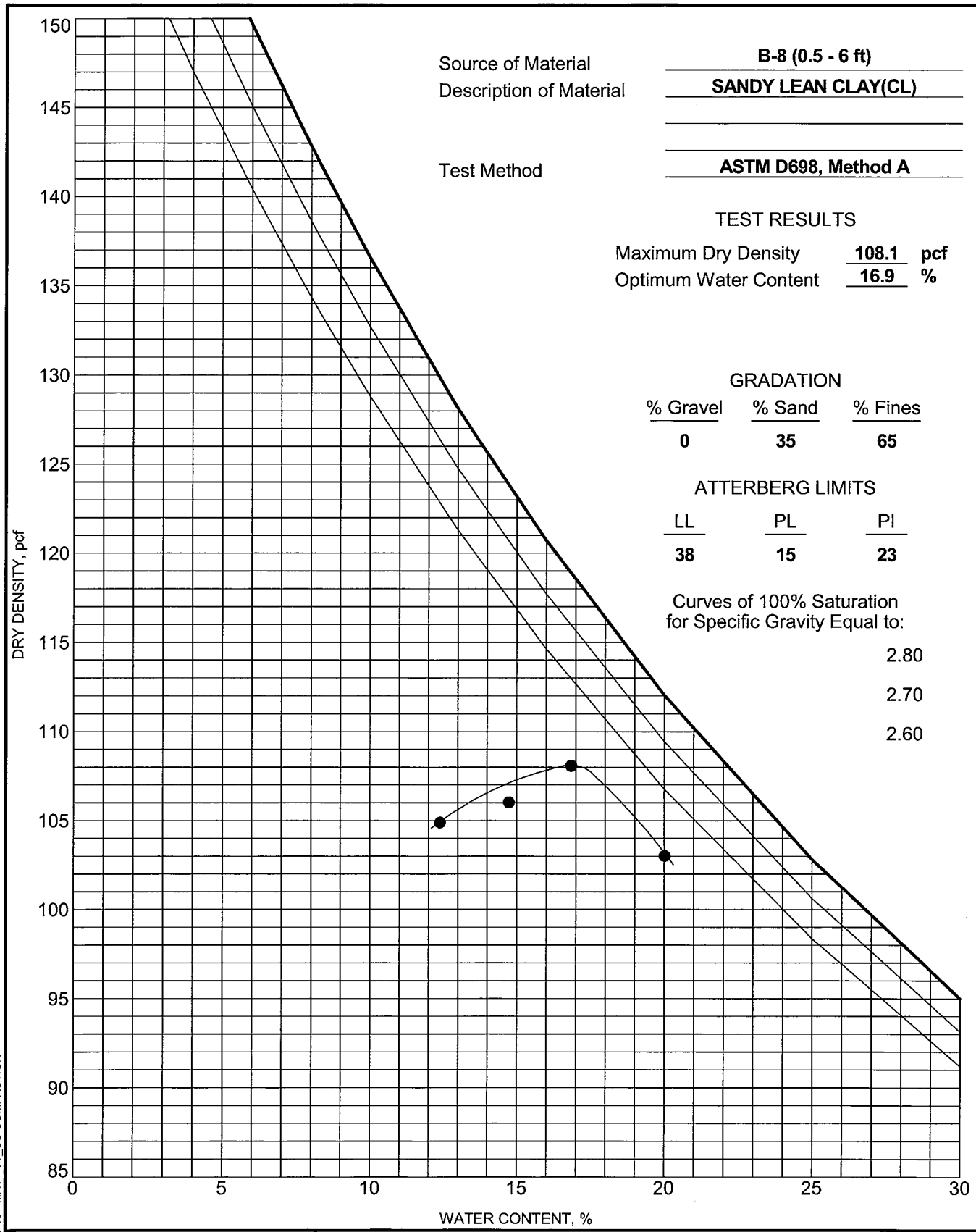
Project: North Butte Satellite Surge Pond - Campbell County, Wyoming

Location: North Portion of West Cell, Refer to Site Map

Number: 114-510340 Figure No. 4

510340 LOGS.GPJ ' 12-13-10 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)



Source of Material: **B-8 (0.5 - 6 ft)**

Description of Material: **SANDY LEAN CLAY(CL)**

Test Method: **ASTM D698, Method A**

TEST RESULTS

Maximum Dry Density	**108.1**	**pcf**
Optimum Water Content	**16.9**	**%**

GRADATION

% Gravel	% Sand	% Fines
0	**35**	**65**

ATTERBERG LIMITS

LL	PL	PI
38	**15**	**23**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

MOISTURE-DENSITY RELATIONSHIP

TETRA TECH

Project: North Butte Satellite Surge Pond - Campbell County, Wyoming

Location: North Portion of West Cell, Refer to Site Map

Number: 114-510340 Figure No. 5

510340 LOGS.GPJ `11-11-10 `MAT `TT_US COMPACTION

Revised 1-23-08 (MAT)

Project Name: North Butte Satellite Surge Pond - Campbell County, Wyoming				
Borehole Location: South Portion of East Cell, Refer to Site Map				
Borehole Number: B-9		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-18-10	Date Finished: 10-18-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 43°46'23.1"
W 105°56'07.8"

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				4		33	18	61		TOPSOIL (6 in. thick).	0.5
			19	5						Clayey SAND (SC), medium dense, light brown, dry to slightly moist.	4
			12							Sandy lean CLAY (CL), stiff to very stiff, light brown, dry to slightly moist, layers of clayey sand, nearly 50/50 sand/clay throughout.	
			13			44	25	68			
10			14								
			15								
			16								
20			26								23
			40							Silty SAND (SM), medium dense to dense, light brown, slightly moist.	
30			32								
			24								38
40			42							SANDSTONE BEDROCK, medium hard, light brown-pink-gray, slightly moist, some gravel sized particles, claystone fragments.	
			33								48
50			58							CLAYSTONE BEDROCK, hard, red/gray, moist.	51.5

Bottom of Boring at 51.5 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

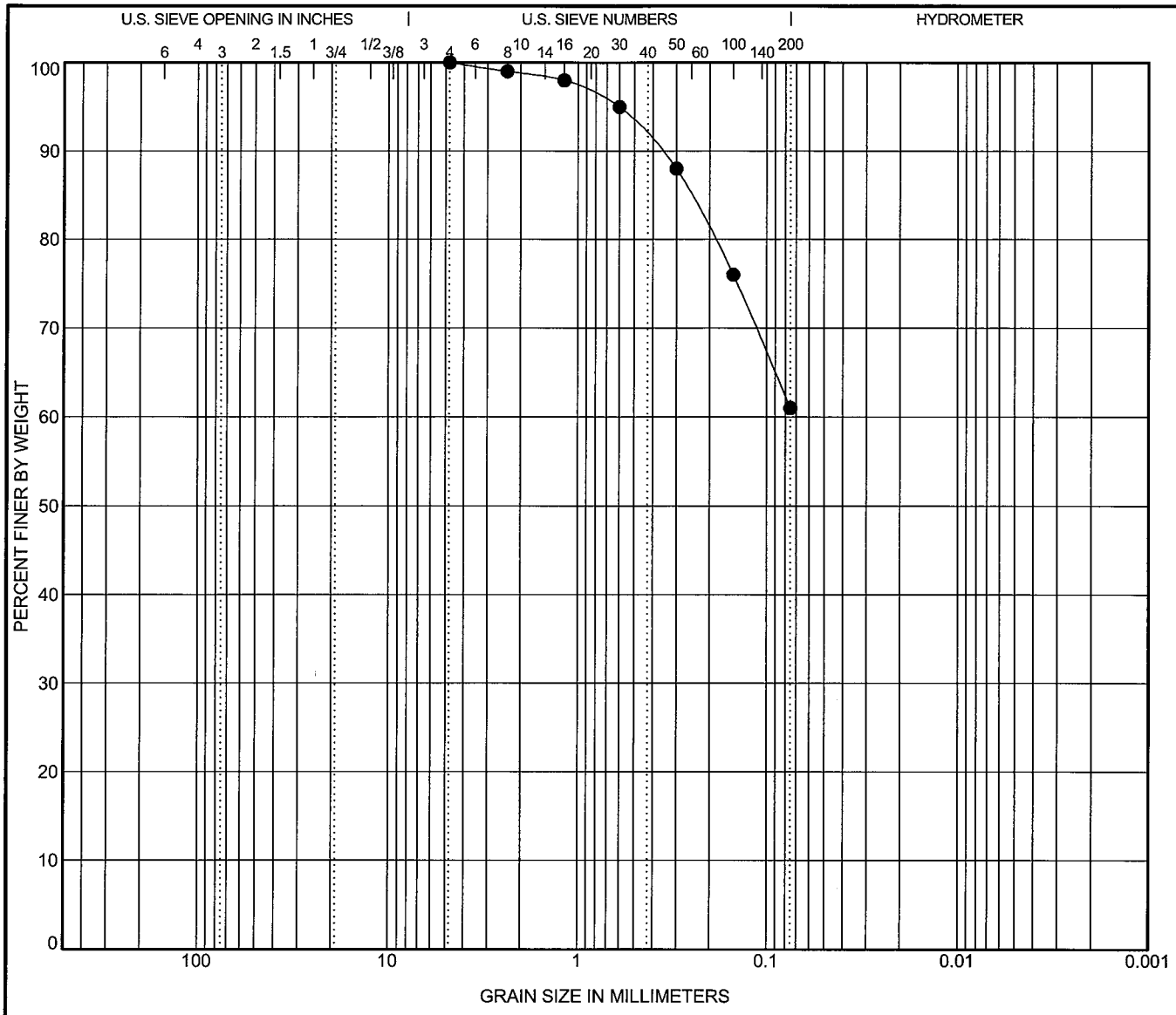
Depth To Water (ft)

Remarks:

114-510340	TETRA TECH	LOG OF EXPLORATORY BORING B-9	Fig. 6

510340 LOGS.GPJ ` 12-13-10 ` MAT ` CASPER ENGLISH (BOR) ` TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-9 - (0.5 - 4 ft)	**SANDY LEAN CLAY(CL)**	**33**	**15**	**18**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-9 - (0.5 - 4 ft)	**4.75**				**0**	**39**	**61**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

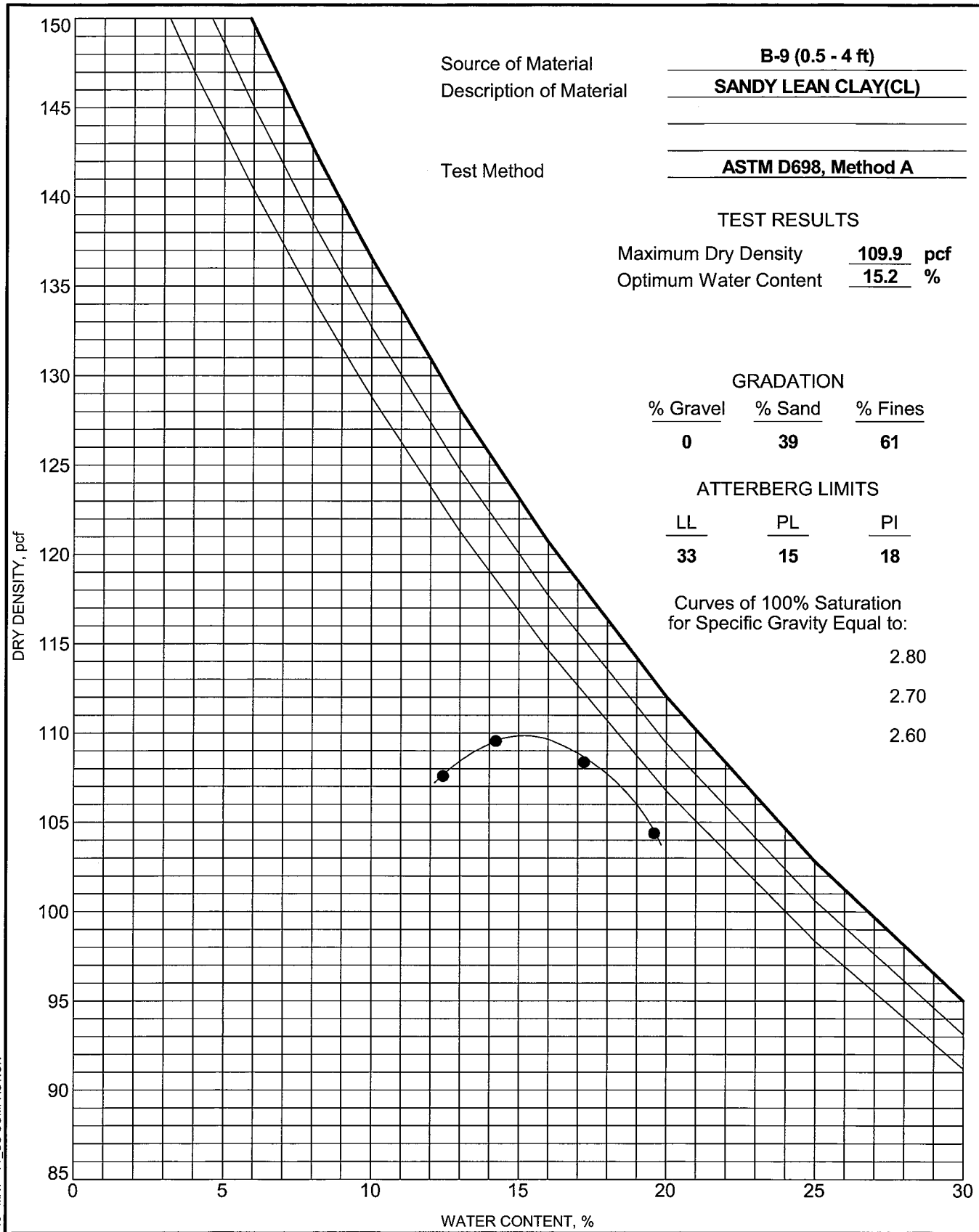
Project: North Butte Satellite Surge Pond - Campbell County, Wyoming

Location: South Portion of East Cell, Refer to Site Map

Number: 114-510340 Figure No. 7

510340 LOGS.GPJ ' 12-13-10 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)



Source of Material: **B-9 (0.5 - 4 ft)**

Description of Material: **SANDY LEAN CLAY(CL)**

Test Method: **ASTM D698, Method A**

TEST RESULTS

Maximum Dry Density	**109.9**	**pcf**
Optimum Water Content	**15.2**	**%**

GRADATION

% Gravel	% Sand	% Fines
0	**39**	**61**

ATTERBERG LIMITS

LL	PL	PI
33	**15**	**18**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

TETRA TECH

MOISTURE-DENSITY RELATIONSHIP

Project: North Butte Satellite Surge Pond - Campbell County, Wyoming

Location: South Portion of East Cell, Refer to Site Map

Number: 114-510340 Figure No. 8

510340 LOGS.GPJ ` 11-11-10 ` MAT ` TT_US COMPACTION

Revised 1-23-08 (MAT)

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

North Butte Satellite Surge Pond
Campbell County, Wyoming

Job No. 115-510340

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING NO. 200 SIEVE	OTHER TESTS	SAMPLE DESCRIPTION/CLASSIFICATION
BORING	DEPTH (ft)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)			
B-8	0.5 to 6	4		38	23	0	35	65	$K = 3 \times 10^{-8}$ cm/sec γ_{dmax} = 108.1 pcf W_{opt} = 16.9%	Sandy Lean Clay (CL)
	2.5	9								
	10			38	20			59	$K = 6 \times 10^{-8}$ cm/sec	Sandy Lean clay (CL)
B-9	0.5 to 4	4		33	18	0	39	62	$K = 1 \times 10^{-7}$ cm/sec γ_{dmax} = 109.9 pcf W_{opt} = 15.2%	Sandy Lean Clay (CL)
	2.5	5								
	7.5			44	25			68	$K = 1 \times 10^{-7}$ cm/sec	Sandy Lean Clay (CL)

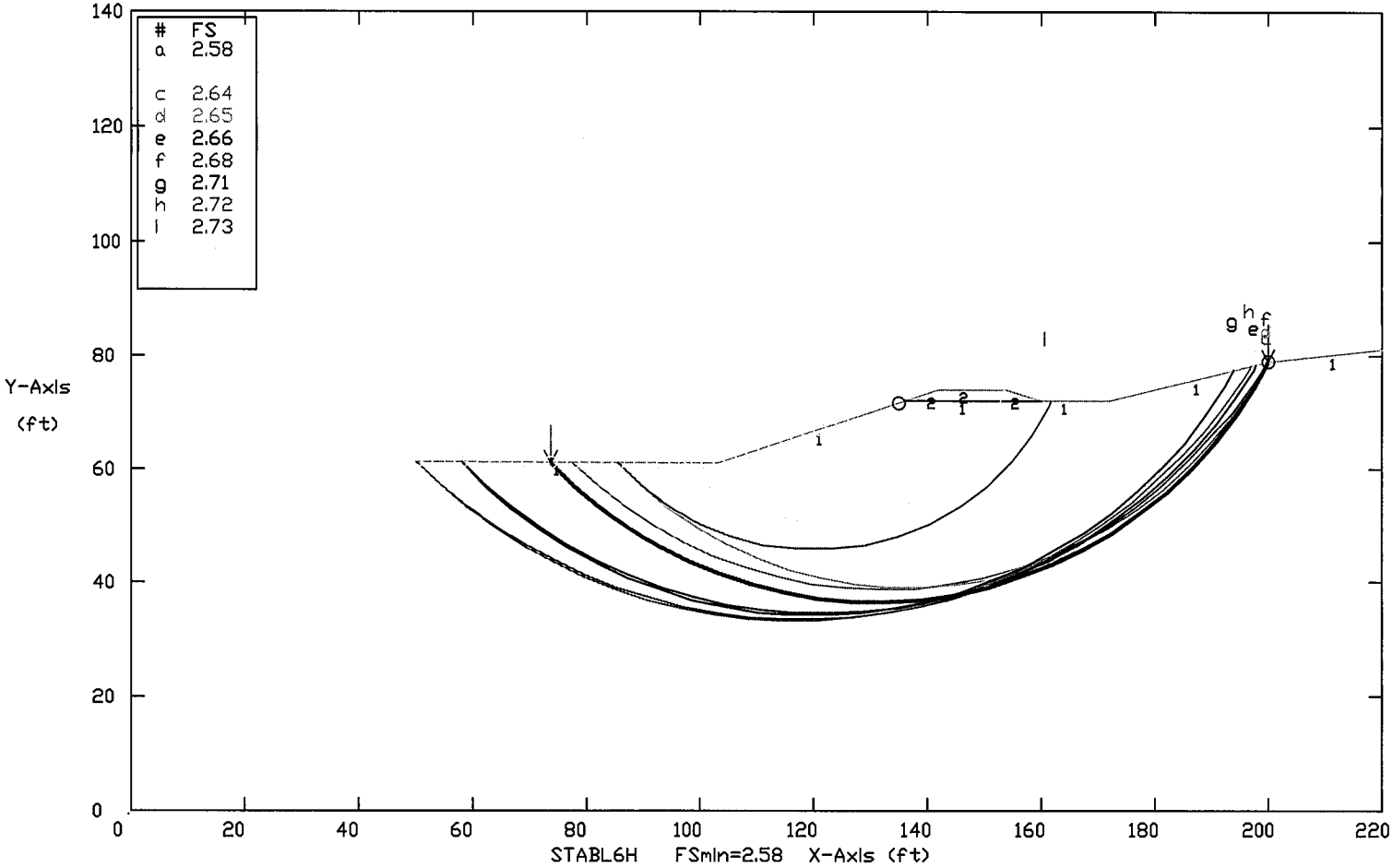
Abbreviation:

γ_{dmax} = Maximum Dry Density, as determined by ASTM D698
W_{opt} = Optimum Moisture Content, as determined by ASTM D698
K = Hydraulic Conductivity

Appendix A

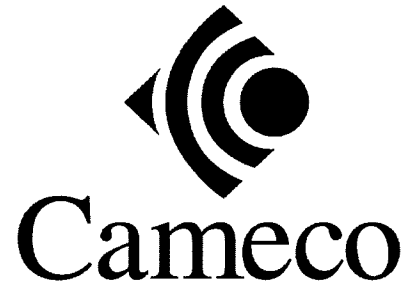
Slope Stability Analyses

North Butte Post Construction 3:1 Inside Slope
Most Critical Surface. C:NBUTTE.PLT By: TETRA TECH 12/07/2010 10:23am
Ten Most Critical. C:NBUTTE.PLT By: TETRA TECH 12/07/2010 10:23am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Native	118	118	700	0	0	0	
2	Embank	120	120	200	12	0	0	

OPERATION AND MAINTENANCE MANUAL
SURGE POND
NORTH BUTTE ISR SATELLITE
CAMPBELL COUNTY, WYOMING



Cameco Resources

July 2011

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APPENDICES

OPERATION AND MAINTENANCE MANUAL
SURGE POND, NORTH BUTTE ISR SATELLITE

A. Introduction

1. Facility Description.

   This facility is used for surge water storage for the North Butte ISR Satellite. The pond will provide temporary storage of water prior to final disposal by deep well injection or other permitted processes. Water will be delivered to the ponds by pipeline from the plant building adjacent to the pond (approximately 100 to 150 ft north of the pond). The pipeline will deliver water over the crest of the pond. Water will be pumped from the pond by pipeline over the crest. A 100-mil HDPE sacrificial wear liner is provided in the pipeline areas to prevent damage to the primary liner from delivery and pumping operations.

   The pond will be constructed with two cells operated independently of each other. The high water level in each cell is at elevation 5072 which provides for 5 ft of free board below the crest of the pond. An overflow channel is provided between the cells at an elevation of 5076 but is intended for emergency use only in a case where one cell is inadvertently over filled. In an emergency, with both cells filled to maximum operating capacity, it is possible to move the entire contents from one cell to the other provided the overflow channel is blocked. The pond has no outlet other than pumping.

   The pond lining system consists of a 60-mil HDPE geomembrane, a leak detection layer, a 40-mil HDPE geomembrane, and a 3-ft thick compacted clay liner. Each cell drains to a low point where two leak detection wells will collect any liquids infiltrating through the primary 60-mil liner.

2. Utilities.

   There are no utilities associated with the surge pond.

3. Emergency Operation and Response.

   This facility will be covered by the plant's Emergency Response Plan which will include provisions indicated herein.

4. Permitting Agencies.

   The facility is permitted through the following agencies:

   a. State of Wyoming, State Engineer's Office, Herschler Building, 4th East, Cheyenne, Wyoming 82002; (307) 777-7354. Permit No. (pending).

   b. State of Wyoming, Department of Environmental Quality, Land Quality Division, 2100 West 5th Street, Sheridan, Wyoming 82801. Permit No. (pending).

5. Engineer of Record

   Jason Stratton, P.E., Tetra Tech, 605 North Warehouse Road, Casper, Wyoming, 82601; (307) 234-2126.

6. General Contractor

   (Pending)

B. Process Flow Diagram

No process flow diagram is presented as all processes are managed under the plant's operation and maintenance plan. There are no enhanced evaporation or other pond specific processes.

C. Compliance Submittals

1. State Engineer.

   a. The permit expires (to be determined). A request for extension must be filed prior to this date if the facility is not closed by this date.

2. Department of Environmental Quality, Land Quality Division.

   a. Immediate oral and/or written notification shall be provided in accordance with the provisions of Section 9, Chapter III, Wyoming Water Quality Rules and Regulations, of any changes or modifications which are not consistent with the terms and conditions of the permit.

      Primary Contact: Glenn Mooney (307) 675-5615
      Secondary Contact: Mark Rogaczewski, District Supervisor (307) 675-5616
      Main Office: (307) 673-9337

   b. Monitoring Requirements:

      1. The two leak detection wells will be checked daily for the presence of water. Any water in the leak detection wells will be sampled and tested for Conductivity and Chloride content.

      2. A composite sample will be obtained from water in both cells on a yearly basis and tested for Total Dissolved Solids, pH, Conductivity, Sodium, Chloride, Sulfate and Alkalinity.

      3. An annual report will be submitted with the monitoring/leak detection well gauges and annual test results on a composite sample from the pond. This report will be made as part of the mine's annual report to the DEQ-LQD.

D. Pond Inspections

The embankments shall be observed by plant personnel for the presence of erosion, slumps, or other defects. The liner shall be observed for presence of cracks or damage. This inspection will be conducted on a monthly basis.

E. Corrective Actions

1. Water in leak detection wells

   a. Immediate notification will be provided to State of Wyoming, Department of Environmental Quality, Land Quality Division, District III, 2100 West 5th Street, Sheridan, Wyoming 82801; (307) 673-9337.

   b. If a leak is verified in the primary liner, the cell operation will cease until repair or corrective action can be taken. The cell may continue operation if a fluid recirculating system is installed and activated. Recirculating pumps should be capable of maintaining a water depth less than elevation 5064 in each well. If a recirculating system is installed:
      - High level alarms will be installed and monitored. High level alarms will be established at elevation 5070 in the wells.
      - A totalizing hour meter shall be read at least weekly.
      - If the recovery rate exceeds 400 gallons per day per acre (gpd/acre) for any sub-cell as delineated by the recovery system, the permittee shall notify the DEQ/LQD within seven (7) days. Repair of the primary liner must be scheduled within 12 months.
      - If the recovery rate exceeds 800 gpd/acre for any sub-cell as delineated by the recovery system, the DEQ/LQD shall be notified within 48 hours. Repair of the primary liner shall be scheduled within 60 days.
      - If the high level alarm level is reached, the DEQ/LQD shall be notified immediately. Operation of the cell will cease immediately until the primary liner is repaired.

   c. If fluids are detected in the leak detection system and there is a threat of contamination to the groundwater, the DEQ/LQD may require the construction of new groundwater monitoring wells along with periodic sampling and testing of the groundwater monitoring wells. Required sampling and testing parameters and frequency will be determined by the DEQ/LQD.

2. Damage to Liner

   a. If damage to the primary geomembrane (60-mil) liner is visible, operating water elevations will be maintained below the level of the visible damage until repairs can be made. Monitoring of the leak detection wells will be made on a weekly basis until 1 month following repairs.

   b. If damage to the primary and secondary liners are visible, operation of the cell will cease until repairs can be made.

3. Erosion

    a. Erosional damage on the embankment or at the toe of the embankment greater than 3 inches deep and less than 6 inches deep shall be repaired by regrading and revegetation of the impacted area within 12 months.

    b. Erosional damage on the embankment or at the toe of the embankment greater than 6 inches deep and less than 12 inches deep will be evaluated by Cameco engineering and repaired within 6 months.

    c. Erosional damage on the embankment or at the toe of the embankment greater than 12 inches deep will require immediate repair and mitigation of circumstances causing the erosional damage. The impacted cell will not be operated until damage is repaired.

4. Slumps, Bulges, Slides, Settlement

    a. If slumps, bulges, slides, settlement, or other non-erosional damage is observed, a qualified engineer will immediately evaluate the conditions. If damage threatens the integrity of the pond or lining system, the impacted cell will immediately cease operation until evaluation by a qualified engineer or repairs are made.

Attachment C

Closure Plan

Cameco Resources
Closure Plan – Surge Pond, North Butte ISR Satellite
Campbell County, Wyoming

Overview and Scope

This document is to provide guidance for the closure, reclamation and restoration of the site of Surge Pond at North Butte ISR Satellite, Campbell County, Wyoming. In general, the closure will entail removal all potentially contaminated materials from the site and final disposal in a licensed off-site landfill. Closure of water delivery systems and the plant site in general are not included in this plan.

Closure of Facilities

When the determination is made to cease use of the surge pond, the facilities will be closed in accordance with applicable regulations and Cameco policy. This pond will have only received material from Cameco sources. The DEQ and any adjacent property owner(s) will be notified at least 180 days prior to the cessation of use of the pond. A notice will be posted to indicate that no more water will be received at the site and the entry into the area will be controlled. The site security fence will remain in place and the gate will remain locked when reclamation activities are not being carried out.

Reclamation and Restoration

After storage of liquids to the pond has ceased, all fluids within the pond will be removed by pumping and/or evaporated. The plant will have the capability of removing all liquid from the ponds within 6 months. Once no fluids remain, the geomembrane liner, leak detection piping, and any sediments that have collected in the pond will be removed from the size and disposed of in an off-site landfill licensed for proper disposal of this waste. Soils from the construction of the embankments will be pushed out onto and over the pond area. The soils will be contoured such that the surface drainage will be from the pond center to the pond perimeter. The surface contours will be maintained as flat as possible to minimize surface erosion from surface drainage. Topsoil stockpiled from construction will be spread evenly over the site and revegetated with native grass species.

Monitoring and Inspection

Annual groundwater monitoring will continue in accordance with the Wyoming DEQ, Water Quality Rules and Regulations. The integrity of the reclamation will be visually inspected annually for erosion and rodent intrusion. Repairs will be made as necessary. Visual inspection of the vegetation will also take place. Re-vegetation will be considered complete after 70% coverage has been established. After the reclamation and re-vegetation activities have been completed, it is expected that the site will be inspected by the DEQ. After the closure is deemed satisfactory and complete, the site will be monitored, post-closure, for at least 5 years.

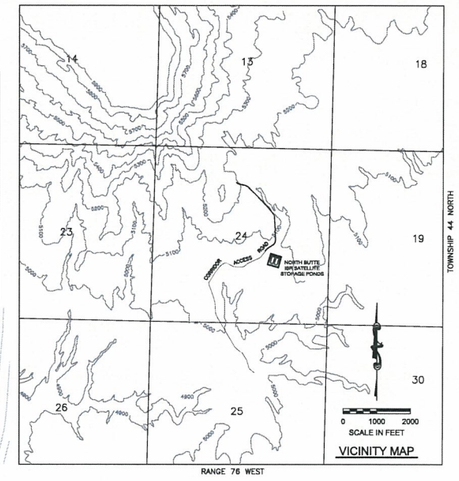
Corrective Action

Should the written result issued by the DEQ indicate that additional steps are needed before the site is in compliance with the closure requirements, Cameco will coordinate with the DEQ to resolve any outstanding issue.

While all potential for a release of any kind should be eliminated by removal of all potentially contaminated materials, in the event of a release during closure or post closure, the release will be appropriately responded to, remediated and investigated; an investigation plan will be developed and submitted in accordance with WDEQ Water Quality rules.

STAGE CAPACITY TABLE

WATER DEPTH (ft)	WATER ELEVATION (ft)	INDIVIDUAL CELL: TOP AREA (acre)	INDIVIDUAL CELL: AVERAGE AREA (acre)	INDIVIDUAL CELL: CAPACITY (acre-ft)	TOTAL POND CAPACITY (BOTH CELLS) (acre-ft)	
0	5064	0	0	0	0	
1	5065	.19	.09	.09	0.19	
2	5066	.22	.20	.29	0.59	
3	5067	.25	.23	.53	1.05	
4	5068	.28	.26	.79	1.58	
5	5069	.32	.30	1.09	2.18	
6	5070	.35	.34	1.43	2.85	
7	5071	.39	.37	1.80	3.60	
8	5072	.43	.41	2.21	4.43	
9	5073	.48	.45	2.67	5.34	
10	5074	.52	.50	3.17	6.33	FREE BOARD
11	5075	.57	.54	3.71	7.42	
12	5076	.61	.59	4.30	8.59	
13	5077	.66	.64	4.93	9.87	



VICINITY MAP

NOTES:

1.1. THE PROPOSED CELLS AND HAVE BEEN DESIGNED BASED UPON INFORMATION PRESENTED IN THE GEOTECHNICAL ENGINEERING STUDY DATED DECEMBER 2010.

1.2. THIS POND IS FOR TEMPORARY WATER STORAGE FROM CAMECO RESOURCES NORTH BUTTE ISR SATELLITE PLANT. THIS WATER ENTERS THE POND THROUGH PIPING OVER THE EMBANKMENT. NORMAL OPERATING FREE BOARD IS 5 ft.

1.3. QUANTITIES: QUANTITIES ARE PROVIDED FOR THE BENEFIT OF THE WYOMING STATE ENGINEER. CONTRACTOR'S ARE RESPONSIBLE FOR THEIR OWN QUANTITY ESTIMATES.

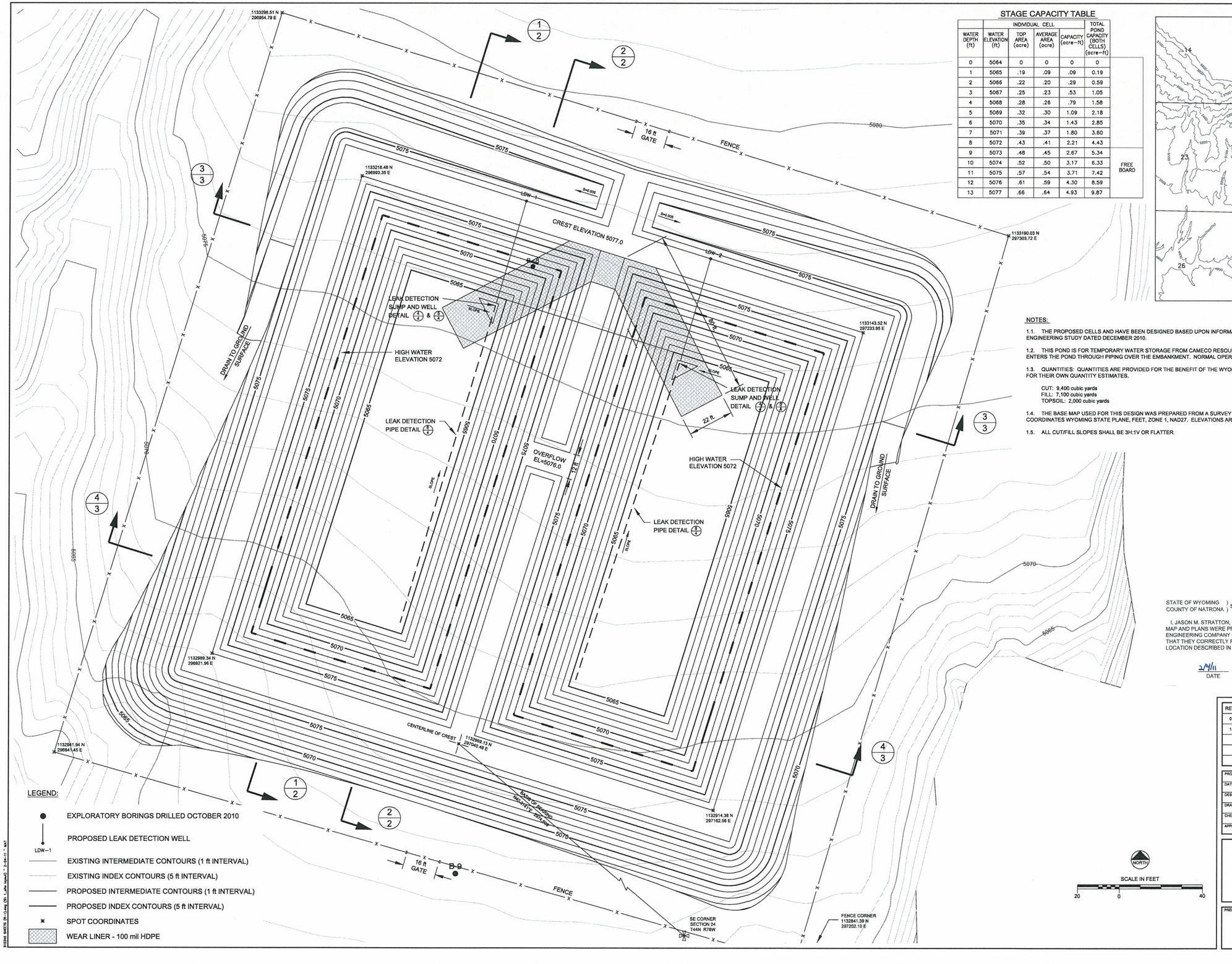
CUT: 9,400 cubic yards
FILL: 7,100 cubic yards
TOPSOIL: 2,000 cubic yards

1.4. THE BASE MAP USED FOR THIS DESIGN WAS PREPARED FROM A SURVEY BY LADD ENGINEERING COMPANY ON NOVEMBER 2010. ALL COORDINATES WYOMING STATE PLANE, FEET, ZONE 1, NAD27. ELEVATIONS ARE NGVD29.

1.5. ALL CUT/FILL SLOPES SHALL BE 3H:1V OR FLATTER.

LEGEND:

- EXPLORATORY BORINGS DRILLED OCTOBER 2010
- PROPOSED LEAK DETECTION WELL (LDW-1)
- EXISTING INTERMEDIATE CONTOURS (1 ft INTERVAL)
- EXISTING INDEX CONTOURS (5 ft INTERVAL)
- PROPOSED INTERMEDIATE CONTOURS (1 ft INTERVAL)
- PROPOSED INDEX CONTOURS (5 ft INTERVAL)
- SPOT COORDINATES
- WEAR LINER - 100 mil HDPE



NORTH

SCALE IN FEET
20 0 40

CERTIFICATE OF ENGINEER

STATE OF WYOMING)
COUNTY OF NATRONA) SS

I, JASON M. STRATTON, OF CASPER, WYOMING, HEREBY CERTIFY THAT THE ACCOMPANYING MAP AND PLANS WERE PREPARED FROM A SURVEY OF THE PROJECT SITE BY LADD ENGINEERING COMPANY OF CASPER, WYOMING, ON NOVEMBER 2010 USING MY DESIGNS AND THAT THEY CORRECTLY REPRESENT THE PROPOSED WATER STORAGE FACILITY AND LOCATION DESCRIBED IN THE ACCOMPANYING APPLICATION.

2/4/11
DATE

JASON M. STRATTON
*8182

Professional Engineer (Civil) JASON M. STRATTON 8182 Date 2/4/11 WYOMING

REV.	DATE	DESCRIPTION	BY
0	12-30-10	Issued for Permitting and Construction	JMS
1	2-04-11	No Changes	JMS

PROJECT NO:	114-510340
DATE:	December 2010
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS/PAW/JRS/MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

MAP TO ACCOMPANY APPLICATION FOR:

SITE PLAN

SURGE PONDS
NORTH BUTTE ISR SATELLITE
CAMPBELL COUNTY, WYOMING

PREPARED FOR:
CAMECO RESOURCES
550 NORTH POPLAR, SUITE 100
CASPER, WYOMING 82601

SHEET NO.
1 of 4

NOTES:

2.1 FOR CLARITY, TOPSOIL STRIPPING, SCARIFICATION, AND TOPSOIL PLACEMENT ARE NOT SHOWN.

2.2 A MINIMUM THICKNESS OF 6 inches OF TOPSOIL SHALL BE STRIPPED FROM ALL CUT, FILL, AND BORROW AREAS, AND SHALL BE STOCKPILED AT LOCATIONS DESIGNATED BY THE OWNER.

2.3 ALL AREAS TO RECEIVE FILL SHALL BE SCARIFIED A MINIMUM DEPTH OF 6 inches, MOISTURE CONDITIONS, AND COMPACTED TO A MINIMUM DENSITY OF 95% OF MAXIMUM DRY DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698.

2.4 ALL FILL SHALL BE PLACED AND COMPACTED TO A MINIMUM OF 95% OF MAXIMUM DRY DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698.

2.5 ALL FILL SHALL BE PLACED IN LIFTS NOT EXCEEDING 9 inches COMPACTED THICKNESS AND SHALL HAVE UNIFORM MOISTURE CONTENT THROUGH THE ENTIRE THICKNESS OF THE LIFT. A SHEEP'S FOOT ROLLER SHALL BE USED FOR COMPACTION EXCEPT WHERE A SMOOTH FINISHED SURFACE IS REQUIRED.

2.6 THE CLAY LINER SHALL BE CONSTRUCTED OF ON-SITE MATERIAL CLASSIFYING AS CL OR CH AND SHALL HAVE A MAXIMUM COEFFICIENT OF HYDRAULIC CONDUCTIVITY (kv) OF 1 X 10-7 cm/s WHEN COMPACTED. SELECTIVE EXCAVATION OF MATERIALS MAY BE REQUIRED. REFER TO THE GEOTECHNICAL REPORT DATED DECEMBER 2010.

2.7 THE GEOMEMBRANE LINER SHALL CONSIST OF 60 mil HDPE OVERLYING 40 mil HDPE. THE 60 mil HDPE LINER SHALL CONSIST OF AGRU DRAIN LINER, OR APPROVED EQUIVALENT, WITH TEXTURE ON THE UPPER SIDE AND 145 mil DRAINAGE STUDS ON THE LOWER SIDE. THE DRAINAGE STUDS SHALL PROVIDE DRAINAGE BETWEEN THE GEOMEMBRANE LAYERS WITH A MINIMUM TRANSMISSIVITY OF $3X10^{-4}$ m^2/sec UNDER A MINIMUM CONFINING PRESSURE OF 1,000 psf AND A GRADIENT OF 0.1 (ASTM D4716).

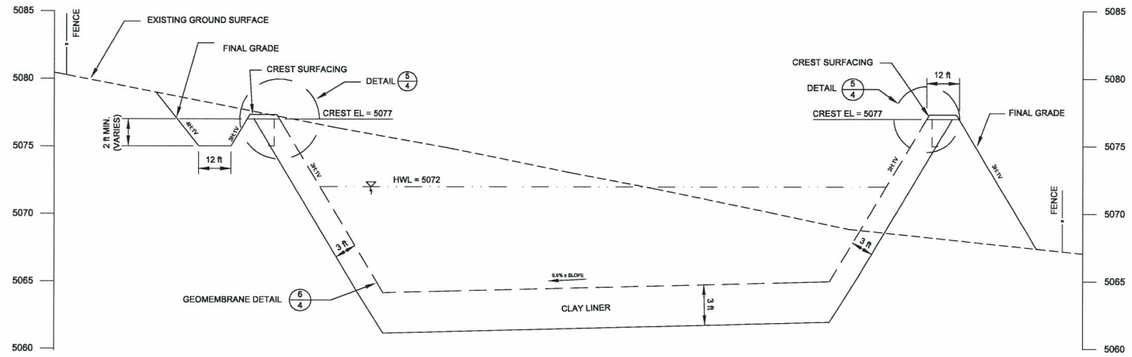
2.8 THE WEAR LINER SHALL CONSIST OF 100 mil HDPE WITH TEXTURE ON BOTH SIDES. THE WEAR LINER SHALL BE WELDED TO THE 60 MIL HDPE ALONG ALL EDGES OF THE WEAR LINER. THE WEAR LINER IS NOT REQUIRED TO EXTEND INTO THE ANCHOR TRENCH.

2.9 UPON COMPLETION OF CONSTRUCTION, A CONTINUOUS ROW OF UV RESISTANT SAND BAGS SHALL REMAIN IN PLACE ALONG THE TOE OF THE INTERIOR SLOPES AND ALONG THE TOE OF THE SLOPES IN THE OVERFLOW BETWEEN CELLS.

2.10 THE CREST SHALL BE FINISHED WITH A 4 inch THICK LAYER OF WYDOT GRADING W BASE COURSE GRAVEL WITH A FINISHED GRADE DRAINING TOWARDS THE POND AT A 0.5% SLOPE. THE CENTRAL DIKE BETWEEN THE TWO CELLS SHALL NOT BE COVERED WITH GRAVEL.

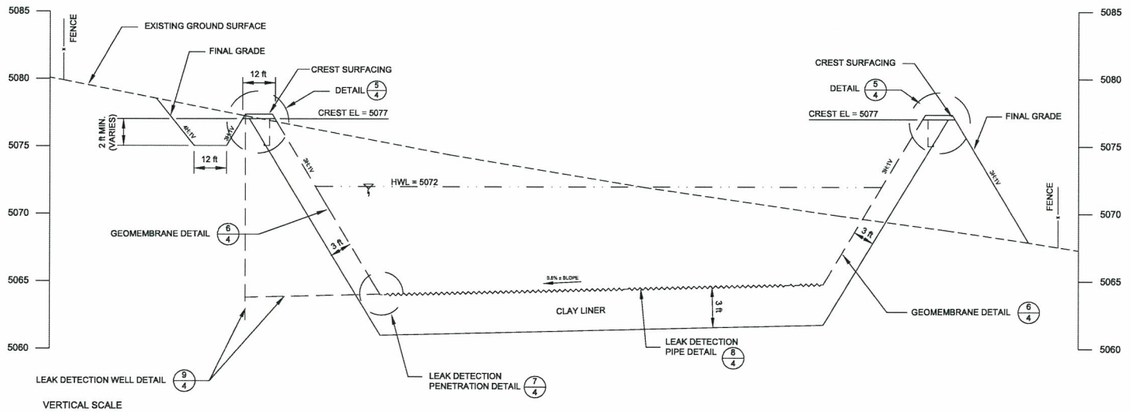
2.11 A MINIMUM OF 6 inches OF TOPSOIL SHALL BE PLACED OVER THE FINAL GRADE OF ALL CUT, FILL, AND BORROW AREAS EXCEPT THE POND CREST AND THE POND LINER. TOPSOIL SHALL BE FERTILIZED, HAY MULCHED, AND SEEDED.

2.12 THE PERIMETER FENCE SHALL CONSIST OF A 6 foot TALL CHAIN LINK FENCE. EACH GATE SHALL CONSIST OF TWO - 8 foot WIDE GATES CREATING A 16 foot WIDE OPENING.



VERTICAL SCALE
0 2.5 5
0 12.5 25
HORIZONTAL SCALE
(SCALE IN FEET)

1/2 CROSS SECTION



VERTICAL SCALE
0 2.5 5
0 12.5 25
HORIZONTAL SCALE
(SCALE IN FEET)

2/2 CROSS SECTION

REV.	DATE	DESCRIPTION	BY
0	12-30-10	Issued for Permitting and Construction	JMS
1	2-04-11	NOTE 2.7 Updated	JMS

PROJECT NO.	114-510340
DATE:	December 2010
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS/PAW/JRS/MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

MAP TO ACCOMPANY APPLICATION FOR:

CROSS SECTIONS

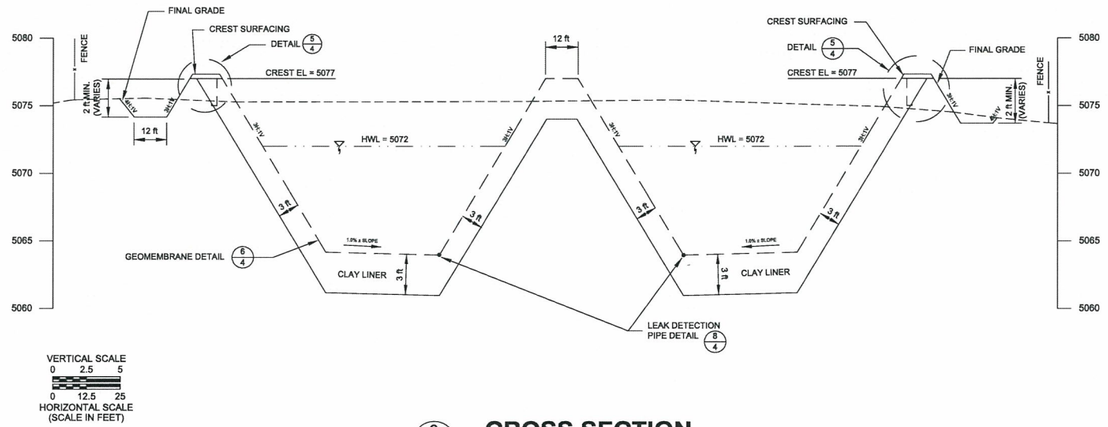
SURGE PONDS
NORTH BUTTE ISR SATELLITE
CAMPBELL COUNTY, WYOMING

PREPARED FOR:

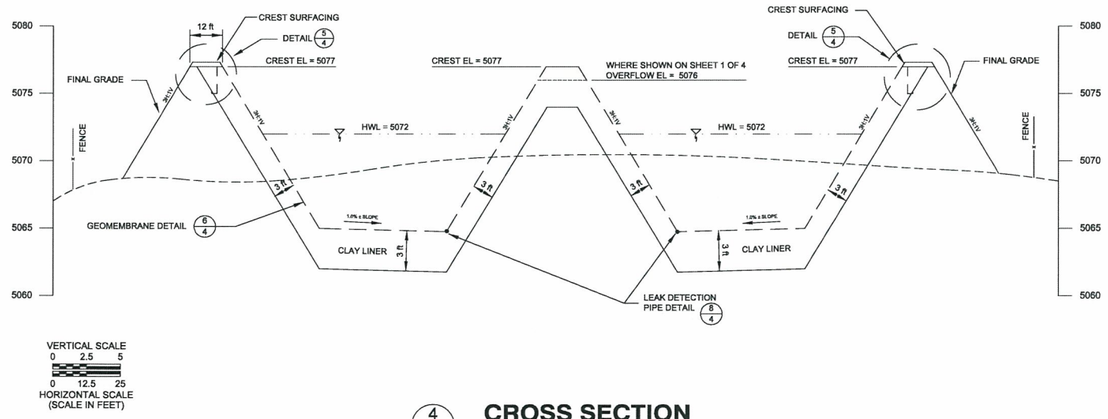
CAMECO RESOURCES
550 NORTH POPLAR, SUITE 100
CASPER, WYOMING 82601

SHEET NO.

2 of 4



3/3 **CROSS SECTION**



4/3 **CROSS SECTION**

NOTES:

3.1 TOPSOIL STRIPPING AND PLACEMENT ARE NOT SHOWN. TOPSOIL SHALL BE PLACED OVER FINAL GRADES SHOWN ON THIS EXCEPT ON THE CREST AND INTERIOR OF THE POND.

REV.	DATE	DESCRIPTION	BY
0	12-30-10	Issued for Permitting and Construction	JMS
1	2-04-11	3/3 & 4/3 Bottom Slope to 1.0%	JMS

PROJECT NO:	114-510340
DATE:	December 2010
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS/PAW/JRS/MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

MAP TO ACCOMPANY APPLICATION FOR:

CROSS SECTIONS

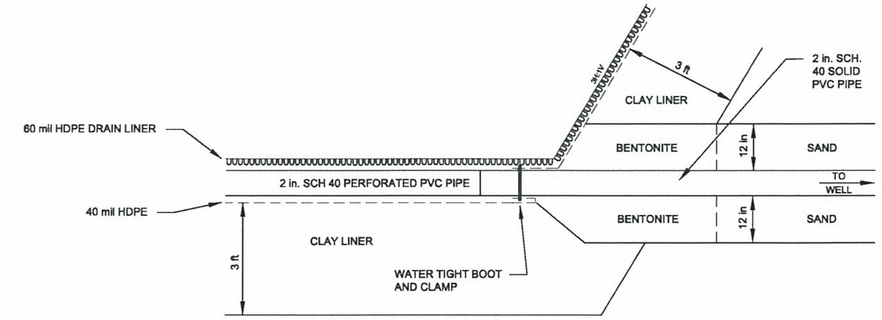
SURGE PONDS
NORTH BUTTE ISR SATELLITE
CAMPBELL COUNTY, WYOMING

PREPARED FOR:

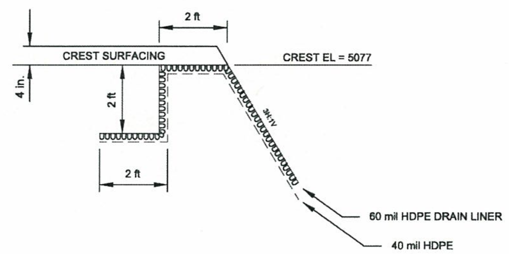
CAMECO RESOURCES
550 NORTH POPLAR, SUITE 100
CASPER, WYOMING 82601

SHEET NO.

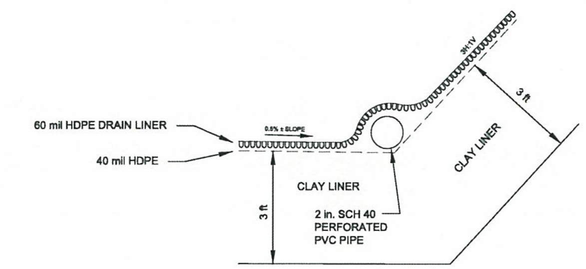
3 of 4



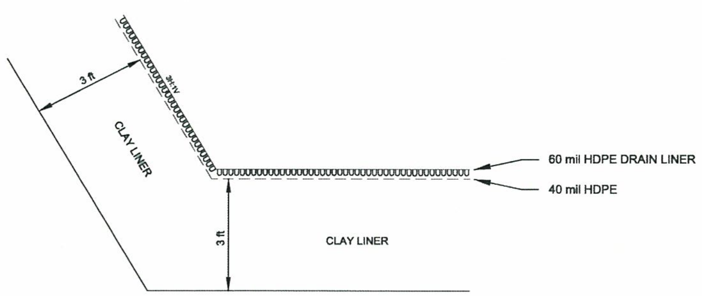
DETAIL (7/4) **LEAK DETECTION PIPE PENETRATION**
NOT TO SCALE



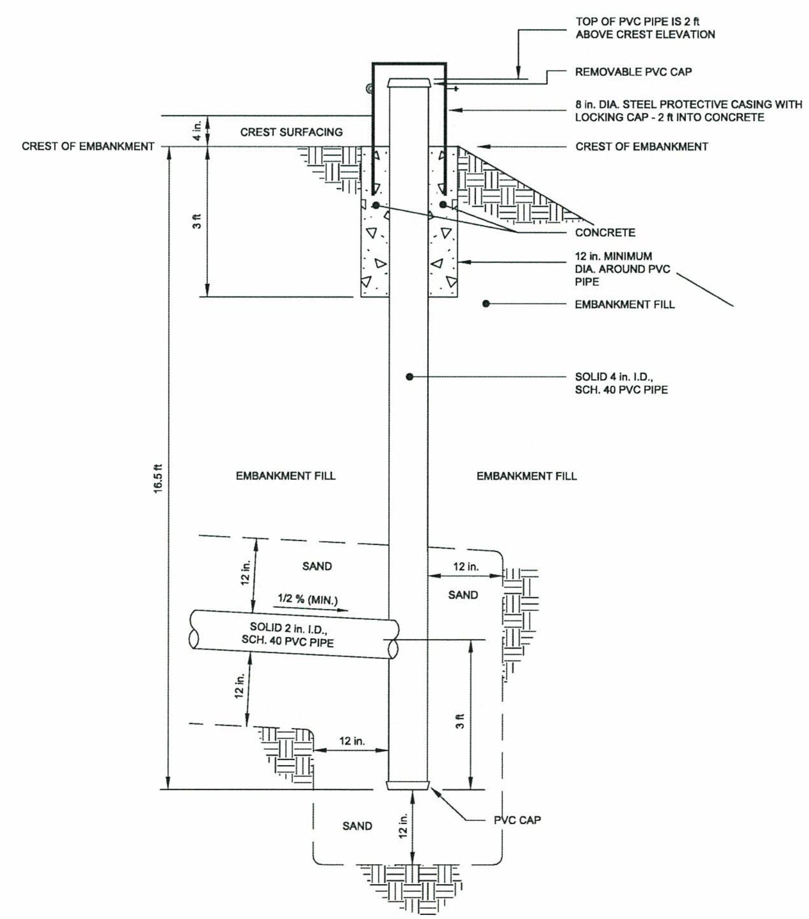
DETAIL (5/4) **LINER ANCHOR** (TYPICAL)
NOT TO SCALE



DETAIL (8/4) **LEAK DETECTION PIPE** (TYPICAL)
NOT TO SCALE



DETAIL (6/4) **GEOMEMBRANE LINER** (TYPICAL)
NOT TO SCALE



DETAIL (9/4) **LEAK DETECTION WELL** (TYPICAL)
NOT TO SCALE

NOTES:

4.1 PERFORATED PVC PIPE SHALL CONSIST OF FACTORY SLOTTED WELL SCREEN. SLOT SIZE SHALL BE 0.500 inch (0.020 TO 0.500 inch IS ACCEPTABLE). JOHNSON WELL SCREEN #OES40200 OR EQUIVALENT IS ACCEPTABLE.

4.2 BENTONITE SHALL CONSIST OF UNTREATED, SODIUM BENTONITE IN A GRANULAR OR CHIP FORM. BENTONITE SHALL HAVE A MAXIMUM SIZE OF 3/8 inch. A MINIMUM THICKNESS OF 12-inches OF BENTONITE SHALL BE PLACED AROUND THE PVC LEAK DETECTION PIPE AND SHALL EXTEND TO PROVIDE A POND SEAL FOR ALL PORTIONS OF THE CLAY LINER DISTURBED DURING INSTALLATION OF THE LEAK DETECTION SYSTEM.

4.3 SAND SHALL MEET ASTM C33 FINE AGGREGATE. SAND SHALL BE COMPACTED UTILIZING A SMOOTH PLATE VIBRATORY COMPACTOR.

4.4 WATER TIGHT BOOT AND CLAMPING SYSTEM SHALL BE PRE-APPROVED BY THE OWNER. A PREFABRICATION BOOT IS REQUIRED. ON-SITE FABRICATION IS NOT PERMITTED. THE BOOT/CLAMP SYSTEM SHALL CONSIST OF A MINIMUM OF TWO GASKETS AND CLAMPS FOR EACH BOOT AND SHALL BE DESIGNED TO NOT LEAK UNDER WATER PRESSURE HEAD OF 20 ft.

REV.	DATE	DESCRIPTION	BY
0	12-30-10	Issued for Permitting and Construction	JMS
1	2-04-11	No Changes	JMS

PROJECT NO:	114-510340
DATE:	December 2010
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS/PAW/JRS/MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

MAP TO ACCOMPANY APPLICATION FOR:

DETAILS

SURGE PONDS
NORTH BUTTE ISR SATELLITE
CAMPBELL COUNTY, WYOMING

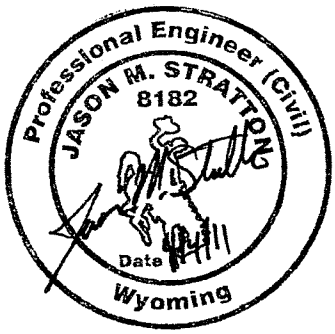
PREPARED FOR:
CAMECO RESOURCES
550 NORTH POPLAR, SUITE 100
CASPER, WYOMING 82601

SHEET NO.
4 of 4

Appendix E

Gas Hills Evaporation Pond Design

TETRA TECH



April 4, 2011

Mr. Nickolas Lewallen
Cameco Resources
400 East First Street, Suite 308
Casper, Wyoming 82601

Subject: **Engineering Design Report, Evaporation Pond, Gas Hills ISR Satellite, Fremont County, Wyoming**
Tetra Tech Project No. 114-510339

Dear Mr. Lewallen:

This letter and attachments represents the engineering design report for the subject facility. The evaporation pond has been designed in accordance with 40-CFR-264 Subpart K and as detailed in NRC Regulatory Guide 3.11 "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities". The Wyoming Department of Environmental Quality - Water Quality Rules and Regulations have also been utilized in design.

The new pond will consist of two equally sized cells with a double geomembrane liner, leak detection system, and compacted clay liner. The pond will store process water from Cameco's North Butte ISR Satellite plant for final disposal by evaporation or other permitted processes. Origination and final disposal of this water is regulated and permitted under those specific processes. This design and report only addresses the storage and evaporation of the water.

The design drawings (Sheets 1 of 4 through 4 of 4) and the Technical Specifications are presented under separate cover. The following attachments are provided herein:

Attachment A: Geotechnical Engineering Study
This study presents evaluation of site conditions, subsurface conditions, suitability of on-site materials for use in construction and as a compacted clay liner, and stability of the pond embankments.

Attachment B: Draft Operations and Maintenance Manual
This draft is presented as a basis for the final Manual which will be transmitted to the Wyoming Department of Environmental Quality upon completion of construction and prior to operation of the Pond. The final manual will contain copies of applicable permits, contractor, and warranty information.

Tetra Tech
605 North Warehouse Road, Casper, WY 82601
Tel 307.234.2126 Fax 307.266.5143 www.tetratech.com

Attachment C: Draft Closure Plan
The draft plan provides a general description of expected closure procedures. Additional design and permitting is anticipated for final closure.

Leak Detection System: Synthetic porous media for the leak detection system is required to have a transmissivity of $3x10^{-4}$ m^2/sec or greater (40 CFR 264.221(c)(2)(ii)). AGRU Drainliner, or equivalent, has been specified as the primary liner for construction. This type of geomembrane liner is produced with a series of studs on one side. These studs have a typical asperity height of 3.68 mm (145 mil). The studs provide a gap between the primary and secondary geomembrane resulting in a geosynthetic drainage layer. Under a confining load of 15,000 psf (far greater than the 500 psf load expected on this liner), manufacturer testing indicates the transmissivity of this layer ranges from $2x10^{-3}$ m^2/sec to $1x10^{-2}$ m^2/sec which satisfies 40 CFR 264.221(c)(2)(ii).

Please contact us if additional design detail or other information is required.

Sincerely,
TETRA TECH

Jason M. Stratton, P.E.
Senior Project Manager

Attachments

n:\geo\2011\114-510339\Gas Hills Pond Design Report.doc

ATTACHMENT A
GEOTECHNICAL ENGINEERING STUDY
EVAPORATION POND
GAS HILLS ISR SATELLITE
FREMONT COUNTY, WYOMING

Cameco Resources

April 2011

TETRA TECH

March 14, 2011

Mr. Nickolas Lewallen, P.E.
Cameco Resources
550 North Poplar, Suite 100
Casper, Wyoming 82601

Subject: **Geotechnical Engineering Study for the Proposed Evaporation Pond to be Located at the Cameco Resources Gas Hills Satellite Facility, Fremont County, Wyoming**
Tetra Tech Project No. 114-510339

Dear Mr. Lewallen:

At your request, we have conducted a geotechnical study for the subject project located in Fremont County, Wyoming.

The subsurface profile across the pond footprint generally consisted of 6 inches of topsoil and 0 to 15 ft of clay and silty sand overlying sandstone and claystone bedrock.

The report which follows summarizes our findings and presents our conclusions and recommendations. If you have any questions regarding this report, please call.

Sincerely,
TETRA TECH

Brian L. Chandler

Brian L. Chandler, P.E.
Senior Geotechnical Engineer

Enclosure

n:\geo\2011\114-510339\Cameco Gas Hills Pond.wpd

Tetra Tech
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Tel 307.234.2126 Fax 307.266.5143 www.tetratech.com

TETRA TECH

Geotechnical Engineering Study

Proposed Evaporation Pond
Cameco Resources Gas Hills Satellite Facility
Fremont County, Wyoming

Prepared for:

Cameco Resources

550 North Poplar, Suite 100
Casper, Wyoming 82601
PH: (307) 237-2128
Fax (307) 237-2142

Prepared by:

Tetra Tech

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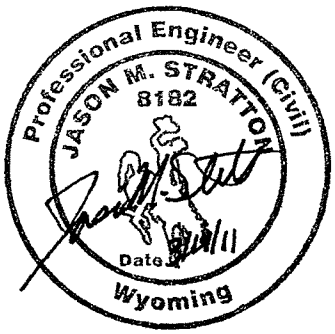
PH: (307 234-2126
Fax (307) 266-5143
Tetra Tech Project No. 114-510339

March 14, 2011



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FIGURES

TABLES

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PURPOSE AND SCOPE OF STUDY

This report presents the results of our geotechnical engineering study for the proposed new evaporation pond to be located at the Cameco Resources Gas Hills Satellite Facility in Fremont County, Wyoming. The site vicinity is shown on Figure 1. The study was conducted to explore the subsurface profile beneath the pond footprint and to perform stability analyses of the proposed pond slopes. This study was conducted in accordance with Cameco Resource's Standard Agreement with Tetra Tech and Tetra Tech's proposal to Cameco Resources dated September 24, 2010.

Tetra Tech conducted a field exploration program for the evaporation pond which consisted of 13 exploratory borings drilled for the proposed pond to obtain information on the subsurface conditions. The exploratory borings were located as shown on Figure 2. Samples obtained during the field exploration were tested in our laboratory to determine physical and engineering characteristics. We analyzed results of the field exploration and laboratory testing to evaluate suitability of soils and bedrock for use in the planned construction, and to develop soil properties for use in the stability analyses. The results of the field exploration and laboratory testing are presented herein.

We have prepared this report to summarize the data obtained during this study, and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. A discussion of geotechnical engineering considerations related to construction is included in the report.

PROPOSED CONSTRUCTION

The proposed project consists of the construction of a new evaporation pond with two cells for process water located at the Gas Hills Satellite Facility. Each cell will have dimensions of approximately 450 ft by 450 ft. The North Cell and South Cell locations and the arrangements are shown on Figure 2. The cell bottoms will have approximate dimensions of 325 ft by 325 ft. The interior and exterior pond sides will be constructed at 3 horizontal to 1 vertical slopes. Embankments, ranging from 0 to 12 ft in height, will be constructed around the cells. The embankments constructed will have crest widths of 12 ft and interior and exterior side slopes of 3

horizontal to 1 vertical. The total pond depths will be approximately 9 ft, which includes 5 ft of freeboard and a water depth of approximately 4 ft. As required by the Nuclear Regulatory Commission (NRC) Regulatory Guide 3.11, a double geomembrane liner with a leak detection system will be constructed. The double geomembrane liner will be installed over a 3 ft thick compacted clay liner. The compacted clay liner is required to have a hydraulic conductivity of no more than $1x10^{-7}$ cm/sec. The soil excavated for the below grade portion of the pond will be used for the above grade embankments and the compacted clay liner.

SITE CONDITIONS

The site is located at the Cameco Resources Gas Hills Satellite Facility in Fremont County, Wyoming. The Gas Hills project site is located approximately 65 miles west of Casper and 45 miles east of Riverton in Fremont County. The proposed ponds are located within the West Canyon Creek drainage approximately one half mile northwest of the existing plant building for the Gas Hills facility. Vegetation on the site consisted of sagebrush, native grasses, and weeds. The topography of the site slopes slightly to moderately downward toward the northeast toward West Canyon Creek. Sandstone outcrops are present near the northern portion of the pond site.

FIELD EXPLORATION

Tetra Tech conducted the field exploration on October 20 and December 21, 2010. On October 20, 2010 three exploratory borings were drilled within the pond footprint and one was drilled in a potential borrow area. On December, 21, 2010 nine additional borings were drilled to explore for additional material to construct the 3 ft thick compacted clay liner. The locations of the exploratory borings are shown on Figure 2. The boring locations were determined by Tetra Tech which were referenced from the pond corners which were staked in the field by Cameco representatives.

The drill crew used a CME-55 truck-mounted drill rig and a CME 750 ATV-mounted drill rig to advance the borings. The borings were advanced through the subsurface soils using 4 inch diameter solid-stem auger. A Tetra Tech field engineer logged the borings. The borings were drilled to depths ranging from 48 ft to 15 ft. Auger refusal was encountered within borings B-1 and B-3 at depths of 37 ft and 48 ft, respectively.

Samples of the subsurface materials were obtained using either a 1⅜-inch inside diameter split barrel sampler or a 2-inch inside diameter California sampler equipped with brass liners. The samplers were driven into the various strata using a 140 lb hammer falling 30 inches. The number of blows required to advance the sampler one 12 inch increment is recorded as the penetration resistance value or N value. This test, when using the California sampler, is similar to the standard penetration test described by ASTM D1586, Split Barrel Sampling of Soils. Penetration resistance values provide an indication of the relative density of granular soils, or consistency of fine-grained soils. Depths at which the samples were obtained and the penetration resistance values are shown on the exploratory boring logs.

Disturbed bulk samples were obtained from the upper portions of the borings. Depths at which the samples were obtained are shown on the Logs of Exploratory Borings.

Groundwater levels were measured in each boring during and upon completion of drilling. The borings were backfilled with hydrated bentonite chips immediately after completion of drilling.

LABORATORY TESTING

A Tetra Tech geotechnical engineer observed the soil samples obtained from the field exploration and visually classified them according to ASTM D2487, which is based on the Unified Soil Classification System. The engineer selected representative samples for testing to determine the engineering and physical properties in general accordance with ASTM standards. Laboratory tests performed for this project include:

TEST	ASTM DESIGNATION
Natural Moisture Content and Dry Density	D2937
Natural Moisture Content	D2216
Particle Size Analysis	D422/1140
Atterberg Limits	D4318
Standard Moisture-Density Relation	D698
Fixed Wall Falling Head Permeability (Remolded and Undisturbed)	

The laboratory test results, along with visual field logging information, were used to prepare the exploratory boring logs. Results of geotechnical laboratory testing are included on the boring logs, presented graphically on the figures following the boring logs, and summarized on Table I.

SUBSURFACE CONDITIONS

The subsurface profile within the proposed pond footprint generally consisted of 6 inches of topsoil, 0 to 6 ft of silty sand, and 0 to 15 ft of sandy lean clay overlying sandstone and claystone bedrock. The exploratory boring logs should be referenced for soil descriptions and classifications, strata thicknesses, N values, and laboratory test results. A brief description of each soil type encountered follows:

Silty Sand (SM)

Silty sand was encountered below the topsoil in borings B-2 and B-4. The silty sand extended to depths of 6.5 ft below the ground surface in both of these borings. The relative density of the silty sand was medium dense as indicated by the N values ranging from 12 to 14. The silty sand was light brown in color and slightly moist. Laboratory test results are presented on Figures 6 and 7. Laboratory test results indicate that the silty sand has natural moisture contents ranging from 6 to 8% and 27 to 37% passing the No. 200 sieve.

Sandy Lean Clay (CL)

Sandy lean clay was encountered below the topsoil in borings B-5, B-7, B-8, through B-13 and below the silty sand in boring B-2. The clay extended to depths of 8.5 ft in borings B-2 and B-11, 3.5 ft in boring B-5, 9 ft in boring B-7, 4 ft in borings B-8 and B-13, and to the depths explored in borings B-9, B-10, and B-12. The consistency of the clay stratum was stiff to hard as indicated by the N values ranging from 12 to 32. The clay was brown to gray in color and slightly moist. Laboratory test results indicate that the clay has liquid limits ranging from 35 to 40, plasticity indices ranging from 17 to 23, and 36 to 59% passing the No. 200 sieve.

Sandstone Bedrock

Sandstone bedrock was encountered below the topsoil in boring B-1, below the silty sand in boring B-4, below the clay in borings B-5 and B-8, and below the claystone in borings B-2 and B-3. The sandstone extended to depths of 16 ft in boring B-4, 7 ft in boring B-8, and to the depths explored in borings B-1, B-2, B-3, and B-5. The sandstone was medium hard to very hard as indicated by the N values ranging from 26 to greater than 50. The sandstone was light brown in color and slightly moist. Laboratory testing indicates that the sandstone has natural moisture contents ranging from 6 to 9% and an in-situ hydraulic conductivity on the order of $5x10^{-5}$ cm/sec. Graphical laboratory test results are presented on Figure 4.

Claystone Bedrock

Claystone bedrock was encountered below the topsoil in borings B-3 and B-6, below the clay in borings B-2, B-7, B-11, and B-13, and below the sandstone in borings B-4 and B-8. The claystone extended to depths of 20 ft in boring B-2, 23 ft in boring B-3, and to the depths explored in borings B-4, B-6, B-7, B-8, B-11, and B-13. The claystone bedrock was firm to very hard as indicated by the N values ranging from 15 to greater than 50. The claystone was olive gray in color and slightly moist to moist.

Laboratory test results indicate that the claystone material has liquid limits ranging from 38 to 41, plasticity indices ranging from 19 to 22, 41 to 58% passing the No. 200 sieve, and natural moisture contents ranging from 9 to 16%. Laboratory testing indicates that the claystone material has a maximum dry density on the order of 108.5 pcf and an optimum moisture content on the order of 17.0% when tested in accordance with ASTM D698, Standard Proctor. The in-situ claystone has a hydraulic conductivity on the order of $3x10^{-9}$ cm/sec and a remolded hydraulic conductivity on the order of $6x10^{-9}$ cm/sec when remolded to 95% of the maximum dry density and near the optimum moisture content as determined by ASTM D698. Graphical laboratory test results are presented on Figures 9, 10, and 12.

Groundwater

Groundwater was not encountered within any of the borings at the time of drilling. Numerous factors contribute to fluctuations of groundwater levels; evaluation of these factors is beyond the scope of this report.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

The recommended design and construction criteria presented in the following sections should be observed for the geotechnical engineering aspects of the project. The details that we recommend should be considered when preparing the project documents.

Site Grading

All topsoil, vegetation, and organic matter should be stripped in all cut and fill areas within the pond footprint. Topsoil should also be stripped in areas where material will be stockpiled, so that vegetation does not mix with the soil when moving the stockpiled material. The topsoil thickness was approximately 6 inches.

Site grading will consist of cuts of up to 15 ft for both cells to achieve the planned pond bottom elevations . An additional cut of 3 ft will be required for the compacted clay liner. The cell side slopes will consist of cut slopes and fill slopes. Fills of up to 12 ft will be required to construct the cell side slopes. Site grading will also include the construction of drainage trenches along the southwest corner of the North Cell and along the southern half of the South Cell to route surface run-off away from the cells. The drainage trenches will be cuts.

Excavation

Cuts and fills will be required for the proposed pond cells. Due to the site topography which slopes downward to the north and east, excavations of up to 18 ft will be required on the southern portions

of both cells to achieve the pond bottom elevations. This maximum depth includes the 3 ft over-excavation depth which will be required for the construction of the 3 ft thick compacted clay liner.

The majority of the excavations will be made within the sandy lean clay and claystone stratums and can, generally, be accomplished with conventional heavy-duty excavation equipment. Sandstone bedrock lenses may be encountered within excavations made for the north cell and may be very hard. Sandstone lenses may be difficult to excavate and may require ripping.

Embankment Construction

Embankments will be constructed along all sides of both cells. The embankment heights will range from 0 ft to 12 ft, will have crest widths of 12 ft, and will be constructed at 3 horizontal to 1 vertical slopes. The on-site soils consisting of silty sand, sandy lean clay, claystone, and sandstone are suitable for use as embankment fill. The silty sand and sandstone should be used first in the lower portions of the embankments. The clay and claystone should be separated and stockpiled for reuse for the compacted clay liner. If the quantity of silty sand and sandstone is not sufficient for the construction of the embankments, the sandy lean clay should be used. Prior to placing embankment fill, the subgrade of all areas to receive new fill should be scarified to a minimum depth of 9 inches, moisture conditioned, and proof-rolled with a heavy-duty sheepsfoot compactor.

All soils used for the construction of the earthen embankment should be processed by scarifying, mixing, or discing and applying moisture to achieve a uniform moisture content within ±2% of the optimum moisture content as determined by ASTM D698, Standard Proctor. All fill should be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698. A sheepsfoot compactor must be used to compact all clay soils to help break up clods and to reduce the potential for laminations between lifts.

The on-site clay encountered within the borings have natural moisture contents ranging from 8 to 10% and the on-site claystone has natural moisture contents ranging from 9 to 16%. Laboratory test results indicate that the claystone will have an optimum moisture content on the order of 17.0%. The natural moisture contents of the clay and claystone ranges from 1 to 9% below optimum moisture content. Therefore, moisture will need to be added to the clay soil to be used for embankment fill and the compacted clay liner.

Compacted Clay Liner

As required by the NRC regulations, a 3 ft thick compacted clay liner is required to be constructed below the double geomembrane liner system. Based on the results of the laboratory permeability testing, the on-site claystone is suitable for the construction of the compacted clay liner. The remolded claystone specimen had a hydraulic conductivity on the order of $6x10^{-9}$ cm/sec when remolded to 95% of the maximum dry density and near the optimum moisture content as determined by ASTM D698.

The compacted clay liner should be constructed of the on-site claystone material. As indicated by the boring logs, the majority of the claystone will be encountered near the southwest corner of the North Cell and near the southeast corner of the South Cell. The claystone may also be encountered in other areas of the cell excavations. Layers of unsuitable materials, such as sandstone lenses, may be encountered within the claystone stratum and these layers must be selectively removed from the claystone material prior to stockpiling. Our estimates indicate that the quantity of the claystone should be sufficient to construct the 3 ft thick clay liner.

If the quantity of unsuitable material within the claystone stratum is higher than expected and the quantity of claystone is not sufficient, the sandy lean clay overburden soil encountered below the topsoil in borings B-7 through B-12 is suitable for use as material to construct the 3 ft thick clay liner. Hydraulic conductivity testing was not performed on the sandy lean clay. However, laboratory testing indicates that the sandy lean clay has similar index properties to the claystone material. Laboratory test results indicate that the sandy lean clay has liquid limits ranging from 35 to 40, plasticity indices ranging from 17 to 23, and 36 to 59% passing the No. 200 sieve and that the claystone material has liquid limits ranging from 38 to 41, plasticity indices ranging from 19 to 22, 41 to 58% passing the No. 200 sieve. We estimate the hydraulic conductivity of the sandy lean clay will be on the order of $1x\ 10^{-8}$ cm/sec.

The sandy lean clay will be encountered near the south half of the South Cell. When excavating for the cells, all clay and claystone that is encountered should be selectively excavated, separated, and stockpiled for reuse as the clay liner. A representative of the geotechnical engineer should be on-site during cell excavation to aid the contractor in identifying and delineating the extent of the clay and claystone bedrock.

The clay and claystone should be separated during excavation. The claystone material should be used primarily for the construction of the clay liner. The sandy lean clay should be used only if the quantity of claystone is insufficient and only after the claystone material has been depleted.

The clay soil for the liner should be moisture conditioned to within -1% to +3% of the optimum moisture content and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698, Standard Proctor. The natural moisture contents of the claystone ranges from 1 to 8% below optimum moisture content. Therefore, moisture will need to be added to the claystone material to be used for the compacted clay liner. The addition of moisture must be performed prior to the placement of the lifts of fill and a sheepsfoot compactor must be used to compact each lift. The addition of moisture to excavated claystone material will be difficult and the contractor should plan to process the material by breaking down large chunks, pre-wetting the material, and throughly mixing using equipment such as a disc.

Slope Stability

As required by the NRC regulations, slope stability analyses were performed. We modeled the north side of the South Cell slope for our slope stability analyses. This area is a low area where the cell embankment will be entirely fill material. The soil strength values used in our analyses were estimated based on the soil type and our experience with soil strengths of similar soil types. The shear strength parameters used in the analyses are presented on the slope stability figures attached in Appendix A. The post-construction and steady-state seepage models were performed on both interior and exterior slopes with no phreatic surfaces. The earthquake or pseudo-static model was not performed due to the low seismic potential project area.

Our slope stability analyses indicates that the pond slopes, both interior and exterior, will be stable in the post-construction condition and the steady-state seepage condition. The slope stability analyses summary is shown graphically for both conditions and for both interior and exterior slopes in Appendix A. We used the slope stability software STABL6 for our analyses. Our analyses indicates a factor of safety on the order of 2.2 for the exterior slope post-construction case, 2.5 for the interior slope post-construction case, 2.5 for the exterior slope steady-state seepage case, and and 2.7 for the interior slope steady-state seepage condition. The minimum factors of safety

required by the NRC for the post construction condition is 1.3 and 1.5 for the steady-state seepage condition.

Settlement

Laboratory testing to determine the compressibility of the site soils was not performed. Based on the subsurface conditions which consist of relatively shallow bedrock and stiff to hard clays, no significant settlements of the embankment fills are anticipated. In addition, based on the liner system consisting of a double geomembrane and a 3 ft thick compacted clay liner, the infiltration of water into the soils beneath the pond is highly unlikely, further reducing any potential for settlement.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the design data submitted to Tetra Tech, data obtained from the exploratory borings drilled at the locations indicated on Figure 2 and the proposed construction discussed in this report. The nature and extent of subsurface variations across the site may not become evident until construction. During construction, if fill, soil, rock or water conditions appear to be different from those described herein, this office should be advised at once so that we may re-evaluate the recommendations made.

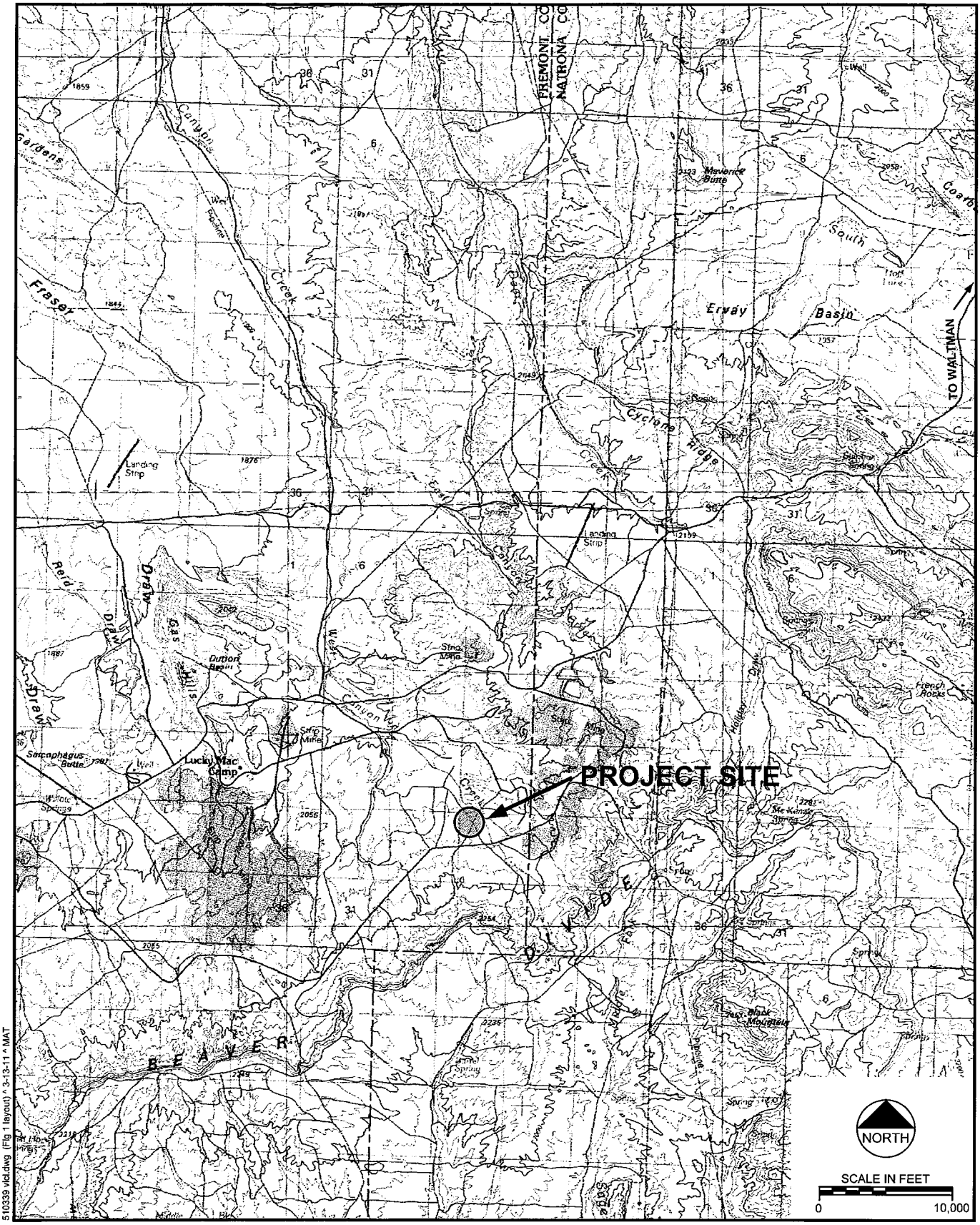
This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our exploratory information which has not been described or documented in this report. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analyses or modifications of the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of fill by a representative of the geotechnical engineer.

Any conclusions by a construction contractor or bidder, relating to construction means, methods, techniques, sequences or costs based upon the information provided in this report are independent conclusions by the contractor or bidder and are not the responsibility of Tetra Tech.

TETRA TECH

Brian L. Chandler, P.E.
Sr. Geotechnical Engineer

Jason M. Stratton, P.E.
Sr. Geotechnical Engineer

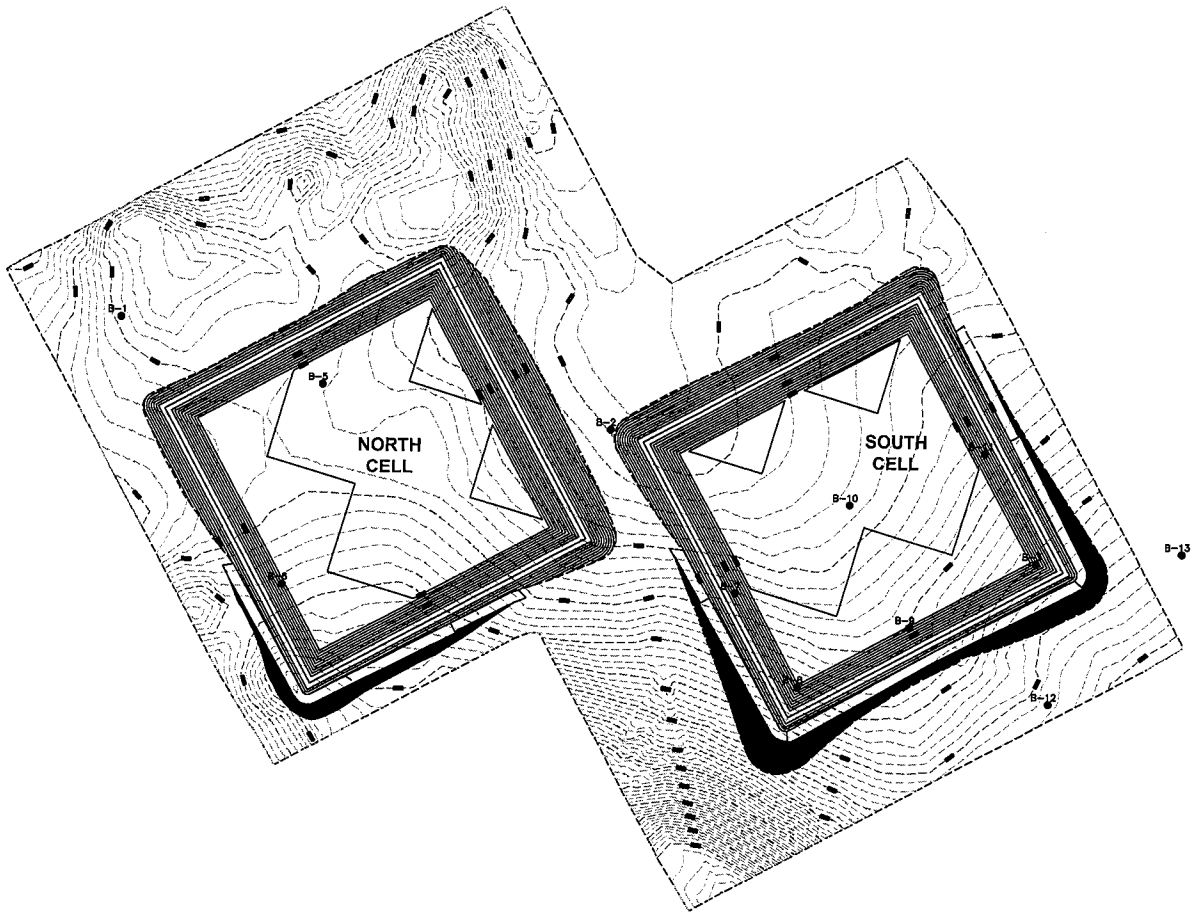


510339 vicl.dwg (Fig 1 layout) ^ 3-13-11 ^ MAT

Project Number: 114-510339

March 2011

Figure 1
SITE VICINITY MAP
Gas Hills Evaporation Pond - Fremont County, Wyoming



0 Feet 150

March 2011

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LOCATION OF EXPLORATORY BORINGS
Proposed Evaporation Ponds
Cameco Recourses Gas Hills Satellite Facility

FIGURE 2

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-1		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-20-10	Date Finished: 10-20-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42°48'34.3"
W 107°31'13.5"
Bedrock outcrops to north and east.

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, silty sand, brown, dry, (6 in. thick).	0.5
			32	6	100					SANDSTONE BEDROCK, medium to very hard, light brown to tan, slightly moist.	
			50/0.8	6	112			10			
			50/0.25							Drilling became hard at 6.5 ft.	
10			50/0.0								
			84							Drilling eased at 13 ft.	
										Drilling became hard at 17 ft.	
20			50/0.1								
			50/0.0								
30			50/0.0								
			50/0.0								37

Bottom of Boring at 37.0 ft
Auger Refusal at 37.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

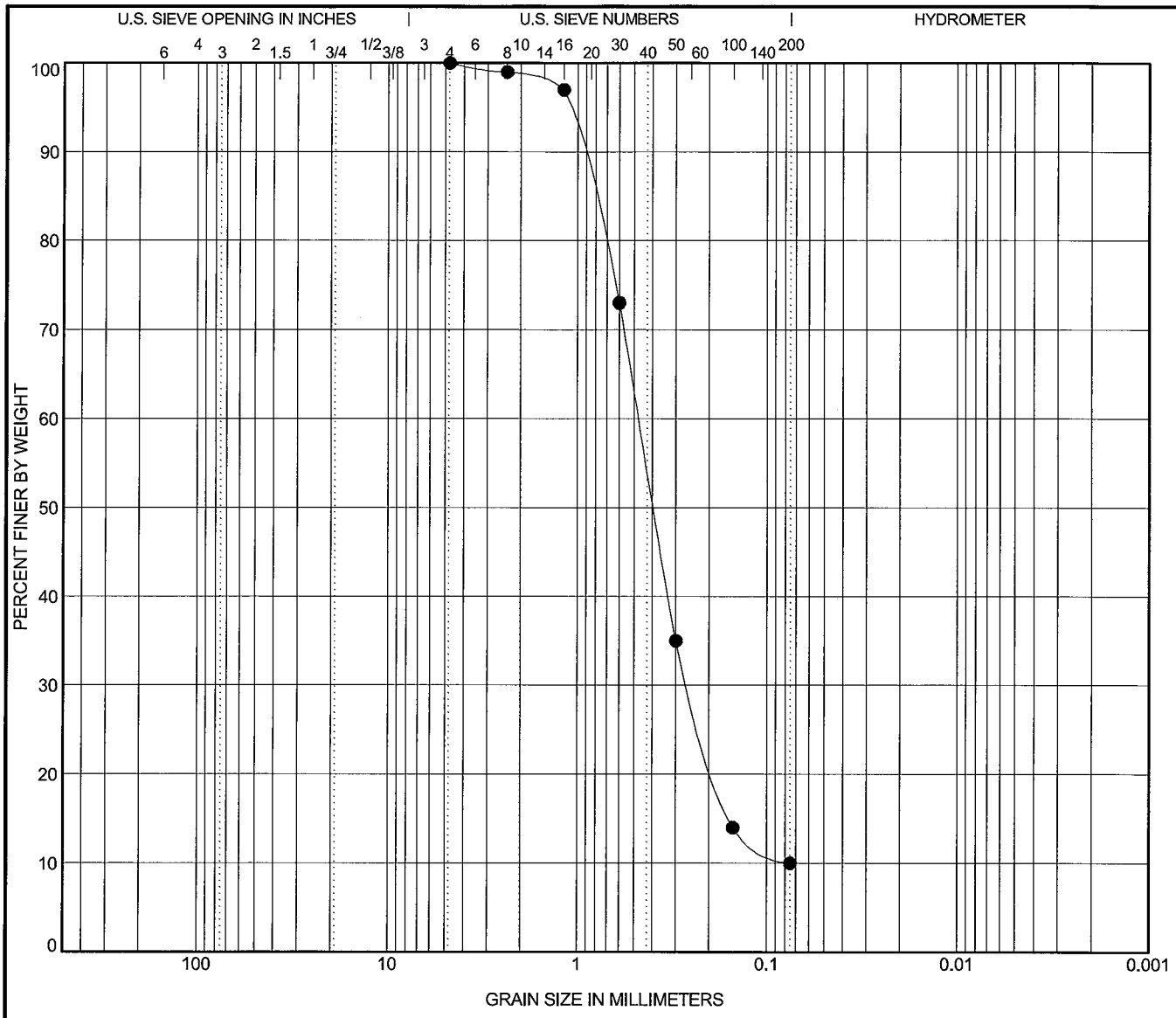
WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft
Time After Drilling
Depth To Water (ft)
Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-1	Fig. 3

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-1 - (5 - ft)	**SANDSTONE BEDROCK**				**1.82**	**6.31**

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-1 - (5 - ft)	**4.75**	**0.473**	**0.254**	**0.075**	**0**	**90**	**10**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming
Location: Refer to Site Map

Number: 144-510339 Figure No. 4

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-2		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-20-10	Date Finished: 10-20-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42°48'29.9"
W 107°31'09.9"

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, silty sand, brown, slightly moist, (6 in. thick).	0.5
			14			NV	NP	23		Silty SAND (SM), medium dense, light brown, slightly moist.	
			12								6.5
			12	8	101	30	NP	37		Sandy lean CLAY (CL), stiff, brown, slightly moist.	8.5
10			26							CLAYSTONE BEDROCK, weathered to hard, olive, moist.	
			50/0.7								
20										Transitions to sandstone by 20 ft.	20
			50/0.6							SANDSTONE BEDROCK, very hard, olive to white, slightly moist.	
			50/0.1								25.1

Bottom of Boring at 25.1 ft

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

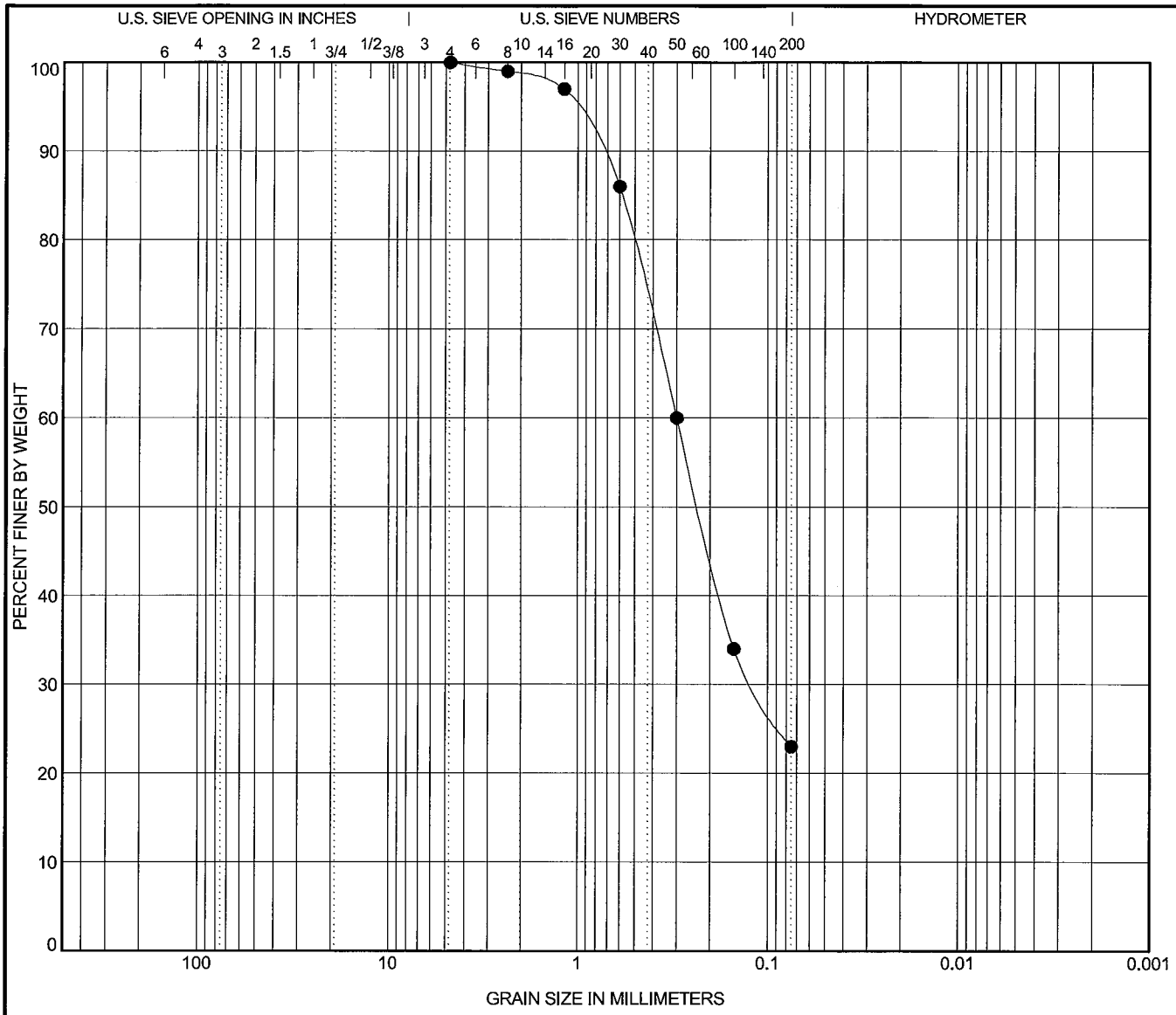
Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-2	Fig. 5

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-2 - (2.5 - ft)	**SILTY SAND(SM)**	**NV**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-2 - (2.5 - ft)	**4.75**	**0.3**	**0.117**		**0**	**77**	**23**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

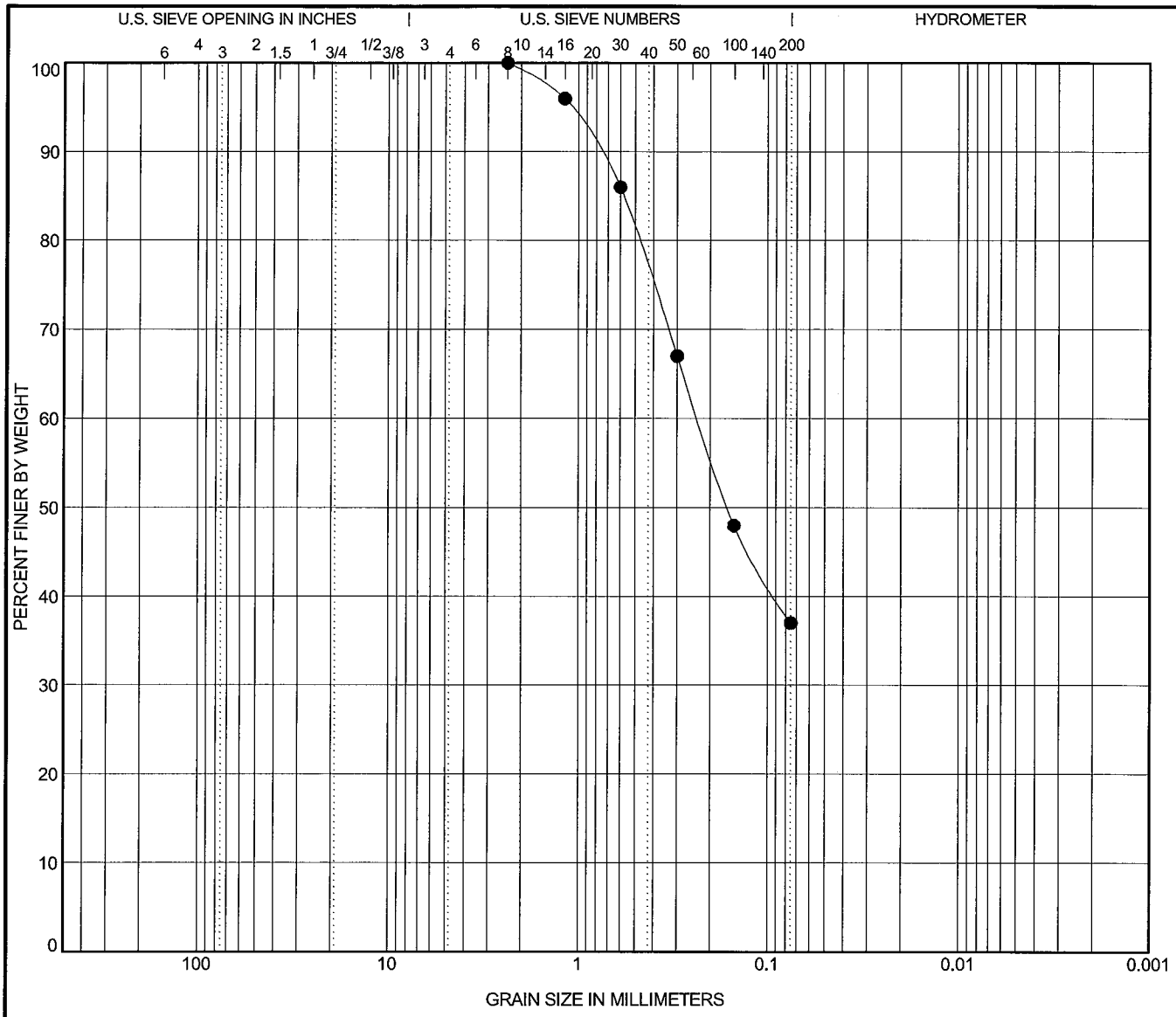
Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming
Location: Refer to Site Map

Number: 144-510339

Figure No. 6

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-2 - (7.5 - ft)	**SILTY SAND(SM)**	**30**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-2 - (7.5 - ft)	**2.36**	**0.232**			**0**	**63**	**37**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming
Location: Refer to Site Map

Number: 144-510339 Figure No. 7

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-3		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-20-10	Date Finished: 10-20-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42°48'26.1"
W 107°31'07.2"

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				17	106	38	18	58		TOPSOIL, silty sand, brown, slightly moist, (6 in. thick).	0.5
			15							CLAYSTONE BEDROCK, weathered to very hard, olive with iron staining, moist, up to 35% of sand in upper portion. Increasing plasticity and lower sand content with depth.	
			32								
			44	16	118	41	22	51			
10			50/0.8								
			50/0.5								
20			50/0.7							Claystone becomes very hard, gray, and slightly moist at 20 ft.	23
			50/0.4							SANDSTONE BEDROCK, very hard, light gray, slightly moist, claystone lenses and thin layers throughout.	
30			50/0.25								
			50/0.3								
40			50/0.0								
			50/0.1								48

Bottom of Boring at 48.0 ft
Auger Refusal at 48.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

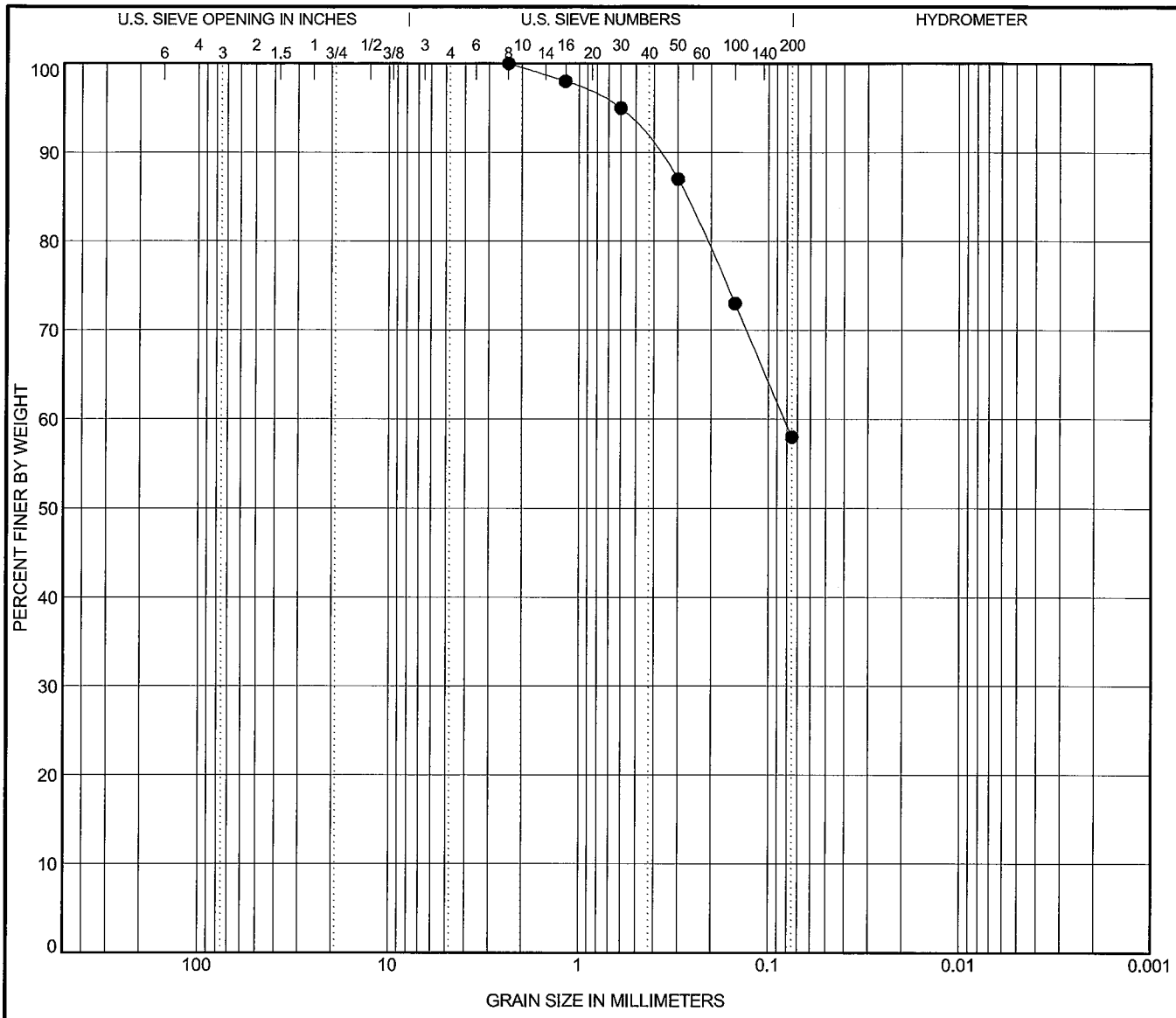
WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft
Time After Drilling
Depth To Water (ft)
Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-3	Fig. 8

510339 LOGS.GPJ `3-14-11`MAT`CASPER ENGLISH (BOR)`TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-3 - (0.5 - 4.5 ft)	**CLAYSTONE BEDROCK**	**38**	**20**	**18**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-3 - (0.5 - 4.5 ft)	**2.36**	**0.082**			**0**	**42**	**58**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

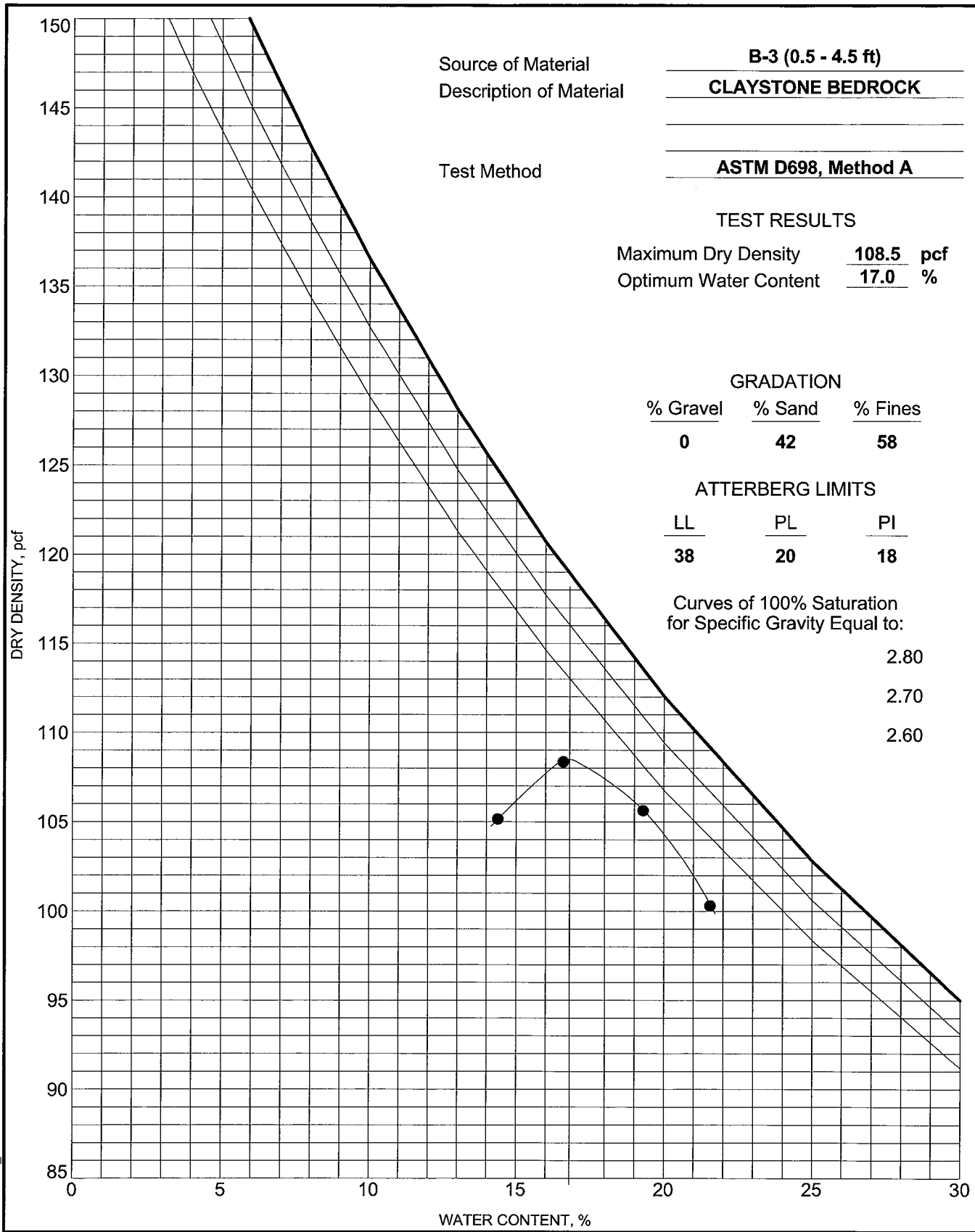
Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming
Location: Refer to Site Map

Number: 144-510339

Figure No. 9

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)



Source of Material: **B-3 (0.5 - 4.5 ft)**

Description of Material: **CLAYSTONE BEDROCK**

Test Method: **ASTM D698, Method A**

TEST RESULTS

Maximum Dry Density	**108.5**	**pcf**
Optimum Water Content	**17.0**	**%**

GRADATION

% Gravel	% Sand	% Fines
0	**42**	**58**

ATTERBERG LIMITS

LL	PL	PI
38	**20**	**18**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

MOISTURE-DENSITY RELATIONSHIP

TETRA TECH

Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming

Location: Refer to Site Map

Number: 144-510339

Figure No. 10

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US COMPACTION

Revised 1-23-08 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-4		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 10-20-10	Date Finished: 10-20-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42°48'22.0"
W 107°31'05.4"

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, silty sand, brown, slightly moist, (6 in. thick).	0.5
			12							Silty SAND (SM), medium dense, light brown, slightly moist.	
			13								
			26	9	114	38	19	41		SANDSTONE BEDROCK, medium hard to very hard, light brown, slightly moist.	6.5
10			60								
										Transitions to claystone from 13 ft.	
			50								16
										CLAYSTONE BEDROCK, hard, olive, slightly moist.	
20			50/0.8								20.8

Bottom of Boring at 20.8 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

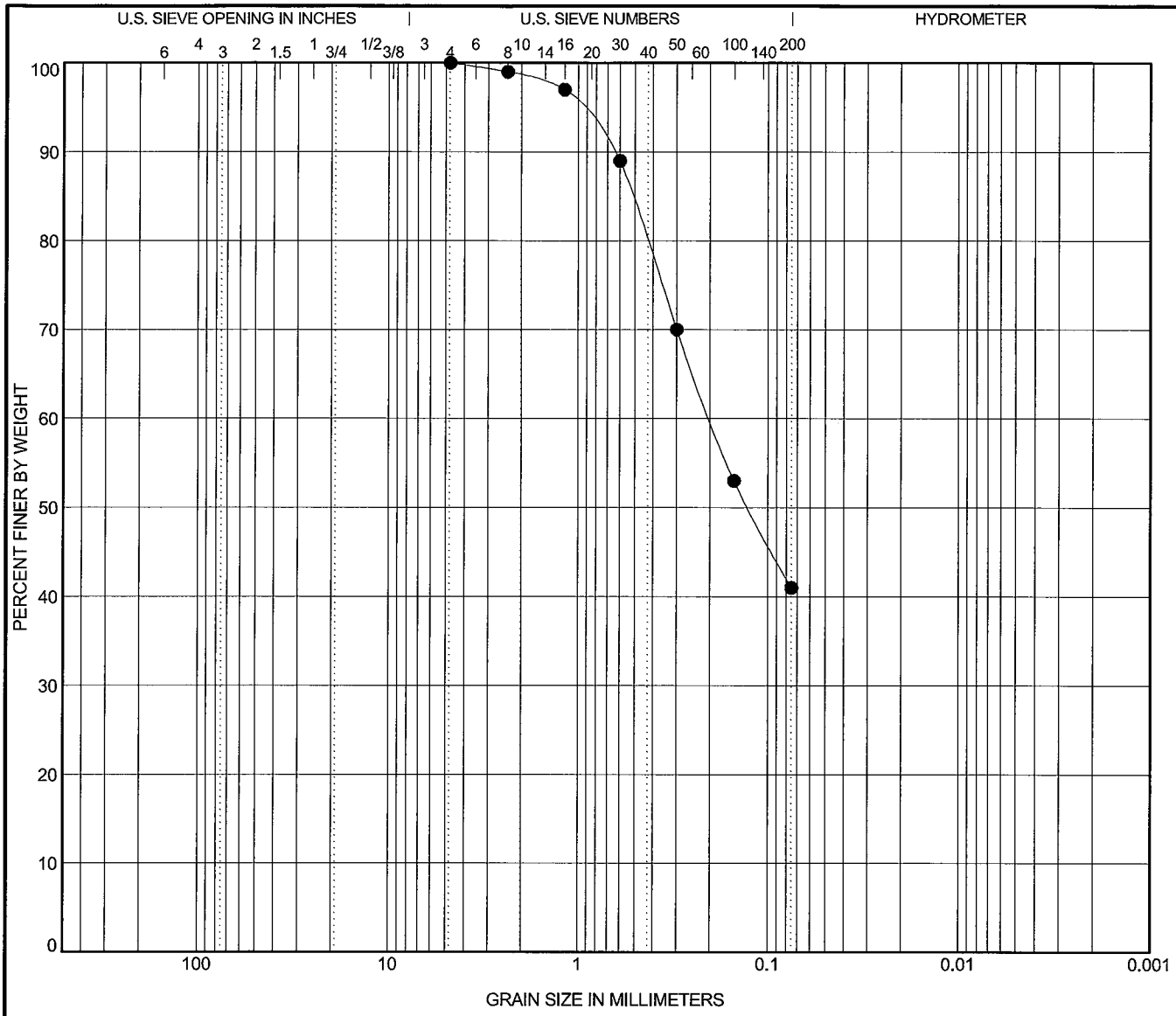
Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-4	Fig. 11

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-4 - (7.5 - ft)	**SANDSTONE/CLAYSTONE BEDROCK**	**38**	**19**	**19**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-4 - (7.5 - ft)	**4.75**	**0.2**			**0**	**59**	**41**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming
Location: Refer to Site Map

Number: 144-510339

Figure No. 12

510339 LOGS.GPJ ' 3-14-11 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name:	Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming			
Borehole Location:	Refer to Site Map			
Borehole Number:	B-5		Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment:	CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80908°
W 107.52007°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				9		40	23	52		TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL), stiff, light brown, wet.	4
			72							SANDSTONE BEDROCK, hard to very hard, white to tan, slightly moist.	
10											
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339 | TETRA TECH | LOG OF EXPLORATORY BORING B-5 | Fig. 13

510339 LOGS.GPJ 3-14-11 MAT CASPER ENGLISH (BOR) TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-6			Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment: CME-750	Borehole Diameter (in.): 4		Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80878°
W 107.52061°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
			22							CLAYSTONE BEDROCK, firm to medium hard, olive to light brown, moist.	
10			42								
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft
Time After Drilling
Depth To Water (ft)
Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-6	Fig. 14

510339 LOGS.GPJ ` 3-14-11 ` MAT ` CASPER ENGLISH (BOR) ` TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-7			Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment: CME-750	Borehole Diameter (in.): 4		Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80781°
W 107.51956°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
			27							Sandy lean CLAY (CL) to clayey SAND (SC), very stiff, light brown, moist.	
10											9
										CLAYSTONE BEDROCK, medium hard, olive to light brown, moist.	
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-7	Fig. 15

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name:	Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming			
Borehole Location:	Refer to Site Map			
Borehole Number:	B-8		Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment:	CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80744°
W 107.51981°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				10		40	22	36		TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL) to clayey SAND (SC), stiff, light brown, slightly moist.	
			53								4.5
										SANDSTONE BEDROCK, hard, light brown, slightly moist, clay fines.	7
10			78							CLAYSTONE BEDROCK, hard to very hard, light gray to pink, slightly moist.	
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-8	Fig. 16

510339 LOGS.GPJ 3-14-11 MAT CASPER ENGLISH (BOR) TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name:	Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming			
Borehole Location:	Refer to Site Map			
Borehole Number:	B-9		Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment:	CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80727°
W 107.51921°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
				9		35	17	51		TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL), stiff, light brown, slightly moist.	
				8		39	22	59			
10											
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-9	Fig. 17

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-10		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80764°
W 107.51904°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL), stiff to very stiff, light brown, slightly moist.	
										Layers with more sand.	
			32								
10			16								
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-10	Fig. 18

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-11		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80755°
W 107.51854°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
			14							Sandy lean CLAY (CL), stiff, light brown, slightly moist, layers of silty sand throughout.	8.5
10										CLAYSTONE BEDROCK, weathered from 8.5 to 10.5 ft, light brown to rust color, moist. Becomes firm to hard at 10.5 ft.	15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-11	Fig. 19

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name:	Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming			
Borehole Location:	Refer to Site Map			
Borehole Number:	B-12		Driller: Mark Medley	Logger: Matt Carlson
Drilling Equipment:	CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80702°
W 107.51940°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL), very stiff to hard, light brown to light gray, slightly moist.	
			29								
10											
											15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-12	Fig. 20

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

Project Name: Gas Hills Evaporation Pond, Cells 1 and 2, Fremont County, Wyoming				
Borehole Location: Refer to Site Map				
Borehole Number: B-13		Driller: Mark Medley	Logger: Matt Carlson	
Drilling Equipment: CME-750	Borehole Diameter (in.): 4	Date Started: 12-21-10	Date Finished: 12-21-10	

Elevation and Datum: Ground: Existing Grade

Notes: N 42.80680°
W 107.51858°

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
										TOPSOIL, sandy lean clay, brown, moist, (6 in. thick).	0.5
										Sandy lean CLAY (CL), stiff, light brown, slightly moist.	4
10			89/0.8							CLAYSTONE BEDROCK, very hard, light gray to brown, slightly moist.	15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▽ ft

Time After Drilling

Depth To Water (ft)

Remarks:

144-510339	TETRA TECH	LOG OF EXPLORATORY BORING B-13	Fig. 21

510339 LOGS.GPJ ' 3-14-11 ' MAT ' CASPER ENGLISH (BOR) ' TT library 1-10 (MAT)

Revised 1-01-07 (MAT)

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Gas Hills Evaporation Pond, Cells 1 and 2
Fremont County, Wyoming

Job No. 115-510339

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING NO. 200 SIEVE	OTHER TESTS	SAMPLE DESCRIPTION/CLASSIFICATION
BORING	DEPTH (ft)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)			
B-1	5	6	112			0	90	10	$K = 5 \times 10^{-5}$ cm/sec	Sandstone Bedrock
B-2	2.5	6	100	NV	NP	0	73	27		Silty Sand (SM)
	7.5	8	101	30	NP	0	63	37		Silty Sand (SM)
B-3	0.5 to 4.5	11		38	20	0	42	58	$\gamma_{dmax} = 108.5$ pcf $W_{opt} = 17.0\%$ $K = 6 \times 10^{-9}$ cm/sec	Claystone Bedrock
	7.5	16	118	41	22			51	$K = 3 \times 10^{-9}$ cm/sec	Claystone Bedrock
B-4	7.5	9	114	38	19	0	59	41		Sandstone/Claystone Bedrock
B-5	0.5 to 4	9		40	23			52		Sandy Lean Clay (CL)
B-8	0.5 to 4	10		40	22			36		Clayey Sand (SC)
B-9	0.5 to 5	9		35	17			51		Sandy Lean Clay (CL)
	5 to10	8		39	22			59		Sandy Lean Clay (CL)

Abbreviation:

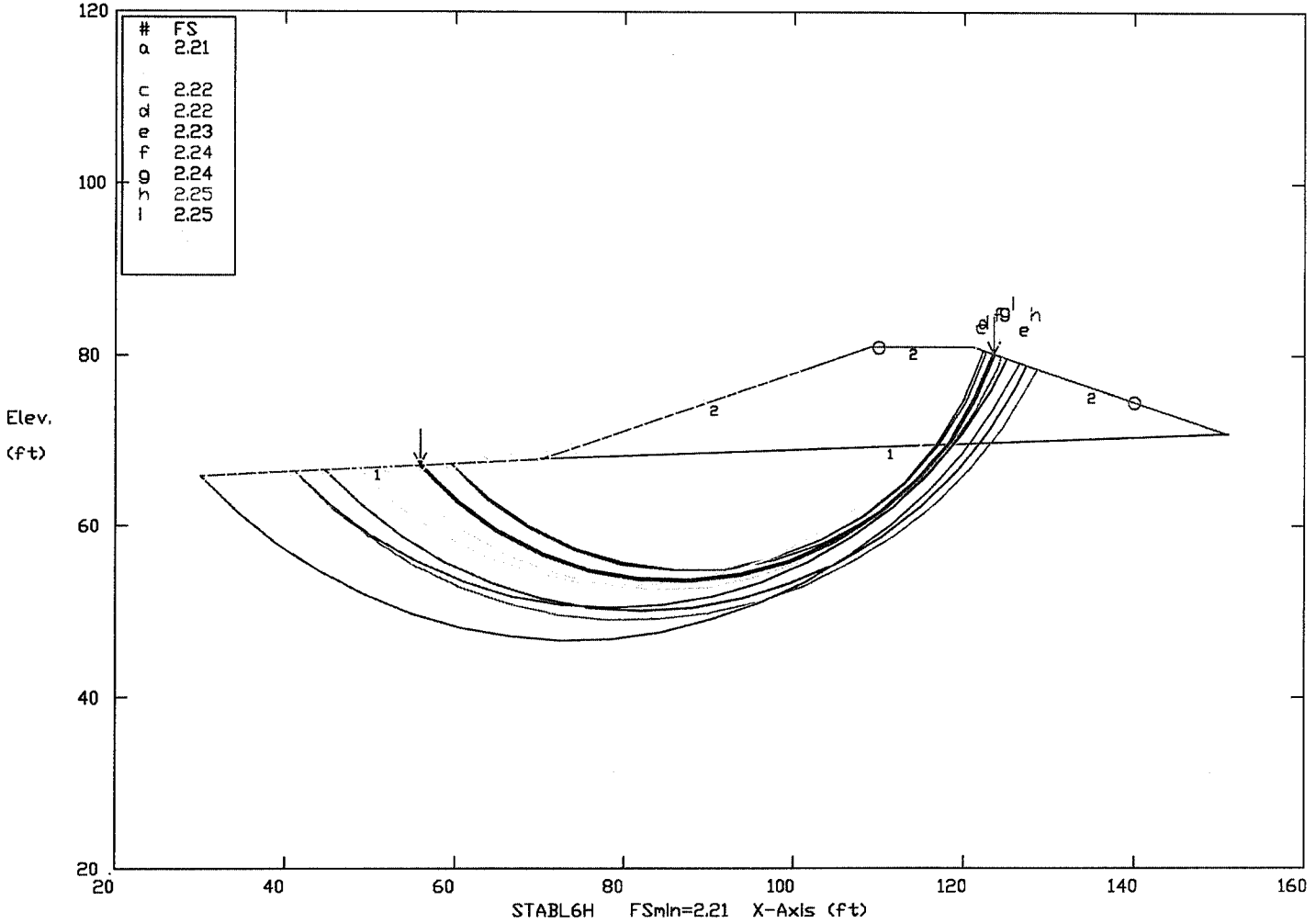
K = Hydraulic Conductivity
NV = No Value
NP = Non Plastic

γ_{dmax} = Maximum Dry Density, as determined by ASTM D698
W_{opt} = Optimum Moisture Content, as determined by ASTM D698

Appendix A

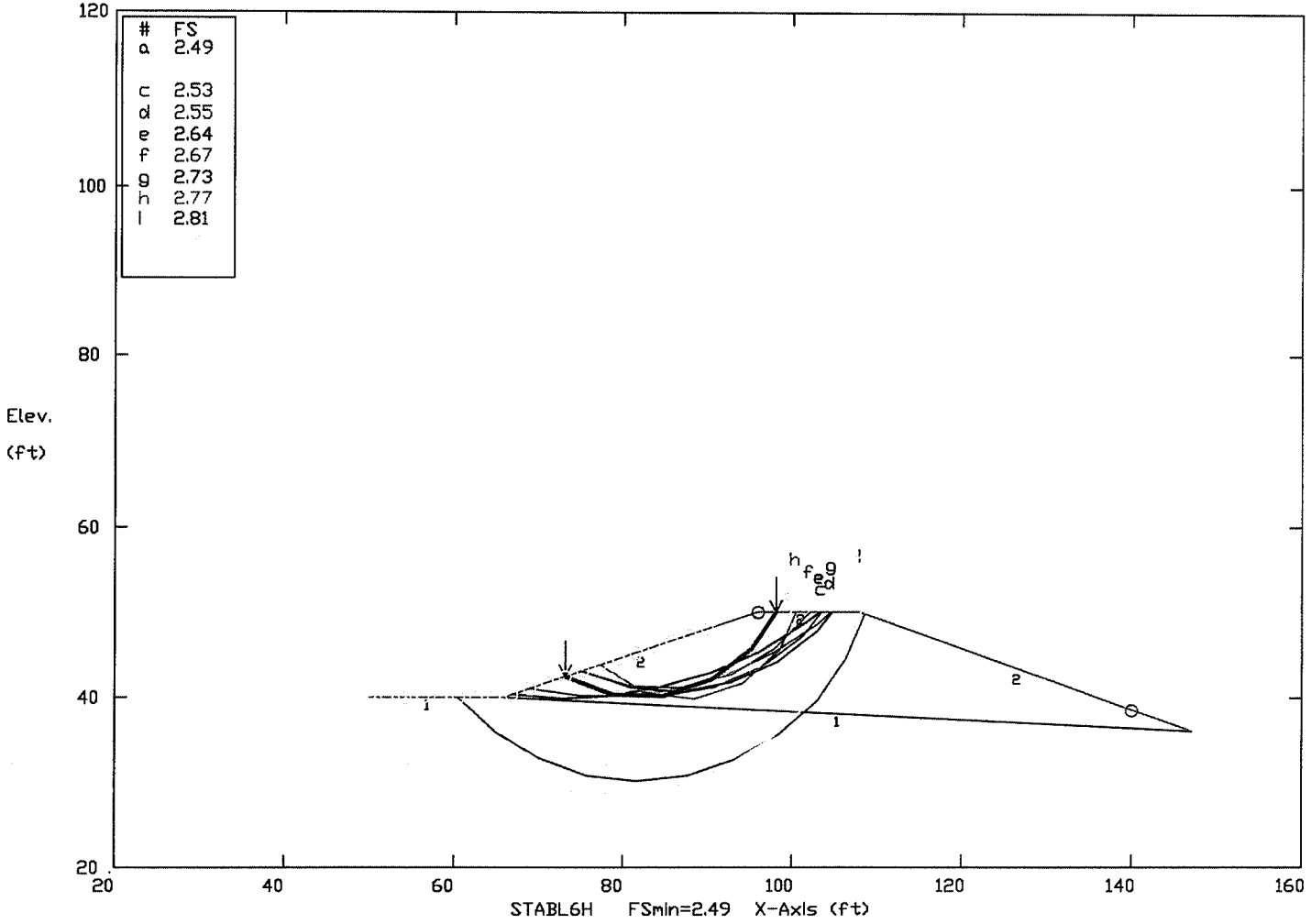
Slope Stability Analyses

Gas Hills Post Construction 3:1 Exterior Slope
Most Critical Surface. C:GH-POSTE.PLT By: TETRA TECH 12/23/2010 10:59am
Ten Most Critical. C:GH-POSTE.PLT By: TETRA TECH 12/23/2010 10:59am



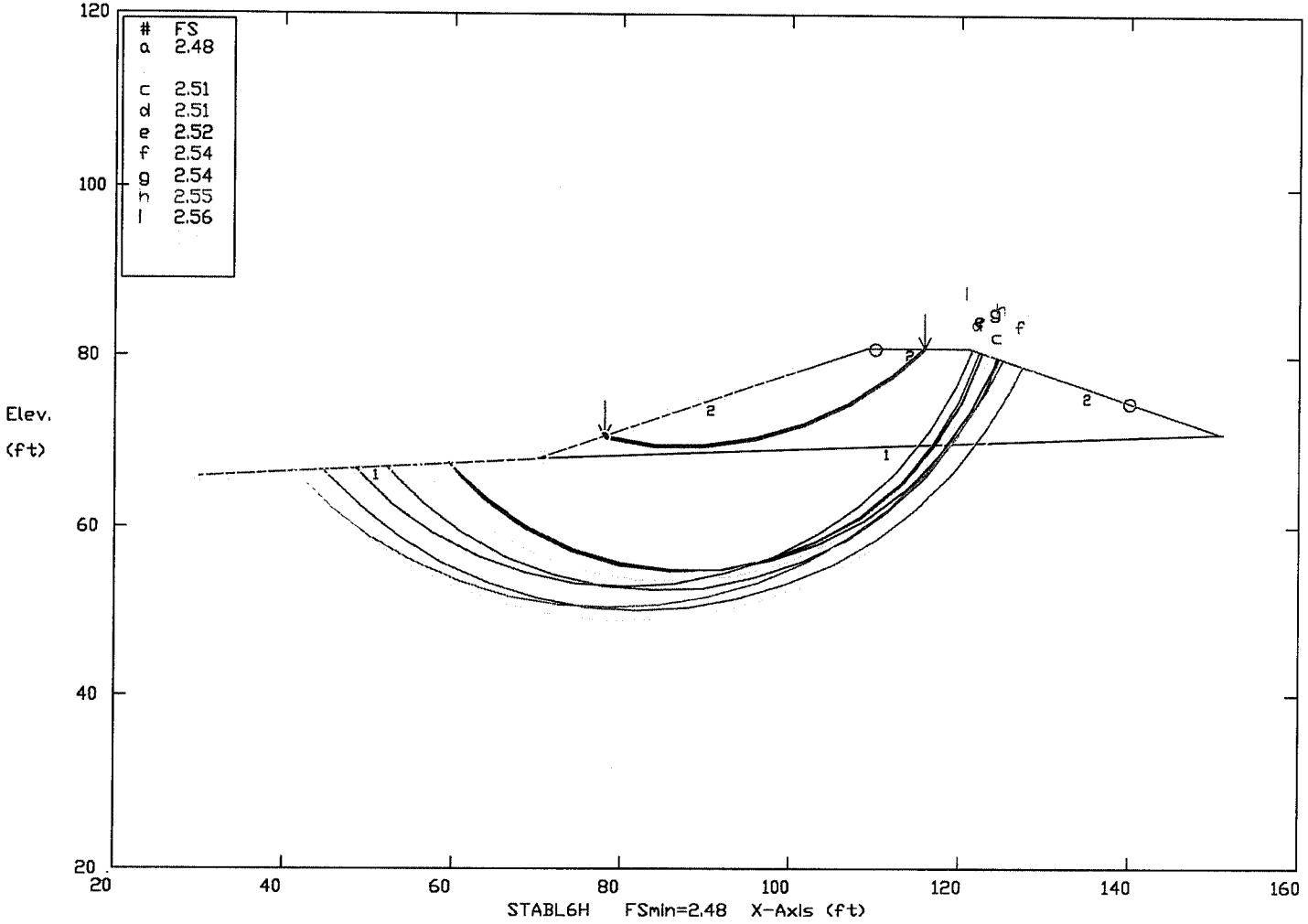
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Plez. Surface No.
1	Native	118	118	700	0	0	0	
2	Embank	120	120	200	12	0	0	

Gas Hills Post Construction 3:1 Interior Slope
Ten Most Critical. C:GH-POSTI.PLT By: TETRA TECH 12/23/2010 11:00am
Most Critical Surface. C:GH-POSTI.PLT By: TETRA TECH 12/23/2010 11:00am



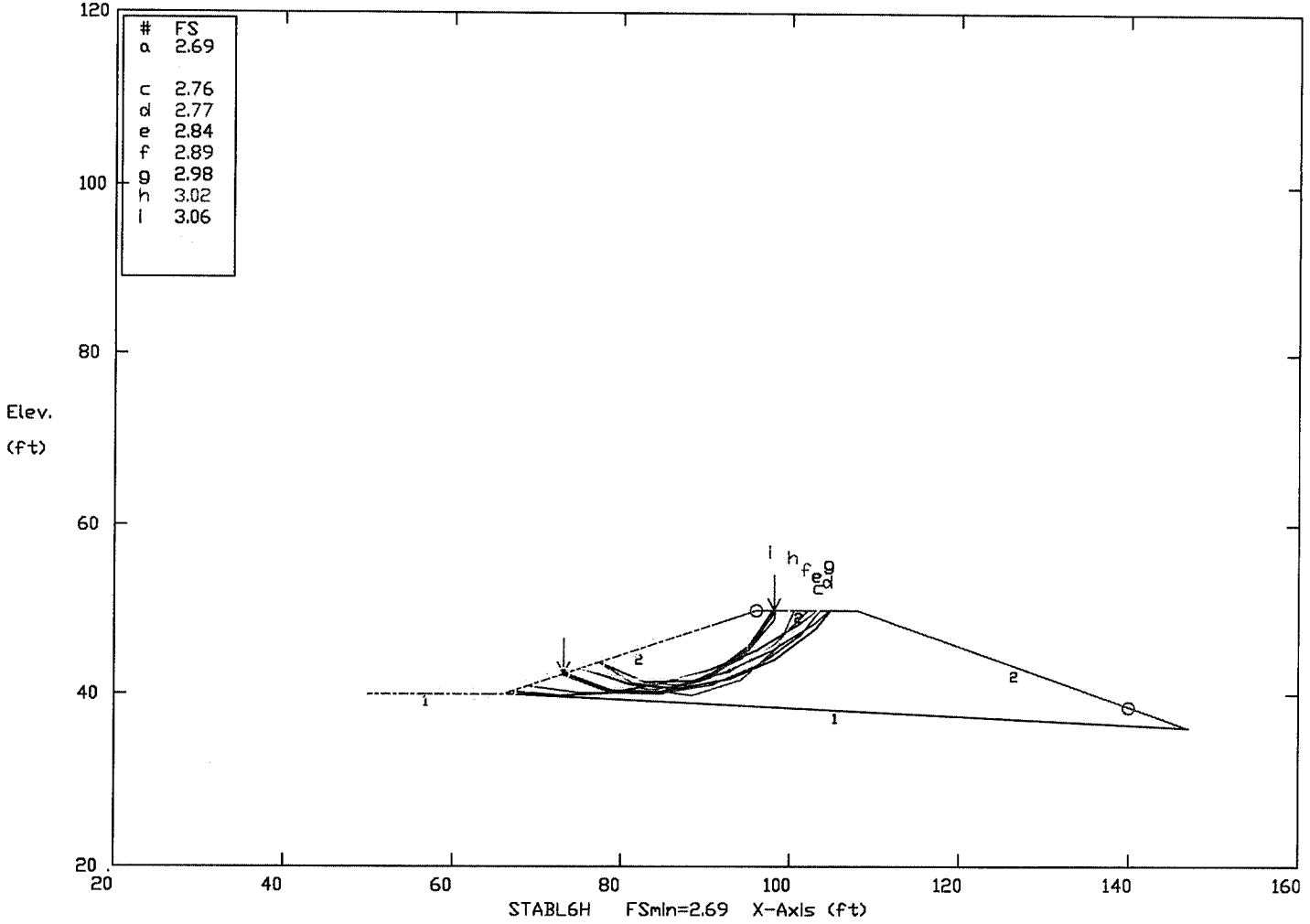
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Native	118	118	700	0	0	0	
2	Embank	120	120	200	12	0	0	

Gas Hills Steady State 3:1 Exterior Slope
Most Critical Surface. C:GH-SS-EX.PLT By: TETRA TECH 12/23/2010 10:57am
Ten Most Critical. C:GH-SS-EX.PLT By: TETRA TECH 12/23/2010 10:57am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Plez. Surface No.
1	Native	119	119	800	0	0	0	
2	Embank	120	120	200	15	0	0	

Gas Hills Steady State 3:1 Interior Slope
Most Critical Surface. C:GH-SS-IN.PLT By: TETRA TECH 12/23/2010 10:58am
Ten Most Critical. C:GH-SS-IN.PLT By: TETRA TECH 12/23/2010 10:58am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Native	119	119	800	0	0	0	
2	Embank	120	120	200	15	0	0	

ATTACHMENT B
DRAFT OPERATION AND MAINTENANCE MANUAL
EVAPORATION POND
GAS HILLS ISR SATELLITE
FREMONT COUNTY, WYOMING

Cameco Resources

APRIL 2011

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APPENDICES

DRAFT OPERATION AND MAINTENANCE MANUAL
EVAPORATION POND, GAS HILLS ISR SATELLITE

A. Introduction

1. Facility Description.

   This facility is used for process water evaporation for the Gas Hills ISR Satellite. The pond will provide final disposal by evaporation or storage for other permitted processes. Water will be delivered to the ponds by pipeline from the plant building adjacent to the pond (approximately 500 ft southeast of the pond). The pipeline will deliver water over the crest of the pond.

   The pond will be constructed with two cells operated independently of each other. The high water level is at elevation 6721 ft for the North Cell and 6717 ft for the South Cell which provides for 5 ft of free board below the crest of each cell. In an emergency, with both cells filled to maximum operating capacity, it is possible to move the entire contents from one cell to the other. The pond has no outlet.

   The pond lining system consists of a 60-mil HDPE geomembrane, a leak detection layer, a 40-mil HDPE geomembrane, and a 3-ft thick compacted clay liner. Each cell is divided into separate areas less than 2 acres in size connected to separate leak detection wells. No area within the bottom of each cell is more than 100 ft distant from a leak detection pipe. The leak detection system will collect any liquids infiltrating through the primary 60-mil liner.

2. Utilities.

   There are no utilities associated with the evaporation pond.

3. Emergency Operation and Response.

   This facility will be covered by the plant's Emergency Response Plan which will include provisions indicated herein.

4. Permitting Agencies.

   The facility is permitted through the following agencies:

   a. State of Wyoming, State Engineer's Office, Herschler Building, 4th East, Cheyenne, Wyoming 82002; (307) 777-7354. Permit No. (pending).

   b. State of Wyoming, Department of Environmental Quality, Water Quality Division, 122 West 25th Street, Herschler Building, 4th West, Cheyenne, Wyoming 82002. Permit No. (pending).

5. Engineer of Record.

   Jason Stratton, P.E., Tetra Tech, 605 North Warehouse Road, Casper, Wyoming, 82601; (307) 234-2126.

6. General Contractor.

   (Pending)

B. Process Flow Diagram

No process flow diagram is presented as all processes are managed under the plant's operation and maintenance plan. There are no enhanced evaporation or other pond specific processes.

C. Compliance Submittals

1. State Engineer.

   a. The permit expires (to be determined). A request for extension must be filed prior to this date if the facility is not closed by this date.

2. Department of Environmental Quality, Water Quality Division.

   a. Immediate oral and/or written notification shall be provided in accordance with the provisions of Section 9, Chapter III, Wyoming Water Quality Rules and Regulations of any changes or modifications which are not consistent with the terms and conditions of the permit.

   b. Monitoring Requirements:

      1. The four leak detection wells will be checked daily for the presence of water. Any water in the leak detection wells will be sampled and tested for Conductivity and Chloride content.

      2. A composite sample will be obtained from water in both cells on a yearly basis and tested for Total Dissolved Solids, pH, Conductivity, Sodium, Chloride, Sulfate and Alkalinity.

      3. An annual report will be submitted with the monitoring/leak detection well gauges and annual test results on a composite sample from the pond. This report will be made as part of the mine's annual report to the DEQ-LQD.

D. Pond Inspections

The embankments shall be observed by plant personnel for the presence of erosion, slumps, or other defects. The liner shall be observed for presence of cracks or damage. This inspection will be conducted on a monthly basis.

E. Corrective Actions

1. Water in Leak Detection Wells.

   a. Immediate notification will be provided to State of Wyoming, Department of Environmental Quality, Water Quality Division, Southwest District, 250 Lincoln Street, Lander, Wyoming 82520; (307) 332-3144; FAX (307) 332-3183.

   b. If a leak is verified in the primary liner, the cell operation will cease until repair or corrective action can be taken. The cell may continue operation if a fluid recirculating system is installed and activated. Recirculating pumps should be capable of maintaining a water depth in the wells below elevation 6717 in the North Cell and elevation 6713 in the South Cell. If a recirculating system is installed:
      - High level alarms will be installed and monitored. High level alarms will be established at well water elevation 6719 in the North Cell and 6715 in the South Cell.
      - A totalizing hour meter shall be read at least weekly.
      - If the recovery rate exceeds 400 gallons per day per acre (gpd/acre) for any sub-cell as delineated by the recovery system, the permittee shall notify the DEQ/WQD within seven (7) days. Repair of the primary liner must be scheduled within 12 months.
      - If the recovery rate exceeds 800 gpd/acre for any sub-cell as delineated by the recovery system, the DEQ/WQD shall be notified within 48 hours. Repair of the primary liner shall be scheduled within 60 days.
      - If the high level alarm level is reached, the DEQ/WQD shall be notified immediately. Operation of the cell will cease immediately until the primary liner is repaired.

   c. If fluids are detected in the leak detection system and there is a threat of contamination to the groundwater, the DEQ/WQD may require the construction of new groundwater monitoring wells along with periodic sampling and testing of the groundwater monitoring wells. Required sampling and testing parameters and frequency will be determined by the DEQ/WQD.

2. Damage to Liner.

   a. If damage to the primary geomembrane (60-mil) liner is visible, operating water elevations will be maintained below the level of the visible damage until repairs can be made. Monitoring of the leak detection wells will be made on a daily basis until 1 month following repairs.

   b. If damage to the primary and secondary liners are visible, operation of the cell will cease until repairs can be made.

3. Erosion.

   a. Erosional damage on the embankment or at the toe of the embankment greater than 3 inches deep and less than 6 inches deep shall be repaired by regrading and revegetation of the impacted area within 12 months.

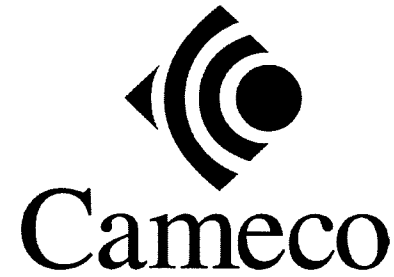
b. Erosional damage on the embankment or at the toe of the embankment greater than 6 inches deep and less than 12 inches deep will be evaluated by Cameco engineering and repaired within 6 months.

c. Erosional damage on the embankment or at the toe of the embankment greater than 12 inches deep will require immediate repair and mitigation of circumstances causing the erosional damage. The impacted cell will not be operated until damage is repaired.

4. Slumps, Bulges, Slides, Settlement.

a. If slumps, bulges, slides, settlement, or other non-erosional damage is observed, a qualified engineer will immediately evaluate the conditions. If damage threatens the integrity of the pond or lining system, the impacted cell will immediately cease operation until evaluation by a qualified engineer or repairs are made.

ATTACHMENT C
DRAFT CLOSURE PLAN
EVAPORATION POND
GAS HILLS ISR SATELLITE
FREMONT COUNTY, WYOMING



Cameco Resources

APRIL 2011

ATTACHMENT C
DRAFT CLOSURE PLAN
EVAPORATION POND, GAS HILLS ISR SATELLITE

Overview and Scope

This document is to provide guidance for the closure, reclamation and restoration of the site of Evaporation Pond at Gas Hills ISR Satellite, Fremont County, Wyoming. In general, the closure will entail removal all potentially contaminated materials from the site and final disposal in a licensed off-site landfill. Closure of water delivery systems and the plant site in general are not included in this plan.

Closure of Facilities

When the determination is made to cease use of the surge pond, the facilities will be closed in accordance with applicable regulations and Cameco policy. This pond will have only received material from Cameco sources. The DEQ and any adjacent property owner(s) will be notified at least 180 days prior to the cessation of use of the pond. A notice will be posted to indicate that no more water will be received at the site and the entry into the area will be controlled. The site security fence will remain in place and the gate will remain locked when reclamation activities are not being carried out.

Reclamation and Restoration

After storage of liquids to the pond has ceased, all fluids within the pond will be removed by pumping and/or evaporated. The plant will have the capability of removing all liquid from the ponds within 6 months. Once no fluids remain, the geomembrane liner, leak detection piping, and any sediments that have collected in the pond will be removed from the size and disposed of in an off-site landfill licensed for proper disposal of this waste. Soils from the construction of the embankments will be pushed out onto and over the pond area. The soils will be contoured such that the surface drainage will be from the pond center to the pond perimeter. The surface contours will be maintained as flat as possible to minimize surface erosion from surface drainage. Topsoil stockpiled from construction will be spread evenly over the site and revegetated with native grass species.

Monitoring and Inspection

Annual groundwater monitoring will continue in accordance with the Wyoming DEQ, Water Quality Rules and Regulations. The integrity of the reclamation will be visually inspected annually for erosion and rodent intrusion. Repairs will be made as necessary. Visual inspection of the vegetation will also take place. Re-vegetation will be considered complete after 70% coverage has been established. After the reclamation and re-vegetation activities have been completed, it is expected that the site will be inspected by the DEQ. After the closure is deemed satisfactory and complete, the site will be monitored, post-closure, for at least 5 years.

Corrective Action

Should the written result issued by the DEQ indicate that additional steps are needed before the site is in compliance with the closure requirements, Cameco will coordinate with the DEQ to resolve any outstanding issue.

While all potential for a release of any kind should be eliminated by removal of all potentially contaminated materials, in the event of a release during closure or post closure, the release will be appropriately responded to, remediated and investigated; an investigation plan will be developed and submitted in accordance with WDEQ Water Quality rules.

TECHNICAL CONSTRUCTION SPECIFICATIONS AND CONSTRUCTION DRAWINGS

Evaporation Pond
Gas Hills Satellite Facility
Fremont County, Wyoming

For

Cameco

550 North Poplar, Suite 100
Casper, Wyoming 82601

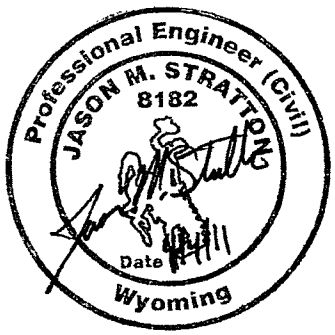
Prepared by:

TETRA TECH

605 N. Warehouse Road
Casper, Wyoming 82601

Contact:
Mr. Jason Stratton, P.E.
307.234.2126
jason.stratton@tetratech.com

April 1, 2011



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DIVISION 1: GENERAL REQUIREMENTS

SECTION 01009

GENERAL INFORMATION AND REQUIREMENTS

PART 1: GENERAL

1.1 SUMMARY

A. Purpose of Project: The purpose of this project is to construct an evaporation pond to be located at Cameco Resources Gas Hills ISR Satellite Plant located in Fremont County, Wyoming. The project includes the construction of a surface storage facility with a capacity on the order of 21.97 ac-ft. The facility will consist of a double geomembraned lined pond with a leak detection and collection system. Borrow material for construction of the homogeneous embankments will come from within the impoundment footprint. All disturbed areas will be revegetation upon completion of construction.

B. Location: The evaporation pond is located in Section 28, Township 33 North, Range 89 West. The pond will be located approximately one half mile northwest of the existing plant building for the gas hills facility. The project site work locations are shown on the drawings.

C. Drawings: Detail the work required at each project location.

D. Work provided by Contractor for construction of ponds:

1. Clearing and Grubbing of Pond Construction Area.
2. Stripping of topsoil.
3. Excavation of drainage features and pond cells.
4. Overexcavation for clay liner.
5. Earth fill for embankments.
6. Earth fill for clay liner.
7. Smooth finishing of liner area.
8. Installation of a 40-mil and a 60-mil HDPE liner.
9. Installation of a leak detection system between the liners includes two wells.
10. Crest surfacing
11. Topsoil placement, fertilization, mulching, and seeding.
12. Perimeter Fence.

E. Work provided by others:

1. Water delivery and pumping systems.
2. Access roads to the exterior of the pond perimeter fence.

1.2 REFERENCES

A. Referenced Specifications/Standards with Abbreviations and/or Acronyms: Wherever the following acronyms are used in these specifications or on the drawings, they are to be construed the same as the respective expressions represented. Copies of the referenced specifications/ standards referred to herein may be procured by the Contractor, from the following:

AASHTO American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249
Washington, DC 20001

ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken PA 19428-2959
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol St. between G and H St., NW Washington, DC 20402
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173
DOT	Department of Transportation 400 Seventh St., SW Washington, DC 2059
EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460
OSHA	Occupational Safety and Health Administration US Department of Labor 200 Constitution Ave., NW Washington DC 20210
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
WYDOT	Wyoming Department of Transportation 5300 Bishop Blvd. Cheyenne, WY 82009

1.3 DEFINITIONS

A. Approvals: Approval of submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After approval of an item, Contractor shall submit a substitute for approval when the approved item cannot be purchased or delivered in time to avoid delay in completion of the project.

1.4 SUBMITTALS

A. Scope: Submittals include design computations, shop drawings, manufacturers' literature, as-built drawings, samples, and maintenance manuals.

B. Requirements: Refer to specifications for submittals required. Allow at least 10 working days for review. Submittals shall be delivered to the Owner as designated in Section 01330, Submittal Procedures.

C. Identification of Submittals: Completely identify each submittal by showing at least the following information:
   1. Name and address of submitter, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number, and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.
   6. Submittal sequence number.

1.5 CERTIFICATES OF CONFORMANCE

A. Requirements: The Owner may permit use, prior to sampling and testing, of materials when accompanied by Certificates of Conformance. Materials used on the basis of a Certificate of Conformance may be sampled and tested. Installation of materials on the basis of Certificates of Conformance shall not relieve the Contractor of responsibility for incorporating materials which conform to the requirements of the drawings and specifications. Material not conforming to those requirements will be subject to rejection, whether in place or not.

B. Related Sections:
   1. Section 01331 – Certificates.

1.6 QUALITY ASSURANCE/QUALITY CONTROL

A. Codes and Standards: The work shall comply with codes and standards applicable to each type of work and as listed in the individual sections of these specifications. This Contract incorporates materials, applications, and tests by reference, with the same force and effect as when they were given in full text.

B. Requirements: Quality Control will be the responsibility of the Owner to assure that Contractor is performing adequate construction and quality control.

C. Conflict: Where a conflict occurs between reference documents and project specifications, the project specifications shall govern. Specifications on project drawings govern over specifications herein.

D. Measurements: Where approved shop drawings give specific measurements or rough-in dimensions, these dimensions shall take precedence over dimensions indicated on the drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Protect products incorporated into the work from damage while in transit to the site. Products must be delivered in original unopened containers with manufacturer's name, brand designation, and contents legibly indicated.

B. Storage: Provide temporary storage facilities for products. Storage shall comply with the manufacturer's instructions. The storage area shall permit access for inspection and handling.

C. Handling: Load and unload products protecting them from damage.

1.8 PROJECT SITE ISSUES

A. Access to the Work: Strict conformance with Cameco Resources access policies to be detailed by the Owner.

B. Remote location: The work area is in a remote location with no access to public telephone, and potable water source.

C. Site Investigation and Conditions Affecting the Work: The contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and location of the work, and that it has investigated and satisfied itself as to the general local conditions which can affect the work or its costs, including but not limited to:
   1. Conditions bearing upon transportation, disposal, handling and storage of materials;
   2. The available of labor, water, electric power and roads;
   3. Uncertainties of weather conditions at the site;
   4. The conformation and conditions of the ground, and;
   5. The character of equipment and facilities needed preliminary to and during work performance.

   The Contractor also acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Owner, as well as from the drawings and specifications made a part of this contract. Any failure of the Contractor to take the actions described and acknowledged in this paragraph will not relieve the Contractor from responsibility for estimating properly the difficulty and cost of successfully performing the work, or for proceeding to successfully perform the work without additional expense to the Owner.

   Percent shrinkage/swell shall not be the basis for extra work claim. Contractor shall have fill risk for percent shrinkage/swell determination.

   The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor based on the information made available by the Owner. Nor does the Owner assume responsibility for any understanding reached or representation made concerning conditions which can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in this contractor.

1.9 SEQUENCING AND SCHEDULING

A. Work Schedule: The schedule shall be submitted for each task after 14 days following the pre-work conference. When requested, submit an updated schedule within 3 calendar days. As a minimum, the estimated start and completion dates shall be shown in the estimate.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 PROJECT MEETINGS

A. Pre-Work Conference:
   1. Will be held prior to the start of work. The Contractor will be notified in advance of meeting time, date and place. The purpose will be to review required work, project

drawings and specifications, site-specific construction related issues, construction schedules, payroll and payments, administrative provisions of the Contract, and other matters pertinent to the Work.

2. The Contractor, subcontractors and the persons responsible for coordination of the work shall be present at the meeting.
3. Be prepared to summarize and explain procedures planned for the project and present a plant for the submittals requested in the specifications.

B. Progress Meetings:
   1. To be held at the project site or by telephone conferencing, or as determined by the Owner.
   2. May be called by either the Owner or the Contractor. Request shall state who should attend and include an agenda.

C. Final Inspection:
   1. To be held at the project site, or as determined by the Owner.
   2. Notify the Owner in writing at least 30 working days before the completion date so the Owner can schedule final inspection.
   3. The Contractor's superintendent shall be present during this inspection.

3.2 PREPARATION

A. Work Layout: The Owner will provide a construction survey control monument map noting all primary control and control coordinates for locating the principal components of the Work with a suitable number of benchmarks adjacent to the Work to give the Contractor measurements, lines and grades necessary for the work executed under the Contract. Baseline monuments or benchmarks disturbed or removed during construction shall be reset by the Contractor at the Contractor's expense. Control points located within areas that must be disturbed can be removed without replacement with prior approval by the Owner.

B. Work Limits and Control Points: Will be established by the Owner.

C. Construction Staking and Surveying: Survey, calculate, furnish and set construction stakes and marks necessary to control the project to the line and grades as shown on the drawings, specifications or as established by the Owner. Make all supporting computations and field notes required for control of the work and as necessary to establish the exact position of the work from control points. Perform surveying, staking and recording of data. The cost for construction staking and surveying shall be considered incidental and no additional compensation will be allowed. Costs incurred as a result of survey errors will be borne by the Contractor.

D. Measurement and Calculations for Pay Quantities: In the event of any design changes or changes of conditions, Contractor shall have a third party licensed professional surveyor perform surveying for final grade and cross-sections, finish grade elevations, perform measurements and calculations for pay quantities, and perform "as constructed" measurements for record drawings.

   Contractor shall submit to Owner all calculations, field notes and survey drawings for layout, control and final payment as necessary to construct the project as specified.

3.3 HEALTH AND SAFETY PLAN

A. Requirements: Contractor shall submit a site specific Health and Safety Plan as outlined in Section 01330 – Submittal Procedures. Owner may have additional Health and Safety requirements separate of these specifications.

3.4. ACCESS TO THE WORK

A. Requirements: Access to the project work area shall be maintained throughout construction. Posted speed limits shall be observed on all the roads. Haul vehicles and all other vehicles used in the work shall strictly comply with these limits. Legal weight limits for public roadways and bridges shall also be observed in all hauling activities.

B. Use of the Premises: Shall be in strict conformance to the following:
   1. Contractor shall confine his equipment, storage of materials, and construction operations to the areas shown on the Drawings or as set forth in the Contract. Only authorized personnel shall be on site during construction activities. Contractor shall not unreasonably encumber the site with his materials and construction equipment. Should Contractor deem it necessary to work outside of the general construction areas shown, Contractor shall obtain written approval from the Owner prior to performing such work.
   2. Contractor shall comply with all reasonable instructions of regarding signs, traffic, fires, explosives, danger signals and barricades.
   3. Contractor shall notify the Owner of the need to temporarily remove or relocate fences for access to the work and shall coordinate such activities with Owner in regards to removal, relocation, prior to commencing work, and restoration of fences upon completion.

3.5 STAGING AREA

A. Staging Area: An equipment and materials staging area shall be located in an area south of the proposed pond or otherwise approved by the Owner. This area shall include an equipment fueling and maintenance area. Any additional space needed or modifications to the boundaries of the staging area shall be subject to approval by the Owner. Contractor shall limit equipment and materials storage to the staging area, unless specifically approved by the Owner. Contractor will be responsible for security of the staging area, hazardous material containment and cleanup (for all materials including motor oil, hydraulic and transmission fluid, antifreeze, brake fluid, and all other materials and chemicals used in the maintenance of equipment and machinery), weed control, and drainage and erosion control. Immediately following completion of construction, the staging area shall be thoroughly cleaned of all trash and debris, scarified, seeded and mulched.

3.6 SITE CLEAN UP

A. Requirements: Shall periodically, or as directed by Owner, during the course of the work remove and dispose of all surplus construction materials and debris and keep the work area and public rights-of-way reasonably clean. Upon completion of the work, Contractor shall remove all temporary construction facilities, debris, and unused materials provided for the project, leaving the project in a neat and clean condition.

3.7 DECONTAMINATION:

A. Requirements: Contractor shall provide for vehicle and equipment decontamination, which includes preparing an area where vehicles and equipment shall be decontaminated as specified. Only vehicles that come in contact with contaminated soil or other solid or liquid hazardous waste shall require decontamination. Design and construction of the decontamination area, including wastewater collection and storage facilities, will be approved by the Owner prior to use. Contractor shall be liable and responsible for any release of wastewater or hazardous substances from the work area. Contractor shall also provide procedures to prevent the uncontrolled spread of wastes on site. The procedures should provide means for minimizing or preventing "tracking" of wastes from excavation areas onto access and haul roads. Accidental spills of materials on haul roads shall be removed immediately.

3.8 MAINTENANCE OF FENCES

A. Requirements: Maintain all fences adjacent to work areas to the satisfaction of the abutting property owners. Any fence removed or destroyed during the course of Work shall be reinstalled or reconstructed in like kind at no cost to Owner or landowner.

3.9 RESTORATION OF DISTURBED AREAS

A. Requirements: All areas disturbed by Contractor's operations such as, but not limited, to, access roads, staging areas, haul roads, loading operations and disposal operations shall be restored by grading to the original contours as set forth in the Contract Documents. Seed mixture shall be as called for in Section 02923 - Seeding or as approved by the Owner.

3.10 SALVAGEABLE ITEMS

A. Requirements: Salvageable items shall be stockpiled at locations approved in writing by the Owner.

3.11 DISPOSAL OF DEBRIS

A. Requirements: Items or debris not designated as salvage for the Owner shall become the property of the Contractor. Disposal of materials in a legal manner and payment of fees required is the Contractor's responsibility.

3.12 PROJECT IDENTIFICATION

A. Requirements: As needed for access and delivery of Contractor's Equipment and Materials.

3.13 AS-BUILT DRAWINGS

A. General Requirements: A complete set of full-sized prints, furnished by the Contractor for this purpose only, shall be kept at the site. As the job progresses, continuously maintain as-built drawings of the work. The changes shall be noted legibly in red pencil or red ink. These drawings shall be submitted to the Owner prior to final inspection. Should final inspection reveal changes in the project not so noted on the as-built drawings, record these changes on the as-built drawings within 5 working days of final inspection and deliver completed as-built drawings to the Owner. Owner's Engineer will prepare final record copy of all drawings.

B. Installation Changes: Records shall be maintained of actual installations where at variance with the work shown, where changed, or where not otherwise located by dimension, elevation or other reference on the Contract drawings. Actual locations and elevations of equipment and components (such as pipe, conduits and ducts) occurring within concealed areas shall be recorded by actual dimensions referenced from readily accessible and permanent structures or monuments.

3.14 WARRANTY

A. Requirements: Materials and equipment furnished under this Contract shall be covered by the most favorable commercial warranties given to customers for such materials or equipment. The rights or remedies provided herein are in addition to and do not limit rights afforded to the Owner by other clauses of this Contract. With respect to warranties, expressed or implied, from manufacturers or suppliers for materials or equipment furnished under the Contract the Contractor shall:
   1. Obtain warranties that would be given in normal commercial practices.
   2. Require warranties to be executed, in writing, for the benefit of the Owner.
   3. Submit warranties to the Owner prior to the final inspection.

3.15 OWNER PROVIDED PERMITS

A. The facility is permitted through the following agencies:
   1. State of Wyoming, State Engineer's Office, Herschler Building, 4th East, Cheyenne, Wyoming 82002; (307) 777-7354. Permit No. pending at the time of publication.
   2. State of Wyoming, Department of Environmental Quality, Water Quality Division, Southwest District, 250 Lincoln Street, Lander, Wyoming 82520; (307) 332-3144; FAX (307) 332-3183. Permit No. pending at the time of publication.

All other permits are the responsibility of the Contractor.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01011

DRAWINGS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes: List of drawings for construction of the Evaporation Pond.

1.2 QUALITY ASSURANCE

A. Inform the Owner of any discrepancies, errors, or omissions discovered on drawings in accordance Section 01009.

1.3 PROJECT CONDITIONS

A. Where there are minor differences as determined by the Owner between details and dimensions shown on drawings and details and dimensions of existing features at jobsite, use details and dimensions of existing features at jobsite.

1.4 COPIES OF DRAWINGS

A. The Contractor will furnish additional copies of drawings for performing work.

1.5 LIST OF DRAWINGS

A. Drawings listed in Table 01011A - List of Drawings, are made a part of these specifications.

Table 01011A - List of Drawings

Sequence No.	Drawing No.	Title
1	1 of 4	Site Map
2	2 of 4	Cross Sections
3	3 of 4	Cross Sections
4	4 of 4	Details

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

There are no applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01016

MATERIAL SAFETY DATA SHEETS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for Material Safety Data Sheets.

B. *"Hazardous material"* includes any material defined as hazardous under the latest version of Federal Standard No. 313 (including revisions adopted during the term of the contract).

1.2 SUBMITTALS

A. Submit in accordance with Section 01330 – Submittals.

B. Submit updated List of Hazardous Materials (LHM) and Material Safety Data Sheets (MSDS) for any hazardous material, as defined in paragraph 1.1 SUMMARY. B., to be delivered under this contract. The hazardous material shall be properly identified and include any applicable identification number, such as National Stock Number or Special Item Number. This information shall also be included on the Material Safety Data Sheet submitted under this contract. This list must be updated during performance of the contract whenever the Contractor determines that any other material to be delivered under this contract is hazardous.

1.3 DELIVERY

A. Do not deliver any hazardous material to jobsite which was not included on the original LHM before acceptance of MSDS by Owner.

PART 2: PRODUCTS

There are not applicable requirements.

PART 3: EXECUTION

There are not applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01330

SUBMITTAL PROCEDURES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for submittals of the work schedules, earned value schedules, design computations, shop drawings, design drawings, scope of supply summaries, technical data, manufacturer's literature, and samples.

B. Requirements: Refer to specifications for submittals required. Allow 10 working days for Owner's review. Review time commences upon receipt by the Owner. Submittals shall be delivered to the Owner.

1.2 SUBMITTALS

A. Requirements: All shop drawings, samples and other submittals shall be submitted as required by the Contract. At a minimum, the following submittals shall be received and approved by the Owner prior to issuing a Notice to Proceed. As an aid to the Contractor the following submittals will be required. This list is not considered to be exhaustive and additional submittals may be requested by the Owner.
   1. Permits, by Contractor
   2. Health and Safety Plan
   3. Erosion Control Plan
   4. Dust Control Plan
   5. Traffic Control Plan
   6. Construction Plan
   7. Water Management Plan
   8. Water Pollution Prevention Plan
   9. Spill Prevention Control and Countermeasure Plan (SPCC)
   10. First Aid Plan
   11. Plan of Temporary Facilities

1.3 QUALITY ASSURANCE

A. Approval: Written approval of the submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Installation of material on the basis of written approval of submittals shall not relieve the Contractor of the responsibility for incorporating material which conforms to the requirements of the drawings and specifications. Written approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After written approval of an item, the Contractor may submit a substitution for approval, if the approved item cannot be purchased or delivered in time to avoid delay in completion of the project

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 WORK SCHEDULE:

A. Requirements: The schedule shall be submitted 14 days after the pre-work conference. When requested, the Contractor shall submit an updated schedule within three working days. As a minimum, the estimated start and completion dates should be shown in the schedule.

3.2 VALUE SCHEDULE

A. Requirements: The Contractor shall prepare a value schedule for presentation 14 days after the pre-work conference.

3.3 DESIGN COMPUTATIONS

A. Requirements: The Contractor shall deliver to the Owner all of his complete design effort, including computations, quantities, specifications and working drawings necessary to construct, design, and bid all items required by the specification sections in this Contract. The Contractor shall provide enough time for reviews, revisions, and resubmittals so as to not delay the work. When submittals have received final written approval, the Contractor shall make distribution to the parties concerned.

3.4 SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

A. General: The Contractor shall deliver to the Owner the shop drawings and manufacturer's literature required by the specification sections in this Contract to the Owner.

B. Identification: When full catalogs or pages and tables are submitted, the specific items to be used on this project shall be circled, blocked in or underlined. Completely identify each submittal by showing the following information:
   1. Name and address of preparer, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.

C. Substitutions: The Contractor shall present requests for substitutions to the Owner according to the following:
   1. Deliver sufficient calculations and data to justify selection of the proposed item and permit comparison with the original item.
   2. Show complete layout of system, except that which is identical to Contract documents, unless unchanged portion must be shown to indicate clearances.
   3. Include drawings, same (or larger) scale as Contract drawings, marked to show differences.
   4. Submit complete technical data including test data, drawings, manufacturer's literature, samples, and complete performance specifications.
   5. The Contractor is responsible for the cost of redesign and modifications to this or other parts of the project caused by the substitutions.

3.5 SAMPLES

A. Requirements:
   1. The Contractor shall deliver samples required by the specification sections in this contract. Submit samples with shop drawings when both are required.
   2. Each item shall clearly note the manufacturer, trade name, product, lot, style, color, model, locations of use and contract document reference.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01331

CERTIFICATES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: The requirements for Certificates of Conformance.

B. Requirements: Refer to specifications for Certificates of Conformance required. Allow three working days for review. Review time commences upon receipt by the Owner. Certificates of Conformance shall be delivered to the Owner.

1.2 QUALITY ASSURANCE

A. Authorization: The Owner may permit use, prior to sampling and testing, of material when accompanied by Certificates of Conformance. Material used on the basis of a Certificate of Conformance may be sampled and tested. Installation of material on the basis of a Certificate of Conformance shall not relieve the Contractor of responsibility for incorporating material which conforms to the requirements of the drawings and specifications. Material not conforming to those requirements will be subject to rejection, whether in place or not.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 PREPARATION

A. Format: The form of the Certificate of Conformance provided by the supplier shall be as follows:
   1. The certificate shall state that the named product conforms to the Contract requirements.
   2. The certificate shall either be accompanied with a certified copy of the test results, or certify that such test results are on file with the manufacturer and will be furnished to the Owner upon request.
   3. The certificate shall provide the name and address of the manufacturer, the testing agency, and the date of tests.
   4. The certificate shall set forth the means of identification which will permit field determination of the product delivered as being the product covered by the certification.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01458

TESTING LABORATORY SERVICES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: The Owner will retain a qualified, Independent Testing Laboratory to conduct specific on-site tests including soil compaction testing for quality assurance purposes. The Contractor will be responsible for all other testing including that for geomembrane testing.

1.2 SUBMITTALS

A. Test Reports: The Independent Testing Laboratory will provide 3 copies of test reports to the Owner. Reports will include testing facility name, address, telephone number, and names of responsible field technicians and field supervisor. Contractor shall submit test results of all Contractors' tests to Owner. Owner may witness Contractor's tests.

1.3 QUALITY ASSURANCE

A. Approval of Laboratory: The qualified, independent testing laboratory will have authority or be licensed to operate in the State in which the project is located. The testing laboratory will be retained by the Owner prior to the Contractor beginning work.

B. Responsibilities of Laboratory:
   1. Test samples of mixes submitted by the Contractor.
   2. Provide qualified personnel at project site. Cooperate with the Owner and Contractor in performance of services.
   3. Perform specified sampling and testing of products and materials in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of specifications.
   5. Promptly notify the Owner and Contractor of observed irregularities or non-conformance of work, products, or materials.
   6. Perform additional tests required by the Owner.
   7. Attend preconstruction meetings and progress meetings.

C. Limitations on Laboratory:
   1. Laboratory may not release, revoke, alter, or enlarge on requirements of specifications.
   2. Laboratory may not approve or accept partial portions of the work.
   3. Laboratory may not assume duties of the Contractor unless approved in writing by the Owner.

1.4 SEQUENCING AND SCHEDULING

A. Establishing Testing Schedule:
   1. By advance discussion with the testing laboratory, the Owner and Contractor will determine the time required for the laboratory to perform its test and to issue its findings.
   2. Contractor shall provide required time within the construction schedule.

B. Revising Testing Schedule: When construction schedule changes are necessary during construction, Contractor shall coordinate such changes with the testing laboratory as required.

PART 2: PRODUCTS

2.1 REPORTS

A. Reports: Will include:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and specification sections.
   6. Location in the Project.
   7. Type of inspection or test.
   8. Date of test.
   9. Results of tests.
   10. Conformance with Contract Documents.

B. Interpretation: When requested by the Owner, provide interpretation of test results.

PART 3: EXECUTION

3.1 FIELD QUALITY CONTROL

A. Contractor Requirements: See individual specifications "Field Quality Control" paragraph for specific testing requirements. When applicable, the Contractor shall:
   1. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work.
   3. Provide incidental labor and facilities:
      a. To obtain, handle, and label or identify samples at the site or at source of products and materials to be tested.
      b. To facilitate tests.
      c. To provide storage and curing of test samples.
   4. Ensure samples are taken by qualified personnel.
   5. Coordinate the laboratory test frequency and timing with the Owner.
   6. Ensure Contractor supplied tests are completed according to the testing schedule.
   7. For Contractor supplied testing furnish verbal test reports prior to leaving the project site and submit written reports within 5 working days after tests have been completed.

B. Field Testing:

Item	Location	Reference	Frequency	Remarks
Subgrade	Embankment Foundation	ASTM D2922	1,500 square ft	Field Density and Moisture Content
Embankment Fill	Embankment	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Any Other Fill	Pipe Bedding, Site Grading, Crest Surfacing, Etc.	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Clay Liner	Embankment/Pond Bottom	ASTM D2922	250 cubic yards	Field Density and Moisture Content.
Embankment Fill	Source	ASTM D422, D4318, D698	5,000 cubic yards	Gradation, Plasticity Index, Standard Proctor
Clay Liner	Source	ASTM D422, D4318, D698	5,000 cubic yards	Gradation, Plasticity Index, Standard Proctor

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for temporary utilities for construction, temporary field office, first aid, sanitary facilities, vehicular access, temporary barriers and controls, and project identification.

1.2 DEFINITIONS

A. Landscape Preservation: The term "injury" includes, without limitation, bruising, scarring, tearing, and breaking of roots, trunks, or branches.

B. Pesticides: Include herbicides, insecticides, fungicides, rodenticides, piscicides, avicides, surface disinfectants, animal repellents, and insect repellents.

C. Security: "Restricted Area" means an area where entry will not be allowed unless authorized by the Owner.
   1. "Security Measures" means those measures contained in regulations or as may be established by the Owner and carried out by an Owner's guard system to provide continuous and effective security of restricted areas.

1.3 SUBMITTALS

A. Temporary Utilities: Submit three copies of the implementation and termination schedule for each utility; and three reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Air Quality: Submit three copies of Air Quality Permit, 10 days prior to commencing for any activity for which an Air Quality Permit is required. Air Quality Permits are required for certain construction-related activities including, but not limited to, earthmoving, or other processes which discharge pollutants into the open air.

C. Water Management Plan: Submit three copies of a detailed Water Quality Management Plan to the Owner for review, approval, and use, at least 30 days prior to commencing construction activities that involve less than 5 acres of land in the vicinity of any stream, flowing or dry watercourse, lake, wetland, reservoir, or underground water source.

D. Water Pollution Prevention Plan: Submit three copies of a Water Pollution Prevention Plan to the Owner not less than 30 days prior to the start of onsite construction work. Prepare a Pollution Prevention Plan as required by the stormwater permit for discharges from construction sites.

E. Spill Prevention Control and Countermeasure Plan (SPCC): Submit an SPCC Plan where the location of a construction site is such that oil from an accidental spillage could reasonably be expected to enter into or upon the navigable waters of the United States or adjoining shorelines, and the aggregate storage of oil at the site is over 1,320 gallons or a single container has a capacity in excess of 660 gallons. Submit the SPCC Plan to the Owner at least 30 days prior to delivery or storage of oil at the site. The Plan must have been reviewed and certified by a

registered professional engineer in accordance with 40 CFR, part 112, as required by section 311 of the Clean Water Act (Public Law 92-500 as amended).

F. First Aid Plans: Submit three copies of plans [and facilities] for providing medical attention for injured or disabled employees, including onsite emergency facilities and ambulance service, before start of operations.

G. Health and Safety Plan: Contractor shall submit three copies of a site specific Health and Safety Plan. The plan shall be written in accordance with the following U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standard practices: Safety and Health Standards 29 Code of Federal Regulations (CFR) 1926 (General Industry), OSHA 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response, Safety and Health Standards 29 CFR 1926 (Construction Industry).

   At a minimum, the plan shall address the following elements: staff organization, responsibilities, and authorities; site description; hazard analysis for each project task and operation; general and site-specific training; personal protective equipment; medical surveillance; personal and environmental exposure monitoring; standard operating safety procedures, engineering controls, and work practices; communications; illumination; site control measures; personnel hygiene and decontamination; equipment decontamination; emergency equipment and first aid; emergency response and contingency procedures; and logs, reports, and record keeping.

   If applicable to a specific work item, Contractor shall provide written documentation that all employees engaged in the work have received the OSHA 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training required under 29 CFR 1910.120.

H. Sediment Control and Erosion Control Plan: Sediment control provisions shall be used to control silt in runoff whenever work is conducted adjacent to water courses. The purpose of these controls is to prevent pollution of waters of the state that may be caused by this project. If prevention is not possible, Contractor must implement best management practices (BMP) that minimize pollution from Contractor's operations.

   Properly installed silt fences, sediment basins, and other approved sediment traps (staked straw bales, etc.) shall be used to implement these BMPs for all work, both during and after working hours. Contractor shall install all construction sediment control measures required by the Technical Specifications and Drawings. Contractor shall also comply with the substance of any permit requirements applicable to this work under state and federal law. If during construction Owner deems it necessary to install additional erosion control measures, these shall be installed by Contractor and paid for at the unit price(s) bid. Erosion control mat and straw or wood mulch shall be incorporated in site reclamation as specified.

   Contractor shall submit an Erosion Control Plan for construction activities in accordance with the Submittals Section 01330. The plan shall be prepared to identify the general types of work and the types of BMPs anticipated for the entire project area. The plan shall be site specific and detail the locations and types of BMPs to be used during this project's construction activities. Information required in the plan includes, but is not limited to:

   - A brief description of the project, types of work activities to be performed, and anticipated sources of sediment and erosion.
   - BMPs for each work area to prevent erosion and provide sediment control. This information shall be accompanied by site sketches showing types and locations of BMPs.

- Erosion control practices for each type of work activity (i.e., stream reconstruction, Repository excavation, cover material placement, etc.). Practices shall be specific and appropriate for each activity.

I. Dust Control: Contractor shall be responsible for dust control during the Work. Contractor shall water or otherwise treat dust-generating surfaces as often as necessary to comply with all federal and state standards for airborne particulates. Prior to commencing any work, Contractor shall submit a written plan for dust control/abatement procedures, identifying at a minimum the following:

- Times and nature of dust generating activity on roads or at the project site;
- Nature of dust abatement measures to be used (i.e., watering or application of chemical treatment, etc.);
- Methods of application of dust control measures;
- Time schedule for application of dust control measures; and
- Procedures/availability of equipment to address dust control at other than scheduled times, if necessary.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with applicable local regulations for haul routes over public highways, roads, or bridges. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to the following:
   1. Building code requirements.
   2. Health and safety regulations.
   3. Utility company regulations.
   4. Police, fire department, and rescue squad rules.
   5. Environmental protection regulations.
   6. Prevention and control of air pollution.
   7. Prevention and control of water pollution.

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
   1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."

C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 EXPLOSIVES

A. Explosives: Shall not be permitted.

1.6 PROJECT CONDITIONS

A. Access Routes: Rights-of-way for access to work from existing roads will be established by the Owner. Use only established roadways, areas, and haul routes, or temporary roadways, areas, or haul routes constructed by the Contractor when and as authorized by the Owner.

PART 2: PRODUCTS

2.1 UTILITIES

A. General: Telephone, internet service, sanitation, heat, electricity, and potable water are not available on the site and will be provided by the Contractor as needed.

2.2 MATERIALS

A. Plastic Safety Fencing: Orange plastic fencing, 4 ft minimum height.

B. Water: Provide potable water approved by local health authorities.

2.3 TOILET UNITS

A. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

2.4 PROJECT IDENTIFICATION

A. Project Site Sign: Within 30 days after Notice to Proceed, furnish and install a project sign which shall be located at the main construction entrance to the site. The size, mounting, construction, paint colors and lettering shall be as detailed on the drawings.

B. Construction Signs: Only signs to expedite deliveries, maintain traffic flow, promote safety, and caution against danger shall be erected, as necessary.

PART 3: EXECUTION

3.1 INSTALLATION

A. Toilets: Install self-contained toilet units specified in Part 2 of this specification section. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
   1. Provide separate facilities for male and female personnel.
   2. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

B. First-Aid Facilities: Make first-aid facilities and services obvious and easily available for providing emergency aid to personnel on the site.

3.2 HAUL ROUTES, ROADWAYS, PARKING AREAS, AND STORAGE/STAGING AREAS

A. Examination: Investigate the condition of available public or private roads for clearances, restrictions, bridge-load limits, bond requirements, and other limitations that affect or may affect access and transportation operations to and from the jobsite.

B. Established Roadways as Haul Routes: Use existing roads as haul routes subject to the applicable local regulations and approval of the Owner. Tracked or heavy vehicles are allowed on dirt surfaced roads. Contractor is responsible for damage caused by construction traffic.
   1. Provide and use means of removing mud from vehicle tires before entering existing paved roads. Road repair and cleanup shall be at no cost to the Owner.
   2. Minimize interference with or congestion of local traffic.
   3. Provide barricades, flagpersons, lighting, signs, and other necessary precautions for safety of the public where haul routes cross public roads.

C. Temporary Roadways and Haul Routes: Construct and maintain temporary roadways, bridges, culverts, and drainage structures required for access to serve construction areas, of a width and load-bearing capacity to provide unimpeded traffic for construction purposes and to allow unimpeded surface drainage.
   1. After their completion, the roadways constructed under the contract will be reclaimed as directed by the Owner.
   2. Temporary roadways and detours may be constructed, as approved by the Owner or as indicated on the drawings.

D. Temporary Parking Areas: Construct temporary parking areas for construction operations personnel. Provide additional offsite parking when site space is not adequate. Locate as approved by the Owner.

E. Storage/Staging Areas: The Contractor may construct a temporary area for trailers, equipment, and materials, located as approved by the Owner. Fencing of materials or equipment shall not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Trailers, materials, or equipment shall not be placed or stored outside the area.

F. Maintenance: Maintain haul routes, roadways, parking and storage areas, in a sound, smooth condition. Maintain the surfacing of roads and areas until completion and acceptance of all the work under this contract. Maintain the surfacing of gravel-surfaced roads and areas in a smooth condition until completion and acceptance of all work under this contract. Snow removal for convenience of the Contractor or to facilitate work operations of the Contractor is considered to be normal required maintenance and at contractor's expense.

G. Repair: Promptly repair ruts, potholes, low areas with standing water, and other deficiencies to maintain road and parking area surfaces and drainage in original or specified condition.

H. Removal: Remove materials used to construct temporary roadways, areas, and haul routes prior to contract completion.

3.3 AIR POLLUTION CONTROL

A. Air Quality Permits: Information concerning the requirements in addition to requirements for earthwork operations will be available from the Owner.

B. Responsibility: Contractor shall be responsible for damages resulting from dust originating from Contractor operations.
   1. Owner may stop any construction activity contributing to air pollutant levels which are excessive or in violation of Federal, State, or local laws and additional expenses resulting from work stoppage will be responsibility of Contractor.

C. Requirements: Utilize such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.

   1. Do not operate equipment and vehicles that show excessive emissions of exhaust gases until corrective repairs or adjustments reduce such emissions to acceptable levels.

   2. Provide dust control and abatement during construction. Prevent, control, and abate dust pollution on rights-of-way provided by Owner or elsewhere during performance of work. Provide labor, equipment, and materials, and use efficient methods wherever and whenever required to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic, and similar conditions.

3. Provide means for eliminating atmospheric discharges of dust during mixing, handling, and storing of cement, pozzolan, and concrete aggregate.

4. Burning shall not be allowed.

3.4 WATER POLLUTION CONTROL

A. Contractor Water Pollution Violations: If noncompliance should occur, report the noncompliance to the Owner immediately (orally), with the specific information submitted in writing within 2 calendar days. Consistent violations of applicable Federal, State, or local laws, orders, regulations, or Water Quality Standards may result in the Owner stopping all site activity until compliance is ensured. The Contractor shall not be entitled to any extension of time, claim for damage, or additional compensation by reason of such a work stoppage. Corrective measures required to bring activities into compliance shall be at the Contractor's expense.

B. Intentionally left blank.

C. Intentionally left blank.

D. Stormwater Discharge Permit Associated With a Construction Site:
   1. Notice of Intent: Both the Owner and the Contractor shall sign the Notice of Intent (NOI) to obtain coverage under a stormwater general permit to control stormwater discharges from the construction site as required under section 402 of the Clean Water Act (Public Law 92-500, as amended). Contractor shall prepare and submit permit application and have responsibility to obtain permit. Costs associated with permit are incidental to the work and at the Contractor's expense.
   2. Pollution Prevention Plan: The Contractor shall prepare a Pollution Prevention Plan as required by the permit. The Contractor shall comply with all terms and conditions to obtain and maintain this stormwater discharge permit.

   3. Monitoring and Water Treatment: Contractor shall provide all monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards, and provide the recordkeeping required by the stormwater discharge permit associated with construction activity.

E. Intentionally left blank.

F. Pollution Controls: Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including State and local control requirements.
   1. Sediment and Erosion Controls: Establish methods for controlling sediment and erosion which address vegetative practices, structural control, silt fences, straw dikes, sediment controls, and operator controls as appropriate. Institute stormwater management measures as required, including velocity dissipaters, and solid waste controls which address controls for building materials and offsite tracking of sediment.

   2. Wastewater and Stormwater Management Controls: Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and erosion, and which will intercept and settle any runoff of sediment-ladened waters. Prevent wastewater from general construction activities such as drainwater collection, aggregate processing concrete batching, drilling grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods. Divert stormwater runoff from upslope areas away from disturbed areas.
      a. Turbidity prevention measures: Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel

filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life. All such wastewaters discharged into surface waters shall contain the least concentration of settleable material possible and shall meet all conditions of section 402, the National Pollutant Discharge Elimination System (NPDES) permit. Do not operate mechanized equipment in waterbodies without having first obtained a section 404 permit, and then only as necessary to construct crossings or perform the required construction.

3. Construction Site Management: Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources. Such pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, mineral salts, and thermal pollution.
   a. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff, or can in any way encroach upon the watercourse.
   b. Place all oil or other petroleum product (hereinafter referred to collectively as oil) storage tanks at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.
   c. Diked storage areas shall be at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to the capacity of all tanks and/or containers located in each area plus a sufficient amount of freeboard to contain the 25-year rainstorm.
   d. Provide diked areas with an impermeable barrier at least 10 mils thick. Provide areas used for refueling operations with an impermeable liner at least 10 mils thick buried under 2 to 4 inches of soil.
   e. Do not use underground storage tanks.

3.5 PEST CONTROL

A. Requirements: Comply with manufacturer's labeling as to handling and application.

B. Records: Keep records of types and amounts of pesticides purchased, delivered, stored, mixed, and actually used and means of disposal of excess pesticide. Keep records current and accurate and make available for review by Owner.

3.6 SECURITY MEASURES

A. Requirements: Protect the site, materials, and operations from theft, vandalism, and unauthorized entry. Initiate program in coordination with Owner's existing program at project site. Maintain program throughout construction period until Owner's acceptance.

B. Entry Control: Restrict entrance of persons and vehicles into the project site and existing facilities. These restricted areas are designated and may be modified or changed by the Owner. Allow entrance only to authorized persons with proper identification.
   1. Maintain log of workers and visitors, make available on request.
   2. Restricted Areas: Construction personnel will not be permitted to enter established or designated restricted areas unless so authorized by the Owner. It shall be the Contractor's responsibility to ensure by appropriate and effective means that contractor's personnel shall not enter these areas unless authorized.

3.7 MAINTENANCE AND REMOVAL

A. Maintenance: Maintain temporary structures, facilities, and controls as long as needed for safe and proper completion of the work and as directed by the Owner.

B. Removal: Remove temporary structures, facilities, and controls as rapidly as progress of the work will permit and as approved by the Owner.

3.8 PROTECTION

A. Barriers: Provide earthen embankments and similar barriers around excavation and subgrade construction, sufficient to prevent flooding by runoff from heavy rains.

3.9 WASTE

A. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately form other waste by containerizing properly. Dispose of material lawfully.

3.10 CLEANUP

A. Requirements: Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

B. Restoration of Storage Area: Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used by the Contractor for the storage of equipment or material, or other use, to the original or better condition. Remove gravel used for surfacing and restore the area to its original condition, including top soil and seeding as necessary.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01505

MOBILIZATION

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Preparatory work and operations, including those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

There are no applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for record drawings.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 RECORD DRAWINGS

A. General Requirements: A complete set of full-sized prints, furnished by the Contractor for this purpose only, shall be kept at the site. As the job progresses, the Contractor shall continuously maintain record drawings of the work. The changes shall be noted legibly in red pencil or red ink. These drawings shall be submitted to the Owner for review prior to the final inspection. Should the final inspection reveal changes in the project not so noted on the record drawings, the Contractor shall record these changes on the record drawings within 5 working days of final inspection and submit the completed record drawings to the Owner. The Owner's Engineer will then prepare final record drawings in DWG and PDF electronic formats.

B. Installation Changes: Records shall be maintained by the Contractor of actual installations where at variance with the work shown, where changed, or where not otherwise located by dimension, elevation or other reference on the Contract drawings. Actual locations and elevations of equipment and components occurring within concealed areas shall be recorded by actual dimensions referenced from readily accessible and permanent building lines or monuments.

3.2 WARRANTY

A. Requirements: Materials and equipment furnished under this Contract shall be covered by the most-favorable commercial warranties the Contractor gives to any customer for such materials or equipment. The rights or remedies provided shall be in addition to, and shall not limit any rights afforded to the Government by any other clause of this Contract. With respect to all warranties, expressed or implied, from manufacturers or suppliers for materials or equipment furnished under the Contract, the Contractor shall:
   1. Obtain all warranties that would be given in normal, commercial practices.
   2. Require all warranties to be executed, in writing, for the benefit of the Government.
   3. Submit all warranties to the Owner, prior to the final inspection.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02231

CLEARING AND GRUBBING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Clearing of vegetation, and grubbing of stumps, roots, and debris; disposal of unutilized materials; and other incidental work related to preparing the site for later use.

1.2 DEFINITIONS

A. Clearing: Clearing shall consist of the trimming and cutting of obstructions and the satisfactory disposal of surface vegetation designated for removal including brush and rubbish occurring in the areas to be cleared.

B. Grubbing: Grubbing shall consist of the removal and disposal of below-surface stumps, roots larger than 3-inches in diameter, and matted roots from the designated grubbing areas.

C. Hazardous Waste: Substance likely to cause death or injury by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful; and includes, but is not limited to flammable dust, flammable fiber, combustible liquid, dangerous chemical, flammable gas, liquified flammable gas, and flammable liquid.

1.3 PROJECT/SITE CONDITIONS

A. Work Limits: As indicated on Project Drawings.

B. Burning: Shall not be permitted.

C. Landscape Preservation: Protect vegetation outside the work limits from injury. Existing brush and shrubs shall not be disturbed or damaged.

1.4 SUBMITTALS

A. None

PART 2: PRODUCTS

2.1 PREPARED PRODUCTS

A. No products, as such, are listed in this section of the specifications. It is however, the responsibility of the Contractor to supply all products to comply with this section of the specifications.

PART 3: EXECUTION

3.1 PROTECTION

A. Roads: Keep roads free of dirt and debris at all times.

B. Trees, Shrubs, and Existing Facilities: Protection shall be according to Section 01500 - Temporary Facilities and Controls.

C. Utility Lines: Protect existing utility lines that are indicated to remain from damage. Notify the Owner immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to the start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Owner at least 72 hours prior to interruption of the service.

3.2 CLEARING

A. Requirements: Contractor shall remove only those trees, large shrubs and bushes designated by the Owner for removal. Clear stumps, roots, brush, and other vegetation in areas to be graded, cut off flush with or below the original ground surface, except such vegetation indicated or directed to be left standing. Vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of existing obstructions that obtrude, encroach upon, or otherwise obstruct the work.

B. Road Improvements and Construction: The existing vegetation that is cleared and grubbed for road improvement and construction shall be windrowed close to the road for later salvage. For permanent roads, salvaged material shall be placed back onto cut/fill slopes outside the traveled roadway. For reclaimed roadways, salvaged material shall be spread evenly over the reclaimed area.

3.3 GRUBBING

A. Requirements: Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

3.4 EXPLOSIVES

A. Requirements: The use of explosives is prohibited.

3.5 DISPOSAL

A. Requirements: Material that is not to be salvaged shall be deposited as directed by the Owner.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02310

SITE GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Stripping and storage of topsoil, excavating, filling, grading, and other related work to prepare the site.

1.2 DEFINITIONS

A. Unclassified Excavation: Shall consist of the material excavation and placement regardless of its nature.

B. Rock Excavation: Removal of material shall be considered rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of 145 kW (195 net horsepower), with a rear-mounted, heavy-duty, single-tooth, ripping attachment.

C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 145 kW (195 net horsepower) or less shall be considered common excavation.

D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

E. Fill Material: Shall be mineral soil free from peat, frozen material, brush, trees, roots over 2 inches in diameter and rocks over 6 inches in greatest diameter obtained from site during excavation.

F. Topsoil: Surface soil approximately 6 inches in depth that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch in diameter.

1.3 QUALITY ASSURANCE

A. Failure Criteria: Not limited to the following:
   1. Formation of pools of moisture where positive drainage is indicated on the drawings.
   2. Settlement of fill.
   3. Flow of moisture toward, or entrapment against, structures and working surfaces.

1.4 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Do not attempt to grade frozen or saturated material. Water dry material to prevent dust.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: See definitions.
   1. Silt Barrier: A silt barrier shall be constructed to prevent silt from polluting existing streams. The silt barrier shall consist of straw bales or a geosynthetic silt fence.

PART 3: EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify the grade elevations existing on the site. Notify the Owner immediately when adjustments are required to provide finish elevations indicated. Site drainage shall be considered of prime importance.

3.2 PREPARATION

A. Clearing: Section 02231 - Clearing and Grubbing.

B. Stripping Topsoil: Strip and stockpile topsoil in the location designated by the Owner.

C. Scarifying: Sod and vegetation shall be removed from the surface upon which the fill shall be placed. The cleared surface shall be completely broken up by scarifying to a minimum depth of 6 inches. Scarifying furrows shall be a maximum of 3 feet apart and shall be parallel to the center line of the fill. No fill materials shall be placed upon unapproved surface.

3.3 INSTALLATION

A. Excavation: Section 02315 - Excavation and Fill.

B. Grades: When not otherwise indicated shall be level, or uniform slopes between points where elevations are given, or between such points and existing finished grades. Abrupt change in slopes shall be rounded.

C. Compaction Methods: Fill material shall be spread over the full area of the cross section of the fill to a maximum loose layer thickness of 9 inches. Compact according to Section 02315 - Excavation and Fill before the next layer is spread. During placing and compacting of the fill material, the optimum moisture content shall be maintained by wetting or drying as required.

D. Frozen Material: Fill shall not be placed when either the material or the surface on which it is to be placed is frozen.

E. Homogeneous Mass: Successive loads of material shall be dumped on the earthfill to produce the best practicable distribution of the material. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.

F. Topsoil: Topsoil to be used for reclamation shall be spread uniformly over compacted material to grades at the depth shown on the drawings and compacted firmly in place. Upon completion of grading operations, spread topsoil from the stockpile onto areas disturbed by grading operations.

3.4 FIELD QUALITY CONTROL

A. Testing: Owner will arrange for a certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Compaction: Fill material shall be compacted to a minimum density of 95 percent of the maximum dry density obtained by ASTM D698. Fill material shall be placed to within plus or minus 2% of optimum moisture content as determined by ASTM D698.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02315

EXCAVATION AND FILL

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, borrow excavation, embankment construction, placement, and disposal of materials as shown on the drawings.

B. Related Sections

1. General Information and Requirements	Section 01009
2. Testing Laboratory Services	Section 01458
3. Clearing and Grubbing	Section 02231
4. Borrow Excavation	Section 02317
5. Watering	Section 02339

1.2 DEFINITIONS

A. Unclassified Excavation: Consists of the material excavation and placement regardless of its nature.

B. Rock Excavation: Removal of material is rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of [195] net horsepower, with a rear-mounted, heavy-duty, single-tooth, ripping attachment.

C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 195 net horsepower or less shall be considered common excavation.

D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

E. Fill Material: Shall be mineral soil free from peat, frozen material, brush, trees, roots over 2 inches in diameter and rocks over 6 inches in greatest diameter obtained from site during excavation.

F. Topsoil: Surface soil approximately 6 inches in depth, unless otherwise specified, that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch in diameter.

1.3 PROJECT/SITE CONDITIONS

A. Excess Material: Usable excess material excavated shall be used in the embankment construction before the use of borrow is allowed. Borrow wasting is not permitted.

B. Borrow Material Source: Obtain borrow material from the source or sources shown on the drawings, subject to use restrictions or requirements as noted.

C. Fencing: When fencing is removed, replace the fencing to the same condition as it was before removal. The Contractor shall be responsible for the livestock confinement when a portion of a fence is removed.

D. Drainage of Borrow Pits: Borrow pits and waste or disposal areas shall be excavated so that water will not collect and stand.

E. Calculation of percent shrinkage/swell to be established by Contactor at Contractor's risk and shall not be the basis of any extra work claim.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: See definitions.

B. Fill Material: Shall be obtained from the common excavation or from designated borrow areas. Material from excavation shall be used unless it contains ice or frozen earth, debris, high moisture content, or is specified in other sections to be replaced. Materials removed in clearing and grubbing shall not be used for backfill or embankment.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing and Grubbing: Section 02231 - Clearing and Grubbing.

B. Borrow Area: Notify the Owner sufficiently in advance of opening borrow areas. This allows cross section determination of elevations and measurements of the ground surface after stripping. Also, the borrow material can be tested before being used. Allow sufficient time for testing the borrow. Borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavation has been completed. Do not excavate beyond the dimensions and elevations established, and no material shall be removed prior to staking out and cross-sectioning of the site. The finished borrow areas shall be approximately true to the line and grade established.

C. Prewatering: Excavation areas and borrow pits may be prewatered before excavating the material. The area to be excavated shall be moistened to the full depth from the surface to the bottom of the excavation. The application of water shall be controlled so that the excavated material will be near the optimum moisture content as specified in paragraph 3.3A Testing, below. When necessary, prewatering shall be supplemented to assure that embankment material and backfill material moisture content comply with paragraph 3.3A Testing, below.

D. Preparation for Grading: Prior to beginning embankment operations in an area, necessary clearing and grubbing in that area shall have been completed and accepted by the Owner. No embankment materials shall be placed upon an unapproved surface.
   1. Embankments: When embankments are to be constructed, the cleared surface shall be completely broken up by plowing or scarifying to a minimum depth of 6 inches. Scarifying or furrows shall be a maximum of 3 feet apart, and shall be parallel to the centerline of the embankment. This area shall then be compacted beginning with the first lift, as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction.

3.2 INSTALLATION

A. Explosives: The use of explosives is prohibited.

B. Excavation: Excavate where shown on the drawings and typical sections, unless staked otherwise. Excavate on a straight grade between the control points shown on the drawings unless staked otherwise. Existing structures which are disturbed or damaged by construction activity shall be reset, repaired, or replaced at the Contractor's expense.

C. Subgrade Compaction: In areas where earthfill, or embankments are to be constructed and in areas where excavation exposes the subgrade surface upon which fill is placed will be constructed, the subgrade shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before embankment construction begins.

D. Disposal of Materials: Excess and unsuitable material, including rock and boulders that cannot be used in embankments, shall be disposed of as directed by Owner.

E. Use of Borrow Material: Do not use borrow material until after the materials obtained from required excavation have been placed in the fill, unless otherwise directed by the Owner. When more borrow is placed than is required, and required excavation is wasted, the waste shall be replaced in the borrow area at the Contractor's expense.

F. Overburden: Overburden shall be stripped from borrow pits and stockpiled for later use. The pit shall be neatly sloped and trimmed. Side slopes shall be flattened to a 4:1 slope. Stockpiled overburden material shall then be spread uniformly over the sides and bottom of the pit area, and vegetation established.

G. Imported Borrow: Section 02317 - Borrow Excavation.

H. Fill Material: Shall be spread over the full width of the cross section of the embankment or fill section to a maximum compacted thickness of 9 inches, and shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before the next layer is spread. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.

I. Frozen Material: Shall not be placed, nor be placed upon a frozen surface.

3.3 FIELD QUALITY CONTROL

A. Testing: The Owner will arrange for a certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Moisture Content:
   1. During placing and compacting of fill material, the optimum moisture content (-2 percent to +2 percent) as determined by ASTM D698, unless otherwise noted on the project drawings, and shall be maintained by wetting or drying.

C. Compaction:
   1. The fill material shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by ASTM D698 unless otherwise noted on the project drawings.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02316

DEWATERING

PART 1: GENERAL

1.1 SUMMARY

A. Section includes: All work associated with required dewatering activities for all components of work.

1.2 WORK INCLUDES

A. Maintain the foundations, excavations and other parts of the work free from water as required for constructing each part of the work.

B. Remove all components of dewatering system, if required, after dewatering is complete.

PART 2: PRODUCTS

There are no requirements

PART 3: EXECUTION

3.1 GENERAL

A. It shall be the Contractor's responsibility to evaluate the subsurface conditions at the project site with respect to required dewatering.

B. The Contractor shall, at all times during construction, provide ample means and devices to remove promptly and dispose of properly all water entering excavations and keep the bottoms of the excavations firm and free of standing water until the structures to be built therein are completed and/or the backfill to be placed therein has been placed. The pumping and dewatering operations shall be carried out in such a manner that no disturbance to the bearing soil or rock or to soil or rock supporting any other work will result from the dewatering operations. The dewatering discharge shall not cause siltation or other negative environmental impact on natural waterways or other property; such discharge shall be in accordance with applicable Federal, state, and local regulations. At dewatering discharge locations, hay-bales, silt barriers or other control measures, as approved by the Owner, shall be installed to control and prevent siltation.

C. The dewatering system shall be operated continuously, as necessary, to prevent flotation of partially completed structures or other work.

3.2 DEWATERING REQUIREMENTS

A. Design, furnish, install, maintain, and operate a dewatering system which shall prevent loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottoms of excavations so that every phase of the work can be performed in the dry. The dewatering operations shall be such that the bottoms of all excavations shall be kept at all times firm, and in all respects acceptable to the Owner as good foundation.

3.3 INSTALLATION AND OPERATION

A. The location of every element of the dewatering system shall be such that interference with excavation and construction activity is minimized. Locations shall be subject to approval by the Owner's Representative.

B. When the dewatering system does not meet the specified requirements, and as a consequence loosening or disturbance of the foundations strata, instability of the slopes or damage to foundations or structures occurs, the Contractor shall supply all materials, labor, and perform all work for restoration of foundation soil, fill soil, slopes, foundations, or structures, to the satisfaction of the Owner's Representative, at no cost to the Owner.

3.4 REMOVAL

A. All elements of the dewatering system(s) shall be removed from the site at the completion of the dewatering work.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02317

BORROW EXCAVATION

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, loading, hauling, and stockpiling imported borrow materials for the fill.

B. Related Sections

1.	General Information and Requirements	Section 01009
2.	Excavation and Fill	Section 02315
3.	Watering	Section 02339

1.2 PROJECT/SITE CONDITIONS

A. Excess Material: Useable excess material excavated as a result of other section work shall be used in embankment construction as approved by the Owner. Wasting borrow is not permitted.

B. Borrow Material Source: Obtain borrow material from the source or sources shown on the drawings, subject to use restrictions or requirements as noted.

PART 2: PRODUCTS

2.1 MATERIALS

A. Borrow: Borrow shall be selected to meet the requirements and conditions for which the particular fill is intended. The borrow material shall be free of roots, trash, and other objectionable materials. Borrow shall be approved by the Owner in writing.

B. Topsoil for Reclaimed Areas: Material excavated from the designated borrow sources can be used for topsoil for reclaimed areas if approved by the Owner if produced to meet the requirements as specification in Section 02726 – Topsoil for Reclaimed Areas.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing and Grubbing: Strip from the borrow area all brush, stumps, roots, and harmful or undesirable materials.

B. Borrow Areas: The borrow excavation slope shall not exceed 2:1. Vertical slopes are not allowed.

3.2 RECLAMATION

A. Borrow areas shall be reclaimed such that surface water will drain.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02319

MULCH

PART 1: GENERAL

1.1 SUMMARY

A. Description: This work shall consist of covering and processing specified seeded areas with a mulch of the stipulated materials.

1.2 SUBMITTALS

A. The following submittals are required:

1. Manufacturer's specifications and material content for mulch products.
2. Manufacturer's recommended application methods and rate.

PART 2: PRODUCTS

2.1 GENERAL

A. Materials: Mulching materials used on the project shall be those described hereafter.

1. Grass Hay: This type of mulch material shall be composed primarily of perennial grasses at least 10 inches. The grass hay mulch shall contain greater than 70% grass by weight and shall not contain a total greater than 5% alfalfa, crested wheatgrass or yellow sweet clover. Grass hay is subject to the Owner's approval and must be certified "Noxious Weed Seed Free" hay provided by a certified supplier. Chopped or ground material is not acceptable. The mulch material is not acceptable if it is musty, moldy or rotted, or if it contains seedbearing stalks of noxious weeds. It shall be free of stones, dirt, roots, stumps or other foreign material.

PART 3: EXECUTION

3.1 GENERAL

A. General: Mulch must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. If the Contractor does not mulch within 24 hours after seeding, the Contractor may be required to re-seed the project at no additional cost to the Owner. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground as long as it doesn't compact the surface. Mulch shall not be applied to snow-covered ground surfaces.

Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Areas not to be mulched shall be determined by the Owner. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the Contractor, to the satisfaction of the Owner.

Additional mulching may be required in accordance with summer erosion control procedures.

The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow or other acceptable means to remove the tracks.

B. Application of Native Hay Mulch: Native hay shall be uniformly spread at a rate approved by the Owner for the intended purpose. Unless otherwise specified by the Owner, hay shall be anchored into the seedbed by using a mulch crimper. Hay shall have a minimum length of 10 inches shall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.

The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions: 1/4-inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done along the contour of the slope.

C. Finishing: Prior to final acceptance of the project, the Contractor shall immediately remulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before remulching. The operations described in this paragraph shall be at the Contractor's expense if the damage is due to his negligence.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02339

WATERING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Distributing and applying water required for excavation, compaction of fill, backfilling, dust control, roadways, parking areas and watering of seeded areas.

1.2 PROJECT/SITE CONDITIONS

A. Water Source: The Owner will designate a source of water.

PART 2: PRODUCTS

2.1 MATERIALS

A. Water: Water shall be obtained from the Owner supplied source.

2.2 EQUIPMENT

A. Requirements: Provide necessary pumping equipment, piping, tanks, water trucks, and measuring devices. Water trucks shall be equipped with a spray bar of adequate capacity and design to ensure uniform application of water in the amounts designated. Measuring devices shall be approved by the Owner.

PART 3: EXECUTION

3.1 APPLICATION

A. Compaction: Water may be applied by sprinkling to either the borrow area or the fill. Water shall be applied uniformly to each layer of fill, as needed, to obtain the optimum moisture content determined by ASTM D698. The final moisture content shall be as specified.

B. Seeding and Dust Control: Water shall be applied to those areas identified by the Owner as dust control or seeded areas.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02372

GEOMEMBRANE LINER

PART 1: GENERAL

1.1 SUMMARY

A. This specification includes furnishing and installing HDPE geomembranes with a formulated sheet density of 0.940 g/cm or greater. Geomembranes with both smooth and textured surfaces are included.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 638, Standard Test Method for Tensile Properties of Plastics.
   2. D 751, Standard Test Methods for Coated Fabrics.
   3. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   4. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
   5. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
   6. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   7. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
   8. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
   9. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
   10. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
   11. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
   12. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
   13. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
   14. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
   15. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
   16. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
   17. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
   18. D 5820, Test Method for Air Testing.
   19. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
   20. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
   21. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

B. Geosynthetic Research Institute (GRI):
   1. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
   2. GRI GM 9, Cold Weather Seaming of Geomembranes
   3. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet

4. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
5. GRI GM 14, Test Frequencies for Destructive Seam Testing

1.3 SUBMITTALS

A. Submit under provisions of Section 01300, Submittals.

B. Submit the following to the Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:
   1. Documentation of manufacturer's qualifications as specified in subsection 1.4A of this Section.
   2. Manufacturer's Quality Control program manual or descriptive documentation.
   3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.
   4. Sample of the material.
   5. Documentation of Installer's qualifications, as specified below and in subsection 1.04B of this Section.
      a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
      b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
      c. Quality Control Program.
   6. Example Material Warranty and Liner Installation Warranty complying with subsections 1.07 and 1.08 of this Section.
   7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements for the project.

C. Shop Drawings
   1. Submit copies of shop drawings for Owner's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner. Butt seams on a slope, if allowed, should be staggered.
   2. Placement of geomembrane will not be allowed to proceed until Owner has received and approved the shop drawings.

D. Additional Submittals (In-Progress and at Completion)
   1. Manufacturer's warranty (refer to subsection 1.7).
   2. Geomembrane installation warranty (refer to subsection 1.8).
   3. Daily written acceptance of subgrade surface (refer to subsection 3.1.C).
   4. Low-temperature seaming procedures if applicable (refer to subsection 3.3.A).
   5. Prequalification test seam samples (refer to subsection 3.5.A.6).
   6. Field seam non-destructive test results (refer to subsection 3.5.B.1).
   7. Field seam destructive test results (refer to subsection 3.5.C.6).
   8. Daily field installation reports (refer to subsection 3.5.G).
   9. Installation record drawing, as discussed in subsection 3.5.

1.4 QUALITY CONTROL

A. Manufacturer's Qualifications: The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such

geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 square feet of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications

1. The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner to install the geomembrane.

2. The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 square feet of the specified type of geomembrane or similar during the last three years.

3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 square feet of geomembrane of the type specified or similar product.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 square feet of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.6 PROJECT CONDITIONS

A. Geomembrane should not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.7 MATERIAL WARRANTY

As required by specification, or as required in GRI GM 13 (attachment A)

1.8 GEOMEMBRANE INSTALLATION WARRANTY

A. The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.9 Geomembrane Pre-Construction Meeting

A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the Earthwork Contractor.

B. Topics for this meeting shall include:
   1. Responsibilities of each party.
   2. Lines of authority and communication. Resolution of any project document ambiguity.
   3. Methods for documenting, reporting and distributing documents and reports.
   4. Procedures for packaging and storing archive samples.
   5. Review of time schedule for all installation and testing.
   6. Review of panel layout and numbering systems for panels and seams including details or marking on geomembrane.
   7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
   8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation. Installation limitations under specific wind conditions shall be discussed.
   9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
   10. Deployment techniques including allowable subgrade for the geomembrane.
   11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
   12. Covering of the geomembrane and cover soil placement.
   13. Health and safety.
   14. Testing program.

C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

PART 2: PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Manufacturing Quality Control

1. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM 13, or modified as required for project specific conditions.

2. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.1.A.3 of this Section, must be supplied to the Owner to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

3. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.2 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE- Density >0.94g/cm) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane will meet the property requirements as shown in Table A. (GRI GM 13)

B. Material conformance testing by the Owner, if required, will be conducted in accordance with the project specifications.

C. The geomembrane seams shall meet the property requirements as shown in Table 2, (Attachment B) or as required by project specifications

PART 3: EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with the project specifications. The geomembrane subgrade shall be uniform and free of all sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.

B. The Geomembrane Installer and Owner shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.

C. The Geomembrane Installer and Owner shall provide daily written acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be approved by the Owner and the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.2 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.3 of this Section are submitted to and approved by the Owner. Should geomembrane material be deployed prior to approval by the Owner it will be at the sole risk of the Geomembrane Installer and/or Contractor. If the material does not meet project specifications it shall be removed from the work area at no cost to the Owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owner. The

specified minimum temperature for material deployment may be adjusted by the Owner' based on recommendations by the manufacturer. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations should be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be regraded to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.9.B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Owner.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.3 SEAMING PROCEDURES

A. Cold weather installations should follow guidelines as outlined in GRI GM9.

B. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperatures below 0 degrees C (32 degrees F) is allowed if the Geomembrane Installer can demonstrate to the Owner, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at sub-freezing temperatures.

2. The Geomembrane Installer shall submit to the Owner for approval, detailed procedures for seaming at low temperatures, possibly including the following:
   a. Preheating of the geomembrane
   b. The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming.
   c. Number of test welds to determine appropriate seaming parameters

C. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Owner. This approval will be based on recommendations by the manufacturer and on a field demonstration by the Geomembrane Installer using prequalification test seams to demonstrate that seams comply with the specification.

D. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

E. Fishmouths or excessive wrinkles at the seam overlaps, shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.4 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.5.B. Alternatively, where field non destructive testing can not be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.

2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.

3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.

4. Care should be taken if flammable gases are present in the area to be tested.

3.5 FIELD QUALITY CONTROL

The Owner shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.

2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.D. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.

4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.5.C.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.

5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.

6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner' for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner.

2. Testing should be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Owner. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.

3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.

4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner all test methods to verify the test procedures are valid.

5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.
   b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).
   c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.
   d. All areas where soap bubbles appear shall be marked, repaired and then retested.
   e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.
   f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:
   a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
   b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.
   c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.
   d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner as an archive sample; one section given to the Owner for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.2 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Owner, typically 3 m (10 ft) on either side of the failed sample and laboratory seem tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects

Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.5.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.

2. Defective seams, tears or holes shall be repaired by reseaming or applying an extrusion welded cap strip.

3. Reseaming may consist of either:
   a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.

4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.

5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams

Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

G. Daily Field Installation Reports

At the beginning of each day's work, the Installer shall provide the Owner with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.6 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Owner when:
   1. The entire installation is finished or an agreed upon subsection of the installation is finished;
   2. All Installer's QC documentation is completed and submitted to the Owner.
   3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.7 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.8 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in an EPA approved landfill, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4: GRI GM13 SPECIFICATION

Attachment A: Minimum Average Weld Properties for HDPE Geomembranes

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	**Test Method**	**30 mil**	**40 mil**	**50 mil**	**60 mil**	**80 mil**	**100 mil**	**120 mil**
Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in.	ASTM 4437	60	80	100	120	160	200	239

Attachment B: GRI GM13 Specification (14 pages attached)

END OF SECTION

ATTACHMENT B

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Rev. 6: June 23, 2003
Revision schedule on pg. 14

GRI Test Method GM13*

Standard Specification for

"Test Properties, Testing Frequency and Recommended Warranty for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

1.5 This specification also presents a recommended warrant which is focused on the geomembrane material itself.

1.6 The recommended warrant attached to this specification does not cover installation considerations which is independent of the manufacturing of the geomembrane.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device

GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet

Note 6: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 7: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

11. Warranty

11.1 Upon request of the purchaser in the contract or order, a manufacturer's warrant of the quality of the material shall be furnished at the completion of the terms of the contract.

11.2 A recommended warranty for smooth and textured HDPE geomembranes manufactured and tested in accordance with this specification is given in Appendix A.

11.3 The warranty in Appendix A is for the geomembrane itself. It does not cover subgrade preparation, installation, seaming, or backfilling. These are separate

operations that are often beyond the control, or sphere of influence, of the geomembrane manufacturer.

Note 9: If a warrant is required for installation, it is to be developed between the installation contractor and the party requesting such a document.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,00 lb
Tensile Properties *(1)* (min. ave.)	D 6693 Type IV								20,000 lb
• yield strength		63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	GM 11								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 20kN/m 12% 700%	 15 kN/m 27 kN/m 12% 700%	 18 kN/m 33 kN/m 12% 700%	 22 kN/m 40 kN/m 12% 700%	 29 kN/m 53 kN/m 12% 700%	 37 kN/m 67 kN/m 12% 700%	 44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	 D 3895 D 5885	 N. R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 45 lb/in. 12% 100%	 84 lb/in. 60 lb/in. 12% 100%	 105 lb/in. 75 lb/in. 12% 100%	 126 lb/in. 90 lb/in. 12% 100%	 168 lb/in. 120 lb/in. 12% 100%	 210 lb/in. 150 lb/in. 12% 100%	 252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 8 kN/m 12% 100%	 15 kN/m 10 kN/m 12% 100%	 18 kN/m 13 kN/m 12% 100%	 22 kN/m 16 kN/m 12% 100%	 29 kN/m 21 kN/m 12% 100%	 37 kN/m 26 kN/m 12% 100%	 44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Appendix "A"

Typical HDPE Geomembrane Warranty

Reviewed by: Donald J. Weiss, Esq.
General Council for GSI

ABC GEOMEMBRANE COMPANY
LIMITED WARRANTY

Warranty No: _____
Project No: _____
Effective Date: _____

PURCHASER NAME: _____ PROJECT NAME: _____

ADDRESS: _____ ADDRESS/LOCATION: _____

CITY, STATE, ZIP, COUNTRY _____ CITY, STATE, ZIP, COUNTRY _____

GEOMEMBRANE TYPE/DESCRIPTION _____

ABC Geomembrane Company warrants each ABC geomembrane to be free from manufacturing defects (as defined by the contract's material specifications) and to be able to withstand normal weathering for a period of 5 years from the above effective date for normal use in approved applications.

This Limited Warranty does not include damages or defects in the ABC geomembrane resulting from acts of God, casualty or catastrophe including but not limited to: earthquakes, floods, piercing hail, tornadoes or force majeure. The term "normal use" as used herein does not include, among other things the exposure of ABC geomembranes to harmful chemicals, abuse of ABC geomembranes by machinery, equipment or people; improper site preparation or covering materials, excessive pressures or stresses from any source or improper application or installation. ABC geomembrane material warranty is intended for commercial use only and is not in effect for the consumer as defined in the Magnuson Moss Warranty or any similar federal, state, or local statues. The parties expressly agree that the sale hereunder is for commercial or industrial use only.

Should defects or premature loss of use within the scope of the above Limited Warranty occur, ABC Geomembrane Company will, at its option, repair or replace the ABC geomembrane on a pro-rata basis at the then current price in such manner as to charge the Purchaser/User only for that portion of the warranted life which has elapsed since purchase of the material. ABC Geomembrane Company will have the right to inspect and determine the cause of any alleged defect in the ABC geomembrane and to take appropriate steps to repair or replace the ABC geomembrane if a defect exists which is covered under this warranty. This Limited Warranty extends only to ABC's geomembrane, and does not extend to the installation service of ABC Geomembrane Company or third parties.

Any claim for any alleged breach of this warranty must be made in writing, by certified mail, to the President of ABC Geomembrane within ten (10) days of becoming aware of the alleged defect. Should the required notice not be given, the defect and all warranties are waived by the Purchaser, and Purchaser shall not have any rights under this warranty. ABC Geomembrane Company shall not be obligated to perform repairs or replacements under this warranty unless and until the area to be repaired or replaced is clean, dry, and unencumbered. This includes, but is not limited to, the area made available for repair and/or replacement of ABC geomembrane to be free from all water, dirt, sludge, residuals and liquids of any kind. If after inspection it is determined that there is no claim under this Limited Warranty, Purchaser shall reimburse ABC Geomembrane Company for its costs associated with the site inspection.

In the event the exclusive remedy provided herein fails in its essential purpose, and in that event only, the Purchaser shall be entitled to a return of the purchase price for so much of the material as ABC Geomembrane Company determines to have violated the warranty provided herein. ABC Geomembrane Company shall not be liable for direct, indirect, special, consequential or incidental damages resulting from a breach of this warranty including, but not limited to, damages for loss of production, lost profits, personal injury or property damage. ABC Geomembrane Company shall not be obligated to reimburse Purchaser for any repairs, replacement, modifications or alterations made by Purchaser unless ABC Geomembrane Company specifically authorized, in writing, said repairs, replacements, modifications or alteration in advance of them having been made. ABC Geomembrane Company's liability under this warranty shall in no event exceed the replacement cost of the material sold to the Purchaser for the particular installation in which it failed.

ABC Geomembrane Company neither assumes nor authorizes any person other than the undersigned of ABC Geomembrane Company to assume for it any other or additional liability in connection with the ABC geomembrane made on the basis of the Limited Warranty. The Limited Warranty on the ABC geomembrane herein is given in lieu of all other possible material warranties, either expressed or implied, and by accepting delivery of the material, Purchaser waives all other possible warranties, except those specifically given.

Limited Warranty is extended to the purchaser/owner and is non-transferable and non-assignable; i.e., there are no third-party beneficiaries to this warranty.

Purchaser acknowledges by acceptance that the Limited Warranty given herein is accepted in preference to any and other possible materials warranties.

ABC GEOMEMBRANE COMPANY MAKES NO WARRANTY OF ANY KIND OTHER THAN THAT GIVEN ABOVE AND HEREBY DISCLAIMS ALL WARRANTIES, BOTH EXPRESSED OR IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS IS THE ONLY WARRANTY THAT APPLIES TO THE MATERIALS REFERRED TO HEREIN AND ABC DISCLAIMS ANY LIABILITY FOR ANY WARRANTIES GIVEN BY ANY OTHER PERSON OR ENTITY, EITHER WRITTEN OR ORAL.

ABC GEOMEMBRANE COMPANY'S WARRANTY BECOMES AN OBLIGATION OF ABC GEOMEMBRANE COMPANY TO PERFORM UNDER THE WARRANTY ONLY UPON RECEIPT OF FINAL

I hereby state that I have read and understand the above and foregoing Limited Warranty and agree to such by signing hereunder.

DATE: _____

PURCHASER NAME: _____ ABC GEOMEMBRANE COMPANY: _____
(President or Authorized Representative)

SIGNATURE: _____ DATE _____ SIGNATURE: _____ DATE _____

TITLE: _____ Sworn before me this _____ day of _____ 200___

Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Properties, Testing Frequency and Recommended Warrant for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.

DIVISION 2: SITE CONSTRUCTION

SECTION 02726

TOPSOIL FOR RECLAIMED AREAS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes:

1. Strip and stockpile topsoil from areas within the work site and from other areas designated by the Owner.
2. Spread stockpiled topsoil on prepared reclaimed disturbed areas as designated by the Owner.

1.2 RELATED WORK

A. Section 02923: Seeding

PART 2: PRODUCT

2.1 TOPSOIL

A. Topsoil for reclaiming disturbed areas shall be developed from stripping of topsoil in the work areas or as designated by the Owner.

2.2 UNACCEPTABLE TOPSOIL MATERIALS

A. Subsoils (no B or C horizon soils)

B. Coarse sand and gravel

C. Stiff clay, hard clods or hard pan soils

D. Rock larger than 3-inch in any dimension

E. Trash, litter or refuse

F. Topsoil containing greater than 5 percent rock.

PART 3: EXECUTION

3.1 GENERAL REQUIREMENTS

A. Place topsoil just before seeding if it can be seeded within the upcoming fall seeding window.

B. Do not strip or handle topsoil when it is wet or frozen.

C. Work topsoil only when it can be left in a friable, loose and crumbly state.

D. On steep cut slopes requiring the placement of topsoil, it may be necessary to place the topsoil as the slope is constructed.

3.2 TOPSOIL STRIPPING

A. Strip the topsoil only from areas identified on the plans or approved by Owner.

B. Remove and dispose of any roots larger than 2-inches in diameter or 12-inches in length.

C. Stockpile stripped topsoil at locations acceptable to the Owner and so that placement or activity around the stockpile does not damage any existing trees or shrubs.

D. Grade to minimize erosion on and around the stockpiles.

3.3 SPREAD STOCKPILED TOPSOIL

A. Clear area to receive topsoil of all trash, debris, weeds, and rock 3-inch or larger, and dispose of objectionable material in an approved manner.

B. Place and spread the stockpiled topsoil over the prepared slopes to the plan depths. A minimum of 6-inches is required in all disturbed areas unless otherwise indicated on the Drawings.

C. Disc or harrow the prepared areas following topsoil placement. When discing or harrowing slopes, follow the contour to help prevent erosion.

D. Provide a crumbly soil texture.

3.4 COMPCATION

A. Cover soil has no compaction requirement.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02821

CHAIN-LINK FENCES AND GATES

PART 1: GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Galvanized steel chain-link fabric
2. Galvanized steel framework

1.2 SUBMITTALS

A. Product Data: Material descriptions, construction details, and dimensions of individual components and profiles.

B. Shop Drawings: Show locations of fence, each gate, posts, rails, and gate swing. Indicate materials, dimensions, size, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and detail of post anchorage and attachment and bracing.

C. Product Certificates: Signed by manufacturers of chain-link fences and gates certifying that products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fence and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of success in-service performance.

B. Source Limitations for Chain-Link Fences and Gates: Obtain each color, grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2: PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. Steel Chain-Link Fence Fabric: Height of 6 feet unless otherwise indicated on Drawings. Provide fabric fabricated in one-piece widths. Comply with CLFMI's "Product Manual" and with requirements indicated below:

1. Mesh and Wire Size: 2-inch mesh, 0.148-inch (nominal 9 gage) diameter.

2. Zinc-Coated Fabric: ASTM A 392, with zinc coating applied to steel wire mesh fabric after weaving with following minimum coating weight.
   a. Class 2: Not less than 2 oz./sq. ft. of uncoated wire surface.

2.2 INDUSTRIAL FENCE FRAMING

A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F 1083. Comply with ASTM F1043, Material Design Group 1A, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. zinc; and the requirements for heavy industrial fence.

B. End, Corner, and Pull Posts: 2.875 inch actual OD, Type I or II steel pipe.

C. Line and Intermediate Rails: 2.375 inch actual OD, Type I or II steel pipe.

D. Bottom Rails: 1.660 inch actual OD, Type I or II steel pipe. Fabricated in longest practical lengths available, with swedged-end or fabricated for expansion-type coupling, forming continuous rail along chain-link fabric.

E. Post Brace Rails: 1.660 inch actual OD, Type I or II steel pipe. Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.

2.3 TENSION WIRE

A. General: Provide horizontal tension wire extended along the top of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire complying with ASTM A 824 and the following.

1. Coating: Type II, zinc coated (galvanized) with the following minimum coating weight:
   a. Class 2: Not less than 1.2 oz./sq. ft. of uncoated wire surface.

2.4 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F900 for the swing-gate types indicated on the Drawings.

B. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1083 and ASTM F1043 for materials and protective coatings.

C. Frames: Fabricate members from either round galvanized steel tubing having minimum 1.90 inch actual OD, or 2 inch square steel tubing weighing 2.52 lb. per sq. ft.

1. Corner Construction: Welded

D. Braces: Diagonal cross-bracing of 5/16-inch-diameter, adjustable truss rods for panels 5 feet wide or wider.

E. Gate Posts: Fabricate members from round galvanized steel pipe with actual outside dimension and minimum weight for the following leaf widths:

1. Up to And Including 6 Feet: 2.875 inches, 4.64 lbs. per ft.
2. Over 6 Feet, Up To and Including 12 Feet: 4.0 inches, 8.65 lbs. per ft.
3. Over 12 Feet, Up To and Including 18 Feet: 6.625 inches, 18.02 lbs. per ft.
4. Over 18 Feet, Up To And Including 24 Feet: 8.625 inches, 27.12 lbs per ft.

F. Hardware: Provide galvanized hardware accessories for each gate according to the following:

1. Latches permitting operation from both sides of the gate, hinges, and, for each gate leaf more than 5 feet wide, keepers. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
2. Hinges: Size and material to suit gate size, offset to permit 180-degree gate opening. Provide 1-½ pair of hinges for each leaf over 6-foot nominal height.
3. Keeper: Provide a keeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.
4. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete and designed to engage a center drop rod or plunger bar. Include a locking device and padlock eyes as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

2.5 FITTINGS

A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

B. Post and Line Caps: Hot-Dip galvanized pressed steel or hot-dip galvanized cast iron. Provide weather tight closure for each post. Provide line post caps with loop to receive tension wire.

C. Rail and Brace Ends: Hot-Dip galvanized pressed steel or hot-dip galvanized cast iron. Provide rail ends or other means for attaching rails securely to each gate, corner, pull, and end post.

D. Rail Fittings: Rail Clamps: Hot-dip galvanized pressed steel. Provide line and corner boulevard clamps for connecting intermediate or bottom rails in the fence line to line posts.

E. Tension and Brace Bands: Hot-dip galvanized pressed steel.

F. Tension Bars: Hot-dip galvanized steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F 626:

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
   a. Hot-Dip Galvanized Steel: 0.106-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

2.6 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C150 Type II modified or Type V, aggregates complying with ASTM C 33, and potable water for ready-mixed concrete complying with ASTM C 94. Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94.

1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

PART 3: EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance. Do not begin installation before final grading is completed, unless otherwise permitted by Architect/Engineer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. General: Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soils.

C. Post Setting: Drill or hand excavate holes for post foundations in firm, undisturbed or compacted soil. Set terminal posts, corner posts, pull posts (bracing post), gate posts and line posts in concrete footings to required depths. Protect the portion of the post above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Verify placement and finishing operations until concrete is sufficiently cured.

D. Dimension and Profile: As indicated on Drawings.

E. Exposed Concrete and Footings: Extend concrete 1 inch above grade, smooth and shape to shed water.

3.4 CHAIN-LINK INSTALLATION

A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

B. Line Posts: Space line posts uniformly a 10 feet o.c., unless otherwise directed.

C. Post Bracing Assemblies: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate post and at both sides of corner and pull posts. Locate horizontal braces at mid-height of fabric on fences with top rail at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

D. Tension Wire: Install according to ASTM D 567, maintaining plumb position and alignment of fencing. Pull wire taught, without sags. Fasten fabric to tension wire with 0.120-inch hog rings of same material and finish as fabric wire, spaced at a maximum of 24-inches o.c. Install tension in wire in locations indicated before stretching fabric. Install tension wire through post cap loops.

E. Intermediate Rails: Install in one piece at post-height center span, spanning between posts, using fittings, special offset fittings, and accessories.

F. Bottom Rails: Install, spanning between posts, using fittings and accessories.

G. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taught and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15-inches o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing. Tie fabric to line posts 12 inches o.c. and to the braces 24 inches o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. General: Install Gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using temper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02923

SEEDING

PART 1: GENERAL

1.1 SUMMARY

A. This work shall consist of ground surface preparation; furnishing, applying and incorporating fertilizer into the soil; furnishing and planting seed; mowing; tracking; and cleanup. The work includes permanent seeding.

1.2 SUBMITTALS

A. Certificate of Indigenous Seed: Indigenous seeds are the seeds of those plants that are naturally adapted to an area where the intended use is for revegetation of disturbed sites. These species include grasses, forbs, shrubs and legumes. The Contractor must supply the Owner with all seed tags and a certification from the supplier stating that the seed complies with all Wyoming and federal seed laws.

1.3 DELIVERY AND STORAGE

A. Seed: Deliver seed in original sealed, labeled, undamaged containers.

PART 2: PRODUCTS

A. Indigenous Seed. All seed shall comply with and be labeled in accordance with the Wyoming and federal seed laws. Each container of indigenous seeds sold in this state for sowing purposes must bear a conspicuous, unaltered label or tag, plainly written or printed in English. Bulk sales must be accompanied by the required label information which must be given to the seed purchaser. The following information must be included on a label:

a. name and address of seed labeler;
b. lot number identification;
c. germination rate and date of germination test or a notation of the year for which the seed was packaged for sale;
d. state or country of origin; and,
e. seed kind or variety.

In addition to the required label information listed above, and any information required by rule established by the Department of Agriculture, the following information shall either be included on the label or provided to the Owner:

a. the statement "Labeled only for reclamation purposes":
b. the common name, genus, species and subspecies, when applicable, including the name of each kind of seed present in excess of 5%. When two or more kinds of seed are named on the label the label shall specify the percentage of each. When only one kind of seed is present in excess of 5% and no variety name or type designation is shown, the percentage must apply to seed of the kind named. If the name of the variety is given, the name may be associated with the name of the kind. The percentage in this case may be shown as "pure seed" and must apply only to the seed of the variety named;

c. the approximate percentage of viable seed, together with the date of test. When labeling mixtures, the percentage viability of each kind shall be stated;
d. the approximate percentage by weight of pure seed, meaning the freedom of seed from inert matter and from other seeds;
e. the approximate percentage by weight of sand, dirt, broken seeds, sticks, chaff and other inert matter;
f. the approximate total percentage by weight of other seeds;
g. the name and approximate number of each kind of species of prohibited and restricted noxious weed seeds occurring per pound of seed;
h. the full name and address of the person, firm or corporation selling the seed;

Seed shall contain no prohibited noxious weed seed. The seed shall contain no restricted noxious weed seed in excess of the maximum numbers per pound as specified by Wyoming statute or the appropriate County Weed Board, whichever is more stringent. The number of seed allowed per pound, for all other noxious weed seeds shown on the "restricted list" will be zero.

Seed shall be grown in the North American continent above 41 degrees north latitude. Known varieties whose origin is above the 41st parallel but grown below are acceptable. All seed shall be a standard grade adapted to Wyoming conditions. Seed which has become wet, moldy or otherwise damaged will not be accepted.

Calculations of pure live seed may be made on the basis of either a germination test or a tertrazolium test in addition to the purity analysis. Seed shall be applied on a pure live seed basis. The quantity of pure live seed in a 100 lb. container shall be determined by the formula: 100 multiplied by germination percentage and this product multiplied by the purity percentage. (For example, if the seed is 85% pure and test 90% germination, then a 100 lb. container would contain 76.5 lbs. of pure live seed.

When legumes are seeded, inoculants specified by the Special Provisions shall be used.

B. Water. Water used for seeding shall be of irrigation quality and free of impurities that would be detrimental to plant growth. Water shall be obtained in accordance with section 02339 -- WATERING.

PART 3: EXECUTION

A. General. Areas to be seeded shall be completed, in reasonable conformity, to specified line and grade prior to seeding and fertilizing and approved by the Owner.

Slopes and areas finished during the period of October 15 through April 30, depending on seeding zone, shall be topsoiled and permanently seeded within this time period. The Contractor must obtain Owner's permission to commence topsoil placement and seeding operations. Slopes and areas finished during the period May 1 through October 14 shall be topsoiled, and mulched or otherwise treated as specified. The permanent seeding of these areas shall then commence during the fall at a time approved by the Owner. The Contractor shall be required to mulch all permanently seeded topsoil area within 15 days of topsoil placement.

Application rates for permanent seeding are shown in the following table.

Pure Live Seed Kind	PLS (Pounds per Acre)
Western wheatgrass	4.0
Pubescent wheatgrass	3.2
Bozoisky Russian Wild Rye	3.2
Revenue Slender Wheatgrass	2.8
Intermediate Wheatgrass	2.8
Total	16.0

Seeding of the finished slopes shall require repeated seeding operations until approved by the Owner, and shall not be construed to mean that the required finishing, topsoiling, and seeding may be done only once at the convenience of the Contractor. Any additional move-in required will not be paid for separately as the cost thereof shall be absorbed in the Contract unit price for seeding.

It is necessary, insofar as practicable and feasible, as determined by the Owner, that the seedbed surface, at the time of application of seeds, not be excessively wet, snow-covered, or frozen. The soil surface should be prepared to provide an acceptable seedbed to a depth of 6" that is not compacted and reasonably free of large aggregates and surface crusts. The seedbed should be left in a relatively rough condition to reduce overland flow and promote the infiltration of water. All seedbed preparation operations shall be oriented across slope (i.e. along the contour). The Contractor shall treat such areas, as required by the Owner, to attain, as nearly as practicable, the condition described.

If seeding is hampered due to standing vegetation, the vegetation shall then be mowed and left lay after seeding. Mowing shall be done, where terrain permits, with equipment using a cutting blade which rotates in a plane parallel to the ground. Whether alive or dead, the vegetation shall be removed if it will prevent good seeding practice.

Excessively tight or compacted soils shall be loosened to the minimum depth of 6 inches. Discing, harrowing, or tilling shall be done along the contour, unless otherwise approved by the Owner. Compaction of the soil, when required, shall be performed by equipment which will produce a uniform rough textured surface ready for seeding and mulching. Compacting of loose soils may be required by the Owner.

Existing structures and facilities shall be adequately protected and any damage done by the Contractor shall be repaired or adjusted to the satisfaction of the Owner.

B. Seed Distribution

1. General. Seed shall be applied to the conditioned seedbed no longer than 48 hours after the seedbed has been conditioned. The preferred method of seeding will be by drill seeding with a rangeland drill. Custom seeders modified to handle native seed may also be appropriate, but must be approved by Owner. Alternative seeding methods (e.g. broadcast seeding) may be necessary for cover materials that have high content of rock fragments or on steep slopes.

   Broadcast or hydraulic seeding methods shall not be used during adverse weather as determined by the Owner.

   The applied seed, regardless of the method of application, shall not be covered by a soil thickness greater than ¼ inch in depth.

2. Seeding by Drill. Seeding equipment used for applying grass seed must be designed, modified or equipped to regulate the application rate and planting depth of grass seed. If equipment for sowing cover crop seed is not equipped with press wheels, the seed shall be compacted with a cultipacker immediately after the ground has been drilled. Seed must be uniformly distributed in the drill hopper during the drilling operation. Acceptable drills are: custom seeders, furrow drills, disc drills, no till drills or other drills approved by the Owner. All grass establishment equipment shall be operated normal to the slope drainage.

   Planting depth shall be regulated by depth bands or coulters. The drill box shall be partitioned by dividers no more than 24 inches apart, in order to provide for more even distribution on sloping areas. A drill shall be no wider than the width of the area over which it is to operate.

   The rows of planted seed shall be a maximum of 8 inches apart and shall run along the contour of the slope.

   The application rate may be reduced to half the broadcast seeding rate specified herein.

3. Broadcast Seeding. Seeding by hand or mechanical broadcasting will be permitted on areas inaccessible to drills or impractical to seed by other prescribed methods. Broadcast seeding requires the approval of the Owner. Broadcast seeding should be followed by a dragging operation (cyclone fence, chain, tires, etc.) to lightly cover seed with soil.

4. Hydraulic Seeding. When using the hydraulic seeding method, the Contractor must provide 1 pound of wood fiber or organic mulch per each 3 gallons of water in the hydraulic seeder as a cushion against seed damage. The mulch used as a cushion may be part of the total required mulch with the remainder applied after the seed is in place.

   When hydraulically applying mulch in a separate operation, the Contractor may mix the seed with the fertilizer if his hydraulic seeding equipment is capable of uniformly mixing water, fertilizer and seed – in that order – and power blowing or spraying the mixture uniformly over the seedbed. THIS OPTION MAY ONLY BE APPLIED ON SLOPES STEEPER THAN 2:1. After blending, the slurry shall be applied to the seedbed within 45 minutes after the seed has been added to the water/fertilizer mixture. If the slurry cannot be applied within the specified 45 minutes, it shall be fortified, at no cost to the Owner, with the correct ratio of seed to the remaining slurry and a new 45-minute time frame established for applying the fortified mixture.

   The Contractor will be required to use extension hoses to reach the extremities of slopes.

   The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow, or other acceptable means to remove the tracks.

C. Tracking. Tracking shall be accomplished using a tracked vehicle equipped with grousers sufficient to groove the surface to at least ½ inch. The tracking vehicle shall be operated so as to completely cover the surface with grouser marks. All grouser's marks shall run perpendicular to the natural slopes. The tracking vehicle shall be operated alternatively between forward and reverse on each pass to eliminate damage to the seedbed resulting from 180 degree skid turns.

   If the area is seeded by hydraulic methods, tracking of the slopes shall be done at such time when the surface has had sufficient time to dry. The length of time established will be at the discretion of the Owner.

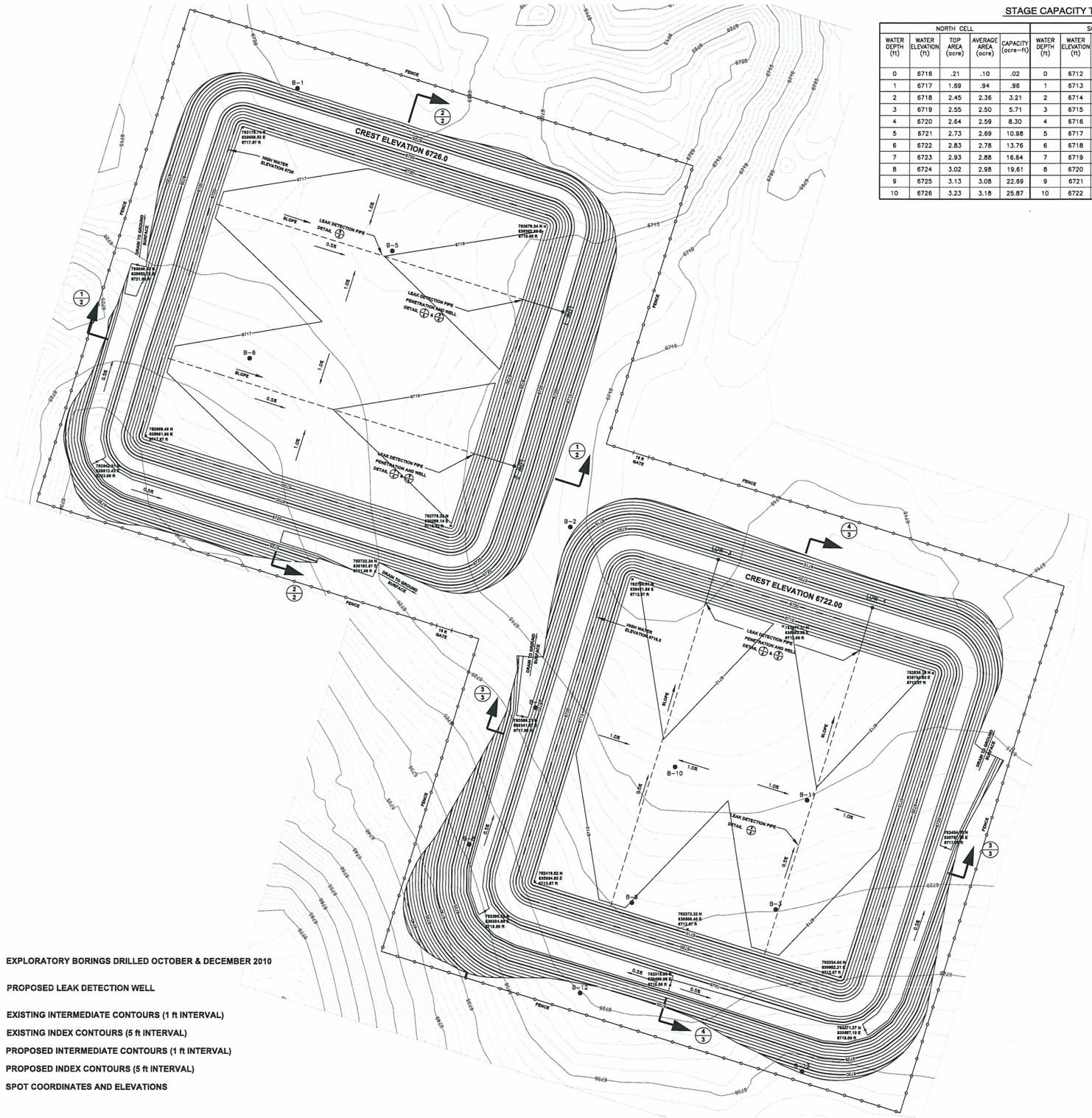
D. Owner Acceptance: The Contractor shall maintain and protect all planted areas until final acceptance. Final acceptance will not be made until an acceptable uniform stand of vegetation is

established. Upon acceptance by the Owner, the Owner will assume responsibility for maintenance.

Any portion of the areas of planting which fail to show a uniform stand of vegetation shall be replanted as before, except commercial fertilizer shall be applied at one-half the original rate. Planting shall be repeated until an acceptable stand of vegetation is provided.

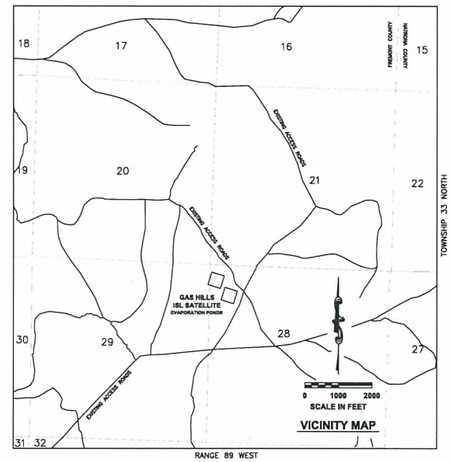
Contractor shall guarantee all work and materials for a period of one year after completion of the seeding work. During the guarantee period, vegetation which dies shall be replaced by and at the expense of the Contractor. Replacement made under the Contractor's guarantee shall be covered by a like guarantee for a period of one year after completion of the replacement.

END OF SECTION



STAGE CAPACITY TABLE

NORTH CELL					SOUTH CELL					TOTAL POND CAPACITY (BOTH CELLS) (acre-ft)	
WATER DEPTH (ft)	WATER ELEVATION (ft)	TOP AREA (acre)	AVERAGE AREA (acre)	CAPACITY (acre-ft)	WATER DEPTH (ft)	WATER ELEVATION (ft)	TOP AREA (acre)	AVERAGE AREA (acre)	CAPACITY (acre-ft)		
0	6716	.21	.10	.02	0	6712	.21	.10	.02	.05	
1	6717	1.69	.94	.96	1	6713	1.70	.94	.97	1.93	
2	6718	2.45	2.36	3.21	2	6714	2.45	2.36	3.21	6.42	SURGE STORAGE CAPACITY
3	6719	2.55	2.50	5.71	3	6715	2.55	2.50	5.71	11.42	
4	6720	2.64	2.59	8.30	4	6716	2.64	2.59	8.30	16.60	
5	6721	2.73	2.69	10.98	5	6717	2.73	2.69	10.99	21.97	
6	6722	2.83	2.78	13.76	6	6718	2.83	2.78	13.77	27.53	
7	6723	2.93	2.88	16.64	7	6719	2.93	2.88	16.65	33.29	FREE BOARD
8	6724	3.02	2.98	19.61	8	6720	3.02	2.98	19.62	39.24	
9	6725	3.13	3.08	22.69	9	6721	3.13	3.08	22.70	45.39	
10	6726	3.23	3.18	25.87	10	6722	3.23	3.18	25.87	51.74	



VICINITY MAP

NOTES:

1.1 THE PROPOSED CELLS AND HAVE BEEN DESIGNED BASED UPON INFORMATION PRESENTED IN THE GEOTECHNICAL ENGINEERING STUDY DATED DECEMBER 2010.

1.2 THESE PONDS ARE FOR EVAPORATION OF WATER FROM CAMECO RESOURCES GAS HILLS ISR SATELLITE PLANT. THIS WATER ENTERS THE POND THROUGH PIPING OVER THE EMBANKMENT. NORMAL OPERATING FREE BOARD IS 5 ft.

1.3 QUANTITIES: QUANTITIES ARE PROVIDED FOR THE BENEFIT OF THE WYOMING STATE ENGINEER. CONTRACTORS ARE RESPONSIBLE FOR THEIR OWN QUANTITY ESTIMATES.

CUT: 36,200 cubic yards
FILL: 27,500 cubic yards
TOPSOIL: 8,000 cubic yards

1.4 THE BASE MAP USED FOR THIS DESIGN WAS PREPARED FROM A SURVEY BY LADD ENGINEERING COMPANY IN NOVEMBER 2010. ALL COORDINATES ARE WYOMING STATE PLANE, FEET, ZONES, NAD27. ELEVATIONS ARE NGVD29.

1.5 ALL CUT/FILL SLOPES SHALL BE 3H:1V OR FLATTER FOR POND EMBANKMENTS.

LEGEND:

- EXPLORATORY BORINGS DRILLED OCTOBER & DECEMBER 2010
- PROPOSED LEAK DETECTION WELL (LDW-1)
- EXISTING INTERMEDIATE CONTOURS (1 ft INTERVAL)
- EXISTING INDEX CONTOURS (5 ft INTERVAL)
- PROPOSED INTERMEDIATE CONTOURS (1 ft INTERVAL)
- PROPOSED INDEX CONTOURS (5 ft INTERVAL)
- SPOT COORDINATES AND ELEVATIONS

NORTH

SCALE IN FEET
50 0 100

CERTIFICATE OF ENGINEER

STATE OF WYOMING)
COUNTY OF NATRONA) SS

I, JASON M. STRATTON, OF CASPER, WYOMING, HEREBY CERTIFIY THAT THE ACCOMPANYING MAP AND PLANS WERE PREPARED FROM A SURVEY OF THE PROJECT SITE BY LADD ENGINEERING COMPANY OF CASPER, WYOMING, ON NOVEMBER 2010 USING MY DESIGNS AND THAT THEY CORRECTLY REPRESENT THE PROPOSED WATER DISPOSAL FACILITY AND LOCATION DESCRIBED IN THE ACCOMPANYING APPLICATION.

3-02-11
DATE

Jason M. Stratton
JASON M. STRATTON
#8182

Professional Engineer (Civil) JASON M. STRATTON 8182 Date 3-11 Wyoming

REV.	DATE	DESCRIPTION	BY
0	1-11-11	DRAFT	JMS
1	3-02-11	ISSUED FOR CONSTRUCTION	JMS

PROJECT NO:	114-510339
DATE:	January 2011
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS / JRS / KMH / MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY: TT

MAP TO ACCOMPANY APPLICATION FOR:

SITE PLAN

EVAPORATION PONDS
GAS HILLS ISL SATELLITE
FREMONT COUNTY, WYOMING

PREPARED FOR:
CAMECO RESOURCES
550 N. POPLAR STREET, SUITE 100
CASPER, WYOMING 82601

SHEET NO.
1 of 4

NOTES:

2.1 FOR CLARITY, TOPSOIL STRIPPING, SCARIFICATION, AND TOPSOIL PLACEMENT ARE NOT SHOWN.

2.2 A MINIMUM THICKNESS OF 6 inches OF TOPSOIL SHALL BE STRIPPED FROM ALL CUT, FILL, AND BORROW AREAS, AND SHALL BE STOCKPILED AT LOCATIONS DESIGNATED BY THE OWNER.

2.3 ALL AREAS TO RECEIVE FILL SHALL BE SCARIFIED A MINIMUM DEPTH OF 6 inches, MOISTURE CONDITIONS, AND COMPACTED TO A MINIMUM DENSITY OF 95% OF MAXIMUM DRY DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698.

2.4 ALL FILL SHALL BE PLACED AND COMPACTED TO A MINIMUM OF 95% OF MAXIMUM DRY DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698.

2.5 ALL FILL SHALL BE PLACED IN LIFTS NOT EXCEEDING 9 inches COMPACTED THICKNESS AND SHALL HAVE UNIFORM MOISTURE CONTENT THROUGH THE ENTIRE THICKNESS OF THE LIFT. A SHEEP'S FOOT ROLLER SHALL BE USED FOR COMPACTION EXCEPT WHERE A SMOOTH FINISHED SURFACE IS REQUIRED.

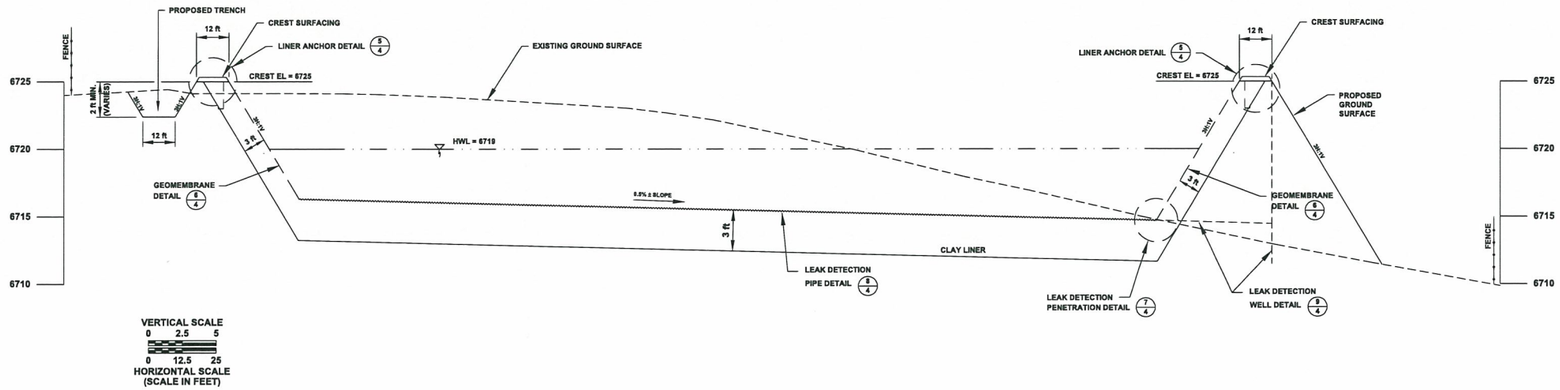
2.6 THE CLAY LINER SHALL BE CONSTRUCTED OF ON-SITE MATERIAL CLASSIFYING AS CL OR CH AND SHALL HAVE A MAXIMUM COEFFICIENT OF HYDRAULIC CONDUCTIVITY (kV) OF 1 X 10-7 cm/s WHEN COMPACTED. SELECTIVE EXCAVATION OF MATERIALS MAY BE REQUIRED. REFER TO THE GEOTECHNICAL REPORT DATED DECEMBER 2010.

2.7 THE GEOMEMBRANE LINER SHALL CONSIST OF 60 mil HDPE OVERLYING 40 mil HDPE. THE 60 mil HDPE LINER SHALL CONSIST OF AGRU DRAIN LINER, OR APPROVED EQUIVALENT, WITH TEXTURE ON THE UPPER SIDE AND 145 mil DRAINAGE STUDS ON THE LOWER SIDE. THE 40 mil HDPE SHALL HAVE TEXTURE ON BOTH SIDES.

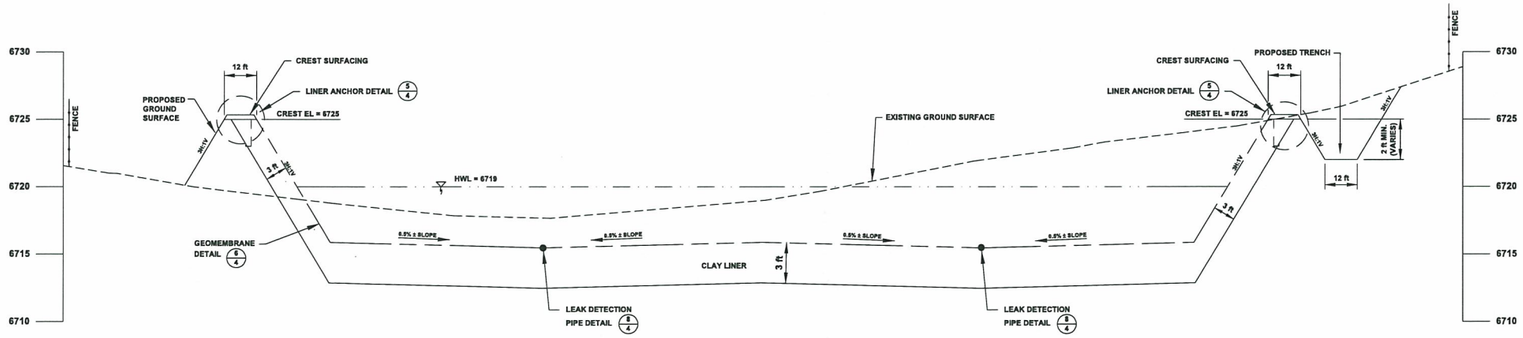
2.8 UPON COMPLETION OF CONSTRUCTION, A CONTINUOUS ROW OF UV RESISTANT SAND BAGS SHALL REMAIN IN PLACE ALONG THE TOE OF THE INTERIOR SLOPES.

2.9 THE CREST SHALL BE FINISHED WITH A 4 Inch THICK LAYER OF WYDOT GRADING " W" BASE COURSE GRAVEL WITH A FINISHED GRADE DRAINING TOWARDS THE POND AT A 0.5% SLOPE.

2.10 A MINIMUM OF 6 inches OF TOPSOIL SHALL BE PLACED OVER THE FINAL GRADE OF ALL CUT, FILL, AND BORROW AREAS EXCEPT THE POND CREST AND THE POND LINER. TOPSOIL SHALL BE FERTILIZED, HAY MULCHED, AND SEEDED.



1/2 CROSS SECTION



2/2 CROSS SECTION

REV.	DATE	DESCRIPTION	BY
0	1-11-11	DRAFT	JMS
1	3-02-11	DRAFT	JMS

PROJECT NO:	114-510339
DATE:	January 2011
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS / JRS / MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

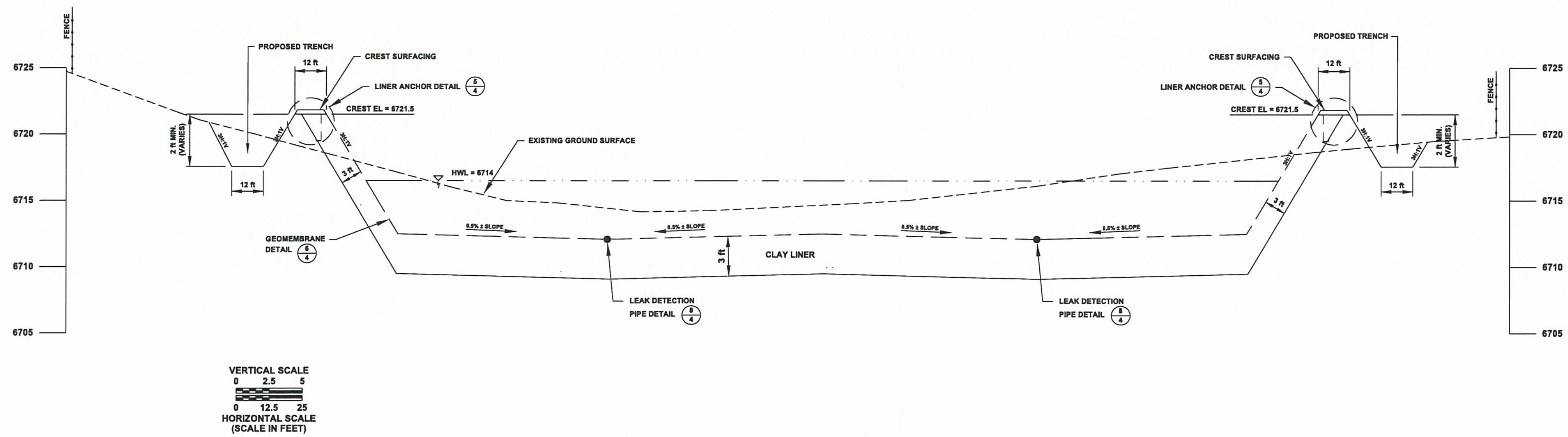
MAP TO ACCOMPANY APPLICATION FOR:

CROSS SECTIONS

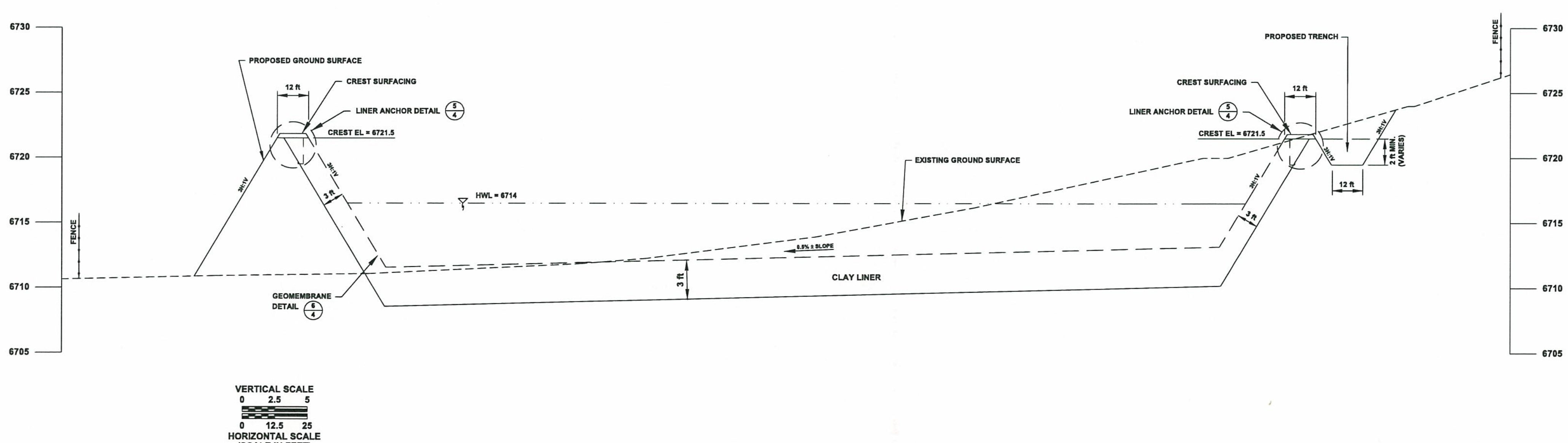
EVAPORATION PONDS
GAS HILLS ISL SATELLITE
FREMONT COUNTY, WYOMING

PREPARED FOR:
CAMECO RESOURCES
550 N. POPLAR STREET, SUITE 100
CASPER, WYOMING 82601

SHEET NO.
2 of 4



3/3 CROSS SECTION



4/3 CROSS SECTION

NOTES:

3.1 FOR CLARITY, TOPSOIL STRIPPING, SCARIFICATION, AND TOPSOIL PLACEMENT ARE NOT SHOWN.

REV.	DATE	DESCRIPTION	BY
0	1-11-11	DRAFT	JMS
1	3-02-11	DRAFT	JMS

PROJECT NO:	114-510339
DATE:	January 2011
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS / JRS / MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

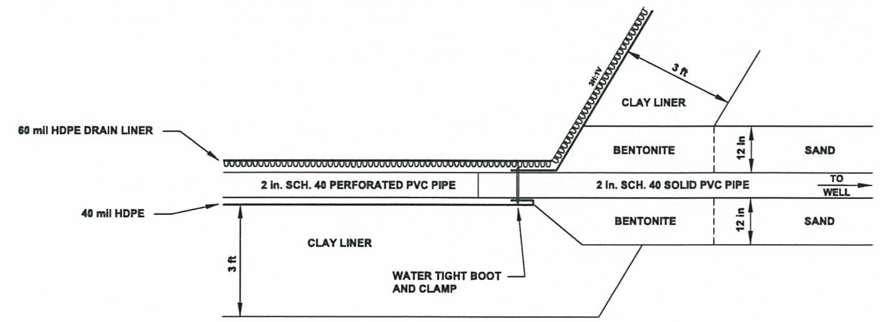
MAP TO ACCOMPANY APPLICATION FOR:

CROSS SECTIONS

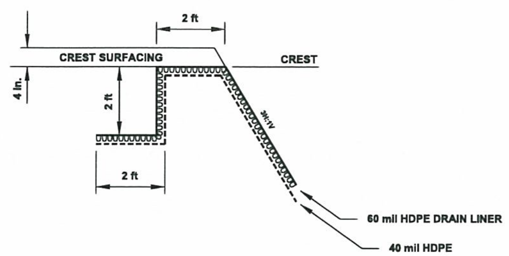
EVAPORATION PONDS
GAS HILLS ISL SATELLITE
FREMONT COUNTY, WYOMING

PREPARED FOR:
CAMECO RESOURCES
550 N. POPLAR STREET, SUITE 100
CASPER, WYOMING 82601

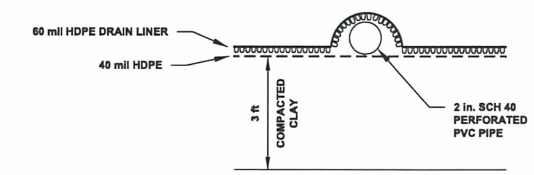
SHEET NO.
3 of 4



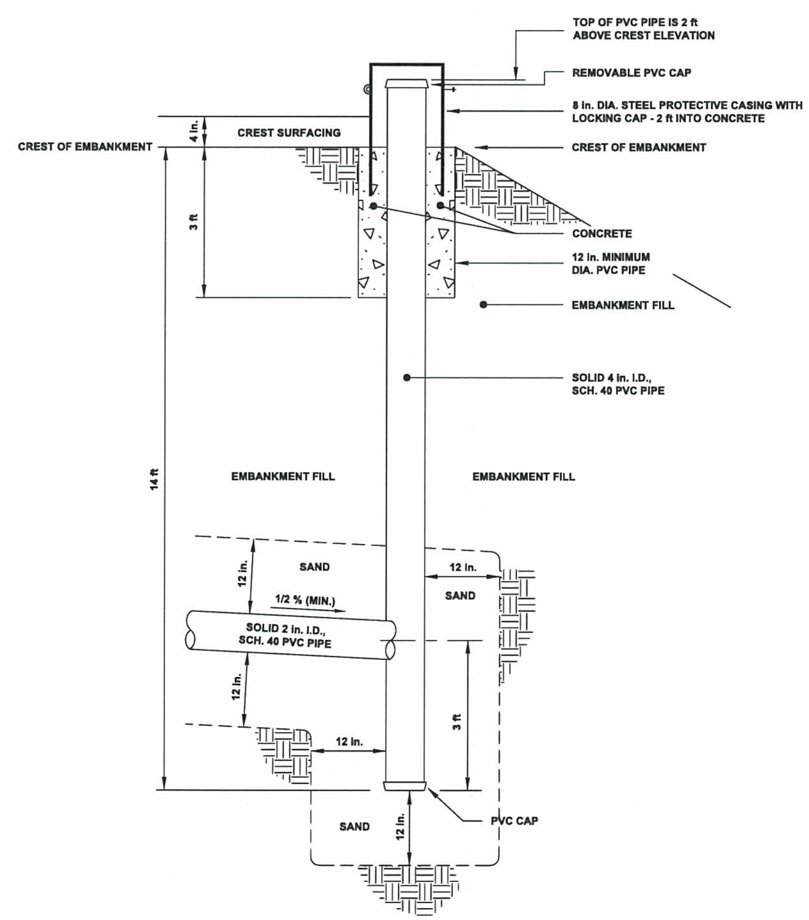
DETAIL (7/4) **LEAK DETECTION PIPE**
NOT TO SCALE
PENETRATION



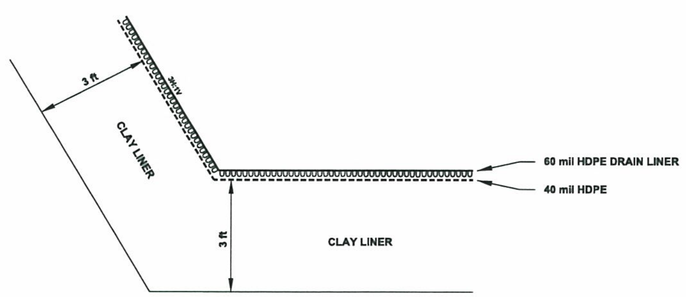
DETAIL (5/4) **LINER ANCHOR**
NOT TO SCALE
(TYPICAL)



DETAIL (8/4) **LEAK DETECTION PIPE**
NOT TO SCALE
(TYPICAL)



DETAIL (9/4) **LEAK DETECTION WELL**
NOT TO SCALE
(TYPICAL)



DETAIL (6/4) **GEOMEMBRANE LINER**
NOT TO SCALE
(TYPICAL)

NOTES:

4.1 PERFORATED PVC PIPE SHALL CONSIST OF FACTORY SLOTTED WELL SCREEN. SLOT SIZE SHALL BE 0.500 inch (0.020 TO 0.500 inch IS ACCEPTABLE). JOHNSON WELL SCREEN #OES40200 OR EQUIVALENT IS ACCEPTABLE.

4.2 BENTONITE SHALL CONSIST OF UNTREATED, SODIUM BENTONITE IN A GRANULAR OR CHIP FORM. BENTONITE SHALL HAVE A MAXIMUM SIZE OF 3/8 inch. A MINIMUM THICKNESS OF 12-inches OF BENTONITE SHALL BE PLACED AROUND THE PVC LEAK DETECTION PIPE AND SHALL EXTEND TO PROVIDE A POND SEAL FOR ALL PORTIONS OF THE CLAY LINER DISTURBED DURING INSTALLATION OF THE LEAK DETECTION SYSTEM.

4.3 SAND SHALL MEET ASTM C33 FINE AGGREGATE. SAND SHALL BE COMPACTED UTILIZING A SMOOTH PLATE VIBRATORY COMPACTOR.

4.4 WATER TIGHT BOOT AND CLAMPING SYSTEM SHALL BE PRE-APPROVED BY THE OWNER. A PREFABRICATION BOOT IS REQUIRED. ON-SITE FABRICATION IS NOT PERMITTED. THE BOOT/CLAMP SYSTEM SHALL CONSIST OF A MINIMUM OF TWO GASKETS AND CLAMPS FOR EACH BOOT AND SHALL BE DESIGNED TO NOT LEAK UNDER WATER PRESSURE HEAD OF 20 ft.

REV.	DATE	DESCRIPTION	BY
0	1-11-11	DRAFT	JMS
1	3-02-11	DRAFT	JMS

PROJECT NO:	114-510339
DATE:	January 2011
DESIGNED BY:	JMS/JRS
DRAWN BY:	JMS / JRS / MAT
CHECKED BY:	KET
APPROVED BY:	JMS

PREPARED BY:

MAP TO ACCOMPANY APPLICATION FOR:

DETAILS

EVAPORATION PONDS
GAS HILLS ISL SATELLITE
FREMONT COUNTY, WYOMING

PREPARED FOR:
CAMECO RESOURCES
550 N. POPLAR STREET, SUITE 100
CASPER, WYOMING 82601

SHEET NO.
4 of 4

Appendix F

Gas Hills Drainage Basin Hydrology

```
**********************************
*                                *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1)  *
*           MAY  1991            *
*         VERSION 4.0.1E         *
*    Lahey F77L-EM/32 version 5.01  *
*      Dodson & Associates, Inc.  *
*  RUN DATE 08/13/98  TIME  07:43:59  *
*                                *
**********************************
```

```
**********************************
*                                *
*  U.S. ARMY CORPS OF ENGINEERS  *
*  HYDROLOGIC ENGINEERING CENTER *
*        609 SECOND STREET       *
*     DAVIS, CALIFORNIA 95616    *
*        (916) 551-1748          *
*                                *
**********************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURES.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT


```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*** FREE ***
                *DIAGRAM
    1           ID   PRI GAS HILLS PERMIT APPLICATION
    2           ID   PMF EVALUATION FOR DIVERSION DITCH AND EVAP. PONDS
    3           ID   8/4/98  FILE: PRI-PMF.DAT
    4           IT      5     200
    5           IN     15
    6           IO      3       0       0
    7           JR   PREC    1.00
    8           PG  TYPEII
    9           PC      0     .17     .26     .32     .38     .42     .46     .49     .53     .56
   10           PC     .6     .63     .67      .7     .73     .77      .8     .83     .85     .88
   11           PC     .9     .93     .95     .98       1
   12           PG     HC   12.06

   13           KKB-1BASIN #1
   14           BA   .0598
   15           PR  TYPEII
   16           PW      1
   17           PT     HC
   18           PW      1
   19           LS      0    74.1       0
   20           UD     .1

   21           KKB-2BASIN #2
   22           BA   .0484
   23           LS      0    77.2       0
   24           UD    .11

   25           KK    C-1
   26           HC      2

   27           KKB-3BASIN #3
   28           BA   .0049
   29           LS      0    78.6       0
   30           UD     .1

   31           KK    C-2
   32           HC      2

   33           KKB-4BASIN #4
   34           BA   .0319
   35           LS      0      76       0
   36           UD    .14
   37           ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT
LINE (V) ROUTING (---->) DIVERSION OR PUMP FLOW

```
NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

 13   B-1BASIN
                .
                .
 21             .    B-2BASIN
                .          .
                .          .
 25          C-1.............
                .
                .
 27             .    B-3BASIN
                .          .
                .          .
 31          C-2.............
                .
                .
 33             .    B-4BASIN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                         *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)     *
*             MAY  1991                   *
*          VERSION 4.0.1E                 *
*     Lahey F77L-EM/32 version 5.01       *
*       Dodson & Associates, Inc.         *
*  RUN DATE  08/13/98  TIME  07:43:59     *
*****************************************

*****************************************
*                                       *
*     U.S. ARMY CORPS OF ENGINEERS      *
*     HYDROLOGIC ENGINEERING CENTER     *
*           609 SECOND STREET           *
*         DAVIS, CALIFORNIA 95616       *
*             (916) 551-1748            *
*                                       *
*****************************************

                    PRI GAS HILLS PERMIT APPLICATION
                    PMF EVALUATION FOR DIVERSION DITCH AND EVAP. PONDS
                    8/4/98  FILE: PRI-PMF.DAT

 6 IO        OUTPUT CONTROL VARIABLES
                 IPRNT          3  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL          0.  HYDROGRAPH PLOT SCALE

 5 IN        TIME DATA FOR INPUT TIME SERIES
                 JXMIN         15  TIME INTERVAL IN MINUTES
                 JXDATE     1 2 0  STARTING DATE
                 JXTIME         0  STARTING TIME

   IT        HYDROGRAPH TIME DATA
                 NMIN           5  MINUTES IN COMPUTATION INTERVAL
                 IDATE      1 2 0  STARTING DATE
                 ITIME       0000  STARTING TIME
                   NQ         101  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     1   0  ENDING DATE
                 NDTIME      0820  ENDING TIME
                 ICENT         19  CENTURY MARK

               COMPUTATION INTERVAL     0.08 HOURS
                   TOTAL TIME BASE      8.33 HOURS

     ENGLISH UNITS
          DRAINAGE AREA          SQUARE MILES
          PRECIPITATION DEPTH    INCHES
          LENGTH, ELEVATION      FEET
          FLOW                   CUBIC FEET PER SECOND
          STORAGE VOLUME         ACRE-FEET
          SURFACE AREA           ACRES
          TEMPERATURE            DEGREES FAHRENHEIT

 JP        MULTI-PLAN OPTION
               NPLAN          1  NUMBER OF PLANS

 JR        MULTI-RATIO OPTION
             RATIOS OF PRECIPITATION
           1.00

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          ***************
          *             *
 13 KK    *  B-1BASIN   *      #1
          *             *
          ***************
```

SUBBASIN RUNOFF DATA

14 BA SUBBASIN CHARACTERISTICS
TAREA 0.06 SUBBASIN AREA

PRECIPITATION DATA

17 PT TOTAL STORM STATIONS HC
18 PW WEIGHTS 1.00

15 PR RECORDING STATIONS TYPEII
16 PW WEIGHTS 1.00

19 LS SCS LOSS RATE
STRTL 0.70 INITIAL ABSTRACTION
CRVNBR 74.10 CURVE NUMBER
RTIMP 0.00 PERCENT IMPERVIOUS AREA

20 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 0.10 LAG

***

PRECIPITATION STATION DATA

STATION	TOTAL	AVG. ANNUAL	WEIGHT
HC	12.06	0.00	1.00

TEMPORAL DISTRIBUTIONS

STATION TYPEII, WEIGHT = 1.00

0.06	0.06	0.06	0.03	0.03	0.03	0.02	0.02	0.02	0.02
0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01								

UNIT HYDROGRAPH
8 END-OF-PERIOD ORDINATES

131. 194. 85. 33. 13. 5. 2. 1.

*** *** *** *** ***

HYDROGRAPH AT STATION B-1BASIN
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 12.06, TOTAL LOSS = 3.37, TOTAL EXCESS = 8.69

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	8.33-HR
+ (CFS)	(HR)					
		(CFS)				
+ 97.	0.50		56.	40.	40.	40.
		(INCHES)	8.647	8.688	8.688	8.688
		(AC-FT)	28.	28.	28.	28.

CUMULATIVE AREA = 0.06 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION B-1BASIN
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 12.06, TOTAL LOSS = 3.37, TOTAL EXCESS = 8.69

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	8.33-HR
+ (CFS)	(HR)					
		(CFS)				
+ 97.	0.50		56.	40.	40.	40.
		(INCHES)	8.647	8.688	8.688	8.688
		(AC-FT)	28.	28.	28.	28.

CUMULATIVE AREA = 0.06 SQ MI

*** ***

****

```
 21 KK    *              *
          *  B-2BASIN    *      #2
          *              *
          ****************

            SUBBASIN RUNOFF DATA

 22 BA        SUBBASIN CHARACTERISTICS
                 TAREA        0.05  SUBBASIN AREA

              PRECIPITATION DATA

 17 PT        TOTAL STORM STATIONS        HC
 18 PW                     WEIGHTS      1.00

 15 PR          RECORDING STATIONS     TYPEII
 16 PW                     WEIGHTS      1.00

 23 LS        SCS LOSS RATE
                 STRTL        0.59  INITIAL ABSTRACTION
                CRVNBR       77.20  CURVE NUMBER
                 RTIMP        0.00  PERCENT IMPERVIOUS AREA

 24 UD        SCS DIMENSIONLESS UNITGRAPH
                 TLAG        0.11  LAG

                                                                    ***

            PRECIPITATION STATION DATA

                  STATION     TOTAL     AVG. ANNUAL     WEIGHT
                       HC     12.06            0.00       1.00

            TEMPORAL DISTRIBUTIONS

            STATION   TYPEII,  WEIGHT =   1.00
                0.06      0.06      0.06      0.03      0.03      0.03      0.02      0.02      0.02      0.02
                0.02      0.02      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                0.01      0.01

                                                  UNIT HYDROGRAPH
                                               9 END-OF-PERIOD ORDINATES
                88.      154.       79.       32.       13.        5.        2.        1.        0.

              ***       ***        ***       ***       ***

                  HYDROGRAPH AT STATION B-2BASIN
                   FOR PLAN 1, RATIO = 1.00

          TOTAL RAINFALL =   12.06, TOTAL LOSS =    2.94, TOTAL EXCESS =    9.12

          PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR      8.33-HR
        +   (CFS)       (HR)
                                        (CFS)
        +     87.       0.50              47.          34.          34.          34.
                                      (INCHES)       9.068        9.121        9.121        9.121
                                      (AC-FT)          23.          24.          24.          24.

                  CUMULATIVE AREA =    0.05 SQ MI

              ***       ***        ***       ***       ***

                  HYDROGRAPH AT STATION B-2BASIN
                   FOR PLAN 1, RATIO = 1.00

          TOTAL RAINFALL =   12.06, TOTAL LOSS =    2.94, TOTAL EXCESS =    9.12

          PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR      8.33-HR
        +   (CFS)       (HR)
                                        (CFS)
        +     87.       0.50              47.          34.          34.          34.
                                      (INCHES)       9.068        9.121        9.121        9.121
                                      (AC-FT)          23.          24.          24.          24.

                  CUMULATIVE AREA =    0.05 SQ MI
```

```
25 KK      **********
           *        *
           *   C-1  *
           *        *
           **********

26 HC      HYDROGRAPH COMBINATION
             ICOMP        2  NUMBER OF HYDROGRAPHS TO COMBINE

HYDROGRAPH AT STATION      C-1
 FOR PLAN 1, RATIO = 1.00

  PEAK FLOW     TIME                    MAXIMUM AVERAGE FLOW
+   (CFS)       (HR)          6-HR        24-HR        72-HR       8.33-HR
                            (CFS)
+    184.       0.50          103.          74.          74.          74.
                  (INCHES)   0.835        8.882        8.882        8.882
                  (AC-FT)      51.          51.          51.          51.

CUMULATIVE AREA =    0.11 SQ MI

27 KK      **********
           *        *
           * B-3BASIN *      #3
           *        *
           **********

SUBBASIN RUNOFF DATA

28 BA      SUBBASIN CHARACTERISTICS
             TAREA        0.00  SUBBASIN AREA

           PRECIPITATION DATA

17 PT      TOTAL STORM STATIONS        HC
18 PW                WEIGHTS      1.00

15 PR        RECORDING STATIONS    TYPEII
16 PW                WEIGHTS      1.00

29 LS      SCS LOSS RATE
             STRTL        0.54  INITIAL ABSTRACTION
             CRVNBR      78.60  CURVE NUMBER
             RTIMP        0.00  PERCENT IMPERVIOUS AREA

30 UD      SCS DIMENSIONLESS UNITGRAPH
             TLAG         0.10  LAG

PRECIPITATION STATION DATA

          STATION    TOTAL    AVG. ANNUAL    WEIGHT
             HC      12.06        0.00         1.00

TEMPORAL DISTRIBUTIONS

STATION   TYPEII,  WEIGHT =   1.00
  0.06      0.06      0.06      0.03      0.03      0.03      0.02      0.02      0.02      0.02
  0.02      0.02      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
  0.01      0.01

                                UNIT HYDROGRAPH
                              8 END-OF-PERIOD ORDINATES
  11.       16.       7.        3.        1.        0.        0.        0.
```

```
                    HYDROGRAPH AT STATION B-3BASIN
                     FOR PLAN 1, RATIO = 1.00

   TOTAL RAINFALL =   12.06, TOTAL LOSS =    2.75, TOTAL EXCESS =    9.31

   PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR      72-HR      8.33-HR
 +   (CFS)      (HR)
                          (CFS)
 +      9.      0.50                  5.         4.         4.          4.
                        (INCHES)    9.258      9.313      9.313       9.313
                        (AC-FT)       2.         2.         2.          2.

                        CUMULATIVE AREA =     0.00 SQ MI

       ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION B-3BASIN
                     FOR PLAN 1, RATIO = 1.00

   TOTAL RAINFALL =   12.06, TOTAL LOSS =    2.75, TOTAL EXCESS =    9.31

   PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR      72-HR      8.33-HR
 +   (CFS)      (HR)
                          (CFS)
 +      9.      0.50                  5.         4.         4.          4.
                        (INCHES)    9.258      9.313      9.313       9.313
                        (AC-FT)       2.         2.         2.          2.

                        CUMULATIVE AREA =     0.00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  31 KK     *     C-2    *
            *            *
            **************

  32 HC         HYDROGRAPH COMBINATION
                    ICOMP             2   NUMBER OF HYDROGRAPHS TO COMBINE

                                                        ***
       ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION      C-2
                     FOR PLAN 1, RATIO = 1.00

   PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR      72-HR      8.33-HR
 +   (CFS)      (HR)
                          (CFS)
 +    193.      0.50                108.        78.        78.         78.
                        (INCHES)    8.854      8.900      8.900       8.900
                        (AC-FT)      53.        54.        54.         54.

                        CUMULATIVE AREA =     0.11 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  33 KK     * B-4BASIN   *      #4
            *            *
            **************

              SUBBASIN RUNOFF DATA

  34 BA         SUBBASIN CHARACTERISTICS
                    TAREA         0.03   SUBBASIN AREA

              PRECIPITATION DATA

  17 PT         TOTAL STORM STATIONS      HC
  18 PW                     WEIGHTS     1.00
```

```
15 PR          RECORDING STATIONS    TYPEII
16 PW                     WEIGHTS      1.00

35 LS        SCS LOSS RATE
                  STRTL         0.63  INITIAL ABSTRACTION
                  CRVNBR       76.00  CURVE NUMBER
                  RTIMP         0.00  PERCENT IMPERVIOUS AREA

36 UD        SCS DIMENSIONLESS UNITGRAPH
                  TLAG          0.14  LAG
```

***

PRECIPITATION STATION DATA

STATION	TOTAL	AVG. ANNUAL	WEIGHT
HC	12.06	0.00	1.00

TEMPORAL DISTRIBUTIONS

STATION TYPEII, WEIGHT = 1.00

0.06	0.06	0.06	0.03	0.03	0.03	0.02	0.02	0.02	0.02
0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01								0.01

UNIT HYDROGRAPH
10 END-OF-PERIOD ORDINATES

34.	85.	68.	31.	15.	7.	3.	2.	1.	0.

*** *** *** *** ***

HYDROGRAPH AT STATION B-4BASIN
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 12.06, TOTAL LOSS = 3.11, TOTAL EXCESS = 8.95

PEAK FLOW (CFS)	TIME (HR)		6-HR	24-HR	72-HR	8.33-HR
			MAXIMUM AVERAGE FLOW			
53.	0.58	(CFS)	30.	22.	22.	22.
		(INCHES)	8.887	8.954	8.954	8.954
		(AC-FT)	15.	15.	15.	15.

CUMULATIVE AREA = 0.03 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION B-4BASIN
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 12.06, TOTAL LOSS = 3.11, TOTAL EXCESS = 8.95

PEAK FLOW (CFS)	TIME (HR)		6-HR	24-HR	72-HR	8.33-HR
			MAXIMUM AVERAGE FLOW			
+ 53.	0.58	(CFS)	30.	22.	22.	22.
		(INCHES)	8.887	8.954	8.954	8.954
		(AC-FT)	15.	15.	15.	15.

CUMULATIVE AREA = 0.03 SQ MI

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 1.00
HYDROGRAPH AT +	B-1BASIN	0.06	1	FLOW	97.
				TIME	0.50
HYDROGRAPH AT +	B-2BASIN	0.05	1	FLOW	87.
				TIME	0.50

COMBINED AT					
	C-1	0.11	1	FLOW	184.
				TIME	0.50
HYDROGRAPH AT					
+	B-3BASIN	0.00	1	FLOW	9.
				TIME	0.50
2 COMBINED AT					
+	C-2	0.11	1	FLOW	193.
				TIME	0.50
HYDROGRAPH AT					
+	B-4BASIN	0.03	1	FLOW	53.
				TIME	0.50

*** NORMAL END OF HEC-1 ***

Basin B-3 PMF Hydrology

```
1*************************************
*                                   *
*   FLOOD HYDROGRAPH PACKAGE (HEC-1)  *
*             MAY  1991             *
*          VERSION 4.0.1E           *
*      Lahey F77L-EM/32 version 5.01  *
*        Dodson & Associates, Inc.    *
*  RUN DATE 09/16/99 TIME 14:07:28   *
*************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*        609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT


```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*** FREE ***
          *DIAGRAM
    1     ID   PRI GAS HILLS PERMIT APPLICATION
    2     ID   PMF EVALUATION FOR DIVERSION DITCH AND EVAP. PONDS
    3     ID  6 HOUR PMP
    4     ID  9/01/99 LIDSTONE AND ASSOCIATES, INC
    5     IT       3 10Jun99    1200     250
    6     IN       3
    7     IO       2

    8     KK   WCC-1BASIN-1
    9     PB   10.85
   10     PC  0.0000  0.0019  0.0037  0.0057  0.0076  0.0095  0.0115  0.0135  0.0156  0.0177
   11     PC  0.0198  0.0219  0.0241  0.0263  0.0285  0.0308  0.0331  0.0354  0.0377  0.0400
   12     PC  0.0422  0.0446  0.0470  0.0495  0.0521  0.0548  0.0576  0.0604  0.0634  0.0664
   13     PC  0.0695  0.0728  0.0761  0.0796  0.0831  0.0868  0.0905  0.0944  0.0984  0.1026
   14     PC  0.1070  0.1116  0.1164  0.1215  0.1267  0.1322  0.1379  0.1439  0.1503  0.1584
   15     PC  0.1682  0.1796  0.1928  0.2076  0.2242  0.2424  0.2688  0.3072  0.3575  0.4195
   16     PC  0.4933  0.5656  0.6281  0.6814  0.7257  0.7607  0.7866  0.8034  0.8130  0.8216
   17     PC  0.8298  0.8375  0.8448  0.8517  0.8581  0.8640  0.8695  0.8746  0.8793  0.8839
   18     PC  0.8883  0.8926  0.8968  0.9008  0.9047  0.9085  0.9122  0.9157  0.9191  0.9225
   19     PC  0.9257  0.9289  0.9320  0.9351  0.9380  0.9409  0.9437  0.9465  0.9491  0.9518
   20     PC  0.9544  0.9569  0.9595  0.9620  0.9645  0.9669  0.9693  0.9717  0.9741  0.9764
   21     PC  0.9787  0.9810  0.9832  0.9854  0.9876  0.9897  0.9918  0.9939  0.9960  0.9980
   22     PC  1.0000
   23     BA   2.37
   24     LS      0    87.6       0
   25     UD    .44
   26     ZZ
```

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  8       WCC-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
****************************************                 ****************************************
*                                      *                 *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                 *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991               *                 *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.0.1E            *                 *         609 SECOND STREET            *
*    Lahey F77L-EM/32 version 5.01     *                 *     DAVIS, CALIFORNIA 95616          *
*       Dodson & Associates, Inc.      *                 *         (916) 551-1748               *
*  RUN DATE 09/16/99  TIME 14:07:28    *                 *                                      *
****************************************                 ****************************************
```

```
                    PRI GAS HILLS PERMIT APPLICATION
                    PMF EVALUATION FOR DIVERSION DITCH AND EVAP. PONDS
                    6 HOUR PMP
                    9/01/99 LIDSTONE AND ASSOCIATES, INC

 7 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          2  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN           3  MINUTES IN COMPUTATION INTERVAL
                   IDATE    10Jun99  STARTING DATE
                   ITIME       1200  STARTING TIME
                      NQ        250  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     11  99  ENDING DATE
                  NDTIME       0027  ENDING TIME
                   ICENT         19  CENTURY MARK

           COMPUTATION INTERVAL   0.05 HOURS
                TOTAL TIME BASE  12.45 HOURS

       ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT
```

*** ***

```
        **************
        *            *
 8 KK   *   WCC-1    *     BASIN-1
        *            *
        **************

 6 IN        TIME DATA FOR INPUT TIME SERIES
                  JXMIN          3  TIME INTERVAL IN MINUTES
                  JXDATE   10Jun99  STARTING DATE
                  JXTIME      1200  STARTING TIME

         SUBBASIN RUNOFF DATA
```

23 BA SUBBASIN CHARACTERISTICS

TAREA 2.37 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 10.85 BASIN TOTAL PRECIPITATION

10 PI INCREMENTAL PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07
0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

24 LS SCS LOSS RATE

STRTL 0.28 INITIAL ABSTRACTION

CRVNBR 87.60 CURVE NUMBER

RTIMP 0.00 PERCENT IMPERVIOUS AREA

25 UD SCS DIMENSIONLESS UNITGRAPH

TLAG 0.44 LAG

***

UNIT HYDROGRAPH

46 END-OF-PERIOD ORDINATES

87.	280.	535.	882.	1334.	1804.	2163.	2380.	2456.	2445.
2317.	2135.	1926.	1659.	1348.	1098.	919.	769.	651.	554.
467.	388.	326.	273.	231.	191.	162.	134.	114.	95.
80.	67.	57.	48.	40.	33.	28.	25.	21.	18.
15.	12.	9.	7.	4.	1.				

HYDROGRAPH AT STATION WCC-1

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
10		1200	1	0.00	0.00	0.00	0.
10		1203	2	0.02	0.02	0.00	0.
10		1206	3	0.02	0.02	0.00	0.
10		1209	4	0.02	0.02	0.00	0.
10		1212	5	0.02	0.02	0.00	0.
10		1215	6	0.02	0.02	0.00	0.
10		1218	7	0.02	0.02	0.00	0.
10		1221	8	0.02	0.02	0.00	0.
10		1224	9	0.02	0.02	0.00	0.
10		1227	10	0.02	0.02	0.00	0.
10		1230	11	0.02	0.02	0.00	0.
10		1233	12	0.02	0.02	0.00	0.
10		1236	13	0.02	0.02	0.00	0.
10		1239	14	0.02	0.02	0.00	0.
10		1242	15	0.02	0.02	0.00	0.
10		1245	16	0.02	0.02	0.00	0.
10		1248	17	0.02	0.02	0.00	1.
10		1251	18	0.02	0.02	0.00	2.
10		1254	19	0.02	0.02	0.00	4.
10		1257	20	0.02	0.02	0.00	7.
10		1300	21	0.02	0.02	0.00	12.
10		1303	22	0.03	0.02	0.01	19.
10		1306	23	0.03	0.02	0.01	27.
10		1309	24	0.03	0.02	0.01	38.
10		1312	25	0.03	0.02	0.01	51.
10		1315	26	0.03	0.02	0.01	67.
10		1318	27	0.03	0.02	0.01	86.
10		1321	28	0.03	0.02	0.01	108.
10		1324	29	0.03	0.02	0.01	134.
10		1327	30	0.03	0.02	0.01	164.
10		1330	31	0.03	0.02	0.01	198.
10		1333	32	0.03	0.02	0.01	236.
10		1336	33	0.03	0.02	0.01	278.
10		1339	34	0.03	0.02	0.01	324.
10		1342	35	0.03	0.02	0.01	374.
10		1345	36	0.03	0.02	0.01	428.
10		1348	37	0.03	0.02	0.01	486.
10		1351	38	0.03	0.02	0.01	548.
10		1354	39	0.03	0.02	0.01	614.
10		1357	40	0.03	0.02	0.01	684.
10		1400	41	0.03	0.02	0.01	758.
10		1403	42	0.03	0.02	0.01	836.
10		1406	43	0.03	0.02	0.01	918.
10		1409	44	0.03	0.02	0.01	1004.
10		1412	45	0.03	0.02	0.01	1094.
10		1415	46	0.03	0.02	0.01	1188.
10		1418	47	0.03	0.02	0.01	1286.
10		1421	48	0.03	0.02	0.01	1388.
10		1424	49	0.03	0.02	0.01	1494.
10		1427	50	0.03	0.02	0.01	1604.
10		1430	51	0.03	0.02	0.01	1718.
10		1433	52	0.03	0.02	0.01	1836.
10		1436	53	0.03	0.02	0.01	1958.
10		1439	54	0.03	0.02	0.01	2084.
10		1442	55	0.03	0.02	0.01	2214.
10		1445	56	0.03	0.02	0.01	2348.
10		1448	57	0.03	0.02	0.01	2486.
10		1451	58	0.03	0.02	0.01	2628.
10		1454	59	0.03	0.02	0.01	2774.
10		1457	60	0.03	0.02	0.01	2924.
10		1500	61	0.03	0.02	0.01	3078.
10		1503	62	0.03	0.02	0.01	3236.
10		1506	63	0.03	0.02	0.01	3398.
10		1509	64	0.03	0.02	0.01	3564.
10		1512	65	0.03	0.02	0.01	3734.
10		1515	66	0.03	0.02	0.01	3908.
10		1518	67	0.03	0.02	0.01	4086.
10		1521	68	0.03	0.02	0.01	4268.
10		1524	69	0.03	0.02	0.01	4454.
10		1527	70	0.03	0.02	0.01	4644.
10		1530	71	0.03	0.02	0.01	4838.
10		1533	72	0.03	0.02	0.01	5036.
10		1536	73	0.03	0.02	0.01	5238.
10		1539	74	0.03	0.02	0.01	5444.
10		1542	75	0.03	0.02	0.01	5654.
10		1545	76	0.03	0.02	0.01	5868.
10		1548	77	0.03	0.02	0.01	6086.
10		1551	78	0.03	0.02	0.01	6308.
10		1554	79	0.03	0.02	0.01	6534.
10		1557	80	0.03	0.02	0.01	6764.
10		1600	81	0.03	0.02	0.01	6998.
10		1603	82	0.03	0.02	0.01	7236.
10		1606	83	0.03	0.02	0.01	7478.
10		1609	84	0.03	0.02	0.01	7724.
10		1612	85	0.03	0.02	0.01	7974.
10		1615	86	0.03	0.02	0.01	8228.
10		1618	87	0.03	0.02	0.01	8486.
10		1621	88	0.03	0.02	0.01	8748.
10		1624	89	0.03	0.02	0.01	9014.
10		1627	90	0.03	0.02	0.01	9284.
10		1630	91	0.03	0.02	0.01	9558.
10		1633	92	0.03	0.02	0.01	9836.
10		1636	93	0.03	0.02	0.01	10118.
10		1639	94	0.03	0.02	0.01	10404.
10		1642	95	0.03	0.02	0.01	10694.
10		1645	96	0.03	0.02	0.01	10988.
10		1648	97	0.03	0.02	0.01	11286.
10		1651	98	0.03	0.02	0.01	11588.
10		1654	99	0.03	0.02	0.01	11894.
10		1657	100	0.03	0.02	0.01	12204.
10		1700	101	0.03	0.02	0.01	12518.
10		1703	102	0.03	0.02	0.01	12836.
10		1706	103	0.03	0.02	0.01	13158.
10		1709	104	0.03	0.02	0.01	13484.
10		1712	105	0.03	0.02	0.01	13814.
10		1715	106	0.03	0.02	0.01	14148.
10		1718	107	0.03	0.02	0.01	14486.
10		1721	108	0.03	0.02	0.01	14828.
10		1724	109	0.03	0.02	0.01	15174.
10		1727	110	0.03	0.02	0.01	15524.
10		1730	111	0.03	0.02	0.01	15878.
10		1733	112	0.03	0.02	0.01	16236.
10		1736	113	0.03	0.02	0.01	16598.
10		1739	114	0.03	0.02	0.01	16964.
10		1742	115	0.03	0.02	0.01	17334.
10		1745	116	0.03	0.02	0.01	17708.
10		1748	117	0.03	0.02	0.01	18086.
10		1751	118	0.03	0.02	0.01	18468.
10		1754	119	0.03	0.02	0.01	18854.
10		1757	120	0.03	0.02	0.01	19244.
10		1800	121	0.03	0.02	0.01	19638.
10		1803	122	0.03	0.02	0.01	20036.
10		1806	123	0.03	0.02	0.01	20438.
10		1809	124	0.03	0.02	0.01	20844.
10		1812	125	0.03	0.02	0.01	21254.
10		1815	126	0.00	0.00	0.00	649.
10		1818	127	0.00	0.00	0.00	602.
10		1821	128	0.00	0.00	0.00	548.
10		1824	129	0.00	0.00	0.00	490.
10		1827	130	0.00	0.00	0.00	432.
10		1830	131	0.00	0.00	0.00	374.
10		1833	132	0.00	0.00	0.00	320.
10		1836	133	0.00	0.00	0.00	271.
10		1839	134	0.00	0.00	0.00	226.
10		1842	135	0.00	0.00	0.00	188.
10		1845	136	0.00	0.00	0.00	157.
10		1848	137	0.00	0.00	0.00	132.
10		1851	138	0.00	0.00	0.00	111.
10		1854	139	0.00	0.00	0.00	93.
10		1857	140	0.00	0.00	0.00	78.
10		1900	141	0.00	0.00	0.00	65.
10		1903	142	0.00	0.00	0.00	55.
10		1906	143	0.00	0.00	0.00	46.
10		1909	144	0.00	0.00	0.00	38.
10		1912	145	0.00	0.00	0.00	32.
10		1915	146	0.00	0.00	0.00	27.
10		1918	147	0.00	0.00	0.00	22.
10		1921	148	0.00	0.00	0.00	18.

10	1309	24	0.03	0.02	0.01	37.	*
10	1312	25	0.03	0.02	0.01	49.	*
10	1315	26	0.03	0.02	0.01	63.	*
10	1318	27	0.03	0.02	0.01	78.	*
10	1321	28	0.03	0.02	0.01	94.	*
10	1324	29	0.03	0.02	0.01	113.	*
10	1327	30	0.03	0.02	0.01	132.	*
10	1330	31	0.03	0.02	0.01	153.	*
10	1333	32	0.04	0.02	0.02	175.	*
10	1336	33	0.04	0.02	0.02	199.	*
10	1339	34	0.04	0.02	0.02	223.	*
10	1342	35	0.04	0.02	0.02	250.	*
10	1345	36	0.04	0.02	0.02	277.	*
10	1348	37	0.04	0.02	0.02	306.	*
10	1351	38	0.04	0.02	0.02	335.	*
10	1354	39	0.04	0.02	0.03	367.	*
10	1357	40	0.05	0.02	0.03	399.	*
10	1400	41	0.05	0.02	0.03	433.	*
10	1403	42	0.05	0.02	0.03	468.	*
10	1406	43	0.05	0.02	0.03	505.	*
10	1409	44	0.06	0.02	0.04	544.	*
10	1412	45	0.06	0.02	0.04	585.	*
10	1415	46	0.06	0.02	0.04	628.	*
10	1418	47	0.06	0.02	0.04	675.	*
10	1421	48	0.07	0.02	0.05	725.	*
10	1424	49	0.07	0.02	0.05	777.	*
10	1427	50	0.09	0.02	0.07	835.	*
10	1430	51	0.11	0.03	0.08	899.	*
10	1433	52	0.12	0.03	0.10	973.	*
10	1436	53	0.14	0.03	0.11	1062.	*
10	1439	54	0.16	0.03	0.13	1172.	*
10	1442	55	0.18	0.03	0.15	1309.	*
10	1445	56	0.20	0.03	0.17	1477.	*
10	1448	57	0.29	0.04	0.25	1686.	*
10	1451	58	0.42	0.05	0.37	1954.	*
10	1454	59	0.55	0.05	0.50	2304.	*
10	1457	60	0.67	0.05	0.63	2769.	*
10	1500	61	0.80	0.04	0.76	3392.	*
10	1503	62	0.78	0.03	0.75	4209.	*
10	1506	63	0.68	0.02	0.65	5225.	*
10	1509	64	0.58	0.02	0.56	6418.	*
10	1512	65	0.48	0.01	0.47	7732.	*
10	1515	66	0.38	0.01	0.37	9075.	*
10	1518	67	0.28	0.01	0.27	10333.	*
10	1521	68	0.18	0.00	0.18	11397.	*
10	1524	69	0.10	0.00	0.10	12184.	*
10	1527	70	0.09	0.00	0.09	12645.	*
10	1530	71	0.09	0.00	0.09	12759.	*
10	1533	72	0.08	0.00	0.08	12537.	*
10	1536	73	0.08	0.00	0.08	12023.	*
10	1539	74	0.07	0.00	0.07	11283.	*
10	1542	75	0.07	0.00	0.07	10395.	*
10	1545	76	0.06	0.00	0.06	9446.	*
10	1548	77	0.06	0.00	0.06	8502.	*
10	1551	78	0.06	0.00	0.05	7607.	*
10	1554	79	0.05	0.00	0.05	6787.	*
10	1557	80	0.05	0.00	0.05	6052.	*
10	1600	81	0.05	0.00	0.05	5406.	*
10	1603	82	0.05	0.00	0.05	4845.	*
10	1606	83	0.05	0.00	0.04	4360.	*
10	1609	84	0.04	0.00	0.04	3937.	*
10	1612	85	0.04	0.00	0.04	3567.	*
10	1615	86	0.04	0.00	0.04	3242.	*
10	1618	87	0.04	0.00	0.04	2957.	*
10	1621	88	0.04	0.00	0.04	2708.	*
10	1624	89	0.04	0.00	0.04	2491.	*
10	1627	90	0.04	0.00	0.04	2302.	*
10	1630	91	0.03	0.00	0.03	2136.	*
10	1633	92	0.03	0.00	0.03	1991.	*
10	1636	93	0.03	0.00	0.03	1864.	*

10	1924	149	0.00	0.00	0.00	15.
10	1927	150	0.00	0.00	0.00	13.
10	1930	151	0.00	0.00	0.00	11.
10	1933	152	0.00	0.00	0.00	9.
10	1936	153	0.00	0.00	0.00	7.
10	1939	154	0.00	0.00	0.00	6.
10	1942	155	0.00	0.00	0.00	5.
10	1945	156	0.00	0.00	0.00	4.
10	1948	157	0.00	0.00	0.00	3.
10	1951	158	0.00	0.00	0.00	2.
10	1954	159	0.00	0.00	0.00	2.
10	1957	160	0.00	0.00	0.00	1.
10	2000	161	0.00	0.00	0.00	1.
10	2003	162	0.00	0.00	0.00	1.
10	2006	163	0.00	0.00	0.00	0.
10	2009	164	0.00	0.00	0.00	0.
10	2012	165	0.00	0.00	0.00	0.
10	2015	166	0.00	0.00	0.00	0.
10	2018	167	0.00	0.00	0.00	0.
10	2021	168	0.00	0.00	0.00	0.
10	2024	169	0.00	0.00	0.00	0.
10	2027	170	0.00	0.00	0.00	0.
10	2030	171	0.00	0.00	0.00	0.
10	2033	172	0.00	0.00	0.00	0.
10	2036	173	0.00	0.00	0.00	0.
10	2039	174	0.00	0.00	0.00	0.
10	2042	175	0.00	0.00	0.00	0.
10	2045	176	0.00	0.00	0.00	0.
10	2048	177	0.00	0.00	0.00	0.
10	2051	178	0.00	0.00	0.00	0.
10	2054	179	0.00	0.00	0.00	0.
10	2057	180	0.00	0.00	0.00	0.
10	2100	181	0.00	0.00	0.00	0.
10	2103	182	0.00	0.00	0.00	0.
10	2106	183	0.00	0.00	0.00	0.
10	2109	184	0.00	0.00	0.00	0.
10	2112	185	0.00	0.00	0.00	0.
10	2115	186	0.00	0.00	0.00	0.
10	2118	187	0.00	0.00	0.00	0.
10	2121	188	0.00	0.00	0.00	0.
10	2124	189	0.00	0.00	0.00	0.
10	2127	190	0.00	0.00	0.00	0.
10	2130	191	0.00	0.00	0.00	0.
10	2133	192	0.00	0.00	0.00	0.
10	2136	193	0.00	0.00	0.00	0.
10	2139	194	0.00	0.00	0.00	0.
10	2142	195	0.00	0.00	0.00	0.
10	2145	196	0.00	0.00	0.00	0.
10	2148	197	0.00	0.00	0.00	0.
10	2151	198	0.00	0.00	0.00	0.
10	2154	199	0.00	0.00	0.00	0.
10	2157	200	0.00	0.00	0.00	0.
10	2200	201	0.00	0.00	0.00	0.
10	2203	202	0.00	0.00	0.00	0.
10	2206	203	0.00	0.00	0.00	0.
10	2209	204	0.00	0.00	0.00	0.
10	2212	205	0.00	0.00	0.00	0.
10	2215	206	0.00	0.00	0.00	0.
10	2218	207	0.00	0.00	0.00	0.
10	2221	208	0.00	0.00	0.00	0.
10	2224	209	0.00	0.00	0.00	0.
10	2227	210	0.00	0.00	0.00	0.
10	2230	211	0.00	0.00	0.00	0.
10	2233	212	0.00	0.00	0.00	0.
10	2236	213	0.00	0.00	0.00	0.
10	2239	214	0.00	0.00	0.00	0.
10	2242	215	0.00	0.00	0.00	0.
10	2245	216	0.00	0.00	0.00	0.
10	2248	217	0.00	0.00	0.00	0.
10	2251	218	0.00	0.00	0.00	0.

10	1639	94	0.03	0.00	0.03	1751.	*	10	2254	219	0.00	0.00	0.00	0.
10	1642	95	0.03	0.00	0.03	1651.	*	10	2257	220	0.00	0.00	0.00	0.
10	1645	96	0.03	0.00	0.03	1563.	*	10	2300	221	0.00	0.00	0.00	0.
10	1648	97	0.03	0.00	0.03	1483.	*	10	2303	222	0.00	0.00	0.00	0.
10	1651	98	0.03	0.00	0.03	1413.	*	10	2306	223	0.00	0.00	0.00	0.
10	1654	99	0.03	0.00	0.03	1349.	*	10	2309	224	0.00	0.00	0.00	0.
10	1657	100	0.03	0.00	0.03	1291.	*	10	2312	225	0.00	0.00	0.00	0.
10	1700	101	0.03	0.00	0.03	1238.	*	10	2315	226	0.00	0.00	0.00	0.
10	1703	102	0.03	0.00	0.03	1188.	*	10	2318	227	0.00	0.00	0.00	0.
10	1706	103	0.03	0.00	0.03	1143.	*	10	2321	228	0.00	0.00	0.00	0.
10	1709	104	0.03	0.00	0.03	1101.	*	10	2324	229	0.00	0.00	0.00	0.
10	1712	105	0.03	0.00	0.03	1062.	*	10	2327	230	0.00	0.00	0.00	0.
10	1715	106	0.03	0.00	0.03	1026.	*	10	2330	231	0.00	0.00	0.00	0.
10	1718	107	0.03	0.00	0.03	994.	*	10	2333	232	0.00	0.00	0.00	0.
10	1721	108	0.03	0.00	0.03	966.	*	10	2336	233	0.00	0.00	0.00	0.
10	1724	109	0.03	0.00	0.03	941.	*	10	2339	234	0.00	0.00	0.00	0.
10	1727	110	0.02	0.00	0.02	919.	*	10	2342	235	0.00	0.00	0.00	0.
10	1730	111	0.02	0.00	0.02	899.	*	10	2345	236	0.00	0.00	0.00	0.
10	1733	112	0.02	0.00	0.02	882.	*	10	2348	237	0.00	0.00	0.00	0.
10	1736	113	0.02	0.00	0.02	866.	*	10	2351	238	0.00	0.00	0.00	0.
10	1739	114	0.02	0.00	0.02	852.	*	10	2354	239	0.00	0.00	0.00	0.
10	1742	115	0.02	0.00	0.02	838.	*	10	2357	240	0.00	0.00	0.00	0.
10	1745	116	0.02	0.00	0.02	825.	*	11	0000	241	0.00	0.00	0.00	0.
10	1748	117	0.02	0.00	0.02	813.	*	11	0003	242	0.00	0.00	0.00	0.
10	1751	118	0.02	0.00	0.02	801.	*	11	0006	243	0.00	0.00	0.00	0.
10	1754	119	0.02	0.00	0.02	789.	*	11	0009	244	0.00	0.00	0.00	0.
10	1757	120	0.02	0.00	0.02	777.	*	11	0012	245	0.00	0.00	0.00	0.
10	1800	121	0.02	0.00	0.02	766.	*	11	0015	246	0.00	0.00	0.00	0.
10	1803	122	0.00	0.00	0.00	754.	*	11	0018	247	0.00	0.00	0.00	0.
10	1806	123	0.00	0.00	0.00	737.	*	11	0021	248	0.00	0.00	0.00	0.
10	1809	124	0.00	0.00	0.00	716.	*	11	0024	249	0.00	0.00	0.00	0.
10	1812	125	0.00	0.00	0.00	687.	*	11	0027	250	0.00	0.00	0.00	0.
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TOTAL RAINFALL = 10.85. TOTAL LOSS = 1.53. TOTAL EXCESS = 9.32

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
				6-HR	24-HR	72-HR	12.45-HR
+	(CFS)	(HR)					
			(CFS)				
+	12759.	3.50		2373.	1145.	1145.	1145.
			(INCHES)	9.309	9.319	9.319	9.319
			(AC-FT)	1177.	1178.	1178.	1178.

CUMULATIVE AREA = 2.37 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS. AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
					6-HOUR	24-HOUR	72-HOUR			
+	HYDROGRAPH AT	WCC-1	12759.	3.50	2373.	1145.	1145.	2.37		

*** NORMAL END OF HEC-1 ***

Appendix G

North Butte Road Design

TECHNICAL CONSTRUCTION SPECIFICATIONS AND CONSTRUCTION DRAWINGS

North Butte Access Road Design
North Butte Satellite Facility
Campbell County, Wyoming

For

Cameco

550 N. Poplar, Suite 100
Casper, Wyoming 82601

Prepared by:

TETRA TECH

605 N. Warehouse Road
Casper, Wyoming 82601

Contact:
Mr. Jason Stratton, P.E.
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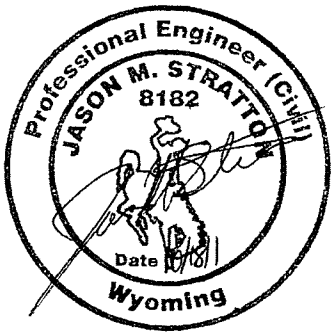


TABLE OF CONTENTS

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01009

GENERAL INFORMATION AND REQUIREMENTS

PART 1: GENERAL

1.1 SUMMARY

A. Purpose of Project: The purpose of this project is to construct a 20 ft wide road which includes removing 1 cattle guard, installing 1 cattle guard and installing 9 culverts. This project includes the construction of approximately 3 miles of roadway near North Butte in Campbell County, Wyoming.

B. Location: The project is located in Section 24 of Township 44 North, Range 76 West approximately 9 miles west of Highway 50 northwest off of Van Buggenum and Christensen Roads. The project site work locations are shown on the drawings.

C. Drawings: Detail the work required at each project location.

1.2 REFERENCES

A. Referenced Specifications/Standards with Abbreviations and/or Acronyms: Wherever the following acronyms are used in these specifications or on the drawings, they are to be construed the same as the respective expressions represented. Copies of the referenced specifications/ standards referred to herein may be procured by the Contractor, from the following:

AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken PA 19428-2959
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol St. between G and H St., NW Washington, DC 20402
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173
DOT	Department of Transportation 400 Seventh St., SW Washington, DC 2059
EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460

OSHA Occupational Safety and Health Administration
US Department of Labor
200 Constitution Ave., NW
Washington DC 20210

PCA Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077

WYDOT Wyoming Department of Transportation
5300 Bishop Blvd.
Cheyenne, WY 82009

1.3 DEFINITIONS

A. Approvals: Approval of submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After approval of an item, Contractor shall submit a substitute for approval when the approved item cannot be purchased or delivered in time to avoid delay in completion of the project.

1.4 SUBMITTALS

A. Scope: Submittals include design computations, shop drawings, manufacturers' literature, as-built drawings, samples, and maintenance manuals.

B. Requirements: Refer to specifications for submittals required. Allow at least 10 working days for review. Submittals shall be delivered to the Owner as designated in Section 01330, Submittal Procedures.

C. Identification of Submittals: Completely identify each submittal by showing at least the following information:
   1. Name and address of submitter, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number, and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.
   6. Submittal sequence number.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01011

DRAWINGS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes: List of drawings for construction of the North Butte Access Road.

1.2 QUALITY ASSURANCE

A. Inform the Owner of any discrepancies, errors, or omissions discovered on drawings in accordance Section 01009.

1.3 PROJECT CONDITIONS

A. Where there are minor differences as determined by the Owner between details and dimensions shown on drawings and details and dimensions of existing features at jobsite, use details and dimensions of existing features at jobsite.

1.4 COPIES OF DRAWINGS

A. The Contractor will furnish additional copies of drawings for performing work.

1.5 LIST OF DRAWINGS

A. Drawings listed in Table 01011A - List of Drawings, are made a part of these specifications.

Table 01011A - List of Drawings

Sheet No.	Sheet Title	Sheet Description
CIV-NB-C1.1	COVER SHEET	
CIV-NB-C1.2	GENERAL NOTES	TYPICAL SECTION AND GENERAL NOTES
CIV-NB-C1.3	GENERAL NOTES	RIPRAP DETAILS AND GENERAL NOTES
CIV-NB-C1.4 to CIV-NB-C1.13	PLAN AND PROFILE	STA 37+86.24 to STA 146+78.76
CIV-NB-C1.14 to CIV-NB-C1.20	CULVERT DETAILS	P-1 to P-7 PLAN & PROFILE
CIV-NB-C1.21	INTERSECTION	PLAN VIEW STATION 91+00

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

There are no applicable requirements.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01330

SUBMITTAL PROCEDURES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for submittals of the work schedules, earned value schedules, design computations, shop drawings, design drawings, scope of supply summaries, technical data, manufacturer's literature, and samples.

B. Requirements: Refer to specifications for submittals required. Allow 10 working days for Owner's review. Review time commences upon receipt by the Owner. Submittals shall be delivered to the Owner.

1.2 SUBMITTALS

A. Requirements: All shop drawings, samples and other submittals shall be submitted as required by the Contract. At a minimum, the following submittals shall be received and approved by the Owner prior to issuing a Notice to Proceed. As an aid to the Contractor the following submittals will be required. This list is not considered to be exhaustive and additional submittals may be requested by the Owner.
   1. Permits, by Contractor
   2. Health and Safety Plan
   3. Erosion Control Plan
   4. Dust Control Plan
   5. Traffic Control Plan
   6. Construction Plan
   7. Water Management Plan
   8. Water Pollution Prevention Plan
   9. Spill Prevention Control and Countermeasure Plan (SPCC)
   10. First Aid Plan
   11. Plan of Temporary Facilities

1.3 QUALITY ASSURANCE

A. Approval: Written approval of the submittals is an indication that the Contractor's submittals have been reviewed and that there are no objections, except as noted. Installation of material on the basis of written approval of submittals shall not relieve the Contractor of the responsibility for incorporating material which conforms to the requirements of the drawings and specifications. Written approval of deviations shall apply only to those deviations or omissions from the requirements of the drawings and specifications brought to the Owner's attention in writing. After written approval of an item, the Contractor may submit a substitution for approval, if the approved item cannot be purchased or delivered in time to avoid delay in completion of the project.

PART 2: PRODUCTS

There are no applicable requirements.

PART 3: EXECUTION

3.1 WORK SCHEDULE:

A. Requirements: The schedule shall be submitted 14 days after the pre-work conference. When requested, the Contractor shall submit an updated schedule within three working days. As a minimum, the estimated start and completion dates should be shown in the schedule.

3.2 VALUE SCHEDULE

A. Requirements: The Contractor shall prepare a value schedule for presentation 14 days after the pre-work conference.

3.3 DESIGN COMPUTATIONS

A. Requirements: The Contractor shall deliver to the Owner all of his complete design effort, including computations, quantities, specifications and working drawings necessary to construct, design, and bid all items required by the specification sections in this Contract. The Contractor shall provide enough time for reviews, revisions, and resubmittals so as to not delay the work. When submittals have received final written approval, the Contractor shall make distribution to the parties concerned.

3.4 SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

A. General: The Contractor shall deliver to the Owner the shop drawings and manufacturer's literature required by the specification sections in this Contract to the Owner.

B. Identification: When full catalogs or pages and tables are submitted, the specific items to be used on this project shall be circled, blocked in or underlined. Completely identify each submittal by showing the following information:
   1. Name and address of preparer, plus name and telephone number of the individual to contact for further information.
   2. Name of project as it appears in these specifications.
   3. Contract number, drawing number and specification section number to which the submittal applies.
   4. Whether this is an original submittal or re-submittal.
   5. Each item shall clearly note the manufacturer's name and address, trade name, product, lot, style, color, catalog designation or model number, and locations of use.

C. Substitutions: The Contractor shall present requests for substitutions to the Owner according to the following:
   1. Deliver sufficient calculations and data to justify selection of the proposed item and permit comparison with the original item.
   2. Show complete layout of system, except that which is identical to Contract documents, unless unchanged portion must be shown to indicate clearances.
   3. Include drawings, same (or larger) scale as Contract drawings, marked to show differences.
   4. Submit complete technical data including test data, drawings, manufacturer's literature, samples, and complete performance specifications.
   5. The Contractor is responsible for the cost of redesign and modifications to this or other parts of the project caused by the substitutions.

3.5 SAMPLES

A. Requirements:
   1. The Contractor shall deliver samples required by the specification sections in this contract. Submit samples with shop drawings when both are required.
   2. Each item shall clearly note the manufacturer, trade name, product, lot, style, color, model, locations of use and contract document reference.

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01458

TESTING LABORATORY SERVICES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: A qualified, Independent Testing Laboratory to conduct specific on-site tests including soil compaction testing.

1.2 SUBMITTALS

A. Test Reports: The Independent Testing Laboratory will provide 3 copies of test reports to the Owner. Reports will include testing facility name, address, telephone number, and names of responsible field technicians and field supervisor. Contractor shall submit test results of all Contractors' tests to Owner. Owner may witness Contractor's tests.

1.3 QUALITY ASSURANCE

A. Approval of Laboratory: The qualified, independent testing laboratory will have authority or be licensed to operate in the State in which the project is located. The testing laboratory will be retained by the Contractor and approved by the Owner prior to the Contractor beginning work.

B. Responsibilities of Laboratory:
   1. Test samples of materials submitted by the Contractor.
   2. Provide qualified personnel at project site. Cooperate with the Owner and Contractor in performance of services.
   3. Perform specified sampling and testing of products and materials in accordance with specified standards.
   4. Ascertain compliance of materials with requirements of specifications.
   5. Promptly notify the Owner and Contractor of observed irregularities or non-conformance of work, products, or materials.
   6. Perform additional tests required by the Owner.
   7. Attend preconstruction meetings and progress meetings.

C. Limitations on Laboratory:
   1. Laboratory may not release, revoke, alter, or enlarge on requirements of specifications.
   2. Laboratory may not approve or accept partial portions of the work.
   3. Laboratory may not assume duties of the Contractor unless approved in writing by the Owner.

1.4 SEQUENCING AND SCHEDULING

A. Establishing Testing Schedule:
   1. By advance discussion with the testing laboratory, the Owner and Contractor will determine the time required for the laboratory to perform its test and to issue its findings.
   2. Contractor shall provide required time within the construction schedule.

B. Revising Testing Schedule: When construction schedule changes are necessary during construction, Contractor shall coordinate such changes with the testing laboratory as required.

PART 2: PRODUCTS

2.1 REPORTS

A. Reports: Will include:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and specification sections.
   6. Location in the Project.
   7. Type of inspection or test.
   8. Date of test.
   9. Results of tests.
   10. Conformance with Contract Documents.

B. Interpretation: When requested by the Owner, provide interpretation of test results.

PART 3: EXECUTION

3.1 FIELD QUALITY CONTROL

A. Contractor Requirements: See individual specifications "Field Quality Control" paragraph for specific testing requirements. When applicable, the Contractor shall:
   1. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used which require testing.
   2. Cooperate with laboratory personnel, and provide access to the Work.
   3. Provide incidental labor and facilities:
      a. To obtain, handle, and label or identify samples at the site or at source of products and materials to be tested.
      b. To facilitate tests.
   4. Ensure samples are taken by qualified personnel.
   5. Coordinate the laboratory test frequency and timing with the Owner.
   6. Ensure Contractor supplied tests are completed according to the testing schedule.
   7. For Contractor supplied testing furnish verbal test reports prior to leaving the project site and submit written reports within 5 working days after tests have been completed.

B. Field Testing:

Item	Location	Reference	Frequency	Remarks
Subgrade	Fill Sections	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Base Course	Road Surface	ASTM D2922	500 cubic yards	Field Density and Moisture Content
Any Other Fill	Pipe Bedding, Grading, Culvert Backfill, Etc.	ASTM D2922	500 cubic yards	Field Density and Moisture Content

END OF SECTION

DIVISION 1: GENERAL REQUIREMENTS

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for temporary utilities for construction, temporary field office, first aid, sanitary facilities, vehicular access, temporary barriers and controls, and project identification.

1.2 DEFINITIONS

A. Landscape Preservation: The term "injury" includes, without limitation, bruising, scarring, tearing, and breaking of roots, trunks, or branches.

B. Pesticides: Include herbicides, insecticides, fungicides, rodenticides, piscicides, avicides, surface disinfectants, animal repellents, and insect repellents.

C. Security: "Restricted Area" means an area where entry will not be allowed unless authorized by the Owner.
   1. "Security Measures" means those measures contained in regulations or as may be established by the Owner and carried out by an Owner's guard system to provide continuous and effective security of restricted areas.

1.3 SUBMITTALS

A. Temporary Utilities: Submit three copies of the implementation and termination schedule for each utility; and three reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Air Quality: Submit three copies of Air Quality Permit for any activity for which an Air Quality Permit is required. Air Quality Permits are required for certain construction-related activities including, but not limited to, earthmoving, or other processes which discharge pollutants into the open air.

C. Water Management Plan: Submit three copies of a detailed Water Quality Management Plan to the Owner for review, approval, and use, for construction activities in the vicinity of any stream, flowing or dry watercourse, lake, wetland, reservoir, or underground water source. Include in the Water Quality Management Plan the following information:
   1. Name of the person who will be responsible for implementing and carrying out the plan.
   2. Relationship of the methods and descriptions herein to the conditions of required permits specified in article 1.6.
   3. Precautions which will be taken to avoid discharge or accidental spills of pollutants into a river, stream, watercourse, or lake.
   4. Demonstrated compliance with State and local waste disposal, sanitary sewer, or septic regulations.
   5. Methods of handling and treating wastewater, including drawings or maps indicating the locations for evaporation or settling ponds, treatment facilities, best management practices to prevent water pollution, and discharge points. Provide estimates of the amount of wastewater which may be handled and treated at each location.
   6. Methods for preventing or controlling runoff and erosion for all construction sites, both during and after construction, including:

a. Access and haul roads;
b. Stockpile, borrow, and waste areas;
c. Construction plant and equipment yards;
d. All excavated surfaces;
e. Areas containing slurry ponds or water treatment facilities;
f. Buffer zones; and
g. Other impacted areas.

7. Information on vegetative practices, structural control, silt fences, straw dikes, sediment and operator controls, stormwater controls, and solid waste controls. Stormwater controls shall address appropriate stormwater management measures including velocity dissipaters. Solid waste controls shall address controls for building materials and offsite tracking of sediment.

D. Water Pollution Prevention Plan: Submit three copies of a Water Pollution Prevention Plan to the Owner prior to the start of onsite construction work. Prepare a Pollution Prevention Plan as required by the stormwater permit for discharges from construction sites.

E. Spill Prevention Control and Countermeasure Plan (SPCC): Submit an SPCC Plan where the location of a construction site is such that oil from an accidental spillage could reasonably be expected to enter into or upon the navigable waters of the United States or adjoining shorelines, and the aggregate storage of oil at the site is over 1,320 gallons or a single container has a capacity in excess of 660 gallons. Submit the SPCC Plan to the Owner prior to delivery or storage of oil at the site. The Plan must have been reviewed and certified by a registered professional engineer in accordance with 40 CFR, part 112, as required by section 311 of the Clean Water Act (Public Law 92-500 as amended).

F. Sediment Control and Erosion Control Plan: Sediment control provisions shall be used to control silt in runoff whenever work is conducted adjacent to water courses. The purpose of these controls is to prevent pollution of waters of the state that may be caused by this project. If prevention is not possible, Contractor must implement best management practices (BMP) that minimize pollution from Contractor's operations.

Properly installed silt fences, sediment basins, and other approved sediment traps (staked straw bales, etc.) shall be used to implement these BMPs for all work, both during and after working hours. Contractor shall install all construction sediment control measures required by the Technical Specifications and Drawings. Contractor shall also comply with the substance of any permit requirements applicable to this work under state and federal law. If during construction Owner deems it necessary to install additional erosion control measures, these shall be installed by Contractor and paid for at the unit price(s) bid. Erosion control mat and straw or wood mulch shall be incorporated in site reclamation as specified.

Contractor shall submit an Erosion Control Plan for construction activities in accordance with the Submittals Section 01330. The plan shall be prepared to identify the general types of work and the types of BMPs anticipated for the entire project area. The plan shall be site specific and detail the locations and types of BMPs to be used during this project's construction activities. Information required in the plan includes, but is not limited to:

- A brief description of the project, types of work activities to be performed, and anticipated sources of sediment and erosion.
- BMPs for each work area to prevent erosion and provide sediment control. This information shall be accompanied by site sketches showing types and locations of BMPs.
- Erosion control practices for each type of work activity (i.e., stream reconstruction, Repository excavation, cover material placement, etc.). Practices shall be specific and appropriate for each activity.

G. Dust Control: Contractor shall be responsible for dust control during the Work. Contractor shall water or otherwise treat dust-generating surfaces as often as necessary to comply with all federal and state standards for airborne particulates. Prior to commencing any work, Contractor shall submit a written plan for dust control/abatement procedures, identifying at a minimum the following:

- Times and nature of dust generating activity on roads or at the project site;
- Nature of dust abatement measures to be used (i.e., watering or application of chemical treatment, etc.);
- Methods of application of dust control measures;
- Time schedule for application of dust control measures; and
- Procedures/availability of equipment to address dust control at other than scheduled times, if necessary.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with applicable local regulations for haul routes over public highways, roads, or bridges. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to the following:
   1. Building code requirements.
   2. Health and safety regulations.
   3. Utility company regulations.
   4. Police, fire department, and rescue squad rules.
   5. Environmental protection regulations.
   6. Prevention and control of air pollution.
   7. Prevention and control of water pollution.

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
   1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."

D. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 EXPLOSIVES

A. Explosives: Shall not be permitted.

1.6 PROJECT CONDITIONS

A. Access Routes: Rights-of-way for access to work from existing roads will be established by the Owner. Use only established roadways, areas, and haul routes, or temporary roadways, areas, or haul routes constructed by the Contractor when and as authorized by the Owner.

PART 2: PRODUCTS

2.1 UTILITIES

A. General: Telephone, internet service, sanitation, heat, and potable water are not available on the site and will be provided by the Contractor as needed.

2.2 MATERIALS

A. Plastic Safety Fencing: Orange plastic fencing, 4 ft minimum height.

B. Water: Provide potable water approved by local health authorities.

2.3 TOILET UNITS

A. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

2.4 PROJECT IDENTIFICATION

A. Project Site Sign: Not required.

B. Construction Signs: Only signs to expedite deliveries, maintain traffic flow, promote safety, and caution against danger shall be erected, as necessary.

PART 3: EXECUTION

3.1 INSTALLATION

A. Toilets: Install self-contained toilet units specified in Part 2 of this specification section. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
   1. Provide separate facilities for male and female personnel.
   2. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

B. First-Aid Facilities: Make first-aid facilities and services obvious and easily available for providing emergency aid to personnel on the site.

3.2 HAUL ROUTES, ROADWAYS, PARKING AREAS, AND STORAGE/STAGING AREAS

A. Examination: Investigate the condition of available public or private roads for clearances, restrictions, bridge-load limits, bond requirements, and other limitations that affect or may affect access and transportation operations to and from the jobsite.

B. Established Roadways as Haul Routes: Use existing roads as haul routes subject to the applicable local regulations and approval of the Owner. Tracked or heavy vehicles are allowed on dirt surfaced roads. Contractor is responsible for damage caused by construction traffic.
   1. Provide and use means of removing mud from vehicle tires before entering existing paved roads. Road repair and cleanup shall be at no cost to the Owner.
   2. Minimize interference with or congestion of local traffic.
   3. Provide barricades, flagpersons, lighting, signs, and other necessary precautions for safety of the public where haul routes cross public roads.

C. Temporary Roadways and Haul Routes: Construct and maintain temporary roadways, bridges, culverts, and drainage structures required for access to serve construction areas, of a width and load-bearing capacity to provide unimpeded traffic for construction purposes and to allow unimpeded surface drainage.
   1. After their completion, the roadways constructed under the contract will be reclaimed as directed by the Owner.
   2. Temporary roadways and detours may be constructed, as approved by the Owner or as indicated on the drawings.

D. Temporary Parking Areas: Construct temporary parking areas for construction operations personnel. Provide additional offsite parking when site space is not adequate. Locate as approved by the Owner.

E. Storage/Staging Areas: The Contractor may construct a temporary area for trailers, equipment, and materials, located as approved by the Owner. Fencing of materials or equipment shall not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Trailers, materials, or equipment shall not be placed or stored outside the area.

F. Maintenance: Maintain haul routes, roadways, parking and storage areas, in a sound, smooth condition. Maintain the surfacing of roads and areas until completion and acceptance of all the work under this contract. Maintain the surfacing of gravel-surfaced roads and areas in a smooth condition until completion and acceptance of all work under this contract. Snow removal for convenience of the Contractor or to facilitate work operations of the Contractor is considered to be normal required maintenance and at contractor's expense.

G. Repair: Promptly repair ruts, potholes, low areas with standing water, and other deficiencies to maintain road and parking area surfaces and drainage in original or specified condition.

H. Removal: Remove materials used to construct temporary roadways, areas, and haul routes prior to contract completion.

3.3 AIR POLLUTION CONTROL

A. Air Quality Permits: As may be generally required by regulatory agencies for construction. Owner will provide information regarding any project specific Air Quality Permits.

B. Responsibility: Contractor shall be responsible for damages resulting from dust originating from Contractor operations.
   1. Owner may stop any construction activity contributing to air pollutant levels which are excessive or in violation of Federal, State, or local laws and additional expenses resulting from work stoppage will be responsibility of Contractor.

C. Requirements: Utilize such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.

   1. Do not operate equipment and vehicles that show excessive emissions of exhaust gases until corrective repairs or adjustments reduce such emissions to acceptable levels.

   2. Provide dust control and abatement during construction. Prevent, control, and abate dust pollution on rights-of-way provided by Owner or elsewhere during performance of work. Provide labor, equipment, and materials, and use efficient methods wherever and whenever required to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic, and similar conditions.

   3. Provide means for eliminating atmospheric discharges of dust during mixing, handling, and storing of cement, pozzolan, and concrete aggregate.

   4. Burning shall not be allowed.

3.4 WATER POLLUTION CONTROL

A. Contractor Water Pollution Violations: If noncompliance should occur, report the noncompliance to the Owner immediately (orally), with the specific information submitted in writing within 2 calendar days. Consistent violations of applicable Federal, State, or local laws, orders, regulations, or Water Quality Standards may result in the Owner stopping all site activity until compliance is ensured. The Contractor shall not be entitled to any extension of time, claim for damage, or additional compensation by reason of such a work stoppage. Corrective measures required to bring activities into compliance shall be at the Contractor's expense.

B. Wetlands: The Owner has made notification to the U.S. Army Corps of Engineers under *Nationwide Permit #12, Utility Line Activities*, for culvert crossings.

C. Stormwater Discharge Permit Associated With a Construction Site:

1. Notice of Intent: Both the Owner and the Contractor shall sign the Notice of Intent (NOI) to obtain coverage under a stormwater general permit to control stormwater discharges from the construction site as required under section 402 of the Clean Water Act (Public Law 92-500, as amended). Contractor shall prepare and submit permit application and have responsibility to obtain permit. Costs associated with permit are incidental to the work and at the Contractor's expense.

2. Pollution Prevention Plan: The Contractor shall prepare a Pollution Prevention Plan as required by the permit. The Contractor shall comply with all terms and conditions to obtain and maintain this stormwater discharge permit.

3. Monitoring and Water Treatment: Contractor shall provide all monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards, and provide the recordkeeping required by the stormwater discharge permit associated with construction activity.

F. Pollution Controls: Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including State and local control requirements.

1. Sediment and Erosion Controls: Establish methods for controlling sediment and erosion which address vegetative practices, structural control, silt fences, straw dikes, sediment controls, and operator controls as appropriate. Institute stormwater management measures as required, including velocity dissipaters, and solid waste controls which address controls for building materials and offsite tracking of sediment.

2. Wastewater and Stormwater Management Controls: Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and erosion, and which will intercept and settle any runoff of sediment-ladened waters. Prevent wastewater from general construction activities such as drainwater collection, aggregate processing concrete batching, drilling grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods. Divert stormwater runoff from upslope areas away from disturbed areas.

a. Turbidity prevention measures: Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life. All such wastewaters discharged into surface waters shall contain the least concentration of settleable material possible and shall meet all conditions of section 402, the

National Pollutant Discharge Elimination System (NPDES) permit. Do not operate mechanized equipment in waterbodies without having first obtained a section 404 permit, and then only as necessary to construct crossings or perform the required construction.

3. Construction Site Management: Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources. Such pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, mineral salts, and thermal pollution.
   a. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff, or can in any way encroach upon the watercourse.
   b. Place all oil or other petroleum product (hereinafter referred to collectively as oil) storage tanks at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.
   c. Diked storage areas shall be at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to the capacity of all tanks and/or containers located in each area plus a sufficient amount of freeboard to contain the 25-year rainstorm.
   d. Provide diked areas with an impermeable barrier at least 10 mils thick. Provide areas used for refueling operations with an impermeable liner at least 10 mils thick buried under 2 to 4 inches of soil.
   e. Do not use underground storage tanks.

3.5 PEST CONTROL

A. Requirements: Comply with manufacturer's labeling as to handling and application.

B. Records: Keep records of types and amounts of pesticides purchased, delivered, stored, mixed, and actually used and means of disposal of excess pesticide. Keep records current and accurate and make available for review by Owner.

3.6 SECURITY MEASURES

A. Requirements: Protect the site, materials, and operations from theft, vandalism, and unauthorized entry. Initiate program in coordination with Owner's existing program at project site. Maintain program throughout construction period until Owner's acceptance.

B. Entry Control: Restrict entrance of persons and vehicles into the project site and existing facilities. These restricted areas are designated and may be modified or changed by the Owner. Allow entrance only to authorized persons with proper identification.
   1. Maintain log of workers and visitors, make available on request.
   2. Restricted Areas: Construction personnel will not be permitted to enter established or designated restricted areas unless so authorized by the Owner. It shall be the Contractor's responsibility to ensure by appropriate and effective means that contractor's personnel shall not enter these areas unless authorized.

3.7 MAINTENANCE AND REMOVAL

A. Maintenance: Maintain temporary structures, facilities, and controls as long as needed for safe and proper completion of the work and as directed by the Owner.

B. Removal: Remove temporary structures, facilities, and controls as rapidly as progress of the work will permit and as approved by the Owner.

3.8 PROTECTION

A. Barriers: Provide earthen embankments and similar barriers around excavation and subgrade construction, sufficient to prevent flooding by runoff from heavy rains.

3.9 WASTE

A. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately form other waste by containerizing properly. Dispose of material lawfully.

3.10 CLEANUP

A. Requirements: Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

B. Restoration of Storage Area: Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used by the Contractor for the storage of equipment or material, or other use, to the original or better condition. Remove gravel used for surfacing and restore the area to its original condition, including top soil and seeding as necessary.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02231

CLEARING AND GRUBBING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Clearing of vegetation, and grubbing of stumps, roots, and debris; disposal of unutilized materials; and other incidental work related to preparing the site for later use.

1.2 DEFINITIONS

A. Clearing: Clearing shall consist of the trimming and cutting of obstructions and the satisfactory disposal of surface vegetation designated for removal including brush and rubbish occurring in the areas to be cleared.

B. Grubbing: Grubbing shall consist of the removal and disposal of below-surface stumps, roots larger than 3-inches in diameter, and matted roots from the designated grubbing areas.

C. Hazardous Waste: Substance likely to cause death or injury by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful; and includes, but is not limited to flammable dust, flammable fiber, combustible liquid, dangerous chemical, flammable gas, liquified flammable gas, and flammable liquid.

1.3 PROJECT/SITE CONDITIONS

A. Work Limits: As indicated on Project Drawings.

B. Burning: Shall not be permitted.

C. Landscape Preservation: Protect vegetation outside the work limits from injury. Existing brush and shrubs shall not be disturbed or damaged.

1.4 SUBMITTALS

A. None

PART 2: PRODUCTS

2.1 PREPARED PRODUCTS

A. No products, as such, are listed in this section of the specifications. It is however, the responsibility of the Contractor to supply all products to comply with this section of the specifications.

PART 3: EXECUTION

3.1 PROTECTION

A. Existing Facilities: Protect existing facilities from damage. Notify the Owner immediately of damage to any existing facility. The contractor shall be responsible for the repairs of damage to any existing facility.

B. Utility Lines: Protect existing utility lines that are indicated to remain from damage. Notify the Owner immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to the start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Owner at least 72 hours prior to interruption of the service.

3.2 CLEARING

A. Requirements: Contractor shall remove only those trees, large shrubs and bushes designated by the Owner for removal. Clear stumps, roots, brush, and other vegetation in areas to be graded, cut off flush with or below the original ground surface, except such vegetation indicated or directed to be left standing. Vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of existing obstructions that obtrude, encroach upon, or otherwise obstruct the work.

B. Road Improvements and Construction: The existing vegetation that is cleared and grubbed for road improvement and construction shall stockpiled in designated areas. For permanent roads, salvaged material shall be placed back onto cut/fill slopes outside the traveled roadway. For reclaimed roadways, salvaged material shall be spread evenly over the reclaimed area.

3.3 GRUBBING

A. Requirements: Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

3.4 EXPLOSIVES

A. Requirements: The use of explosives is prohibited.

3.5 DISPOSAL

A. Requirements: Material that is not to be salvaged shall be deposited as directed by the Owner.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02315

EXCAVATION AND FILL

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, borrow excavation, embankment construction, placement, and disposal of materials as shown on the drawings.

B. Related Sections

1. General Information and Requirements	Section 01009
2. Testing Laboratory Services	Section 01458
3. Clearing and Grubbing	Section 02231
4. Watering	Section 02339

1.2 DEFINITIONS

A. Unclassified Excavation: Consists of the material excavation and placement regardless of its nature.

B. Rock Excavation: Removal of material is rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of [195] net horsepower, with a rear-mounted, heavy-duty, single-tooth, ripping attachment.

C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 195 net horsepower or less shall be considered common excavation.

D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

E. Fill Material: Shall be mineral soil free from peat, topsoil, frozen material, brush, trees, roots over 2 inches in diameter and rocks over 6 inches in greatest diameter obtained from site during excavation.

F. Topsoil: Surface soil approximately 6 inches in depth, unless otherwise specified, that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch in diameter.

1.3 PROJECT/SITE CONDITIONS

A. Excess Material: Usable excess material excavated shall be used in the road subgrade construction before the use of borrow is allowed. Borrow wasting is not permitted.

C. Fencing: When fencing or cattle guards are removed the Contractor shall be responsible for the confinement of livestock with temporary fencing.

D. Drainage of Borrow Pits: Borrow pits and waste or disposal areas shall be excavated so that water will not collect and stand.

E. Calculation of percent shrinkage/swell to be established by Contactor at Contractor's risk and shall not be the basis of any extra work claim.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: See definitions.

B. Fill Material: Shall be obtained from the common cut areas. Material from the cut areas shall be used unless it contains ice or frozen earth, debris, high moisture content, or is specified in other sections to be replaced. Materials removed in clearing and grubbing shall not be used for backfill or embankment.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing and Grubbing: Section 02231 - Clearing and Grubbing.

B. Borrow Area: No borrow areas are anticipated.

C. Prewatering: Excavation areas and borrow pits may be prewatered before excavating the material. The area to be excavated shall be moistened to the full depth from the surface to the bottom of the excavation. The application of water shall be controlled so that the excavated material will be near the optimum moisture content as specified in paragraph 3.3A Testing, below. When necessary, prewatering shall be supplemented to assure that fill material and backfill material moisture content comply with paragraph 3.3A Testing, below.

D. Preparation for Grading: Prior to beginning construction operations in an area, necessary clearing and grubbing in that area shall have been completed and accepted by the Owner. No fill materials shall be placed upon an unapproved surface.

1. Fill Sections: When fill sections are to be constructed, the cleared surface shall be completely broken up by plowing or scarifying to a minimum depth of 6 inches. Scarifying or furrows shall be a maximum of 3 feet apart, and shall be parallel to the centerline of the roadway. This area shall then be compacted beginning with the first lift, as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction.

3.2 INSTALLATION

A. Explosives: The use of explosives is prohibited.

B. Excavation: Excavate where shown on the drawings and typical sections, unless staked otherwise. Existing structures which are disturbed or damaged by construction activity shall be reset, repaired, or replaced at the Contractor's expense.

C. Subgrade Compaction: In areas where earthfill, or roadways are to be constructed and in areas where excavation exposes the subgrade surface upon which fill is placed will be constructed, the subgrade shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before roadway construction begins.

D. Disposal of Materials: Excess and unsuitable material, including rock and boulders that cannot be used in roadways, shall be disposed of as directed by Owner.

E. Use of Borrow Material: Do not use borrow material until after the materials obtained from required excavation have been placed in the fill, unless otherwise directed by the Owner.

When more borrow is placed than is required, and required excavation is wasted, the waste shall be replaced in the borrow area at the Contractor's expense.

F. Fill Material: Shall be spread over the full width of the cross section of the fill section to a maximum compacted thickness of 9 inches, and shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before the next layer is spread. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.

G. Frozen Material: Shall not be placed, nor may fill be placed upon a frozen surface.

3.3 FIELD QUALITY CONTROL

A. Testing: A certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Moisture Content:
   1. During placing and compacting of fill material, the optimum moisture content (-2 percent to +2 percent) as determined by ASTM D698, unless otherwise noted on the project drawings, and shall be maintained by wetting or drying.

C. Compaction:
   1. The fill material shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by ASTM D698 unless otherwise noted on the project drawings.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02319

MULCH

PART 1: GENERAL

1.1 SUMMARY

A. Description: This work shall consist of covering and processing specified seeded areas with a mulch of the stipulated materials.

1.2 SUBMITTALS

A. The following submittals are required:

1. Manufacturer's specifications and material content for mulch products.
2. Manufacturer's recommended application methods and rate.

PART 2: PRODUCTS

2.1 GENERAL

A. Materials: Mulching materials used on the project shall be those described hereafter.

1. On projects which require specific mulch, that type will be "Vegetative Mulch" or "Wood Fiber Mulch", and the type specified will be the only type accepted for use.

2. On projects which can be mulched equally well by any one of several types, the Contractor will have the option of selecting which one of the specified types he will use. However, once selected, only one type of mulch will be used throughout the project.

B. Vegetative Mulch: This type of mulch material shall be composed of grass hay, wheat straw, rye straw, or barley straw, in that order of preference.

1. Grass Hay: This type of mulch material shall be composed primarily of perennial grasses at least 10 inches. The grass hay mulch shall contain greater than 70% grass by weight and shall not contain a total greater than 5% alfalfa, crested wheatgrass or yellow sweet clover. Grass hay is subject to the Owner's approval and must be certified "Noxious Weed Seed Free" hay provided by a certified supplier.

2. Straw: This type of mulch material shall be clean grain straw, at least 10 inches, shall be certified "Noxious Weed Seed Free" straw and shall not contain greater than 5% cereal seed by weight, i.e., seed heads. Written confirmation from a certified supplier will be required.

Chopped or ground material is not acceptable. The mulch material is not acceptable if it is musty, moldy or rotted, or if it contains seedbearing stalks of noxious weeds. It shall be free of stones, dirt, roots, stumps or other foreign material.

C. Wood Fiber Mulch: Wood fiber mulch shall consist of specially prepared wood fibers and shall be processed in such a manner that it will not contain any growth or germination inhibiting factors. Fiber shall not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fiber shall be dyed an appropriate color

to facilitate visual metering during application. The mulch shall be of such a consistency that after being combined in a slurry tank with water and other approved additives, the fibers in the material will be uniformly suspended to form a homogeneous slurry. During application the material shall produce a mat-like net covering the grass seed. Wood fiber shall be supplied in packages. Each package shall be marked by the manufacturer to show the air-dry weight content. All mulch material must be acceptable to the Owner. If requested by the Owner, the Contractor shall submit a signed statement certifying that the material furnished has been laboratory and field tested and that it meets requirements and intents specified. Wood fiber mulch shall be as manufactured by Weyerhaeuser Company or approved equal.

D. Organic Mulch: Organic mulch shall be a neutral pH organic produce formulated from grass/straw by-products, and shall be processed specifically for mulching purposes. Processing shall be in such a manner that the organic mulch not contain stalks or seeds of noxious weeds or grasses, or any growth or germination inhibiting factors. To facilitate visual metering during application, a non-toxic water soluble green colored dye shall be added to the water. The mulch shall be of such a consistency that after being combined in a slurry tank with water, dye and other approved additives, the mulch material will be uniformly suspended to form a homogeneous slurry. Upon application the material shall produce a mat-like net covering the grass seed. Organic mulch shall be supplied in packages. Each package shall be marked by the manufacturer to show the air-dry weight content. All mulch material must be acceptable to the Owner. If requested by the Owner, the Contractor shall submit a signed statement certifying that the material furnished has been laboratory and field tested and that it meets requirements and intents specified.

E. Tackifier: Tackifier shall be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. The tackifier shall uniformly disperse when mixed with water and not be detrimental to the homogeneous properties of the mulch slurry. Any tackifier which has been moisture damaged or damaged by other means will not be acceptable. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application.

Organic soil and mulch tackifier for use in hydraulically planting of grass seeds, flowers, or woody tree seeds, or stolon, either alone or in combination with fertilizer, wood fiber mulch and other approved additives, shall consist of specifically blended compatible hydrocolloids. Starch-based tackifiers are unacceptable.

The soil and mulch tackifier shall be supplied in easily disposable packages containing 5, 20, or 40 pounds of material having an equilibrium air-dry moisture content at time of manufacture of 8%, plus or minus 2%, with a minimum water-holding capacity of 6 1/2 times by weight of dry material.

The organic soil and mulch tackifier shall have the additional characteristics of hydrating and dispersing in circulating water to form a homogeneous slurry and remain in such a state in the hydraulic mulching unit, or adequate equal, with the specified, or other approved materials.

Soil and mulch tackifier shall be applied at a minimum rate of 40 pounds per acre on slopes 2:1 or flatter, or at 80 pounds per acre, or more on slopes steeper than 2:1, or at manufacturer's recommendations, approved by the Owner.

When applied, the organic soil and mulch tackifier shall form a loose chain-like protective film, but not a plant inhibiting membrane, which will allow moisture to percolate into the underlying soil, while helping "stick" seeds, fertilizer and other specified materials to the soil surface during germination and initial seedling growth, after which the organic soil and mulch tackifier shall breakdown by microbial action.

PART 3: EXECUTION

3.1 GENERAL

A. General: Mulch, when required, must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. If the Contractor does not mulch within 24 hours after seeding, the Contractor may be required to re-seed the project at no additional cost to the Owner. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground as long as it doesn't compact the surface. Mulch shall not be applied to snow-covered ground surfaces.

Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Areas not to be mulched shall be determined by the Owner. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the Contractor, to the satisfaction of the Owner.

Additional mulching may be required in accordance with summer erosion control procedures.

The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow or other acceptable means to remove the tracks.

B. Application of Vegetative Mulch: Vegetative mulch shall be applied after seeding and fertilizing is completed. The mulch shall be applied in a uniform manner by a mulch spreader, at the rate specified on the Drawings. The mulch spreader shall be designed specifically for this type of work. The vegetative material shall be fed into the mechanical mulch spreader at an even, uniform rate.

When asphalt or a tackifying agent is used as a binder for vegetative mulch, it shall be applied at the rate specified on the Drawings. It shall be evenly distributed over the vegetative material as it emerges from the blower discharge or it may be hydraulically applied directly following mulch application. Uneven distribution, caused by inadequately powered or improperly adjusted equipment, poor workmanship, erratic material feed or discharge, or similar causes within the Contractor's control, shall be corrected. The quantity of asphalt or tackifying agent specified is subject to increase or decrease as determined in the field by the Owner.

Straw or native hay shall be uniformly spread at the rate specified on the Drawings. Unless otherwise specified by the Owner, straw or hay shall be anchored into the seedbed by using a mulch crimper. Straw or hay shall have a minimum length of 10 inches shall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.

The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions: 1/4-inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done along the contour of the slope.

C. Application of Fabricated Mulch and Fabricated Netting: Fabricated mulch shall be laid on the areas specified on the Drawings or designated by the Owner and securely fastened to the ground by wire staples, wooden pegs, or other satisfactory devices.

D. Application of Wood Fiber Mulch, Or Organic Mulch: Wood fiber mulch or organic mulch shall be applied by means of hydraulic equipment which utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, must be maintained throughout the distribution cycle. The pump pressure shall be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines shall be large enough to prevent stoppage.

The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of the mulch slurry to the seedbed. Mulching shall not be done in the presence of free surface water resulting from rains, melting snow, or other causes.

The Contractor shall start at the top of the slope and work downward. If necessary, he may be required to use extension hoses to reach the extremities of slopes.

E. Finishing: Prior to final acceptance of the project, the Contractor shall immediately remulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before remulching. The operations described in this paragraph shall be at the Contractor's expense if the damage is due to his negligence.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02339

WATERING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Distributing and applying water required for excavation, compaction of fill, backfilling, dust control, roadways, and watering of seeded areas.

1.2 PROJECT/SITE CONDITIONS

A. Water Source: Water shall be supplied by the owner.

PART 2: PRODUCTS

2.1 MATERIALS

A. Water: Water shall be supplied by the contractor from the owner's source.

2.2 EQUIPMENT

A. Requirements: Provide necessary pumping equipment, piping, tanks, water trucks. Water trucks shall be equipped with a spray bar of adequate capacity and design to ensure uniform application of water in the amounts designated. Measuring devices shall be approved by the Owner if needed.

PART 3: EXECUTION

3.1 APPLICATION

A. Compaction: Water may be applied by sprinkling to either the cut area or the fill. Water shall be applied uniformly to each layer of fill, as needed, to obtain the optimum moisture content determined by ASTM D698. The final moisture content shall be as specified.

B. Seeding and Dust Control: Water shall be applied to those areas identified by the Owner as dust control or seeded areas.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02378

RIPRAP AND ROCK LINING

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Providing riprap used for soil stabilization and slope protection.

1.2 DEFINITIONS

A. Satisfactory Materials: Materials classified in ASTM D 2487 as GW, GP, SW and free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 100 mm (4 inches) in dimension are satisfactory.

B. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as Pt, OH, and OL are unsatisfactory. Unsatisfactory materials also include human-made fills, refuse, or backfills from previous construction.

1.3 SUBMITTALS

A. General: Submittals shall be according to Section 01009 - General Information and Requirements, Section 01330 – Submittal Procedures.

B. Certificates of Conformance: Submit three copies of written certification from a certified testing laboratory that the Contractor furnished riprap to be used on this project conforms to the requirements of this specification section.

C. Field Tests: Submit three copies of laboratory and field test reports within 24 hours of the completion of the test.

PART 2: PRODUCTS

2.1 MATERIALS

A. Riprap Source: Riprap shall be obtained by the Contractor from off-site sources.

B. Bedding: Material shall be composed of tough, durable particles, free from thin, flat, and elongated pieces. The material shall contain no organic matter, or soft, friable particles in quantities in excess of those approved by the Owner.

1. Bedding material shall meet the following gradation:

Sieve Designation	Percentage Passing
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 200	0-5

C. Riprap: Stone shall consist of hard, durable stone, cobbles or spalls; angular in shape, resistant to weathering and to water action. Material shall be free from overburden, spoil, shale, and organic material, and shall meet the gradation requirements specified below.
   1. Minimum Bulk Density: Shall be 160 pcf.
   2. Resistance to Disintegration
      a. Sulfate Soundness Test: Stones shall have a loss not exceeding 10% with the sulfate test after 5 cycles according to AASHTO T 104.
      b. Freezing and Thawing Test: The stone should not have a loss exceeding 10% after 12 cycles of freezing and thawing according to AASHTO T 103.
   3. Gradation: Loose riprap shall meet the gradation below. Sand, gravel rock dust and rock smaller than 4 inches in diameter shall not exceed 5 percent, by weight, of the total riprap material.

Screen Size	Total Size Smaller than Given Size (%)
12-inch	100
9-inch	30 to 70
5-inch	0 to 20

D. Contractor shall obtain riprap, bedding and boulders from an off-site source subject to approval by the Owner. Contractor shall be responsible for all incurred costs in acquiring off-site rock, bedding and boulder material.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing: Slopes to be protected by riprap shall be free of brush, trees, stumps, and other trash. Dress to a smooth surface.

B. Excavation: Foundation trenches and other necessary excavations shall be excavated as provided in Section 02315 - Excavation and Fill. Place riprap after receiving approval in writing by the Owner. Soft or spongy material shall be removed to the depth shown on the drawings, and replaced with approved material. Filled areas will be compacted as specified in Section 02315 - Excavation and Fill.

3.2 INSTALLATION

A. Gravel Filter Layer: Place on the prepared slope or area to the full specified thickness of each layer in one operation. Use methods that avoid causing segregation of particle sizes within the

bedding. The surface of the finished layer shall be even and free from mounds or windrows. Additional layers of filter material, when required, shall be placed in the same manner. Use methods that avoid causing mixture of the material in the different layers.

B. Stone: Place on the prepared slope or area to produce a solid, well-graded mass of [stone] [material] within the limits shown on the drawings. Place riprap to its full course thickness in one operation and avoid displacing the underlying material. Placing of riprap by dumping into chutes, or by similar methods likely to cause segregation, will not be permitted. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02640

CULVERTS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: The removal of existing pipe and Installing Contractor-furnished pipe culverts.

1.2 SUBMITTALS

A. General: Submittals shall be according to Section 01009 - General Information and Requirements, Section 01330 - Submittal Procedures and Section 01331 - Certificates.

B. Certificates of Conformance: Submit three copies of written certification from the culvert fabrication company for the Contractor-furnished culverts to be used on this project that they conform to the requirements of this specification section.

1.3 QUALITY ASSURANCE

A. Failure Criteria: Not limited to the following:
   1. Breaks in outer coating or spelter.
   2. Deformed, broken, or chipped culvert pipe.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Culverts shall not be dragged, dropped, or otherwise mishandled.

1.5 SEQUENCING AND SCHEDULING

A. Pipe Length: Prior to ordering pipe, present a pipe list to the Owner. The list furnished shall reflect exact pipe sizes and lengths required.

PART 2: PRODUCTS

2.1 MATERIALS

A. Corrugated Metal Pipe: ASTM A 760/A 760M Types I for circular pipe. Special sections, such as elbows and flared end sections shall be of the same gauge as the conduit to which they are joined, or 16-gauge for new pipe. Minimum width of coupling bands shall be 12 inches.

B. Nuts, Bolts, and Aluminum Alloy Plates: ASTM B 746/B 746M

PART 3: EXECUTION

3.1 PREPARATION

A. Removal of Existing Pipe: Remove existing pipe as shown on the drawings. Dispose of pipe off site or as approved by the Owner.

B. Clearing: Section 02231 - Clearing and Grubbing.

C. Excavation: Excavate the trench in which the pipe is to be laid to the established line and grade to provide a firm and uniform bearing for the entire length of the pipe. Where directed to remove unsuitable foundation material, excavate the trench to a depth of 6 inches below the bottom of the pipe, and backfill with material approved by the Owner. Compact the material to provide a firm and uniform bearing for the pipe.

3.2 INSTALLATION

A. Lay corrugated metal pipe to the lines and grades shown on the drawings. Lay the pipe with outside laps of circumferential joints pointing upstream and with longitudinal joints at the sides. Draw all fastenings up tight. Using coupling bands where necessary to join sections of pipe. Install the coupling bands properly, in a manner to ensure tight joints, with the joints between sections approximately at the center of the couplings.

B. Backfill:
   1. As each unit of pipe is laid, tamp sufficient backfill material about the pipe to hold it rigidly in place until the joints are completed. After the joints have been completed, place and compact backfill. Insofar as practicable, obtain backfill material from material obtained in required excavations for pipe or from adjacent excavation.

   2. Place backfill to the lines and grades shown on the drawings. As each pipe unit is laid, tamp sufficient backfill material about the pipe to hold it rigidly in place until the joints are completed. After the joints are completed, place backfill carefully and spread backfill in uniform layers. Backfill with rocks larger than 3" will not be allowed. Place backfill to about the same elevation on both sides of the pipe to prevent unequal loading and displacement of the pipe. Do not exceed a difference in elevation of the backfill on both sides of the pipe 6 inches at any time.

   3. Place, moisten, and compact all material in backfill as per Section 02315 – Excavation & Fill. Equipment travel over the pipe will not be permitted until backfill has been placed and compacted to the depth recommended by the pipe manufacturer, but not less than 1 foot above the top of the pipe. Prevent damage from construction equipment loads by providing adequate earth cover over pipe.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02722

CRUSHED AGGREGATE BASE COURSE

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing, placing and compacting crushed aggregate on the prepared 20 ft traveled roadway.

1.2 SUBMITTALS

A. General: Submittals shall be according to Section 01009 - General Information and Requirements. Section 01330 - Submittal Procedures and Section 01331 - Certificates.

B. Test Data: Submit three copies of test data for the Contractor-furnished aggregate to be used on this project. Testing shall have been performed by an independent testing laboratory within 12 months of submitting the report for approval.

C. Certificates of Conformance: Submit three copies of written certification from the supplier of the Contractor-furnished aggregate to be used on this project that it conforms to the requirements of this specification section.

1.3 DELIVERY, STORAGE AND HANDLING

A. Delivery: Mitigate spillage or damage that occurs during delivery.

PART 2: PRODUCTS

2.1 MATERIALS

A. Contractor-Furnished Crushed Aggregate: Shall meet the requirements of base aggregate as outlined in the *State of Wyoming Department of Transportation 2010 Standard Specifications, Section 803.4 – Aggregate for Subbase and Base* and shall meet the grading requirements for Grading "GR" or Grading "W" as presented in Table 803.4.4-1

PART 3 EXECUTION

3.1 PREPARATION

A. Requirements: High places in the road-bed shall be cut to grade and the resulting material hauled and deposited on low areas or on fill slopes as approved by the Owner. If depressions or narrow embankments remain, sufficient approved material shall be obtained. Place material to bring the width and surface of the roadway in close conformity with the lines, grades, and cross sections shown on the plans or established by the Owner. The roadbed shall then be rebladed and reshaped. At intersections, the roadbeds of side roads shall be treated similarly, as governed by the grading performed, to provide for proper joining of the proposed and existing riding surfaces. The roadbed shall be compacted. A complete and acceptable foundation shall be constructed. The roadbed shall be in specified condition at the time of placement of the base course.

3.2 INSTALLATION

A. General: The material shall be placed on the prepared surface and compacted in one 6-inch layer. Aggregates shall be placed directly on the prepared subgrade.
   1. Placing shall be from vehicles equipped to distribute the material in a continuous uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted, the finished layer shall have the required thickness.
   2. When hauling is done over previously placed material, hauling equipment shall be routed uniformly as possible over the entire surface of the constructed layers.

B. Spreading: When uniformly mixed, the mixture shall be spread smoothly for compaction to the required thickness.

C. Compacting: Immediately following final spreading and smoothing, each layer shall be compacted to the full width by approved compaction equipment. Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road, and shall continue until the surface has been rolled. Irregularities or depressions that develop shall be corrected by loosening the material at these places. Add or remove material until the surface is smooth and uniform. Base material shall be rolled until visual displacement ceases as observed by the Owner.

D. Watering: Provide water and watering equipment to control dust and obtain required compaction. This work shall be done according to Section 02339 - Watering.

E. Moisture Content: During placing and compacting of base material, the optimum moisture content (-3 percent to +2 percent) as determined by ASTM D698, unless otherwise noted on the project drawings, and shall be maintained by wetting or drying.

F. Compaction: The base material shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by ASTM D698 unless otherwise noted on the project drawings.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02726

TOPSOIL FOR RECLAIMED AREAS

PART 1: GENERAL

1.1 SUMMARY

A. Section includes:

1. Strip and stockpile topsoil from areas within the work site and from other areas designated by the Owner.
2. Spread stockpiled topsoil on prepared reclaimed disturbed areas as designated by the Owner.

1.2 RELATED WORK

A. Section 02923: Seeding

PART 2: PRODUCT

2.1 TOPSOIL

A. Topsoil for reclaiming disturbed areas shall be developed from stripping of topsoil in the work areas or as designated by the Owner.

2.2 UNACCEPTABLE TOPSOIL MATERIALS

A. Subsoils (no B or C horizon soils)

B. Coarse sand and gravel

C. Stiff clay, hard clods or hard pan soils

D. Rock larger than 3-inch in any dimension

E. Trash, litter or refuse

F. Topsoil containing greater than 5 percent rock.

PART 3: EXECUTION

3.1 GENERAL REQUIREMENTS

A. Place topsoil just before seeding if it can be seeded within the upcoming fall seeding window.

B. Do not strip or handle topsoil when it is wet or frozen.

C. Work topsoil only when it can be left in a friable, loose and crumbly state.

D. On steep cut slopes requiring the placement of topsoil, it may be necessary to place the topsoil as the slope is constructed.

3.2 TOPSOIL STRIPPING

A. Strip the topsoil only from areas identified on the plans or approved by Owner.

B. Remove and dispose of any roots larger than 2-inches in diameter or 12-inches in length.

C. Stockpile stripped topsoil at locations acceptable to the Owner and so that placement or activity around the stockpile does not damage any existing trees or shrubs.

D. Grade to minimize erosion on and around the stockpiles.

3.3 SPREAD STOCKPILED TOPSOIL

A. Clear area to receive topsoil of all trash, debris, weeds, and rock 3-inch or larger, and dispose of objectionable material in an approved manner.

B. Place and spread the stockpiled topsoil over the prepared slopes to the plan depths. A minimum of 6-inches is required in all disturbed areas unless otherwise indicated on the Drawings.

C. Disc or harrow the prepared areas following topsoil placement. When discing or harrowing slopes, follow the contour to help prevent erosion.

D. Provide a crumbly soil texture.

3.4 COMPCATION

A. Cover soil has no compaction requirement.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02824

WIRE FENCES AND GATES

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing and installing wire fences.

1.2 SUBMITTALS

A. General: Submittals shall be according to Section 01009 - General Information and Requirements, and Section 01331 - Certificates.

B. Certificates of Conformance: Submit three copies of written certification from the manufacturer that the Contractor-furnished fence posts, droppers, in-line strainers, crimp sleeves and wire conform to the requirements of this section.

1.3 QUALITY ASSURANCE

A. General: Contractor-furnished accessories will be approved by the Owner before installation.

PART 2: PRODUCTS

2.1 CONTRACTOR-FURNISHED MATERIALS

A. Barbed Wire: A strand of two 12-1/2-ga galvanized wires twisted together with 2-point barbs of 14-ga wire spaced 4 inches apart. Wire and barbs shall be zinc-coated steel, with a zinc coating of at least 0.3 oz/ft^2 of coated surface area. The minimum breaking strength of each wire shall be 950 lb-force. The barbed wire shall conform to ASTM A 121.

B. Barbless Wire: A strand of two 12-1/2-ga, galvanized wires twisted together. Wire shall be zinc-coated steel wire of at least 0.3 oz/ft^2 of coated surface area. The minimum breaking strength of each wire shall be 950 lb-force. The barbless wire shall conform to ASTM A 121.

C. Wire Fence Stays: Twisted wire fence stays manufactured from smooth galvanized 9-ga wire.

D. Wood Fence Stays: Sound and straight pieces, 2½- to 3½-inch diameter of the species listed under wood posts and braces. Treatment with preservative is required. Stays shall be of uniform length sufficient to extend a minimum of 3 inches above the top fence wire and 6 inches below the bottom wire.

E. Fiberglass Droppers: Pultrusion manufacture and be 1/2-inch diameter and of uniform length sufficient to extend 1 inch above and 1 inch below the top and bottom wires. Reject or used rod is not acceptable.

F. Staples: Bright-finish or galvanized 9 gauge with slash-cut points 1½ inches long.

G. Nails: 60d ring shank (6-inch, 7-ga).

H. Steel Fence Posts: ASTM A 702; solid green "T" or "U" (channel) bar type, with a welded or riveted anchor plate. Furnish with clip-type wire fasteners (punched tabs for fastening wires are

not acceptable). Steel posts shall be manufactured from wrought, rail, or new billet steel, and shall have a minimum weight of 1.25 lb/lin ft. The anchor plates shall weigh a minimum of 0.67 pounds ±5 percent, and be a minimum of 18 inch^2 in area.

I. Wood Posts and Braces:
   1. Acceptable Wood Posts and Braces: Sound single-stem members. A slight bend in one plane is acceptable. Posts and brace rails may be full stem members, sawed members of square cross section, or split members (western red cedar only). Line posts and brace rails shall be 3 inches minimum diameter at the small end. Sawed members shall be 4 x 4 rough sawn. Minimum cross sectional area at the small end for split members shall be 10 in^2. Honey locust, western red cedar (full stem with bark removed), juniper, osage orange, and white oak are acceptable without treatment.
   2. Basis for Rejection: Posts are not acceptable when sweep causes a straight line joining the center of the top to the center of the butt to fall outside the body of the post, or at a point 2 inches or more from the center of the post. Posts that are charred, twisted, rotted, or excessively bent are not acceptable. Seasoning checks, single or opposite each other with a sum total equal to or more than 1/2 the thickness of the post are not acceptable.

J. Steel Panels and Braces: One-inch square tube with .065-inch wall thickness and butt-welded joints.

K. Wire Gates: Type of Wire and spacing shall be as shown on the drawings. Wood stays for wire gates shall be sound and straight pieces, 3-inch minimum diameter, and of the species listed under posts and braces.

L. Brace Wires: Four wires of 9-ga smooth, galvanized wire or 2 wires of galvanized, 12-1/2-ga barbless wire. The minimum weight of zinc coating for 9-gauge wire shall be at least 0.4 oz of zinc/ft^2 of coated surface area; for 12-1/2-ga wire at least 0.3 oz of zinc/ft^2 of coated surface area.

M. Miscellaneous Wire: Wire for ties, gate loops and fastening wood stays shall be 9 or 12-1/2-ga galvanized wire.

N. Clip-Type Wire Fastener: Galvanized wire, 8 gauge.

O. In-Line Strainers: Single-click, rachet type, using a double-leg strainer handle for adjustment

P. Crimp Sleeves: Shall be of acceptable manufacture for use on high-tensile smooth wire.

Q. Post Grout: Furnish a rapid setting commercial product manufactured for anchoring posts.

PART 3: EXECUTION

3.1 PREPARATION

A. Clearing: Maximum clearing width is 4 feet on each side of the fenceline. Provide minimum disturbance to existing grass and sod.

3.2 INSTALLATION

A. General: Steel posts shall not be used for end-panel, corner-panel, gate-panel, or stress-panel posts. Set wood posts in dug or drilled holes unless written authorization is obtained for driving line posts. Drive steel posts. When treated members must be bored or cut during construction, thoroughly swab untreated surfaces with copper naphthenate.

B. Ratio of Wood to Steel Line Posts: As per Drawings.

C. Setting Posts: Dig holes for setting wood posts to the depth as shown on the Drawings. Set posts plumb and to the spacing and grades as shown on the drawings, unless staked otherwise. Space within 6 inches of that dimension shown on the drawings. Holes shall provide adequate open space around the post so backfill can be tamped the full depth around the post. Backfill gradually and uniformly with soil around each post. Compact backfill firmly from the bottom of the hole to the ground surface.

D. Driving Posts:
   1. Wood Posts: Drive [only when approved by the Owner. Wood posts to be driven shall be machine-pointed on the end. Drive posts plumb. Posts that are split, bent or broomed, will not be accepted.
   2. Steel Posts: Drive into the ground to the depth shown on the drawings or until the anchor plate is slightly below the ground surface. Posts shall be driven plumb. When rock formations prevent driving remove anchor plate and excavate or drill holes a minimum of 18 inches deep and slightly larger than the diameter of the post. Place posts in the holes and grout the post solidly in position.

E. Corner Post, Gate Post, Corner Panel, Brace, and End Panel (Stress Panel) Assemblies: Construct as shown on the drawings or as staked in the field. Rock jacks shall not be substituted for these items. Construct stress panels on crests of hills, and a maximum of 660 feet center-to-center for woven wire fence sections and a maximum of 1320 feet center-to-center for barbed wire sections. In addition, stress panels are required at points between which wire is to be stretched. Construct end panels at the end of fence runs unless shown otherwise on the drawings.

F. Figure Fours and Rock Jacks: May be used in rock. Figure fours shall be used in lieu of steel posts, and rock jacks in lieu of wood line posts, except that where a series of figure fours are required, a rock jack shall be substituted for every fifth figure four. Figure fours and rock jacks shall be constructed as shown on the drawings.

G. Wire: Stretch tightly and staple to wood posts or securely attach to steel posts with standard wire clips. Wire is properly stretched when it is springy to the touch. Drive staples crosswise with the grain of the wood. The wire shall be free to move through the staples as it expands and contracts. With woven wire, the tension curves will begin to straighten when properly stretched. When erecting woven wire below 40 degrees F, not more than half the tension curve shall be removed. Terminate wire at each end post, gate post, corner post, or stress panel. Wrap wire around the post two times and tie off by wrapping around the incoming wire a minimum of four times. High tensile wire shall be tied off at premarked heights by looping each wire around the post and fastening with two crimp sleeves. At the midpoint of the fence staple wires to the midpoint post. At the far end post cut and tie off wires using crimp sleeves. Take up slack at the midpoint of the fence and install in-line wire strainers for each fence wire.

H. Brace Wire: Double-loop and twist tight with a stick. For steel pipe panels, each wrap shall be looped once around the post. Leave one end of the stick long enough to fasten behind the horizontal brace to prevent wire from unwinding.

I. Grounding: Connect ground rod connectors to the fence posts with a means suitable for the materials when the posts are of conducting material. When the posts are of nonconducting material, make suitable bonding connections to the fence mesh and barbed wire strands at each grounding conductor point. Ground at both ends of the fence line, at each brace panel, and on both sides of a gate. Wire fences with wood posts shall be grounded every 100 yards with steel posts or copper rods. Establish ground points about 25 feet in both directions, along the fence, from the point directly below the crossing of overhead electric lines

J. Gates: Installed according to the Work Data Sheet, the drawings, and as recommended by the manufacturer when applicable.

K. Spiking: For spikes larger than 40d, predrilled lead holes shall be used. The hole diameter shall be three-fourths the diameter of the spike and drilled to a depth no greater than 1/2 the length of the spike.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02879

WELDED STEEL CATTLE GUARDS

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing and installing cattle guard grids, bases and foundations, and accessories.

1.2 DESIGN REQUIREMENTS

A. Size: Design cattle guards to have a clear travel roadway width for vehicular treads of not less than 20 feet, with the length along the line of traffic not less than 8 feet.

B. Foundations: Cattle guard foundations shall be precast concrete. Construct the grill units of welded steel members to form a rigid deck. Provide suitable cleanouts and a method of draining the cattle guard through the end of the foundation.

1.3 SUBMITTALS

A. Manufacturer's Literature: Submit three copies of the manufacturer's descriptive data including design data for commercial cattle guard grids.

B. Certificates: Submit three copies of written certification from the supplier of the Contractor-furnished cattle guards that the cattle guards to be used on this project conform to the requirements of this specification section.

C. Alternate Design: Submit three copies of detailed engineering drawings, material specifications and fabrication instructions. Alternate Designs: Shall be furnished with design calculations and be certified by a Registered Engineer that they meet design requirements.

D. Qualification Record: Submit two copies of the required procedures qualification record.

E. Welding Procedure Specification: Submit two copies of the welding procedure specification.

1.4 QUALITY ASSURANCE

A. Welder Qualifications: As a minimum, the welder shall meet the qualifications for: Electrodes up to and including E 7018 according to AWS D1.1, Section 5; Steel thickness 1/8 to 3/8 inch (3 to 10 mm); fillet, groove, low-hydrogen welding; or meet code qualifications for structural plate and rolled structural shapes.

PART 2: PRODUCTS

2.1 MATERIALS

A. General: Shall be constructed of materials as shown on the drawings and described in these specifications. Design loading of grids and dimensions shall be as shown on the drawings and the Work Data Sheet. New material shall be used in the fabrication of cattle guards.

B. Hot-rolled structural steel sections: ASTM A 36/36M or AASHTO M 183.

C. Cold-formed rails: ASTM A 242/242M. This type rail shall be welded with E 7015 or E 7016 electrodes.

D. Structural tube sections: ASTM A 500, Grade B, Copper Steel or ASTM A 618, Grade 2.

E. Steel pipe: ASTM A 53, Schedule 80

F. Crane rails: ASCE 60 crane rail.

G. Zinc-plated connectors, bolts and nuts: ASTM A 307, or SAE Grade 8: SAE J 429.

H. Anchor clips: Shall be furnished loose and may be either field welded or bolted or shop welded or bolted.

I. Galvanized parts: ASTM A 123 for steel shapes and ASTM A 153 for fasteners.

J. End Wings: Shall be as shown on the drawings.

K. Object Markers: Provide Permanent object markers, including hardware. Markers shall be MUTCD Type 2, mounted on steel or treated wood sign posts.

L. Backfill Material: Shall be native material. Backfill shall be free from rocks, stones larger than 3 inches (80 mm) maximum diameter, sticks, or excess organic materials, and shall be of the best material available onsite.

M. Paint: Color shall be Federal Safety Yellow or match color no. 13655, Fed. Spec.TT-C-595. Cattle guards shall be painted after fabrication.

2.2 FABRICATION

A. Welding: Shall be accomplished with AWS E 7018 electrodes, except for cold-formed rails.

B. Steel Cattle Guard Grids: Steel grids shall be all-welded construction. Welds shall be secure and complete along both edges of cross pieces and at joints in the frame, and shall conform to AWS D1.1.

C. Paint: Structural steel shall be cleaned according to SSPC SP-6. Cattle guard grids and end wings shall each receive a prime and finish coat. The prime coat shall be a lead free, zinc-rich, rust-inhibitive alkyd metal primer. Minimum thickness shall be 1½ mils (0.05 mm) dry-film thickness (DFT). The finish coat shall be an oil alkyd-enamel, gloss paint. Minimum thickness shall be 3 mils (0.10 mm) DFT, applied in two applications.

D. Cattle Guard Foundations: Foundations shall be constructed as precast concrete.

2.3 SOURCE QUALITY CONTROL

A. Material Marking: Material to be used in the fabrication process shall be labeled, marked, or otherwise segregated from differing material.

B. Weld Inspection: The quality of the weld shall be "acceptable" under the visual requirements of AWS D1.1, AWS B1.10, and AWS WI, CH16. Unacceptable welds or defects in the welds as detected by visual inspection or by radiographic, penetrant dye, or magnetic particle techniques shall be repaired or removed and replaced by methods acceptable under the

applicable AWS welding codes, or the entire piece may be rejected by the Owner. Repaired or replaced welds shall be re-inspected by the applicable nondestructive testing method.

PART 3: EXECUTION

3.1 PREPARATION

A. Excavation and Backfill: Initial excavation for cattle guard bases may be made with power equipment, but over excavation shall be avoided. Over-excavated areas shall be backfilled. Drain the area to prevent water from pooling within the excavation. Place backfill in layers not exceeding 6-inches (150 mm) thickness, and mechanically or manually compact each layer to 95 percent of maximum dry density and within 2% of optimum moisture content as determined by ASTM D698 before placing the new layer.

3.2 INSTALLATION

A. Precast Concrete Foundation: Prior to casting members, the Owner shall have 24 hours to inspect the forms, the placement of the reinforcing steel, and features of the fabrication plant. Do not transport precast units until flexural strength is a minimum of 500 psi (3400 kPa); or, if flexural strength tests are not made, until the units are 10 days old. Place precast units on wood pallets during transporting to assure a proper bearing surface.

B. Grid: Securely bolt cattle guard grids to the bases, as shown on the drawings.

C. Wings: Securely bolt the end wings to the adjacent fence, as shown on the drawings.

D. Object Markers: Install object markers as shown on the drawings for each completed cattle guard.

E. Backfill: After installation, backfill and compact the cattle guard with approved specified material compacting it to 95 percent of the maximum dry density and within 2% of optimum moisture content as determined by ASTM D698 and finish the road surface according to the drawings.

END OF SECTION

DIVISION 2: SITE CONSTRUCTION

SECTION 02923

SEEDING

PART 1: GENERAL

1.1 SUMMARY

A. This work shall consist of ground surface preparation; furnishing, applying and incorporating fertilizer into the soil; furnishing and planting seed; mowing; tracking; and cleanup. The work includes permanent seeding.

1.2 SUBMITTALS

A. Certificate of Indigenous Seed: Indigenous seeds are the seeds of those plants that are naturally adapted to an area where the intended use is for revegetation of disturbed sites. These species include grasses, forbs, shrubs and legumes. The Contractor must supply the Owner with all seed tags and a certification from the supplier stating that the seed complies with all Wyoming and federal seed laws.

1.3 DELIVERY AND STORAGE

A. Seed: Deliver seed in original sealed, labeled, undamaged containers.

PART 2: PRODUCTS

A. Indigenous Seed. All seed shall comply with and be labeled in accordance with the Wyoming and federal seed laws. Each container of indigenous seeds sold in this state for sowing purposes must bear a conspicuous, unaltered label or tag, plainly written or printed in English. Bulk sales must be accompanied by the required label information which must be given to the seed purchaser. The following information must be included on a label:

a. name and address of seed labeler;
b. lot number identification;
c. germination rate and date of germination test or a notation of the year for which the seed was packaged for sale;
d. state or country of origin; and,
e. seed kind or variety.

In addition to the required label information listed above, and any information required by rule established by the Department of Agriculture, the following information shall either be included on the label or provided to the Owner:

a. the statement "Labeled only for reclamation purposes":
b. the common name, genus, species and subspecies, when applicable, including the name of each kind of seed present in excess of 5%. When two or more kinds of seed are named on the label the label shall specify the percentage of each. When only one kind of seed is present in excess of 5% and no variety name or type designation is shown, the percentage must apply to seed of the kind named. If the name of the variety is given, the name may be associated with the name of the kind. The percentage in this case may be shown as "pure seed" and must apply only to the seed of the variety named;

c. the approximate percentage of viable seed, together with the date of test. When labeling mixtures, the percentage viability of each kind shall be stated;
d. the approximate percentage by weight of pure seed, meaning the freedom of seed from inert matter and from other seeds;
e. the approximate percentage by weight of sand, dirt, broken seeds, sticks, chaff and other inert matter;
f. the approximate total percentage by weight of other seeds;
g. the name and approximate number of each kind of species of prohibited and restricted noxious weed seeds occurring per pound of seed;
h. the full name and address of the person, firm or corporation selling the seed;

Seed shall contain no prohibited noxious weed seed. The seed shall contain no restricted noxious weed seed in excess of the maximum numbers per pound as specified by Wyoming statute or the appropriate County Weed Board, whichever is more stringent. The number of seed allowed per pound, for all other noxious weed seeds shown on the "restricted list" will be zero.

Seed shall be grown in the North American continent above 41 degrees north latitude. Known varieties whose origin is above the 41st parallel but grown below are acceptable. All seed shall be a standard grade adapted to Wyoming conditions. Seed which has become wet, moldy or otherwise damaged will not be accepted.

Calculations of pure live seed may be made on the basis of either a germination test or a tertrazolium test in addition to the purity analysis. Seed shall be applied on a pure live seed basis. The quantity of pure live seed in a 100 lb. container shall be determined by the formula: 100 multiplied by germination percentage and this product multiplied by the purity percentage. (For example, if the seed is 85% pure and test 90% germination, then a 100 lb. container would contain 76.5 lbs. of pure live seed.

When legumes are seeded, inoculants specified by the Special Provisions shall be used.

B. Water. Water used for seeding shall be of irrigation quality and free of impurities that would be detrimental to plant growth. Water shall be obtained in accordance with section 02339 -- WATERING.

PART 3: EXECUTION

A. General. Areas to be seeded shall be completed, in reasonable conformity, to specified line and grade prior to seeding and fertilizing and approved by the Owner.

Slopes and areas finished during the period of October 15 through April 30, depending on seeding zone, shall be permanently seeded within this time period. The Contractor must obtain Owner's permission to commence seeding operations. Slopes and areas finished during the period May 1 through October 14 shall be mulched or otherwise treated as specified. The permanent seeding of these areas shall then commence during the fall at a time approved by the Owner.

Application rates for permanent seeding are shown in the following table.

Pure Live Seed Kind	PLS (Pounds per Acre)
Western wheatgrass	5.0
Thickspike Wheatgrass	5.0
Slender Wheatgrass	5.0
Total	15.0

Seeding of the finished slopes shall require repeated seeding operations until approved by the Owner, and shall not be construed to mean that the required finishing and seeding may be done only once at the convenience of the Contractor. Any additional move-in required will not be paid for separately as the cost thereof shall be absorbed in the Contract unit price for seeding.

It is necessary, insofar as practicable and feasible, as determined by the Owner, that the seedbed surface, at the time of application of seeds, not be excessively wet, snow-covered, or frozen. The soil surface should be prepared to provide an acceptable seedbed to a depth of 6" that is not compacted and reasonably free of large aggregates and surface crusts. The seedbed should be left in a relatively rough condition to reduce overland flow and promote the infiltration of water. All seedbed preparation operations shall be oriented across slope (i.e. along the contour). The Contractor shall treat such areas, as required by the Owner, to attain, as nearly as practicable, the condition described.

If seeding is hampered due to standing vegetation, the vegetation shall then be mowed and left lay after seeding. Mowing shall be done, where terrain permits, with equipment using a cutting blade which rotates in a plane parallel to the ground. Whether alive or dead, the vegetation shall be removed if it will prevent good seeding practice.

Excessively tight or compacted soils shall be loosened to the minimum depth of 6 inches. Discing, harrowing, or tilling shall be done along the contour, unless otherwise approved by the Owner. Compaction of the soil, when required, shall be performed by equipment which will produce a uniform rough textured surface ready for seeding and mulching. Compacting of loose soils may be required by the Owner.

Existing structures and facilities shall be adequately protected and any damage done by the Contractor shall be repaired or adjusted to the satisfaction of the Owner.

B. Seed Distribution

1. General. Seed shall be applied to the conditioned seedbed no longer than 48 hours after the seedbed has been conditioned. The preferred method of seeding will be by drill seeding with a rangeland drill. Custom seeders modified to handle native seed may also be appropriate, but must be approved by Owner. Alternative seeding methods (e.g. broadcast seeding) may be necessary for cover materials that have high content of rock fragments or on steep slopes.

   Broadcast or hydraulic seeding methods shall not be used during adverse weather as determined by the Owner.

   The applied seed, regardless of the method of application, shall not be covered by a soil thickness greater than ¼ inch in depth.

2. Seeding by Drill. Seeding equipment used for applying grass seed must be designed, modified or equipped to regulate the application rate and planting depth of grass seed. If equipment for sowing cover crop seed is not equipped with press wheels, the seed shall be

compacted with a cultipacker immediately after the ground has been drilled. Seed must be uniformly distributed in the drill hopper during the drilling operation. Acceptable drills are: custom seeders, furrow drills, disc drills, no till drills or other drills approved by the Owner. All grass establishment equipment shall be operated normal to the slope drainage.

Planting depth shall be regulated by depth bands or coulters. The drill box shall be partitioned by dividers no more than 24 inches apart, in order to provide for more even distribution on sloping areas. A drill shall be no wider than the width of the area over which it is to operate.

The rows of planted seed shall be a maximum of 8 inches apart and shall run along the contour of the slope.

The application rate may be reduced to half the broadcast seeding rate specified herein.

3. Broadcast Seeding. Seeding by hand or mechanical broadcasting will be permitted on areas inaccessible to drills or impractical to seed by other prescribed methods. Broadcast seeding requires the approval of the Owner. Broadcast seeding should be followed by a dragging operation (cyclone fence, chain, tires, etc.) to lightly cover seed with soil.

4. Hydraulic Seeding. When using the hydraulic seeding method, the Contractor must provide 1 pound of wood fiber or organic mulch per each 3 gallons of water in the hydraulic seeder as a cushion against seed damage. The mulch used as a cushion may be part of the total required mulch with the remainder applied after the seed is in place.

   When hydraulically applying mulch in a separate operation, the Contractor may mix the seed with the fertilizer if his hydraulic seeding equipment is capable of uniformly mixing water, fertilizer and seed – in that order – and power blowing or spraying the mixture uniformly over the seedbed. THIS OPTION MAY ONLY BE APPLIED ON SLOPES STEEPER THAN 2:1. After blending, the slurry shall be applied to the seedbed within 45 minutes after the seed has been added to the water/fertilizer mixture. If the slurry cannot be applied within the specified 45 minutes, it shall be fortified, at no cost to the Owner, with the correct ratio of seed to the remaining slurry and a new 45-minute time frame established for applying the fortified mixture.

   The Contractor will be required to use extension hoses to reach the extremities of slopes.

   The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow, or other acceptable means to remove the tracks.

C. Tracking. Tracking shall be accomplished using a tracked vehicle equipped with grousers sufficient to groove the surface to at least ½ inch. The tracking vehicle shall be operated so as to completely cover the surface with grouser marks. All grouser's marks shall run perpendicular to the natural slopes. The tracking vehicle shall be operated alternatively between forward and reverse on each pass to eliminate damage to the seedbed resulting from 180 degree skid turns.

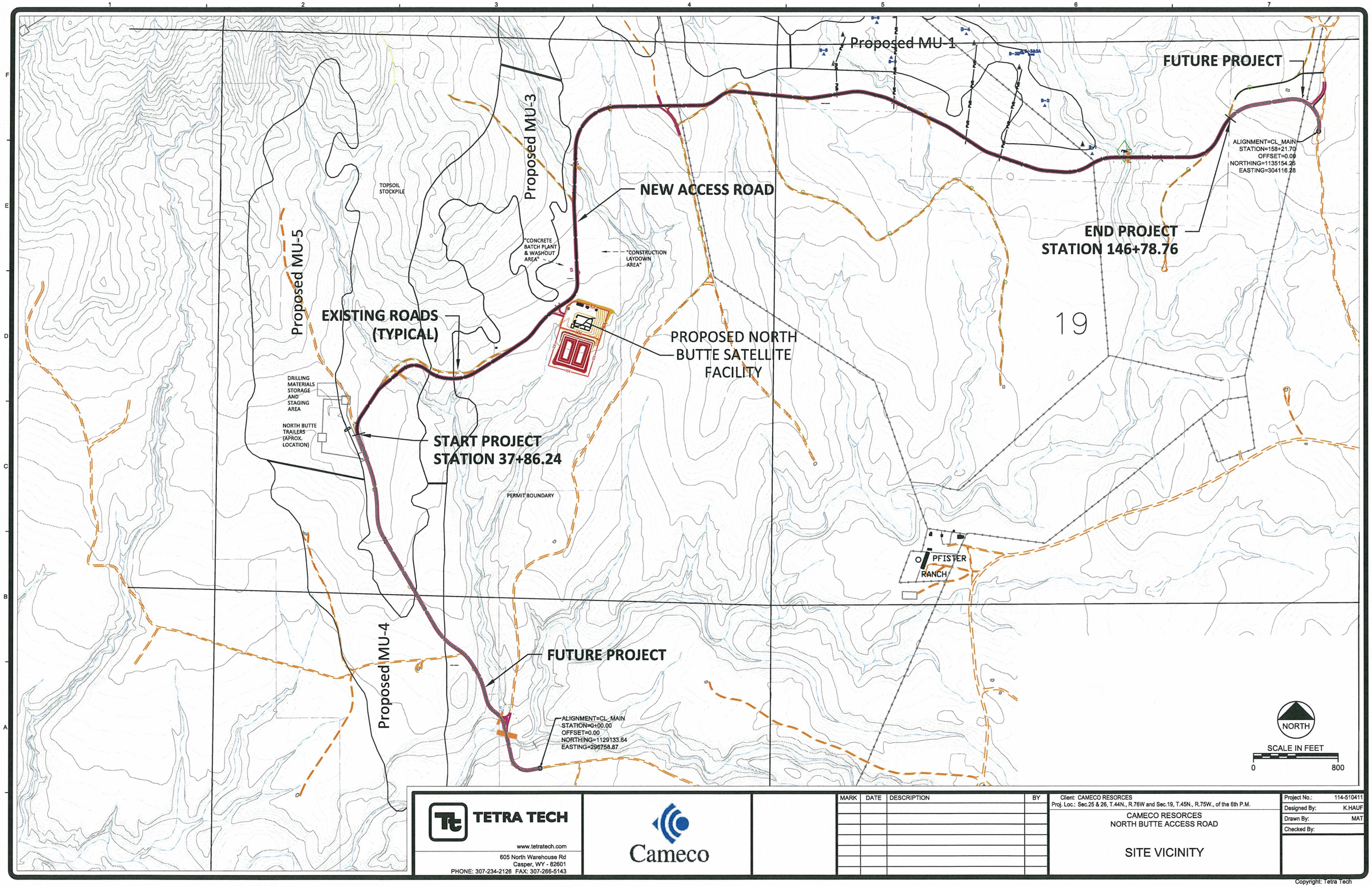
   If the area is seeded by hydraulic methods, tracking of the slopes shall be done at such time when the surface has had sufficient time to dry. The length of time established will be at the discretion of the Owner.

D. Owner Acceptance: The Contractor shall maintain and protect all planted areas until final acceptance. Final acceptance will not be made until an acceptable uniform stand of vegetation is established. Upon acceptance by the Owner, the Owner will assume responsibility for maintenance.

Any portion of the areas of planting which fail to show a uniform stand of vegetation shall be replanted as before, except commercial fertilizer shall be applied at one-half the original rate. Planting shall be repeated until an acceptable stand of vegetation is provided.

Contractor shall guarantee all work and materials for a period of one year after completion of the seeding work. During the guarantee period, vegetation which dies shall be replaced by and at the expense of the Contractor. Replacement made under the Contractor's guarantee shall be covered by a like guarantee for a period of one year after completion of the replacement.

END OF SECTION



10/19/2011 2:09:18 PM - N:\GEO\2011 GEO JOBS\114-510411 - CAMECO - N. BUTTE ROAD DESIGN\CIVIL\PRODUCTION DRAWINGS\DRAFTING\C-SP-NB-PLANVIEW SITE VICINITY.DWG - TAYLOR, MARIE

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MARK	DATE	DESCRIPTION	BY

Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

SITE VICINITY

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	MAT
Checked By:	

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

605 N. WAREHOUSE RD

CASPER, WY -82601

PHONE: 307-234-2126 FAX: 307-266-5143

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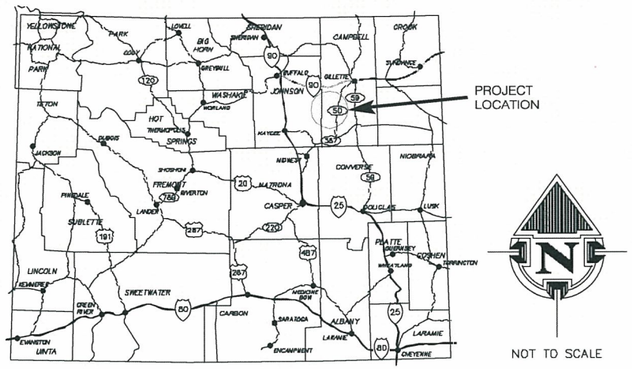
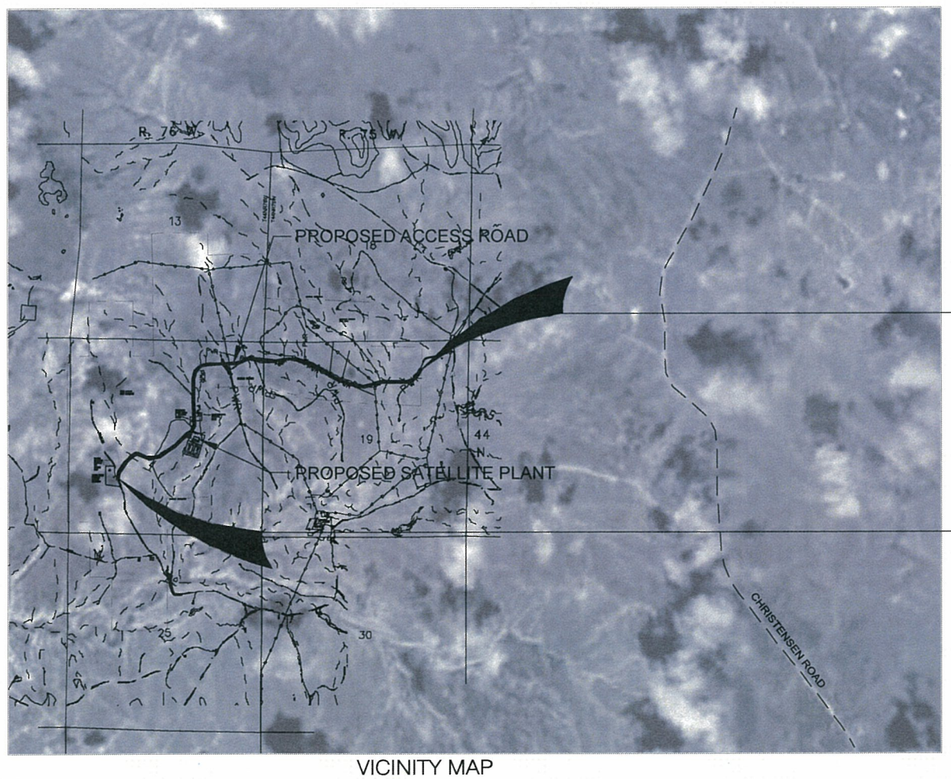
TETRA TECH



LOCATION MAP



VICINITY MAP

PROJECT LOCATION:

SEC.24, T.44N., R.76W., 6TH P.M.
CAMPBELL COUNTY, WY

CLIENT INFORMATION:

CAMECO RESOURCES
550 N. POPLAR ST., SUITE 100
CASPER, WY - 82601

Tt PROJECT No.:

114-510411

CLIENT PROJECT No.:

DEV-2011-RR-008

PROJECT DESCRIPTION / NOTES:

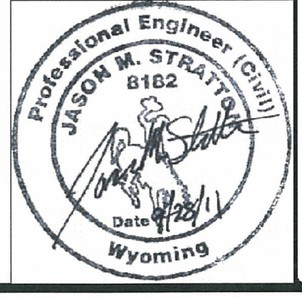
SITE AND GRADING OF ACCESS ROAD
FOR THE NORTH BUTTE SATELLITE FACILITY

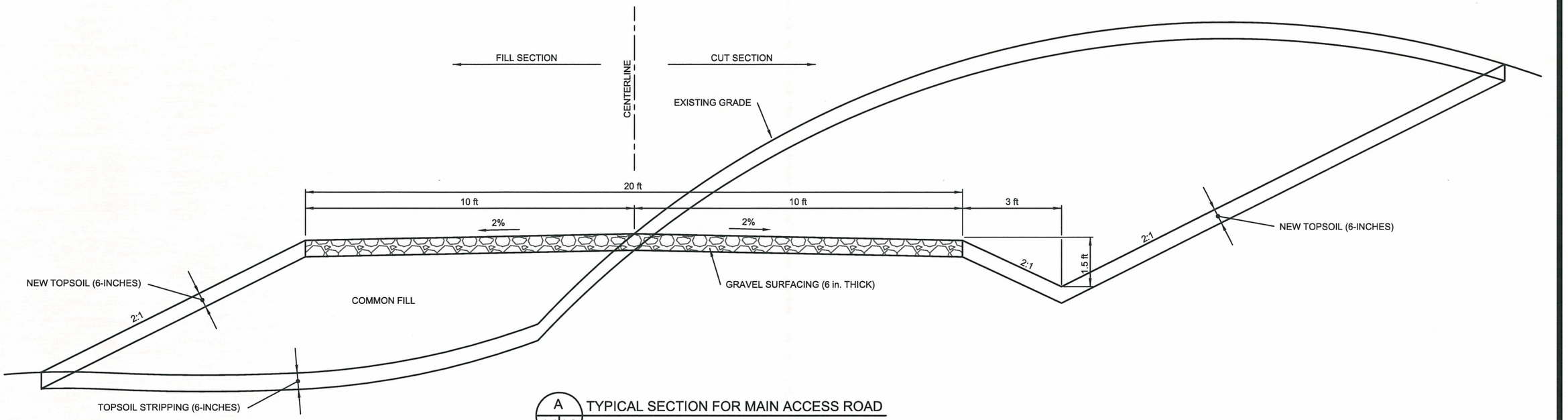
ISSUED:

FOR CONSTRUCTION SEPTEMBER 28, 2011

SHEET INDEX:

Sheet Number	Sheet Title	Sheet Description
CIV-NB-C1.1	COVER SHEET	
CIV-NB-C1.2	GENERAL NOTES	
CIV-NB-C1.3	GENERAL NOTES	
CIV-NB-C1.4	PLAN & PROFILE	STA.: 37+86.24 TO 48+00
CIV-NB-C1.5	PLAN & PROFILE	STA.: 48+00 TO 59+00
CIV-NB-C1.6	PLAN & PROFILE	STA.: 59+00 TO 70+00
CIV-NB-C1.7	PLAN & PROFILE	STA.: 70+00 TO 81+00
CIV-NB-C1.8	PLAN & PROFILE	STA.: 81+00 TO 92+00
CIV-NB-C1.9	PLAN & PROFILE	STA.: 92+00 TO 103+00
CIV-NB-C1.10	PLAN & PROFILE	STA.: 103+00 TO 114+00
CIV-NB-C1.11	PLAN & PROFILE	STA.: 114+00 TO 125+00
CIV-NB-C1.12	PLAN & PROFILE	STA.: 125+00 TO 136+00
CIV-NB-C1.13	PLAN & PROFILE	STA.: 136+00 TO 146+78.76
CIV-NB-C1.14	P-1 CULVERT	36 INCH CMP CULVERT
CIV-NB-C1.15	P-2 CULVERT	36 INCH CMP CULVERT
CIV-NB-C1.16	P-3 CULVERT	24 INCH CMP CULVERT
CIV-NB-C1.17	P-4 CULVERT	24 INCH CMP CULVERT
CIV-NB-C1.18	P-5 CULVERT	24 INCH CMP CULVERT
CIV-NB-C1.19	P-6 CULVERT	42 INCH CMP CULVERT
CIV-NB-C1.20	P-7 CULVERT	48 INCH CMP CULVERT
CIV-NB-C1.21	INTERSECTION	PLAN VIEW STATION 91+00



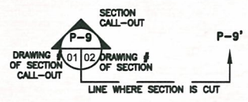


A 1.4|1.2 TYPICAL SECTION FOR MAIN ACCESS ROAD

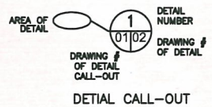
LEGEND:

- CENTERLINE
- EDGE OF NEW ROAD
- EXISTING CONTOUR (5 ft INTERVAL)
- NEW CONTOUR (FINAL GRADE 1 ft INTERVAL)
- NEW CONTOUR (FINAL GRADE 5 ft INTERVAL)
- GAS LINE (APPROXIMATE
- POWER LINE (APPROXIMATE)
- WATER LINE (APPROXIMATE)
- NEW CULVERT

Nxx°xx'xx"W / XXX.XX — BASIS OF BEARING / DISTANCE



CROSS SECTION LOCATION



DETIAL CALL-OUT

GENERAL NOTES:

2.1 GAS AND POWER LINES ALONG THE EXISTING ROADWAY ALIGNMENT HAVE NOT BEEN SURVEYED AND ARE BASED ON FIELD OBSERVATIONS. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE LOCATIONS OF ALL UTILITIES.

2.2 FINISHED GRADE REFERS TO TOP OF GROUND AFTER PLACEMENT OF SURFACE GRAVEL AND TOPSOIL.

2.3 TOPSOIL SHALL BE STRIPPED FROM ALL AREAS DISTURBED DURING CONSTRUCTION, UNLESS OTHERWISE NOTED, TO A DEPTH OF 6 INCHES BELOW EXISTING GRADE. STRIPPING OF THE EXISTING GRAVEL ROAD SURFACE IS NOT REQUIRED EXCEPT WHERE NEEDED TO PROVIDE FOR THE FULL THICKNESS OF NEW GRAVEL SURFACING.

2.4 THE EXISTING GROUND SHOWN ON PROFILES AND CROSS-SECTIONS IS BASED ON A 5-FT CONTOUR INTERVAL BASE MAP. SIGNIFICANT FLUCTUATIONS IN THE PROFILE COULD BE PRESENT BETWEEN THE CONTOUR INTERVALS.

2.5 EXCESS TOPSOIL SHALL BE STORED IN AREAS NOTED ON DRAWINGS.

2.6 COMMON FILL SHALL CONSIST OF MATERIAL OBTAINED FROM EXCAVATIONS REQUIRED FOR ROADWAY CONSTRUCTION OR OF MATERIAL OBTAINED FROM THE DESIGNATED BORROW SOURCE (STATION 82+00 RIGHT SIDE OF ROADWAY). NO ADDITIONAL EXCAVATIONS SHALL BE MADE TO OBTAIN COMMON FILL.

2.7 BORROW AREA #1 SHALL SHALL BE EXCAVATED AND COMPLETED SUCH THAT FINAL GRADE DOES NOT EXCEED 4H:1V AND SURFACE WATER DRAINAGE IS PROVIDED FOR ALL AREAS. FINAL GRADE SHALL HAVE A MINIMUM GRADE OF 1%.

2.8 ALL FILL SHALL BE PLACED AND COMPACTED TO A MINIMUM OF 95% OF MAXIMUM DRY DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698. MOISTURE SHALL BE UNIFORM THROUGHOUT EACH LIFT OF FILL.

2.9 GRAVEL SURFACING SHALL MEET THE REQUIREMENTS OF GRADING "GR" AS SPECIFIED ON TABLE 803.4.4-1 AND TABLE 803.4.4-2 OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, WYOMING DEPARTMENT OF TRANSPORTATION, 2010 EDITION.

2.10 ALL AREAS DISTURBED DURING CONSTRUCTION, UNLESS OTHERWISE SPECIFIED, SHALL BE COVERED WITH TOPSOIL WITH A MINIMUM THICKNESS OF 6 INCHES. ALL TOPSOIL SHALL BE MULCHED AND SEEDED.

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Cameco

MARK	DATE	DESCRIPTION	BY
1	9/28/11	FOR CONSTRUCTION	MAT

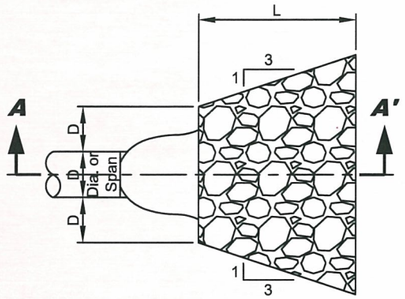
Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

GENERAL NOTES

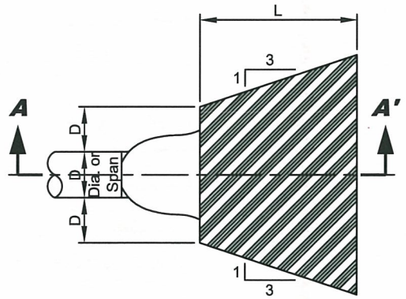
Project No.:	114-510411
Designed By:	
Drawn By:	M.TAYLOR
Checked By:	J.STRATTON

CIV-NB-C1.2



PLAN VIEW

CULVERT WITH STANDARD END SECTION

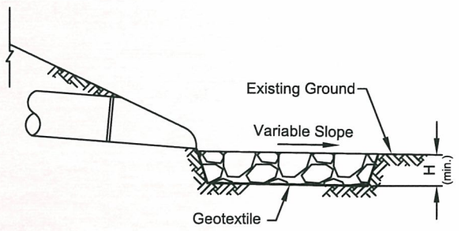


PLAN VIEW

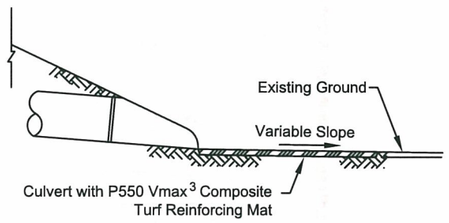
CULVERT WITH P550 Vmax[3] COMPOSITE TURF REINFORCING MAT

RIPRAP / PROTECTION AREA

CULVERT LOCATION	CULVERT TYPE	LENGTH OF PROTECTION (ft)	WIDTH OF PROTECTION (ft)
P-1	CMP	9	12
P-2	CMP	9	12
P-3	CMP	6	8
P-4	CMP	9	12
P-5	CMP	6	8
P-6	CMP	64	19
P-7	CMP	44	22



SECTION A-A'



SECTION A-A'

GENERAL NOTES

3.1 DETAIL SHEETS ARE PROVIDED FOR ALL CULVERTS 24-INCHES IN DIAMETER AND LARGER.

3.2 INVERT ELEVATIONS OF CULVERTS SHALL MATCH EXISTING GRADE. INVERT ELEVATIONS AND COORDINATES ARE NOT PROVIDED DUE TO THE ACCURACY OF THE BASE SURVEY. INVERT ELEVATIONS AND CULVERT ORIENTATION SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE.

3.3 FLARED END SECTIONS SHALL BE PROVIDED FOR CULVERTS 42-INCHES IN DIAMETER AND LARGER.

3.4 DOWNSTREAM EROSION CONTROL AT EACH CULVERT SHALL CONSIST OF RIP-RAP OR PERMANENT EROSION CONTROL MATS.

3.5 RIP-RAP SECTIONS SHALL CONSIST OF 18-INCH THICK RIP-RAP SECTION OVERLYING A 12-INCH THICK BEDDING SECTION. FINAL RIP-RAP GRADE SHALL MATCH EXISTING GRADE. RIP-RAP SHALL HAVE A NOMINAL DIAMETER OF 9-INCHES. BEDDING SHALL CONSIST OF CLASS II BEDDING SAND.

3.6 PERMANENT EROSION CONTROL MAT SHALL CONSIST OF NORTH AMERICAN GREEN P550 Vmax3 COMPOSITE TURF REINFORCING MAT (NO SUBSTITUTIONS). MAT SHALL BE INSTALLED OVER EXISTING GRADE (NO TOPSOIL STRIPPING) AND SHALL BE SECURED AS SPECIFIED BY THE MANUFACTURER.

3.7 18-INCH DIAMETER CULVERTS SHALL BE INSTALLED GENERALLY AS SHOWN ON THE PLAN AND PROFILE SHEETS. 18-INCH DIAMETER CULVERTS SHALL BE PROVIDED WITH A MINIMUM OF 12-INCHES OF SOIL COVER. EXCAVATION AT THE UPSTREAM INVERT MAY BE REQUIRED. DETAIL SHEETS ARE NOT PROVIDED FOR 18-INCH DIAMETER CULVERTS.

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Cameco

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1	9/28/11	FOR CONSTRUCTION	MAT

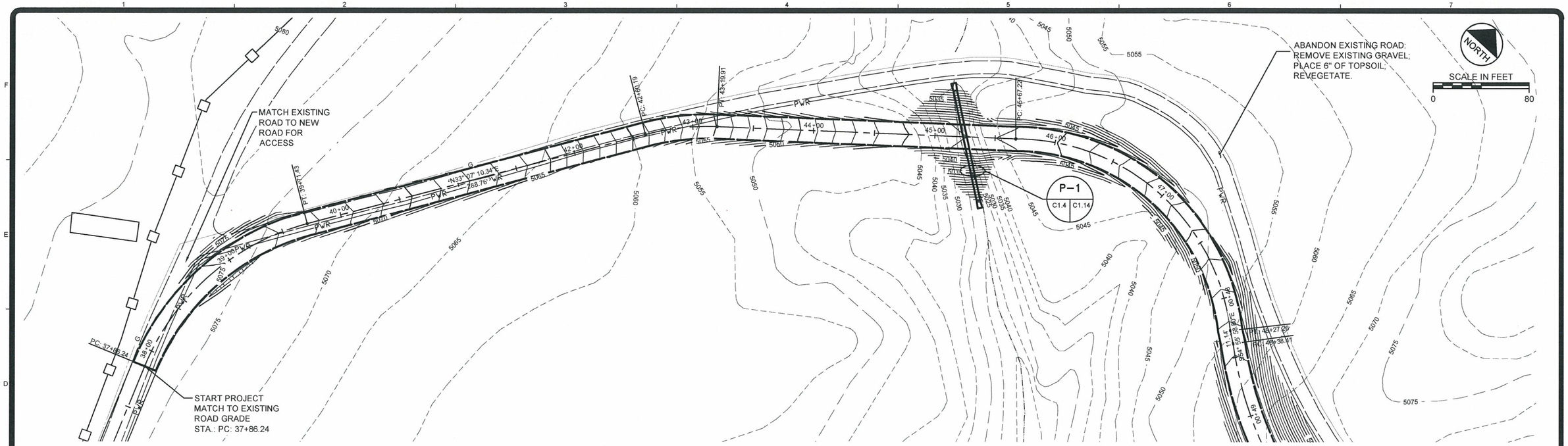
Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

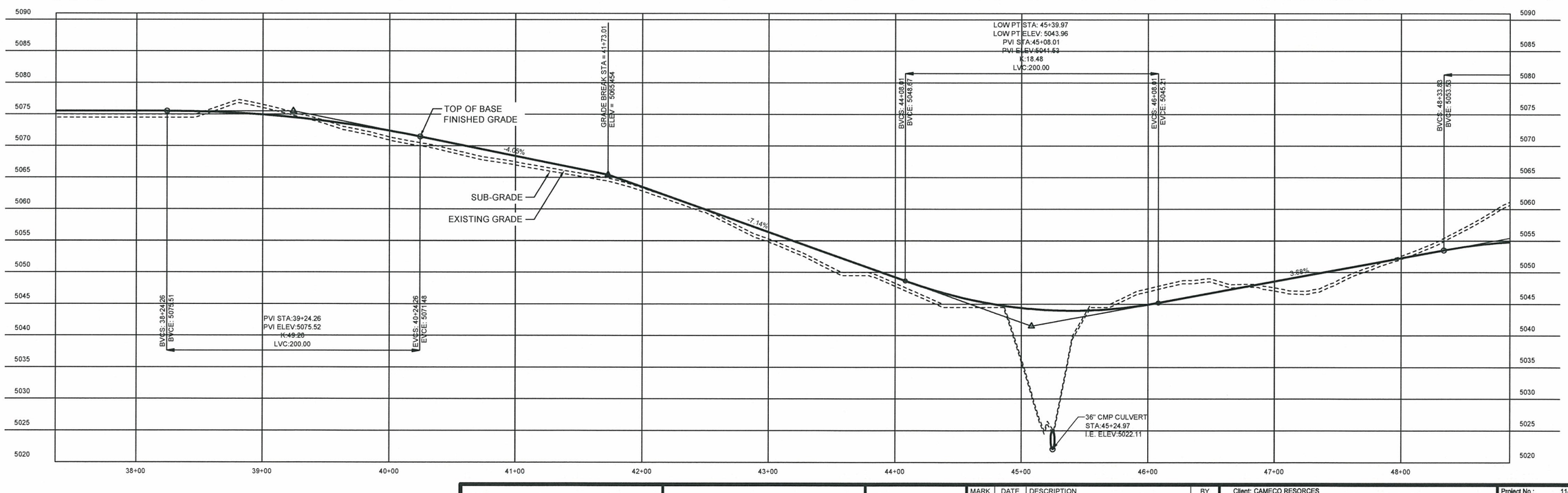
CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

GENERAL NOTES

Project No.:	114-510411
Designed By:	
Drawn By:	M.TAYLOR
Checked By:	J.STRATTON

CIV-NB-C1.3





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1	9/28/11	FOR CONSTRUCTION	KMH

Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 37+86.24 TO 48+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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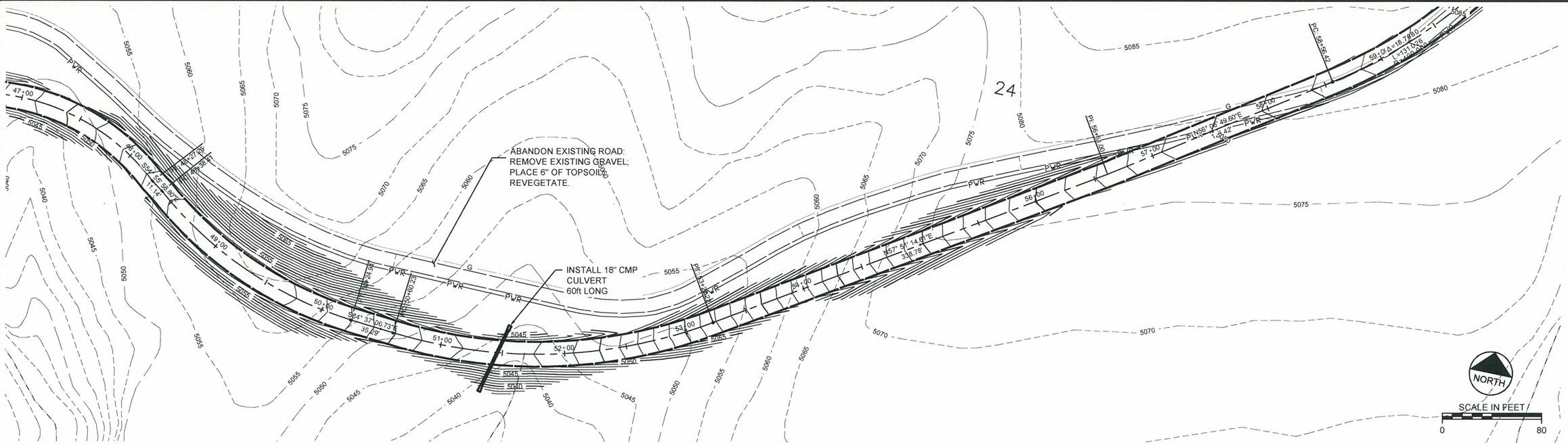

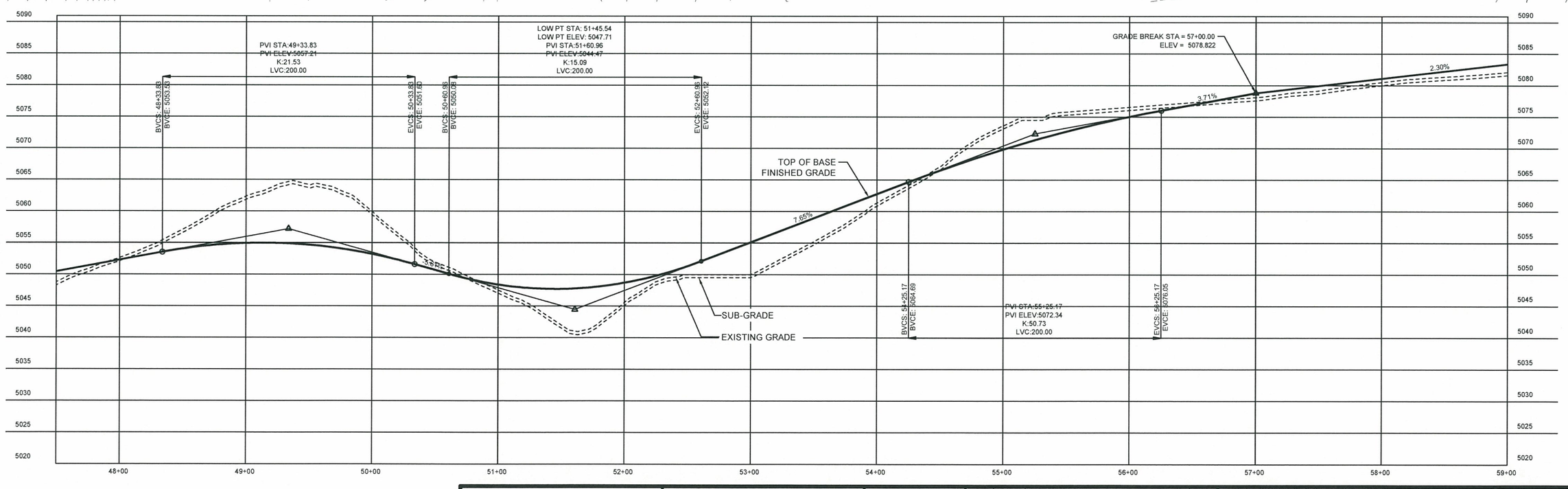

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1	9/28/11	FOR CONSTRUCTION	KMH

Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 48+00 TO 59+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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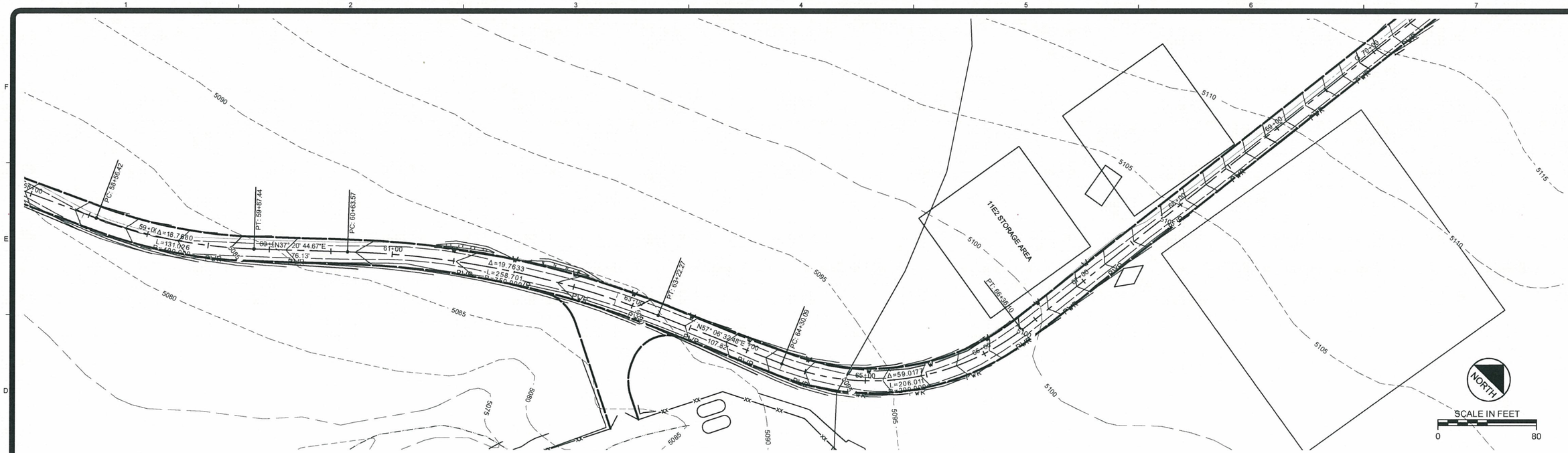

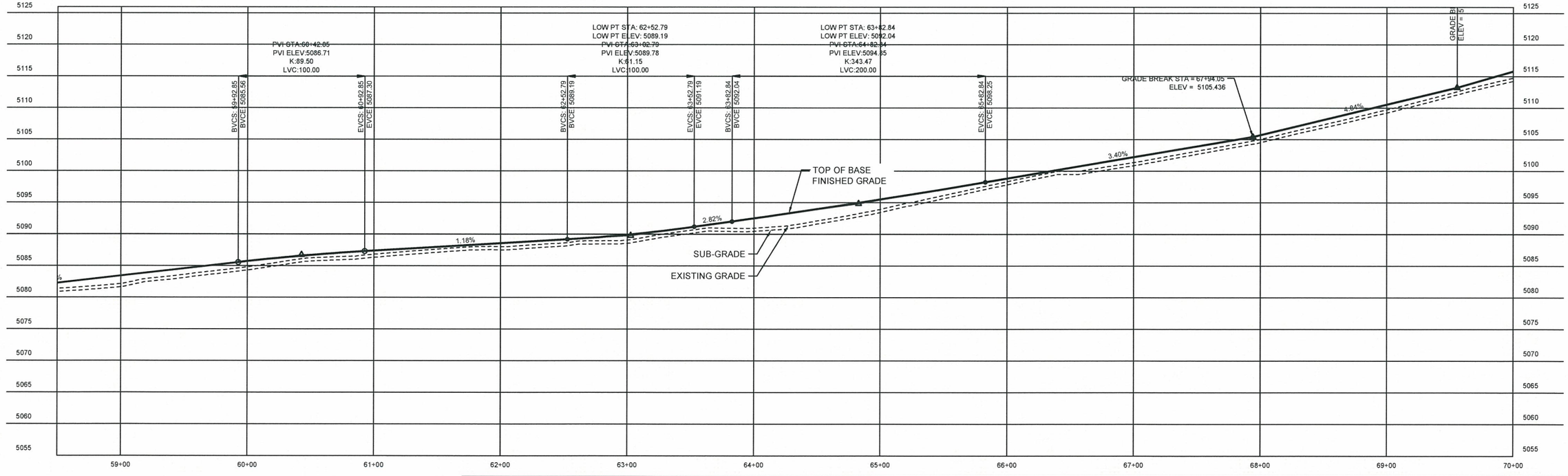

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 59+00 TO 70+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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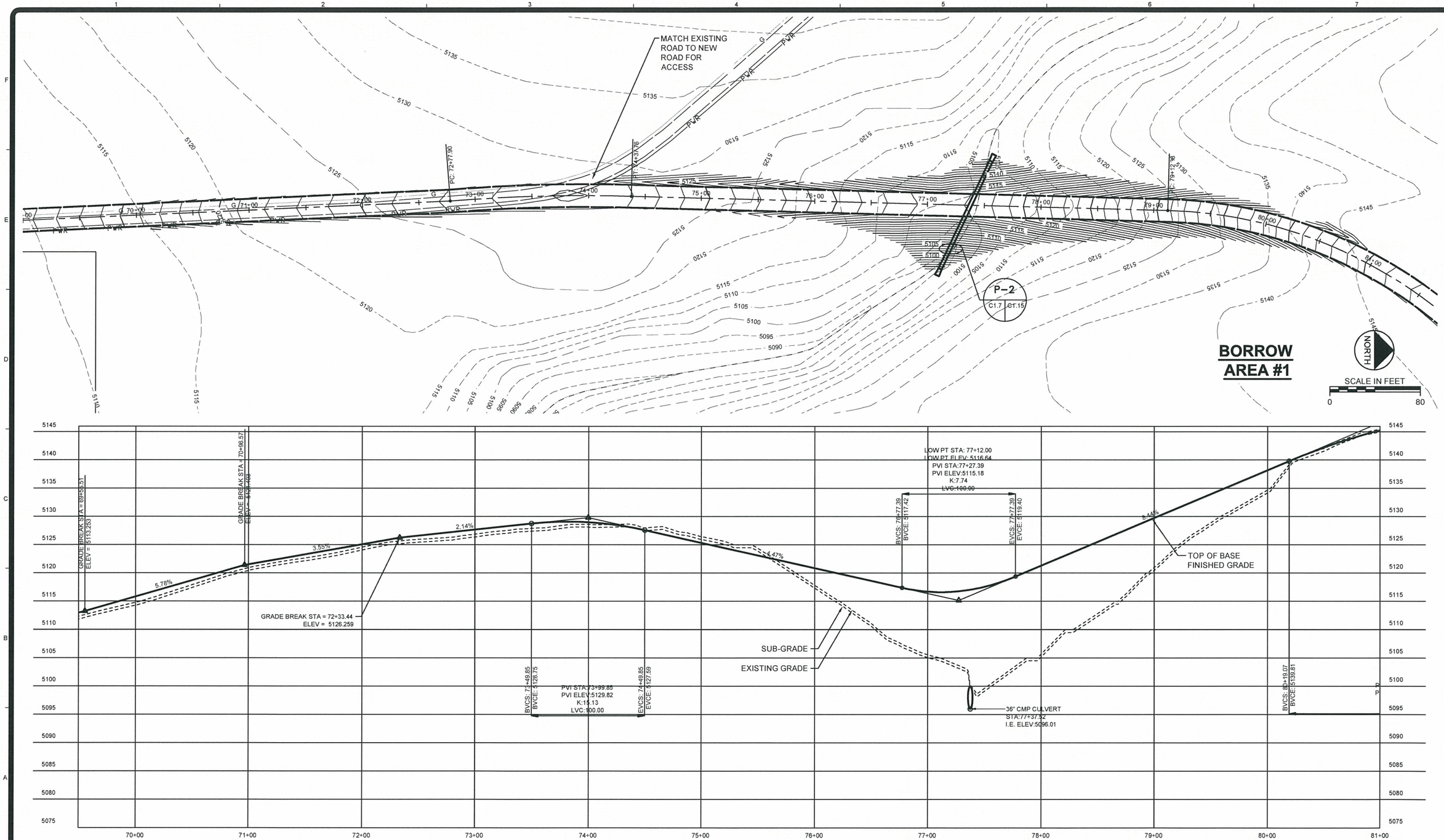

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 70+00 TO 81+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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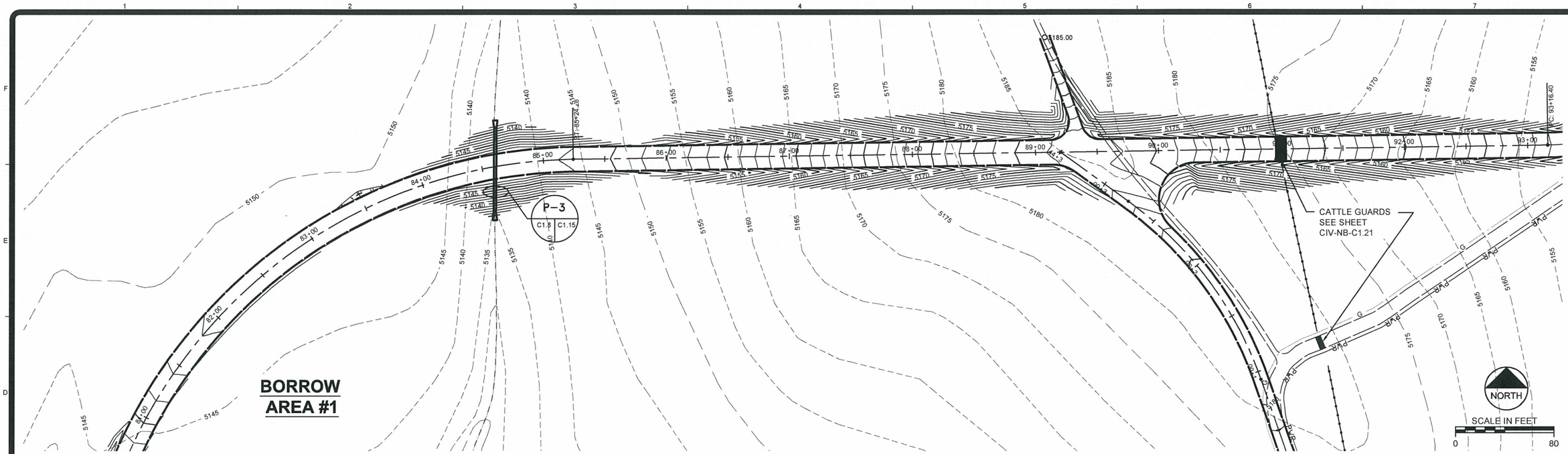

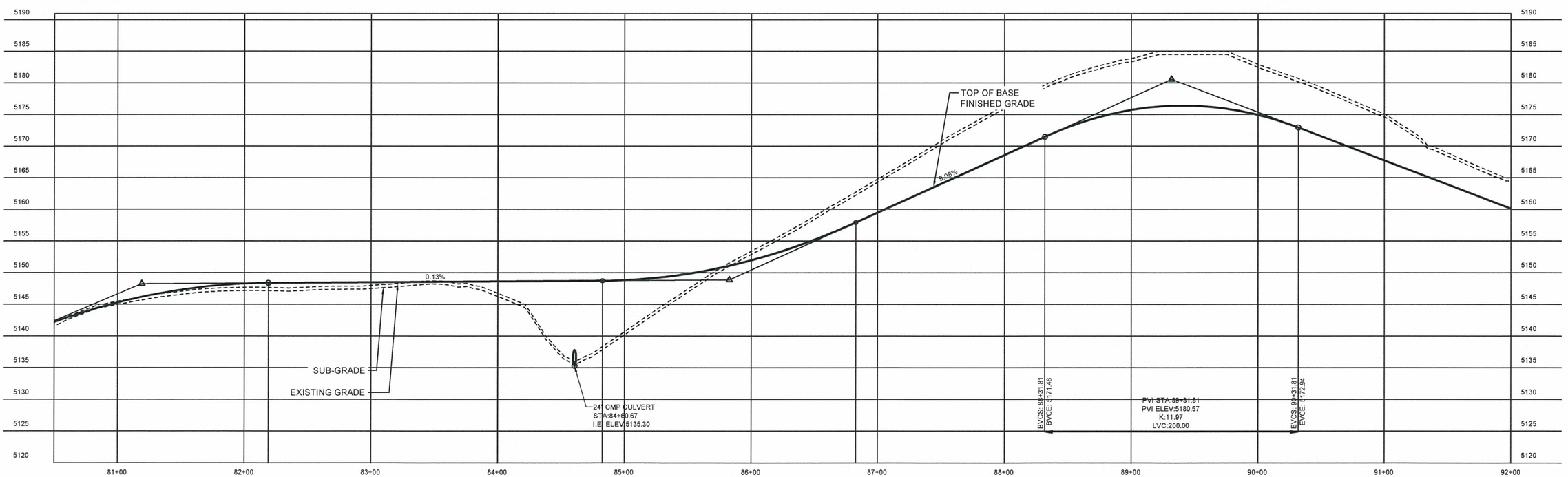

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 81+00 TO 92+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.8

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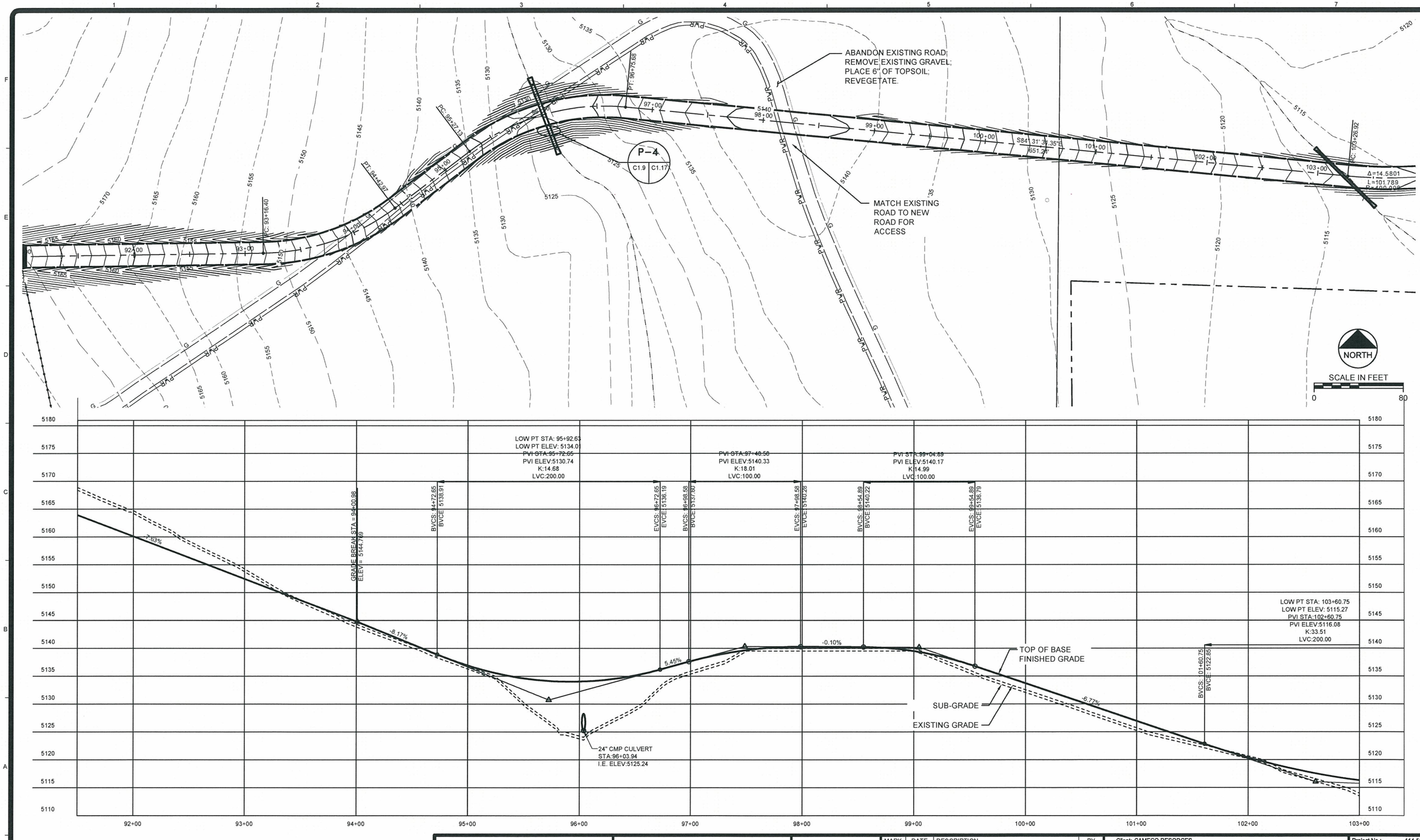

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 92+00 TO 103+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.9

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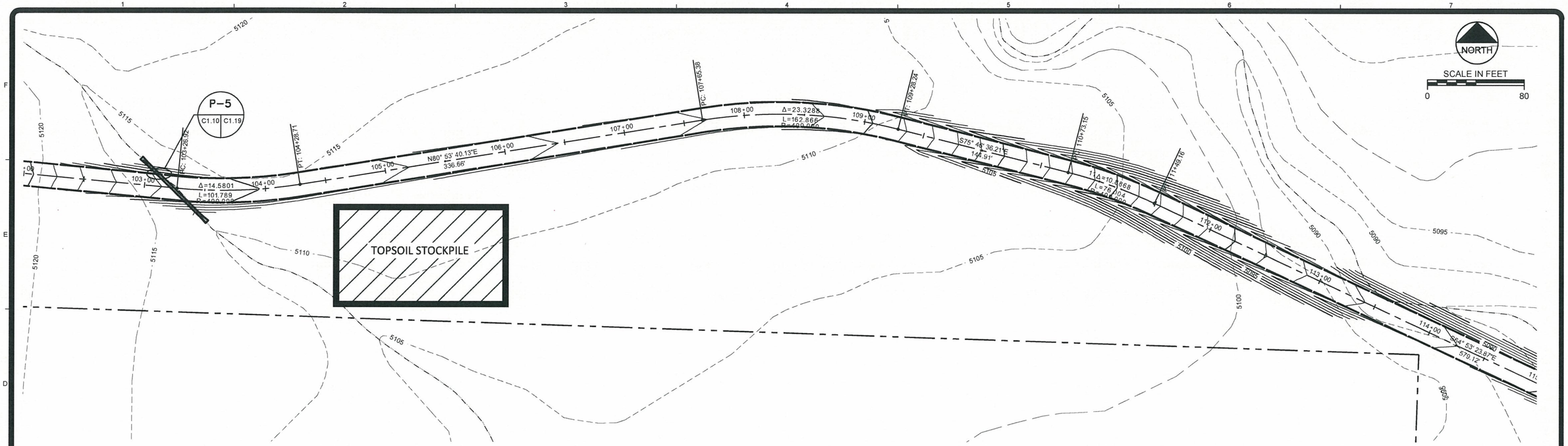

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TETRA TECH
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PHONE: 307-234-2126 FAX: 307-266-5143

Cameco

MARK	DATE	DESCRIPTION	BY
1	9/28/11	FOR CONSTRUCTION	KMH

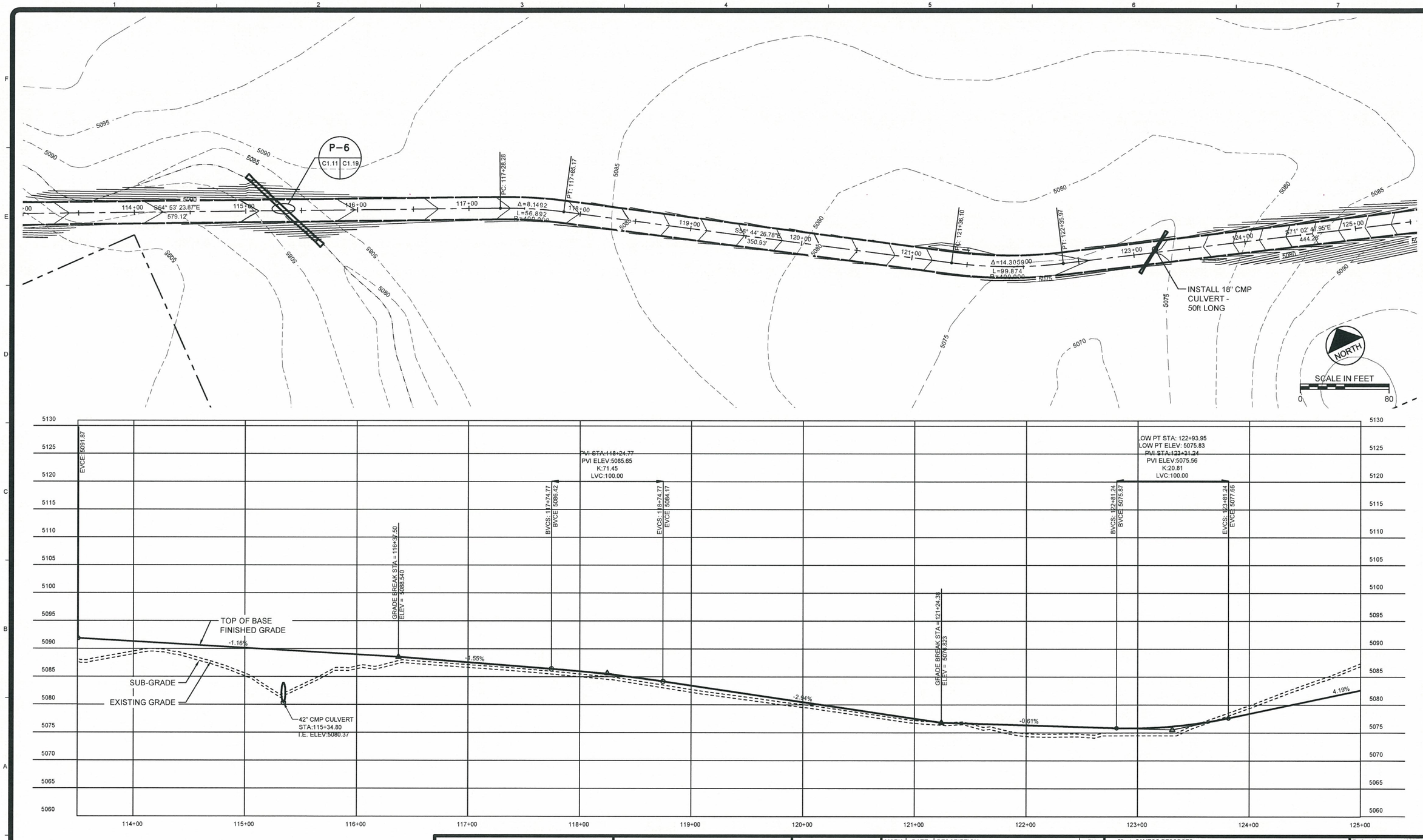
Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.75W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 103+00 TO 114+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.10



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MARK	DATE	DESCRIPTION	BY
1	9/28/11	FOR CONSTRUCTION	KMH

Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

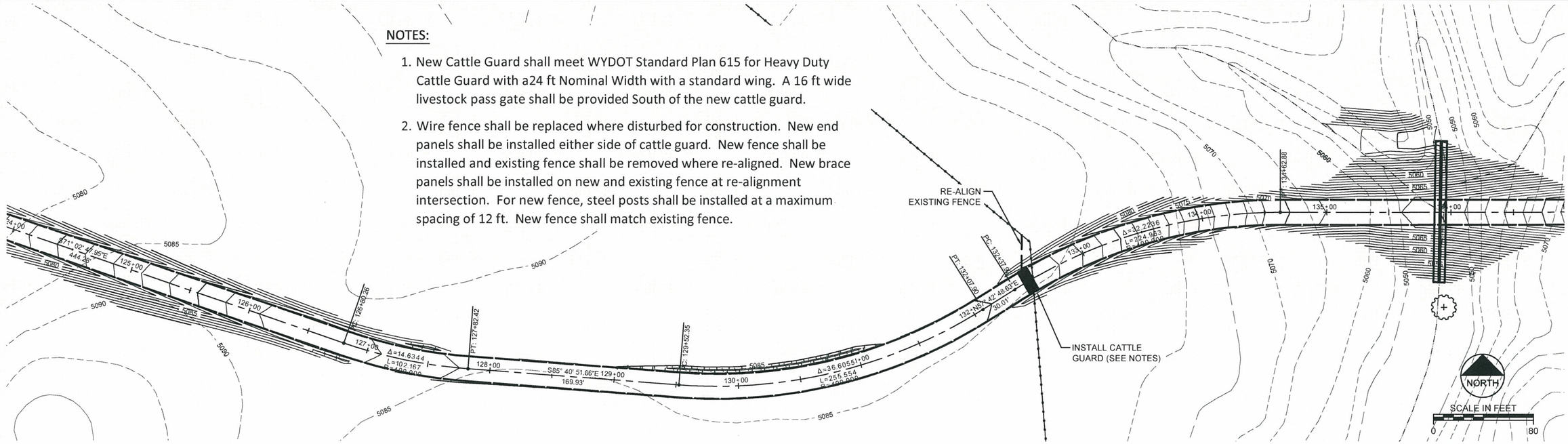
PLAN & PROFILE
STA.: 114+00 TO 125+00

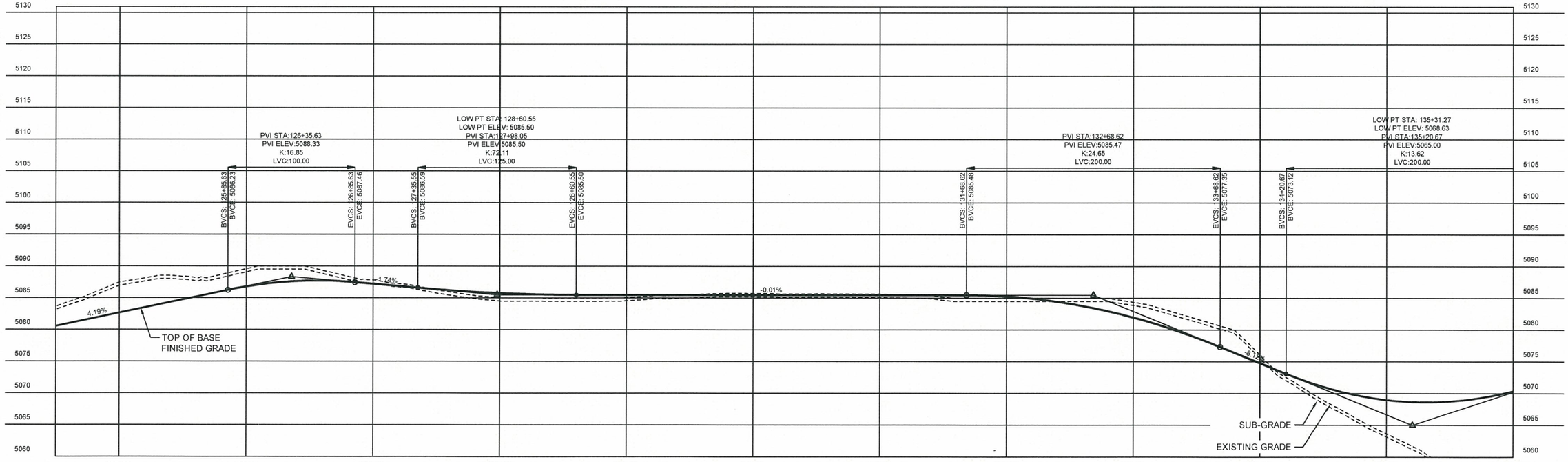
Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.11

NOTES:

1. New Cattle Guard shall meet WYDOT Standard Plan 615 for Heavy Duty Cattle Guard with a24 ft Nominal Width with a standard wing. A 16 ft wide livestock pass gate shall be provided South of the new cattle guard.
2. Wire fence shall be replaced where disturbed for construction. New end panels shall be installed either side of cattle guard. New fence shall be installed and existing fence shall be removed where re-aligned. New brace panels shall be installed on new and existing fence at re-alignment intersection. For new fence, steel posts shall be installed at a maximum spacing of 12 ft. New fence shall match existing fence.





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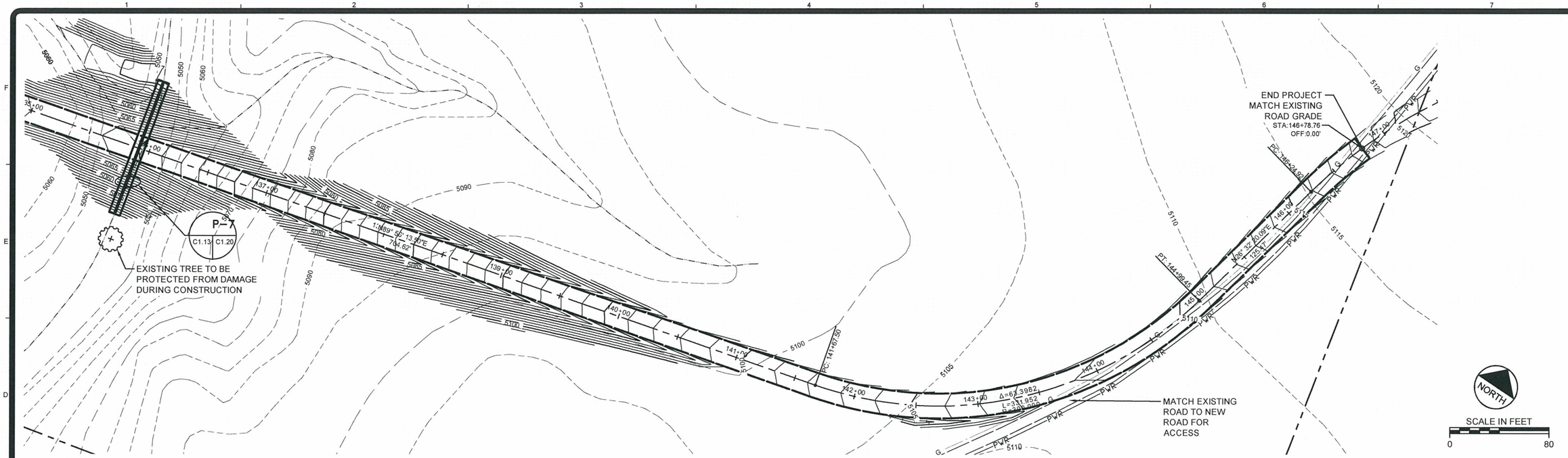
Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

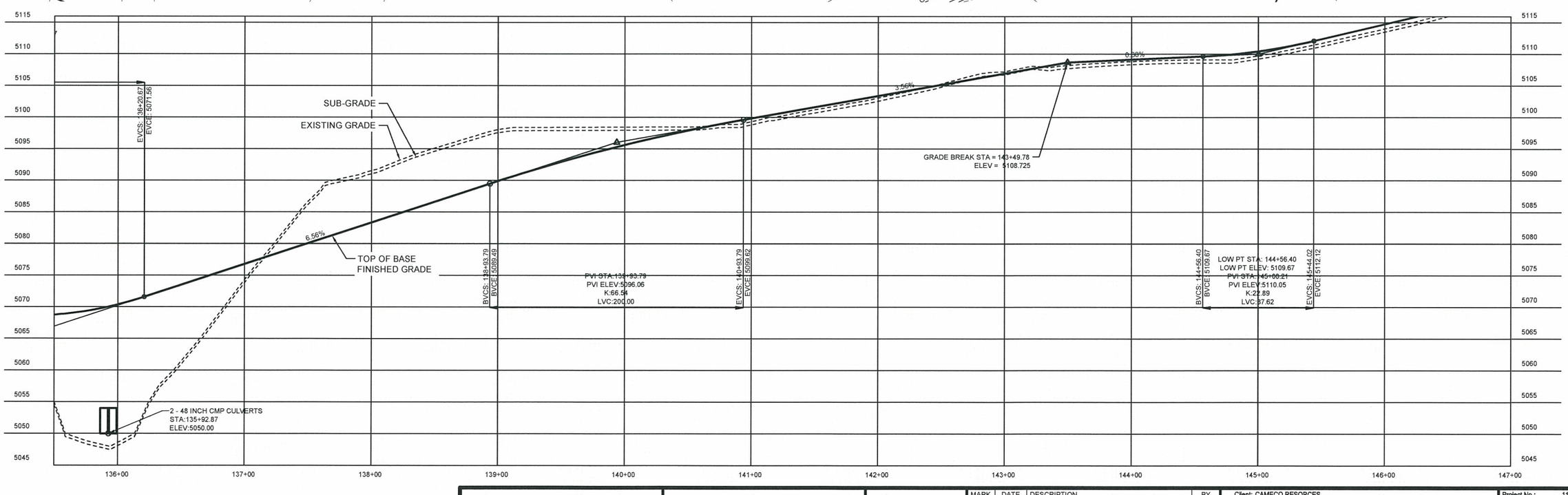
CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

PLAN & PROFILE
STA.: 125+00 TO 136+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.12





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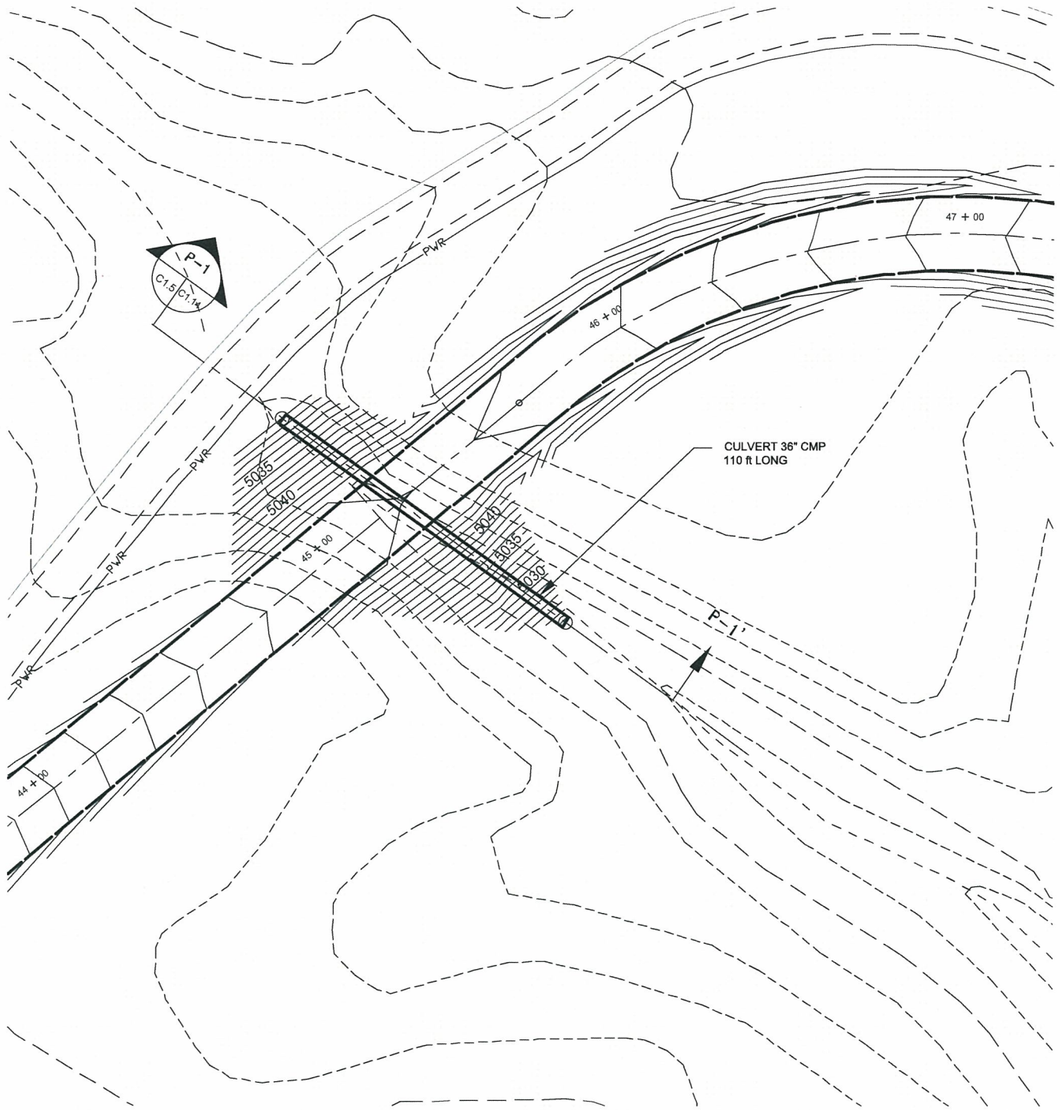
Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

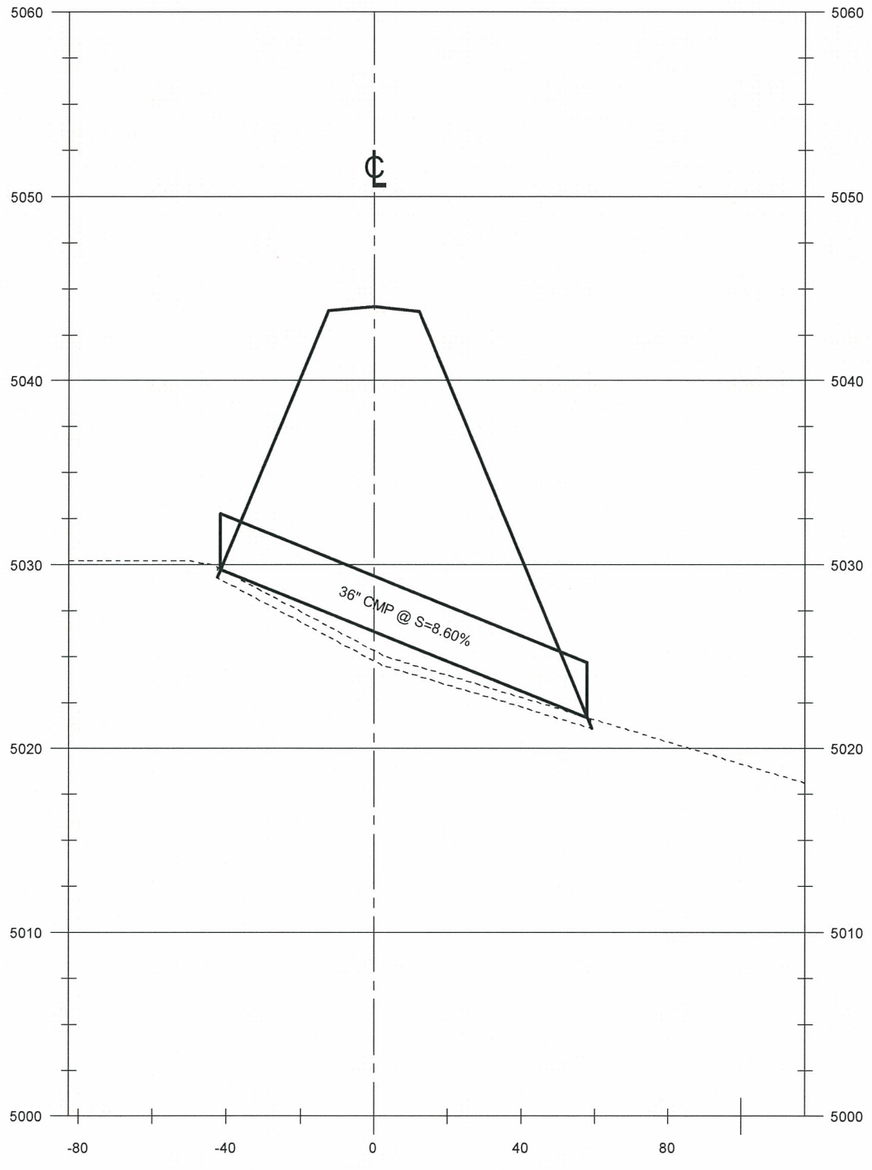
PLAN & PROFILE
STA.: 136+00 TO 146+78.76

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

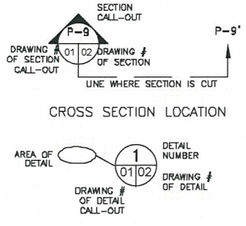
CIV-NB-C1.13



PLAN VIEW



PROFILE



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Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-1

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.14

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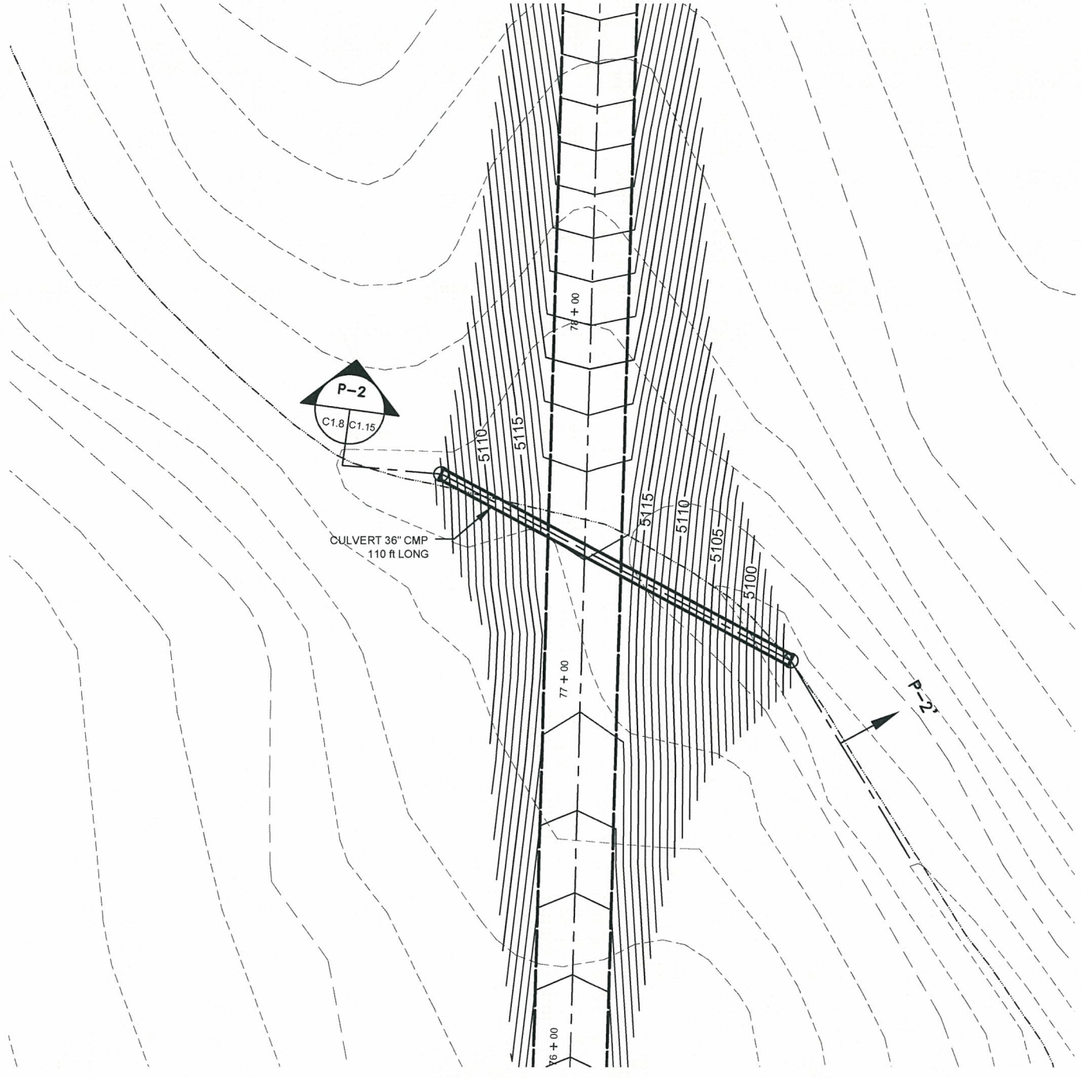
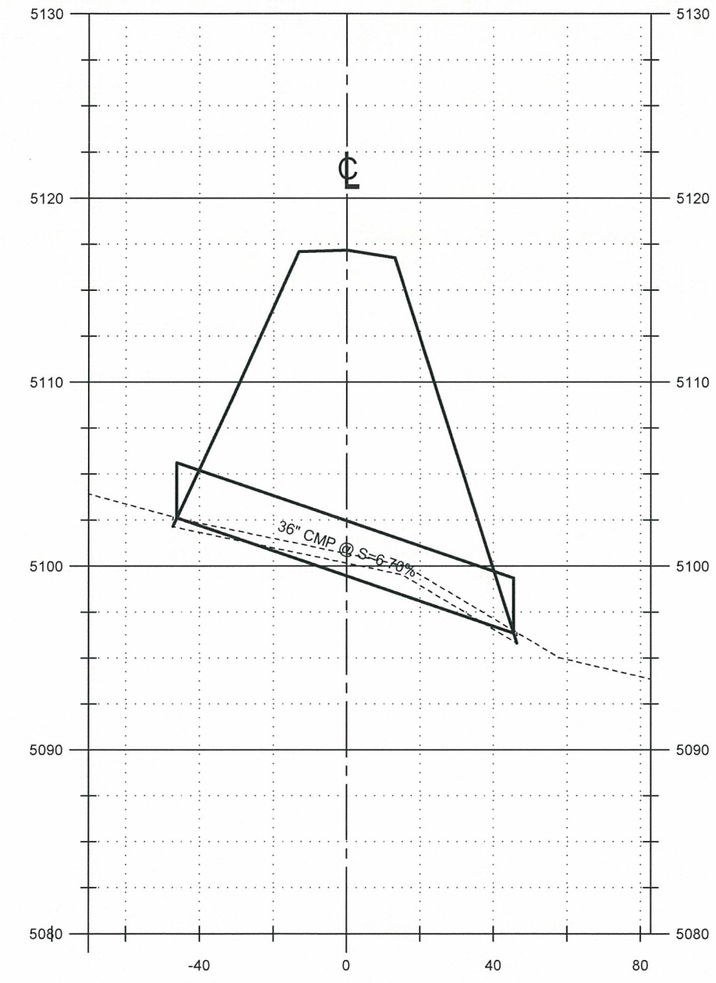


PLAN VIEW



P-2
C1.8 C1.15

PROFILE

SCALE IN FEET
0 40

NORTH

SCALE IN FEET
0 40

SECTION CALL-OUT
P-9
01 02
DRAWING # OF SECTION CALL-OUT
DRAWING # OF SECTION
LINE WHERE SECTION IS CUT
P-9'

CROSS SECTION LOCATION

AREA OF DETAIL
1
01 02
DETAIL NUMBER
DRAWING # OF DETAIL CALL-OUT
DRAWING # OF DETAIL

DETIAL CALL-OUT

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-2

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.15

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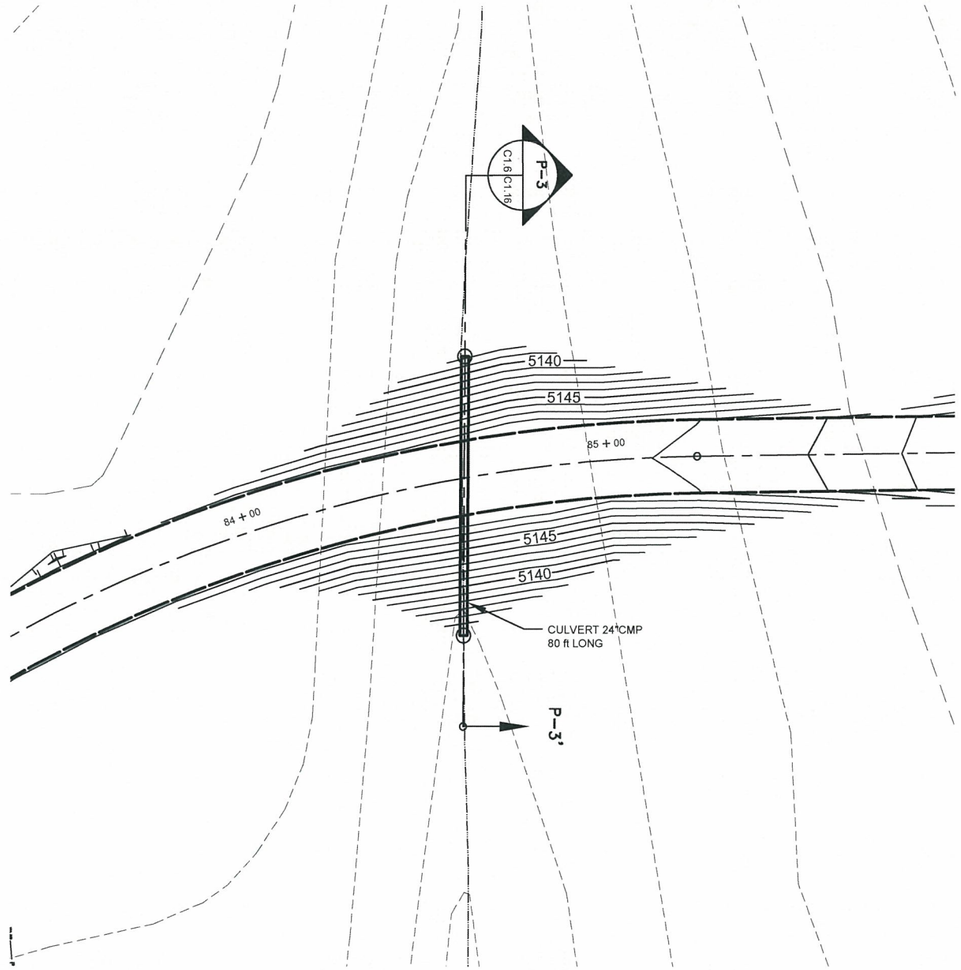
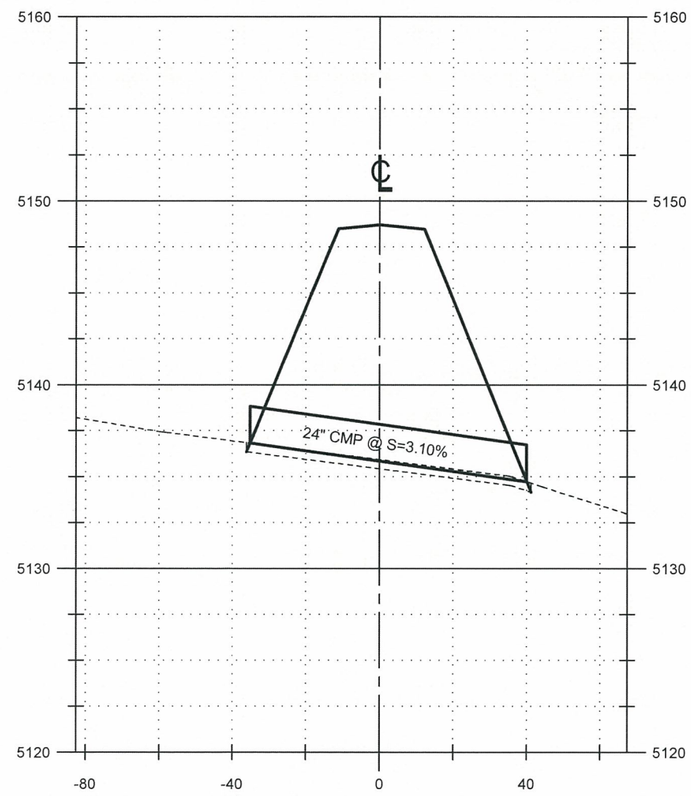


PLAN VIEW

NORTH

SCALE IN FEET

0 40

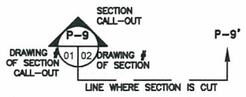


PROFILE

P-3
C1.6 C1.16

SCALE IN FEET

0 40



CROSS SECTION LOCATION

DETIAL CALL-OUT

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Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

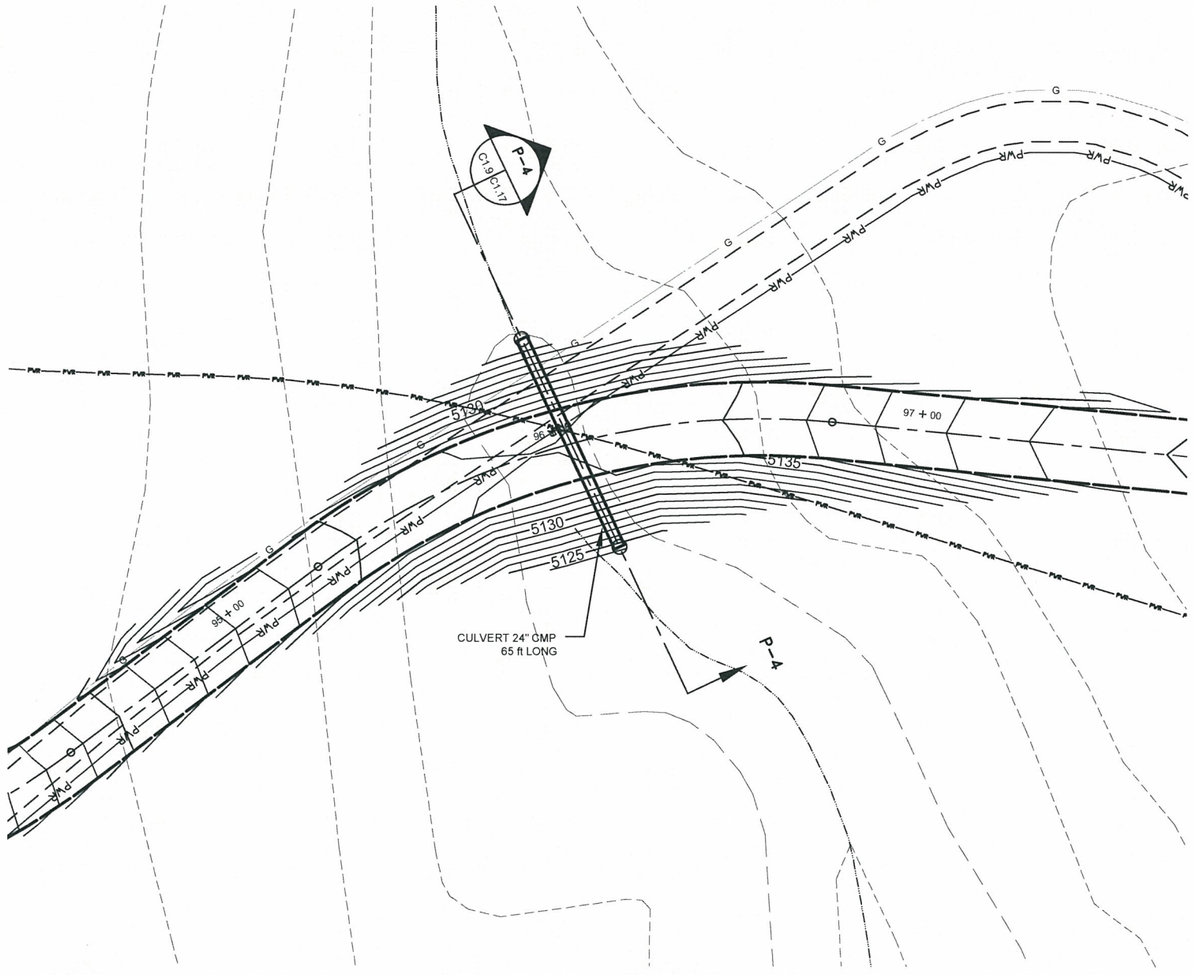
CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-3

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.16

9/28/2011 1:05:09 PM - N:\GEO\2011 GEO JOBS\1114-510411 - CAMECO - N. BUTTE ROAD DESIGN\CIVIL\PRODUCTION DRAWINGS\DRAFTING\C-SP-NORTH BUTTE-DRAINAGE.DWG - HAUF, KEN



PLAN VIEW

NORTH

SCALE IN FEET

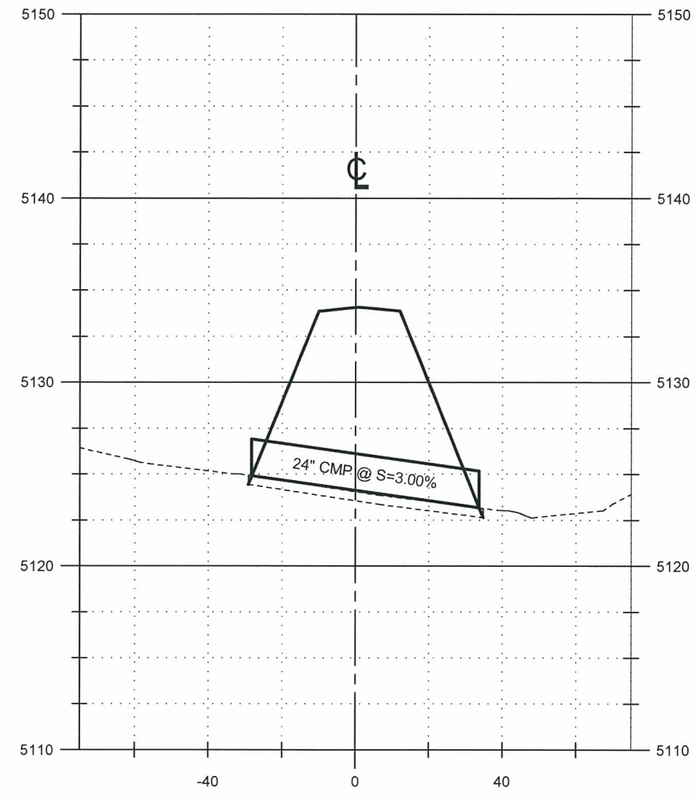
0 40

SECTION CALL–OUT
P–9
DRAWING # OF SECTION CALL–OUT
01 02
DRAWING # OF SECTION
P–9'
LINE WHERE SECTION IS CUT

CROSS SECTION LOCATION

AREA OF DETAIL
1
01 02
DETAIL NUMBER
DRAWING # OF DETAIL CALL–OUT
DRAWING # OF DETAIL

DETIAL CALL–OUT



P–4
C1.9 C1.17

PROFILE

SCALE IN FEET

0 40

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-4

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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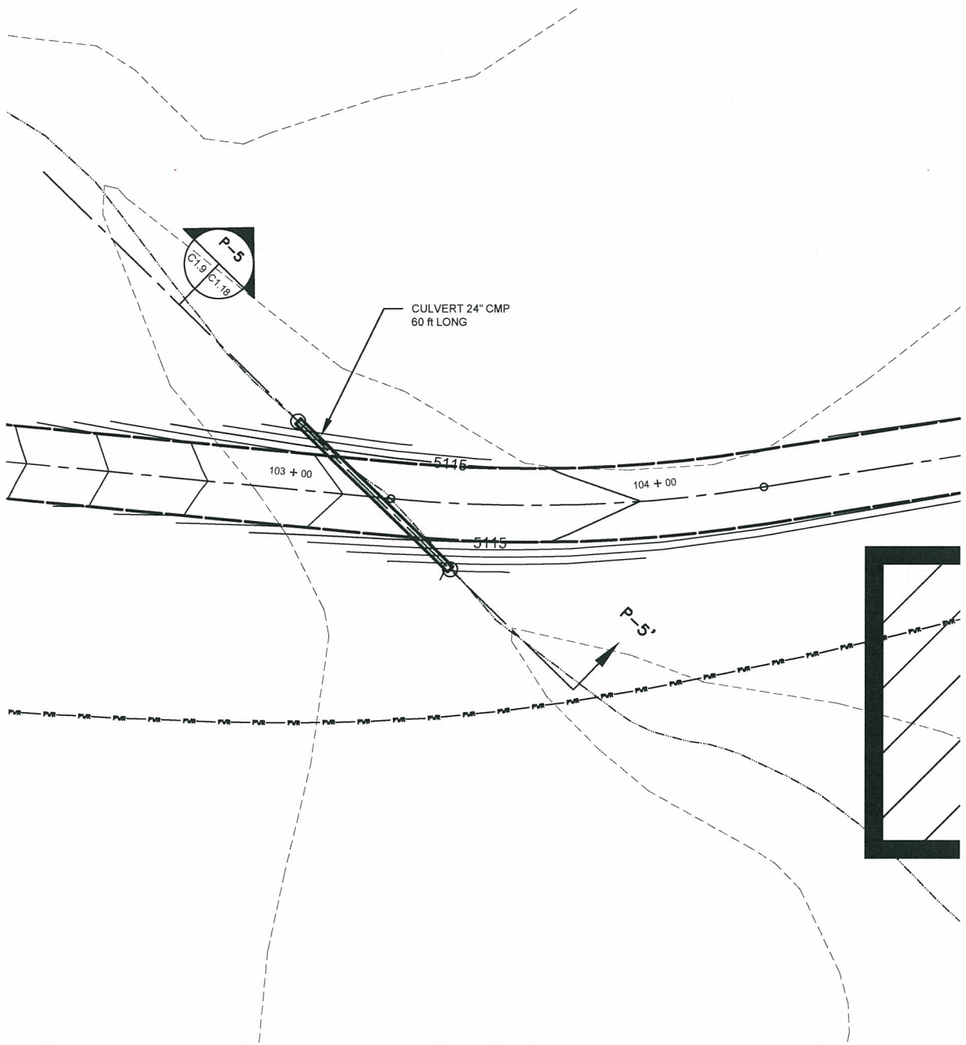


PLAN VIEW

NORTH

SCALE IN FEET

0 40

SECTION CALL-OUT

P-9

DRAWING OF SECTION CALL-OUT

01 02

DRAWING # OF SECTION

P-9'

LINE WHERE SECTION IS CUT

CROSS SECTION LOCATION

AREA OF DETAIL

1

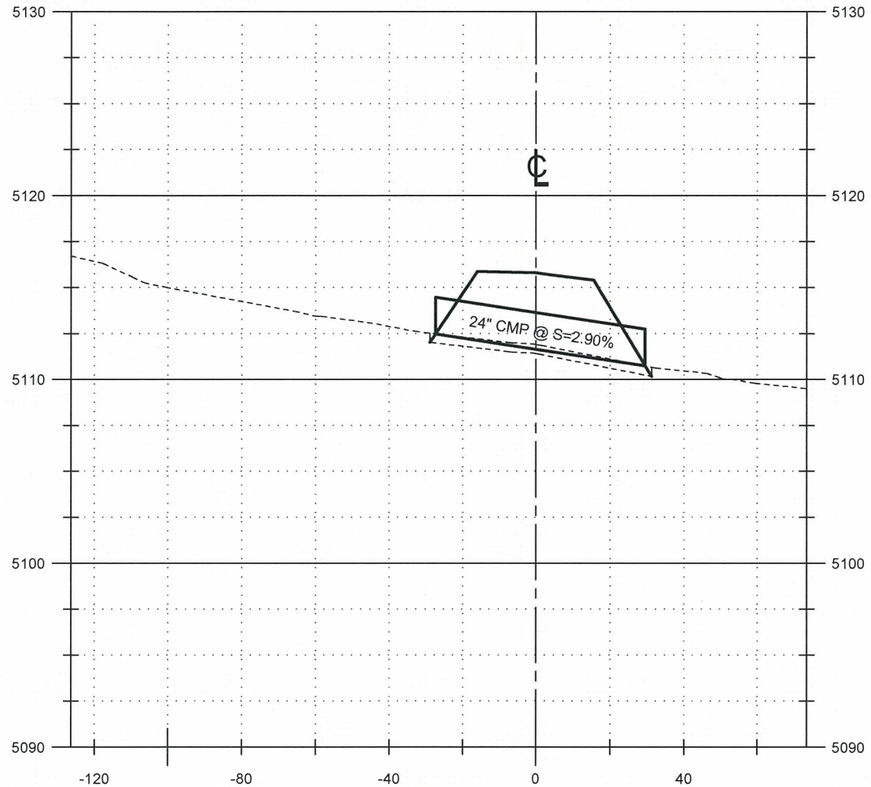
01 02

DETAIL NUMBER

DRAWING # OF DETAIL

DRAWING # OF DETAIL CALL-OUT

DETIAL CALL-OUT



P-5

C1.9 C1.18

PROFILE

SCALE IN FEET

0 40

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-5

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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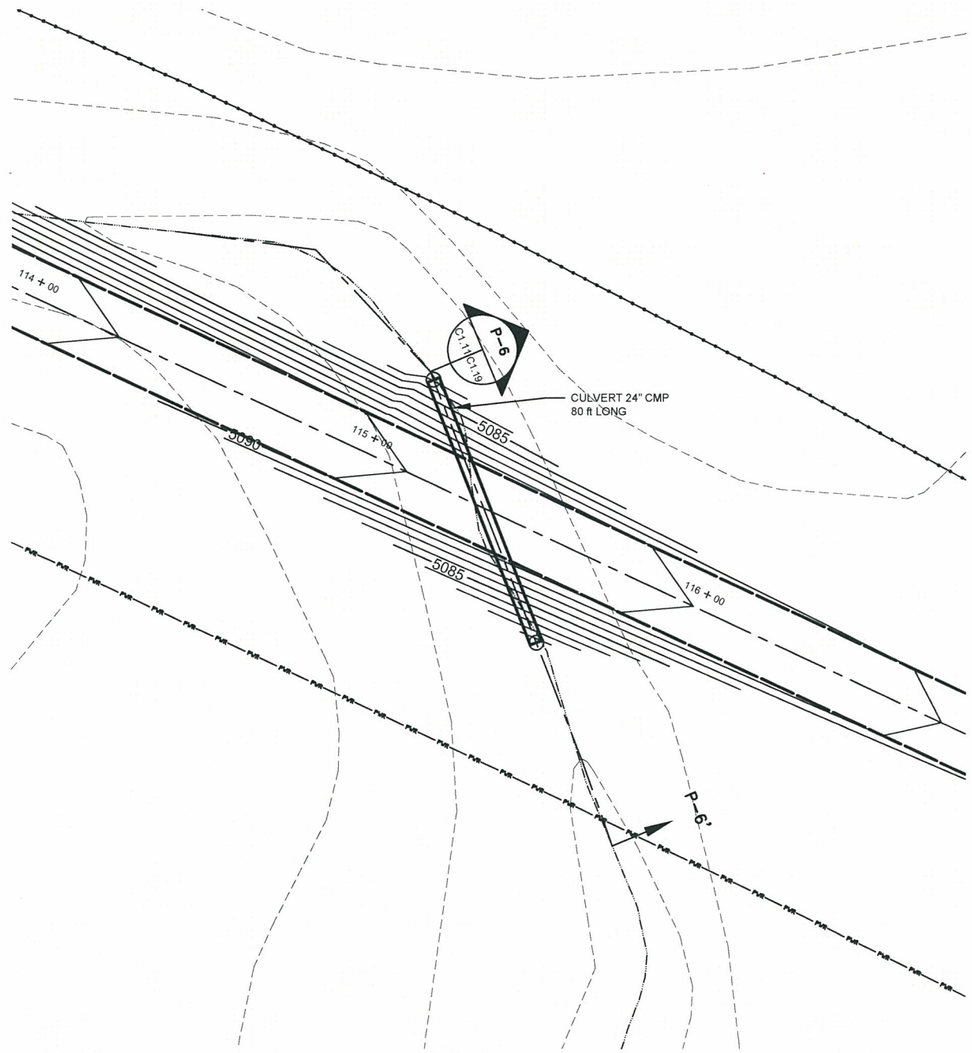
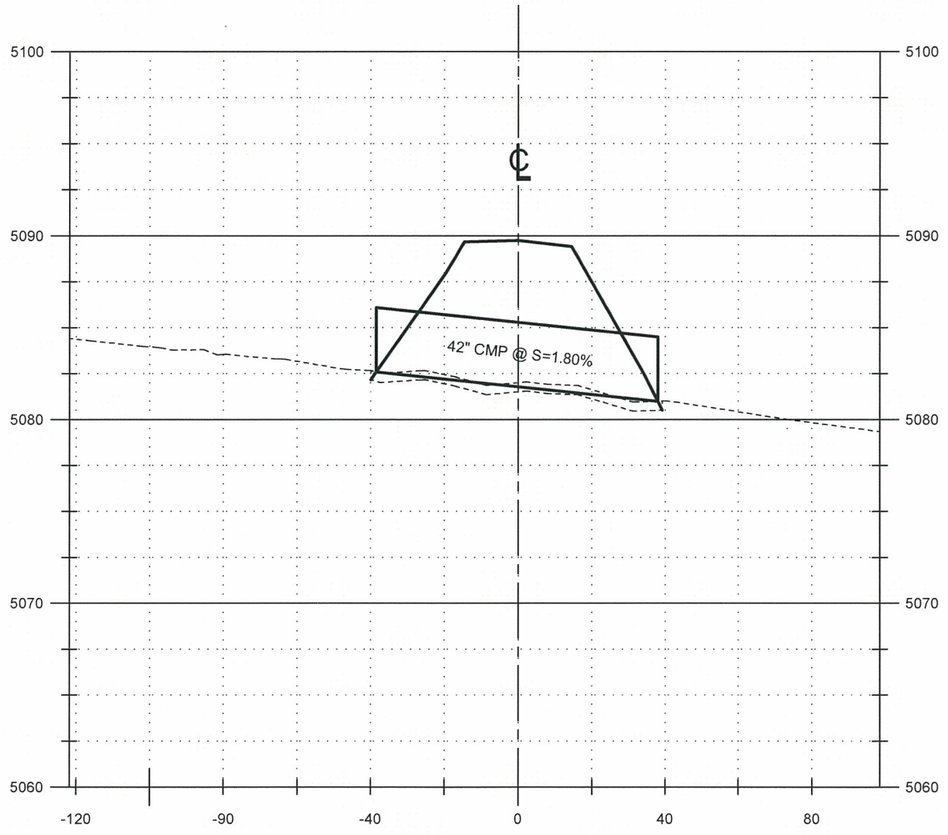


PLAN VIEW



P–6 (C1.11 | C1.19)

PROFILE

SCALE IN FEET
0 40

NORTH

SCALE IN FEET
0 40

SECTION CALL–OUT
P–9
01 | 02
DRAWING # OF SECTION CALL–OUT
DRAWING # OF SECTION
LINE WHERE SECTION IS CUT
P–9'

CROSS SECTION LOCATION

AREA OF DETAIL
1
01 | 02
DETAIL NUMBER
DRAWING # OF DETAIL CALL–OUT
DRAWING # OF DETAIL

DETIAL CALL–OUT

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-6

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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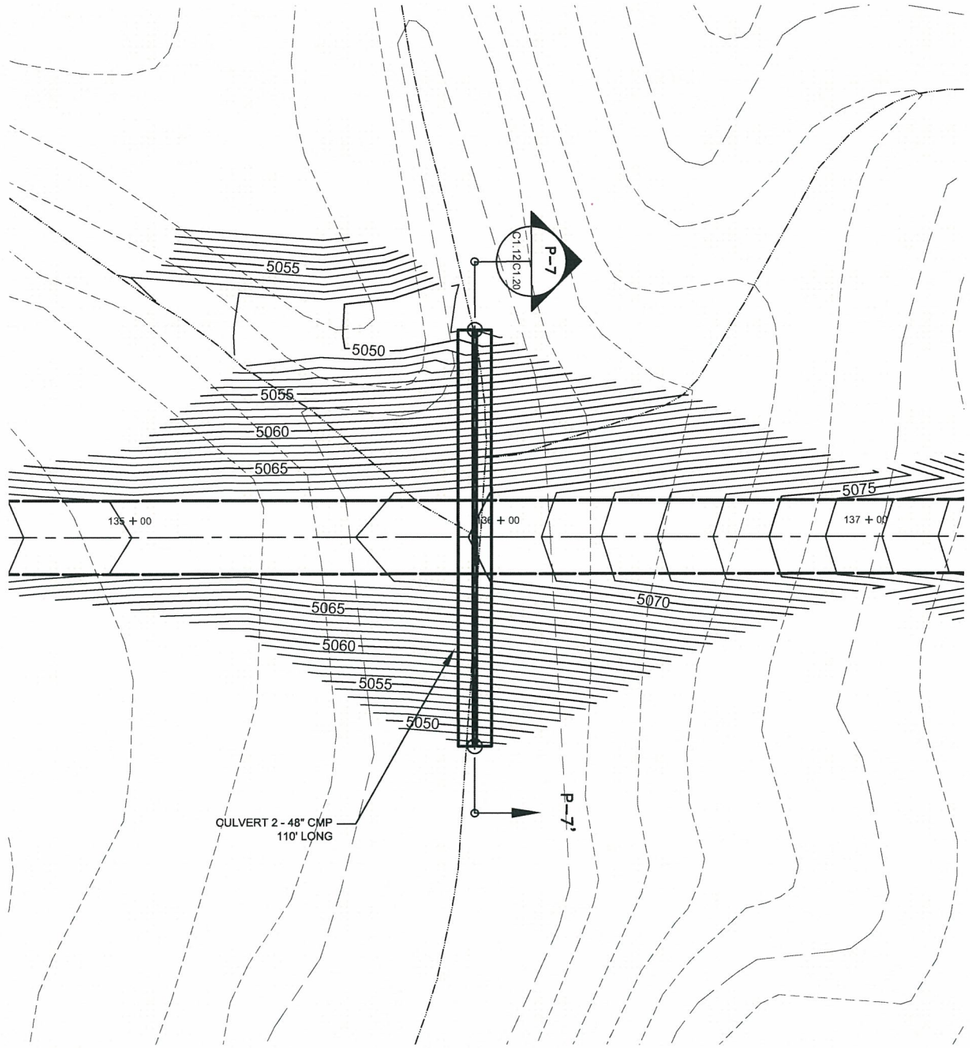
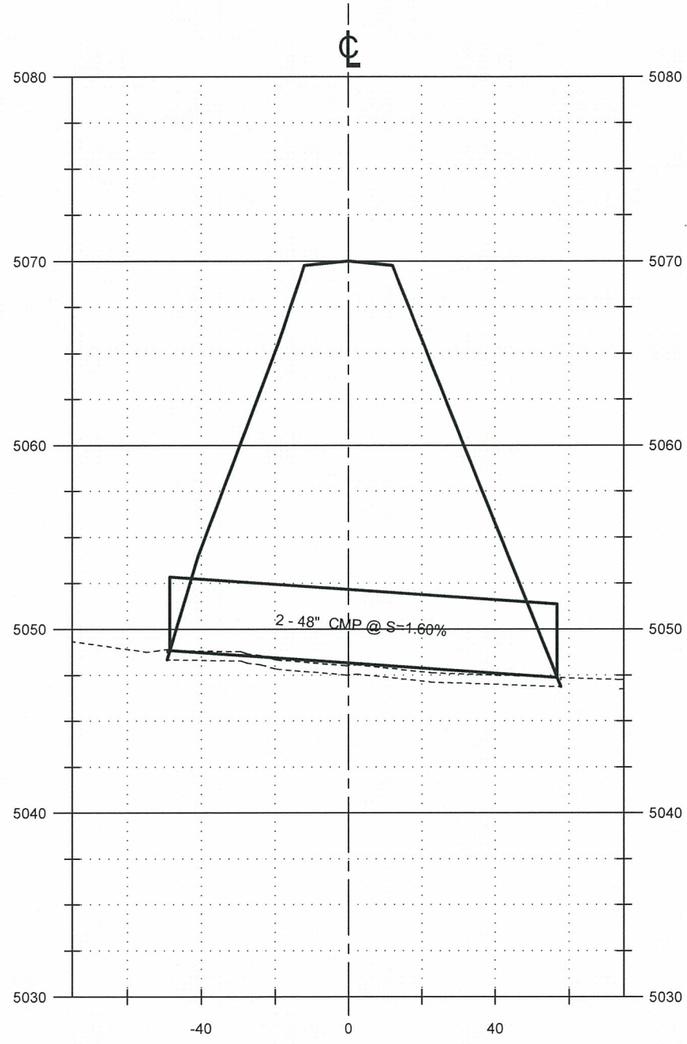


PLAN VIEW



PROFILE

NORTH

SCALE IN FEET
0 40

P-7
C1.12 C1.20

SCALE IN FEET
0 40

SECTION CALL-OUT
P-9
01 02
DRAWING # OF SECTION CALL-OUT
DRAWING # OF SECTION
LINE WHERE SECTION IS CUT
P-9'

CROSS SECTION LOCATION

AREA OF DETAIL
1
01 02
DETAIL NUMBER
DRAWING # OF DETAIL CALL-OUT
DRAWING # OF DETAIL

DETIAL CALL-OUT

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CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

CULVERT P-7

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

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EXISTING ROAD TO REMAIN IN PLACE

MATCH EXISTING

℄ 85.00

8.0

INSTALL CATTLE GUARD (SEE NOTES)

ABANDON EXISTING ROAD: REMOVE EXISTING GRAVEL; PLACE 6" OF TOPSOIL; REVEGETATE.

12.0

REMOVE EXISTING CATTLE GUARD AND REPAIR FENCE (SEE NOTES)

MATCH EXISTING

℄ 5178.46

EXISTING ROAD TO REMAIN IN PLACE

NOTES:

1. Existing Cattle Guard shall be removed and placed in fenced equipment yard west of station 38+00.
2. After removing existing cattleguard, the resulting ground shall be levelled and the opening shall be closed with new fence. The existing fence brace/end panels shall remain in place. New fence to fill the opening shall have steel fence posts at 12 ft minimum spacing. Existing livestock pass gates shall remain in-place and operational.
3. New Cattle Guard shall meet WYDOT Standard Plan 615 for Heavy Duty Cattle Guard with a24 ft Nominal Width with a standard wing. A new livestock pass gate is not required.
4. An opening in the existing fence shall be provided for the new cattle guard location. New brace/end panels shall be provided on either side of the cattle guard and fence repaired/stretched to meet project specifications and to match existing fencing. New livestock pass gates are not required.
5. New roadways north and south of the main road shall be dimensioned as shown and shall be surfaced with the same material as the main access road.

NORTH

SCALE IN FEET

0 50

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Client: CAMECO RESORCES
Proj. Loc.: Sec.25 & 26, T.44N., R.76W and Sec.19, T.45N., R.75W., of the 6th P.M.

CAMECO RESORCES
NORTH BUTTE ACCESS ROAD

INTERSECTION PLAN VIEW STATION 91+00

Project No.:	114-510411
Designed By:	K.HAUF
Drawn By:	K.HAUF
Checked By:	J.STRATTON

CIV-NB-C1.21

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