UNDERGROUND COAL MINE PERMIT

ACT 007/007

Sunnyside Coal Company

SUNNYSIDE MINES

CARBON COUNTY, UTAH

BOOK 3

CHAPTER 5.0 ENGINEERING

General Table of Contents

1.0 General, Legal, and Related Information

- 1.00 Introduction
- 1.10 Summary of Environmental Impact
- 1.20 Legal, Financial, Compliance, and Related Information

2.0 Soils

- 2.10 Introduction
- 2.20 Environmental Description
- 2.30 Operation Plan
- 2.40 Reclamation Plan

3.0 Biology

- 3.10 Introduction
- 3.20 Resource Information
- 3.30 Operation Plan
- 3.40 Reclamation Plan

4.0 Land Use and Air Quality

- 4.10 Land Use
- 4.20 Air Quality

5.0 Engineering, Operations and Reclamation

- 5.10 Introduction
- 5.20 Operation Plan
- 5.30 Operation Designs and Plan
- 5.40 Reclamation Plans

6.0 Geology

- 6.10 Introduction
- 6.20 Geological Information
- 6.30 Operation Plan

7.0 Hydrology

- 7.10 Introduction
- 7.20 Environmental Description
- 7.30 Operation Plan
- 7.40 Design and Criteria
- 7.50 Reclamation Plans

8.0 Bond Calculation

9.0 Resource Recovery and Protection

Chapter 5

Engineering, Operations, and Reclamation

Table of Contents

		Page
5.10	Introduction	1
5.11	Reporting and Emergency Procedures	1
5.20	Operation Plan	1
5.21	General	1
5.22	Coal Recovery	1
5.23	Mining Methods	2
5.24	Blasting and Explosives	4
5.25	Subsidence Control	6
5.26	Mine Facilities	9
5.27	Transportation Facilities	12
5.28	Coal Handling and Waste Disposal	13
5.29	Management of Mine Openings	19
5.30	Operational Design and Plans	19
5.40	Reclamation Plan	19
5.41	General and Contemporaneous Reclamation	19
5.42	Abandonment of Mine Openings and Disposal Areas	21
5.43	Removal of Facilities	22
5.44	Backfilling, Grading and Soil Replacement	23
5.45	Schedules and Timetables	24
5.46	Management and Monitoring	25
5.47	Reclamation Cost Estimate	25

5.0 Engineering, Operations and Reclamation

5.10 Introduction

This chapter describes the mining operations, the design information for the operations, and the reclamation plan for the disturbed surface areas.

5.11 Reporting and Emergency Procedures

When impoundment hazards are discovered to exist the SPCC plan will be followed, the situation will be described by telephone, facsimile, or other means to the Division. Other agencies will be informed at the same time.

A temporary cessation of operations notice will be submitted to the Division when it is known that the cessation will last more than 30 days. This notice will state that the surface facilities and access openings will be managed, maintained and secured. All activities required in the maintainence of the water treatment and monitoring, and other environmental monitoring will be done. The number of surface disturbed areas at that time will be reported, and any plans for reclamation during the period will be submitted.

5.20 Operation Plan

5.21 General

Surface facilities, mining methods, blasting subsidence control, transportation, waste disposal and management of mine openings are discussed in this section and are illustrated with maps and cross-sections. No changes are anticipated for the permit period although some work may be done in the area of coarse refuse disposal. Any changes in facilities or new construction will have plans submitted for approval prior to work being done.

The total acreage in the permit is 14,520 acres; of which 334 acres are post 1977 disturbed. Of the disturbed acreage 19.8 acres will remain as is after reclamation (D & RGW Rail Road and Right-of-way, and post-mined land use roads) such that 314 acres will be reclaimed.

5.22 Coal Recovery

Sunnyside Mines has long practiced longwall mining which generally provides the maximum mining recovery of any mining method. Since Federal leases are mined a R2P2 plan is required and is included in Chapter 9. Since subsidence due to longwall mining seems to be minimal and its impacts to the environment have not been adverse, the requirements of this section are more than adequately met. Minimizing the effects of mining and reclamation

operations of surface land is inherent in underground mining; however, engineering and design will further reduce those effects. New technology will be investigated and where suitable plans submitted for approval prior to implementation.

5.23 Mining Methods

Sunnyside Mine employs the longwall mining system on a retreat basis as the major part of the mining method. Continuous miners develop the main entries and the longwall gate entries to access the longwall panels. These entries provide ventilation, passages, coal haulage way for belt conveyors, men and material haulage ways for mantrips and supply vehicles, passageways for water and rockdust pipes, electric power and control cables, and other uses. The gate entries last only the life of the longwall panel (approximately a year) while the main entries last the life of the mine from the longwall panel to the outside. This life of the mine aspect of the main entries requires that barrier pillars separate those entries from the mined out areas and provide roof support to protect the main entries from longwall abutment pressures.

The advent of longwall mining utilizing hydraulically operated, self-advancing support systems has enabled operators to increase the recovery ratio and to successfully mine coal in high overburden conditions that would make room and pillar mining extremely hazardous. This technique allows essentially full extraction of the seam, within the height limitations of the equipment, excepting only the barrier pillars left to protect haulage and ventilation entries.

The mines have been developed with main slopes driven down the pitch and development entries driven on the strike. See Plate 7-1. Motor haulage roads are driven on the strike to intersect the main hoist slopes.

At the present time, all the coal is transported by belt conveyor across a strike entry to the No. 3 Mine main slope. From there, coal is transferred to another belt conveyor by which it is brought up dip to the surface and dumped onto a belt feeding the rotary breaker.

The only room and pillar work contemplated in the future will be in isolated or small areas not conducive to longwall mining.

Future mining will consist of extending the main slopes down-dip far enough to turn off the next set of development entries, driving a two-entry system to connect with the bleeder slopes, leaving a barrier pillar and driving starting rooms up-dip to connect with the previous panel. The continuous miners develop to keep at least one and preferably two panels ahead.

The mine-run coal exits the mine via the No. 3 Mine Belt Slope portal. When "B" canyon development starts, it's production will come out through the No. 1 Mine Rock Tunnel portal (P 18) in mine cars pulled by electric locomotives. Coal, at one time, also came out through the Water Canyon portals (P 8 and P 11) from the No. 2 Mine when it was in operation. Men and materials are currently transported through the No. 1 Mine Rock Tunnel portal and No. 3 Mine Main Slope portal (P 14).

All other portals are primarily used for ventilation. All shafts with the exception of the Manshaft (B 10) are used for ventilation purposes. The manshaft provides access for men and materials.

Each of the three mines has a main slope (Plate 7-1). There is a No. 4 Slope which borders the "B" Canyon property.

The Sunnyside complex encompasses three mines, each with its separate ventilation, access and haulageway systems. Currently, the bulk of the coal production comes from the No. 1 Mine. The No. 2 Mine in the southwestern portion of the property has not been mined since 1986 and is being reclaimed. The No. 3 Mine is located in the central part of the property and will be active during the life of the permit period.

Plans are to complete the acquisition of the "B" Canyon Reserve, submit a new permit application, and upon approval begin development from No. 1 Mine.

Since the mines are already in existence most of the engineering is operational and maintenance based. Again, although no plans exist for any additional features, such additions would be submitted for approval after all engineering design criteria had been met or if new technology were involved a co-operational effort with the Division would be made.

The annual and total production during the permit period is estimated at follows:

YEAR	TONS
1991	800,000 - 1,000,000
1992	1,000,000
1993	1,000,000
1994	1,100,000
1995	1,200,000
TOTAL	5,000,000

The first year of the permit is a transition year for production.

The normal operating schedule would be 5 days per week except for holidays, 50 weeks per year since 2 weeks vacation is planned for July each year. Each day operates 2 production shifts and 1 maintenance shift both of which are eight hours.

The major equipment in use at the mine is listed. Changes are made continually in the various types of equipment used as new technology is developed.

Surface Equipment

Production equipment on the surface includes that associated with the preparation plant, car dumper, conveyors, stockpile, and loadout, and also that associated with the underground operations (ventilation fans, bulk rockdust tank, man, material and coal hoists, and electrical substations, transformers, and switch stations). The operation also uses various mobile equipment including dozers, front end loaders, refuse haulage trucks, water trucks, and other vehicles.

Underground Equipment

Major underground equipment includes:

- Continuous miners
- Feeder breakers
- Shuttle cars
- Roof Bolters
- Diesel Scoops
- Rock dusters
- Longwall mining systems including shield type roof supports, shearer and face conveyor
- Belt haulage system
- Rail haulage system (hoists, locomotives, track systems)
- Power centers and electric distribution system
- High pressure spray pumps
- Dewatering pumps and water lines
- Compressor stations and air lines

The mine presently operates with one longwall unit and two continuous miner units.

5.24 Blasting and Explosives

Blasting and the use of explosives is not expected to be done on the surface at the Sunnyside Mines. The normal storage and handling is for underground blasting. However a plan for surface blasting has been developed in the event that blasting on the surface is needed.

The blasting plan is:

Blasting operations will be conducted by persons who have been trained, examined and certified by the State Industrial Commission and are trained in the applicable regulations of the Division regarding explosives. The design on a blast of more than 5 pounds of explosive will be submitted to the Division prior to the blast. Accompanied with the design will be the pre-blast survey description.

Storage, handling and use of explosives are all in compliance with MSHA's rules and regulations. The powder magazine (M 1) and detonator caps magazine (M 2) are located in Number Two Canyon (see Plate 7-4, (1-3)).

On the request of a resident or owner of a dwelling or structure that is located within one-half mile of any surface blasting activity, Sunnyside Mines will conduct a pre-blasting survey of the dwelling or structure and promptly submit a report of the survey to the Division.

Prior to blasting, all residents or owners of a dwelling or structure that is located within one-half mile of an area affected by surface blasting will be notified 24 hours prior to the surface blasting event. Blasting will then be conducted between sunrise and sunset. Warning and all clear signals of different character that are audible within a range of one-half mile from the point of the blast will be given. Each person within the permit area and each person who resides or works within one-half mile of the permit area will be notified as to the meaning of the signals.

Access to the blasting area and areas subject to flyrock from blasting will be restricted. Unauthorized personnel and livestock will be controlled to prevent their presence during blasting and until the area is cleared of slides, undetonated charges, or other unusual safety hazards.

Airblast will be controlled so that it does not exceed the allowable values. Measurements of airblast will be taken when required by the Division.

Flyrock, including blasted material traveling along the ground, will not be cast from the blasting vicinity more than one-half the distance to the nearest dwelling or other occupied structure and in no case beyond the line of property owned or leased by Sunnyside Coal Company.

Blasting will be conducted to prevent injury to persons, damage to public or private property outside the permit area, adverse impacts on any underground mine, or change the course, channel or availability of ground or surface waters outside the permit area.

Blasting will not be conducted within 1,000 feet of any building used as a dwelling, church, hospital, or nursing facility; and 500 feet of facilities including, but not limited to, disposal wells, petroleum or gas storage facilities, municipal water storage facilities, fluid-transmission pipelines, gas or oil collection lines or water and sewage lines.

Maximum weight of explosives that will be detonated within an 8-millisecond period is three (3) pounds. Maximum peak particle velocity will not exceed 1 inch per second at any dwelling, public building, school, church, or commercial or institutional building.

A record of each blast will be retained for three years and will be available for public inspection on request. The record will contain the name of the operator conducting the blast; location, date and time; name, signature and license number of blaster-in-charge; direction, distance in feet to the nearest dwelling, school, church, or commercial or institutional building; weather conditions, including temperature, wind directions, and approximate velocity; type of material blasted, number of holes, burden, and spacing, diameter of holes and depth, type of explosives used, total weight of explosives used, maximum weight of explosives detonated within an 8-millisecond period, maximum number of holes detonated within any 8-millisecond period, initiation system, type and length of stemming, mats or other protection used, type of delay detonator or delay period, sketch of the delay pattern and number of persons in the blasting crew.

5.25 Subsidence Control

A survey of the permit area and adjacent lands shows that structures and renewable resource lands exist. There are: Grassy Trail Reservoir, grazing lands, cultural resources, wild life habitats, a perennial stream, area for recharge of aquifers, and some aquifers.

With the use of longwall mining system controlled caving results, such that subsidence would be expected to occur. However, the amount of subsidence and its effects on structures and resources appears to be minimal or negligible. Not disputing presently that subsidence could cause material damage or diminution, the subsidence control plan follows.

1.) The method of coal removal is by longwall mining except for development areas mined by continuous miners.

2.) Some physical conditions affecting subsidence are: depth, over 1,000 foot of cover will be encountered for the permit period (greater cover decreases the amount of subsidence); the geologically massive 150 foot thick Castlegate Sandstone (see Figure 6-1d) reduces the amount of subsidence by limiting the caving; (other sandstone

units will do likewise); coal thickness contributes to the amount of subsidence the greater the seam thickness, the greater the subsidence, the seam thickness will vary from 10 feet to 6.5 feet as the permit term progresses).

3.) In main entries where subsidence is not planned, the control of subsidence is planned by the use and sizing of barrier pillars.

4.) The current monitoring plan is discussed in Chapter 6; Section 32.

5.) The possible effects, which are not anticipated, and the mitigation there of is discussed as follows:

Surficial alluvial joint aquifers overlie part of the permit area. These are located in north facing slopes and at the head of canyons covered with deep soils. Recharge occurs primarily from melting snow pack on the immediate surface. Past mining in an area with overburden ranging between 500 feet and 2,000 feet between Pasture Canyon and Fan Canyon to the south from 1915 to 1965 was under surficial aquifers and recharge areas. There is little or no inflow from these mined out areas into the mine at the present time. Springs and seeps presently flowing in this area are of good quality. Lack of quality and quantity before mining took place prevents the actual comparison with present data. However, no evidence can be seen that the aquifer or recharge area were damaged by mining. Therefore, future mining and related subsidence is expected and will not cause material damage or diminution of reasonably foreseeable use of the aquifers or areas of recharge if overburden is over 500 feet. Flow of surface and underground water will be monitored to provide actual measurements of impacts of mining on these resources.

In the unpredictable event of material damage or diminution of reasonably foreseeable use of aquifers, areas of recharge and spring flow, Sunnyside Coal Company will restore or rehabilitate the resource to the extent technologically and economically feasible.

The Soil Conservation Service (SCS) made an inventory of grazing lands on the surface properties in 1976 and again in 1983, finding most of the area is very steep and yields only marginal grazing potential. Estimated Animal Unit Months (AUM's) is around 400. From the on-site investigation, it was felt that the range was being properly used and there were no signs of over stocking as of August 17, 1983 (Don Andrews, Range Conservationist, SCS). Visual surveys for subsidence by Osterwald, 1962 showed most evidence of subsidence in areas of steep slopes and on ridge tops where little grazing can take place. These areas are not critical for grazing and therefore mining will not cause material damage or diminution of reasonably foreseeable use of grazing area. In the

unpredictable event of material damage or diminution of reasonable foreseeable use of grazing over the mining area, Sunnyside Coal Company will restore or rehabilitate the resource to the extent technologically and economically feasible.

Sunnyside Coal Company will also provide the owner or lessor of those rights with pasture ground or an equivalent monetary value until such time that the damage is corrected,

Wildlife habitats found in the permit area that could be affected by mining are raptor nesting areas and a Class 3 put and take fishery on Grassy Trail Creek. Raptor nesting areas are primarily in cliff areas that can be affected by subsidence by spalling of the face and destruction of the nest or roosting area. Plate 3-2 shows the locations of present Golden Eagle nests in the permit area which are on the west facing slopes of the Book Cliffs. All future mining will be 1.5 miles to the east or down dip of the nest locations. Therefore future mining will not cause material damage or diminution of reasonably foreseeable use of raptor nesting areas. If new nests are established over present or future mining areas, the operator will consult the Division, USFWS, and UDWR concerning mitigation.

A historical and cultural resource survey of the Sunnyside Mines permit area by the Consulting Services Branch, Antiquities Section of the Utah Division of State History has revealed no previously recorded sites in the listing of the National Register of Historic Places. However, sixteen prehistoric or historic sites were recorded during the survey; ten of these are eligible for nomination to the National Register.

These sites have coexisted with the Sunnyside Mines for over eighty years and have not been deleteriously affected by the mining operation. Present and future mining are and will be at depths of 3,000 feet such that surface subsidence effect will be very unlikely. Control measures may range from documentation or excavation to avoidance of the site.

The perennial stream has already been mined under with no effects presently. Mining in the future is down dip and to the east of the stream.

Grassy Trail Reservoir is within the permit area but will not be mined under within the permit period. This area will become part of the "B" Canyon Permit application. However, the amount of mining under the dam and reservoir will be limited to first mining and a subsidence barrier will be designed for protection.

The other major structures are roads. Historically they have been mined under without any known detrimental effects. In the event of any damage Sunnyside Coal Company will repair or restore the roads to the extent technologically and economically possible.

5.26 Mine Facilities

The main facility is located at the mouth of #2 Canyon and Whitmore Canyon and serves both No. 1 and No. 3 Mines. No. 2 mine is being reclaimed and has separate facilities. The main facility consists of office buildings, warehouses, a bath-house, shops, the shop fan, a mine supply yard area, a bulk rockdust tank, electrical substations, the preparation plant and loadout facilities, and the portals for both No.1 and No. 3 Mines.

Other surface facilities are primarily up Whitmore Canyon for No. 1 Mine and consist of an area at the mouth of Pole Canyon and another area ahead up Whitmore Canyon. The first area consists of the Whitmore Fan and intake air shaft, the return air shaft, an electrical substation and borehole for power, mine discharge ponds 002A and 002B, and the unused Pole Canyon airshaft. The next area up stream consists of the manshaft and manhoist, a bath-house, twin shafts fan and air shafts, emulsion oil facility, mine discharge pond 001, and sediment pond 006.

No. 1 Mine also has some facilities at the Outcrop fan area which consists of portals, Outcrop fan, and an unused building; and also the Slaughter Canyon area, which has been reclaimed.

No. 2 Mine surface facilities are scheduled for reclamation after finishing mine sealing. Plans for reclamation are being made and will be submitted to the Division for approval. These facilities are located at Fan Canyon, Lower Water Canyon, and No. 2 Canyon Fan area.

Table 5-1, Plate III-1 list the surface facilities and show the location of the facility or structures and the year of construction if available. The location of each structure is shown on Plate 7-4, (1-3) by its identification number. These identification numbers are also referred to in the narrative as appropriate.

Some new surface facilities or structures may be constructed during the permit period. Some existing facilities also may be modified or reconstructed. In either case, nothing is presently planned.

The support facilities area will be maintained to prevent damage to fish, wildlife, and related environmental values and to prevent additional contributions of suspended solids to stream flow or runoff outside the permit area.

The surface coal handling facilities are described as follows:

Run-of-mine coal is transported from the underground mine to the surface by mine cars or by conveyor belt. The cars are dumped by a rotary car dumper (see Plate 5-26). Thence, the coal is sent to the raw coal bins after having gone through a rotary breaker. The raw coal is washed in the preparation plant to produce the final clean coal product as well as the coarse and fine (slurry) refuse. The clean coal is sent by belt conveyor to an open storage stockpile. Beneath the stockpile is an arch-supported tunnel through which railroad cars pass for loading. Car loading is via two 5-foot diameter openings controlled by air-actuated gates. The cars are loaded while in motion.

The surface facilities for coal handling, preparation, storage and loadout are listed in Table 5-1 and identified on Plate 7-4.

The utility facilities are:

Power for the Sunnyside Mines operation is supplied by Utah Power and Light through a 44,000 V transmission line. It is distributed to the five substations (E1 to E 5) identified in Table 5-1.

From the substations, power is distributed at 4,160 V to surface facilities and through portals and shafts to the underground mine workings.

The sewers of the Sunnyside Mines are tied to the sewage system of the City of Sunnyside.

The culinary water lines supplying Sunnyside Coal Company, East Carbon City and the City of Sunnyside run underground down the canyon parallel to the existing road from Grassy Trail Reservoir to the cities. At the mouth of Pasture Canyon the City of Sunnyside has a chlorinator and a 50,000 gallon surface water storage tank. From a tee above the tank, two water lines run down the canyon, one through the chlorinator and water tank for Sunnyside and the other past the tank of East Carbon. Sunnyside Coal Company receives its water from the City of Sunnyside.

In the spring of 1984, the cities of Sunnyside and East Carbon built a culinary water treatment plant in Whitmore Canyon near the Manshaft bathhouse, eliminating the use of the chlorinator at Pasture Canyon. The area needed for the water plant has been sold to the cities and withdrawn from the permit area (Plate 1-1).

Phone lines service Sunnyside Mines from the Highway 123 right-of-way.

The Sunnyside Mines operations use all of the above utilities and thus has need to see that the operations and reclamation

activities will not disrupt those services.

Water pollution control facilities used in the permit area and the surface disturbed areas are:

1.) Sediment ponds
2.) Mine water discharge ponds
3.) Diversion ditches
4.0 and B.T.C.A. items such as silt fences, rock and straw bale gabions, and oil absorbing materials.

Sedimentation control ponds are used to store water runoff from disturbed areas up to and including a 10 year 24 hour event. Designs of the ponds are located in Appendix 5-1.

Rainfall in excess of a 10-year 24-hour event is passed through the structure with a vertical standpipe or a rip rapped channel emergency spillway. There are eighteen impoundment structures on the permit area which are shown on Plate 7-4, (1-3). Out of the eighteen impounding structures, ten are sedimentation ponds , three are mine water discharge ponds, four slurry cells and a clear water pond adjacent to No. 1 and No. 2 slurry cells. Sediment control structures are periodically cleaned of sediments when the sediment height reaches a predetermined design level. The State Board of Health requires that three feet be maintained between the sediment and the water outlet. A copy of the NPDES permit is found in Appendix 7-3. The maximum sediment level is marked on the vertical standpipe spillway or on a ground stake. Water accumulations in the pond are discharged after storing the water for at least twenty-four hours allowing the settling of sediments. No impounding structures are contemplated during the permit renewal period.

All sediment ponds will be inspected a minimum of four (4) times per year for structural weakness, erosion, proper function, sediment levels and other hazardous conditions. A written record of findings will be maintained at the mine office for inspection. Reports of adverse dam conditions including erosion, structural weakness or other hazardous conditions will be submitted to the Division within thirty (30) days of the inspection. Hazardous conditions will be reported directly to the Division immediately after the finding.

Sediments removed from the ponds will be disposed in the industrial waste dump (Plate 7-4, (1-3)) or used as a borrow material. If the material is to be used as a borrow material, the operator will contact the Division to receive approval of the location and the amount of material to be used. The Division may require a chemical analysis of the sediments prior to disposal as borrow depending upon the area of disposal.

Sediment control measures approved by the division include adding a flocculent to the water to drop out suspended iron particles. A loose straw and rock gabion structure located at the bottom of the coarse refuse pile to wash out the sediments. On the mine water discharge ponds a spreader bar is located on the pond inlet pipe (the mine discharge pipe) and a "skimmer" on the discharge pipe coming from the pond to trap oil and grease.

Diversion ditches are used to divert runoff from a disturbed area or to direct runoff from the disturbed area to a pond. The designs for these are located in Appendix 5-1 with the sediment ponds.

There are some areas which are small and relatively undisturbed and in the interests of mining surface disturbances which use the B.T.C.A. measures for sediment control. These locations are on Plates 7-4, (1-3) and 5-5, (1-7).

The B.T.C.A areas will be operated and maintained as to their purposes and requirements.

5.27 Transportation Facilities

Table 5-2 is a list of roads in the permit area. All of these roads existed prior to 1977. Table 5-3 lists the specifications for these roads.

All culverts under roads are listed in Table 5-4 along with specifications and are plotted on Plate III-1 as RC-1 through RC-10-4. Permanent road culverts are found on Plate 7-10 and listed in the culvert design summary of Appendix 5-1. All other culverts designs are found in the appropriate disturbed area calculations of Appendix 5-1.

Typical cross sections of each road and side ditch are located on Plate 5-17.

No plans exist, during the permit period, to alter a natural drainage way, or make alterations involving a steep cut slope.

A county owned road (extension of State Highway 123) traverses a portion of the permit area (see Plate 7-4, (1-3)). Previous mining, which included full extraction of the coal seam, has not affected the road or its use by the public. Future mining is planned under other portions of the road. This will take place at greater depths below the surface than in the past and is expected to have no effect on the road or its continued use by the public. There are no plans to relocate this or any other public road.

The roads in Fan Canyon, lower Water Canyon, and short access roads to the raise holes, manshaft, fans and ponds will be removed after the mine life. The remainder of roads are necessary for land

access appropriate to the uses of fish and wildlife habitat, livestock grazing and recreation. These roads are typically pre-law and occur on land owned by Sunnyside Coal Company and/or also provide access to facilities owned by others i.e., the rodeo grounds, Grassy Trail Reservoir, tar sands deposits, etc.

Roads will be maintained throughout the life of the facility and during the 10-year responsibility period. Maintenance will consist of basic custodial care to control erosion, repair of structures and drainage systems, removal of debris from culverts and ditches, and replacement of road surface material as needed.

The transportation facilities area will be maintained and restored at the end of the mine life to prevent damage to fish, wildlife, and related environmental values, as well as to prevent additional contributions of suspended solids to stream flow or runoff outside the permit area.

5.28 Coal Handling and Waste Disposal

This section discusses the coal handling facilities from the portal through the preparation plant to the train load out and rail road track. The handling of coal processing water, mine development waste and non-coal waste is described. Overburden, excess spoil, and return of coal processing waste underground are not part of Sunnyside Mines operations

The surface coal handling facilities are described as follows:

Run-of mine coal is transported from the underground mine to the surface by mine cars or by conveyor belt. The cars are dumped by a rotary car dumper (see Plate 5-26). Thence, the coal is sent to the raw coal bins after having gone through a rotary breaker. The raw coal is washed in the preparation plant to produce the final clean coal product as well as the coarse and fine (slurry) refuse. The clean coal is sent by belt conveyor to an open storage stockpile. Beneath the stockpile is an arch-supported tunnel through which railroad cares pass for loading. Car loading is via two 5-foot diameter openings controlled by air-actuated gates. The cars are loaded while in motion.

The surface facilities for coal handling, preparation, storage and loadout are listed in Table 5-1 and identified on Plate 7-4, (1-3).

Plate 5-26 shows the surface location of the following conveyor belts and tracks:

I.D. Number	Description
1	48" slope belt. Conveys coal from No. 3 Mine to the surface and the rotary breaker.
2	60" belt from rotary dumper to rotary breaker
3	42" belt from rotary breaker to raw coal bins
4	42" tripper belt over the raw coal bins
5	42" raw coal reclaim belt
6	42" raw coal feed belt (to Baum jigs)
7	36" clean coal stockpile
8	24" coarse refuse belt
9	Old loadout belt (not in use)
10	Old loadout belt (not in use)
11	Denver & Rio Grande Western Railroad tracks
12	40" gage mine tracks (the mine haulage system provides a transportation link between the surface and underground working for coal as well as for men and materials).

The slurry (refuse) ponds (D 1.1 and D 1.2) and coarse refuse disposal areas (D 2a and D 2b) are listed in Table 5-1 and shown on Plate 7-4, (1-3).

The slurry refuse ponds and the coarse refuse area has been acquired by Environmental Power Corporation for feed material for a co-gen power plant. If a commercial project becomes viable, the transfer, submittal, amendment of new or existing permits will be discussed and developed with the Division prior to operations.

(a) Slurry ponds:

Fine refuse from the preparation plant is moved to dewatering or disposal areas by slurry transport in an open ditch. There are four slurry ponds: the West Slurry Cell (WSC), the East Slurry Cell (ESC), Slurry Pond One (SP1), and Slurry Pond Two (SP2) (Plate 7-4, (1-3)). The East and West Slurry Cells are settling and evaporation impoundments that were constructed prior to or during 1974. Slurry Ponds One and Two are settling and filtration ponds constructed in 1978. Presently, SP1 and SP2 are actively used, while WCS and ESC are used as an overflow for SP1 and SP2 when they are not in service. Pond WSC is used as a disposal area for dried slurry from SP1 and SP2.

The West Slurry Cell was the first impoundment to be constructed for the disposal of slurry and refuse material in the late fifties and early seventies. (Appendix 5-2). Coarse refuse material and other waste was used as fill material to block a wash in the pediment material at the mouth of Whitmore Canyon overlooking the Icelander Drainage. Slurry from the preparation plant was transported to the impoundment by ditch for disposal. As the level of the slurry increased, additional coarse refuse was added to the

top and sides of the impoundment. The present level of the slurry in the impoundment is over 200 feet above the bottom of the wash. Currently, use of the impoundment is used as a disposal area for dried slurry material from SP1 and SP2. Trucks end-dump the slurry material onto the northwest side of the cell from the top of the dike. A large dozer then spreads and compacts the material. The entire impoundment is expected to be filled at the end of the mine life.

Construction of the East Slurry Cell on the east side of WSC was in 1974. Coarse refuse was placed and compacted in dikes to contain the refuse. After the dikes were completed and covered with soil material, the impoundment was filled with slurry. Disposal of slurry continued until 1983. Presently, the impoundment is used as an overflow for SP1 and SP2.

Slurry Pond One and Two were constructed in 1978 to the north of the other slurry cells. These ponds were constructed by excavating a depression in the colluvium of a gentle slope. Material from the depression was spread out down slope of the ponds for 50 to 100 feet. SP1 and SP2 are used in rotation. Slurry is introduced into a pond where it settles and is then filtered (Plate 7-7). During the use of the first pond, the second pond is decanted and the dried slurry removed by truck to the WSC. After the second pond is cleaned, the cycle is reversed. If both ponds are in the drying and cleaning cycle, the slurry will be diverted to the ESC. Water (NPDES 004) from SP1 and SP2 is used to irrigate alfalfa fields or discharged into Icelander Drainage. Discharged water meets all State and Federal water quality standards. The east and west slurry cells are shown on Plate 5-21.

Design and construction of the slurry ponds was conducted pre-law, consequently, some design standards were not met. A geotechnical evaluation, certification of the alternate methods of construction and current static and seismic safety factors was conducted to determine compliance. Results of the evaluations are found in Appendix 5-3. It was found that the impoundment dikes constructed of coarse refuse are stable with the exception of the west dike of WSC. This dike will become stable as the current coarse refuse pile level reaches the level of the west dike. Present plans are to continue to stabilize the dike. The coarse refuse pile is being specifically constructed in this site to stabilize the dike wall to meet MSHA requirements. Water samples from the seep below the coarse refuse disposal pile meet State and Federal water quality standards (see Section 3.4.9.1(b)). The West Slurry Cell will not be used as an impoundment until the coarse refuse pile level reaches the level of the west side dike or obtains a static safety factor of 1.5.

Evaluation of the ESC embankment under saturated conditions showed a safety factor of 0.5. Actual soil conditions encountered during soil testing showed that the embankment was not saturated.

Soil conditions encountered during installation of three piezometers showed that the coarse refuse material in the embankment was not saturated.

All surface drainage from the areas above the slurry ponds is diverted away from the embankments by diversion ditches designed to carry the peak runoff from 100-year, 24-hour precipitation event (Plate 5-1, Appendix 5-1). The diversions will be maintained to prevent blockage.

Visual inspections by a qualified registered professional engineer or a qualified MSHA impoundment inspector will be conducted according to 30 CFR 77.216-3 to assess the stability of the impoundments and determine the amount of seepage, if any. Piezometers installed 8/6/85, in the East Slurry Cell embankment will be monitored weekly when water is present in the structure to access the amount of embankment saturation, if any. Records of the inspection finding and recommendations will by maintained at the mine site. If the inspection discloses that potential hazards exist, the Division will be informed promptly of the findings, the emergency procedures formulated for public protection, and remedial action measures that will be implemented.

Maintenance of the embankments will consist of filling and grading any erosion or other failure features discovered by the above inspections.

Subsidence will not affect the pond and embankments since the structures do not overlie the coal seam and are located several miles west of the nearest outcrop. Mudflows, rock debris falls or other landslides are not expected to be a problem because the embankments are located at or above the level of the surrounding topography. Possibility of failure downhill of the embankments is limited to a thin layer of colluvial material on bedrock. Failure of this material would not threaten the embankments.

(b) Coarse refuse

Coarse refuse or reject materials from the preparation plant are disposed of in a waste bank. The refuse is hauled by truck from the refuse loadout at the preparation plant to the coarse refuse pile (Plate 7-4, (1-3)) where it is end dumped in piles. When sufficient material has been hauled to the dump, the refuse is spread out in a 24-inch horizontal layer by a large dozer. Loaded haul trucks transporting the next layer of refuse randomly compact the layer surface to prevent fire and increase the stability of the structure. The outer slope of the refuse pile is maintained at 27 degree slope. At 50 feet vertical increments, a 20-foot wide terrace is constructed for water runoff and erosion control.

Refuse material from activities located outside the permit

area will be disposed of in the waste bank only if approval is obtained from the Division. There are no plans for outside waste disposal.

Construction of the coarse refuse pile will continue as outlined above. Layering of the pile and compaction has been designed to achieve structural stability and to prevent fires. The material is compacted to attain at least 90 percent of the maximum dry density. Construction of the pile was started in 1977 before enactment of the present regulations. As a result, the subdrainage system required was not incorporated in the design; however, a 24-inch perforated culvert was placed in the drainage bottom to collect ground water seepage. Geotechnical stability and certification studies have been conducted (see Appendix 5-2) to prove the adequacy of the alternate method of construction. The study shows a long-term static factor of safety of 2.31.

All surface drainage from the area above the waste bank and from the crest and face of the final structure will be diverted away from the fill into stabilized diversion channels designed to pass safely the runoff from a 100-year, 24-hour precipitation event. A plan view of the diversion ditches are found on Plate 7-8. Calculations are found in Appendix 5-1.

Present discharge of water from the toe of the waste bank meets current Division standards. In the past, some samples, after large precipitation events, have exceeded the total iron standards of 7.0 milligrams per liter. During periods of high iron discharge, a polymer flocculent and straw bale filter is used to remove the iron from suspension.

The coarse refuse pile will be inspected on a quarterly basis by a qualified, registered engineer or other qualified person for slopes, seepage, and other visible factors which could indicate potential failure. The results of the inspections will be recorded and maintained at the mine site. If any inspection discloses that a potential hazard exists, the Division will be informed of the findings and of the emergency procedures formulated for public protection and remedial action.

Maintenance of the embankments will consist of filling and grading any erosion or other failure features discovered by the above inspections. Ditches on the terraces will be cleaned and graded as need warrants. Riprap in the drainage system will be repaired as needed.

Subsidence will not affect the refuse pile as the structure does not overlie the coal seam and is several miles west of the nearest outcrop. Mudflows, rock debris falls, or other landslides are not expected to be a problem. Possibility of failure near the sides and downhill of the refuse piles is limited to a thin layer of colluvial material on bedrock. Failure of this material would not threaten the refuse pile.

(c) Underground development waste is minimal presently and no large projects are planned for the future (such as air shafts, rock tunnels, large underground bunkers, etc.). The insignificant amounts from overcasts, undercasts, and entry grading is loaded onto the belt haulage system and treated as raw coal production since some coal is part of the material. The waste material then becomes part of the coal processing waste.

(d) Industrial waste: Non-coal waste is disposed in the Sunnyside City Landfill or the industrial waste dump. Material place in the industrial waste dump is primarily from the rotary breaker such as timbers, cans, rock, or other non-coal waste that comes out on the mine belt. All other non-coal waste (office garbage, etc.) is sent to the Sunnyside City Landfill for disposal.

A temporary non-coal industrial waste gathering area in No. 2 Canyon is used to facilitate the final disposal of the non-coal waste to the Carbon County Landfill or the industrial waste dump.

The industrial waste dump has been approved by the State Board of Health (Figure 7-4). It is located at the northeast end of the East and West Slurry Ponds in the refuse disposal area (Plate 7-4, (1-3)). The dump was constructed and is used by excavating a trench, compacting the sides and bottom for a water barrier, and then covering the waste with a minimum of two feet of borrow material.

A major impoundment is Grassy Trail Reservoir (W3a and W3b) which is formed by the Whitmore Canyon Dam and is used to store culinary water for the City of Sunnyside and the City of East Carbon as well as the facilities of Sunnyside Coal Company. This was constructed in 1952 and was designed by Templeton, Linke, and Associates and Company.

The Whitmore Canyon Dam is routinely maintained. Vegetative growth is cut where necessary to facilitate inspection and repairs. Inspections are conducted as frequently as daily by qualified personnel. A yearly inspection of the dam is conducted by a

professional engineer from the State Engineer's Office. The inspection reports are available for viewing at the mine office. Construction plans for the dam were approved by the State Engineer on September 21, 1951 and the final construction was approved by Joseph M. Tracy, State Engineer on November 24, 1952.

5.29 Management of Mine Openings

All of the mine openings have restricted access generally and specific area fences and locked gates. The shaft openings are either covered by the fan house or substantially constructed grid decks. The outcrop portals not in present use have been barricaded and closed off to inadvertant entrance with warning signs posted. Portals in use require a check in procedure to gain access to the immediate portal area. No trespassing signs are posted along the public roads and fences.

The mine openings are designed to prevent most surface and ground water from entering the mine. Ditches, berms and slopes are used for surface control; and concrete walls and grouting help control ground water at air shafts. At the Manshaft area a de-watering well has been installed to provide culinary water for the cities of Sunnyside and East Carbon.

The sealing of all openings upon reclamation is discussed in Section 5.40. Management of boreholes is discussed in Chapter 6.

5.30 Operational Designs and Plans

The calculations and designs of the ponds, culverts, ditches are included in Appendix 5-1.

5.40 Reclamation Plan

5.41 General and Contemporary Reclamation

The reclamation and revegetation plans are designed to return the distrubed lands to productive uses once mining activities have ceased. These postmine land uses will be the same as the current and pre-mine uses, i.e., fish and wildlife habitat, recreation, and livestock grazing.

The majority of the disturbed areas are small in acreage and are pre-law disturbance except for the main complex area. The reclamation plans take into consideration the fact that little topsoil was saved for purposes of revegetation. Research into improvement of materials and betterment of techniques for reclamation of disturbed lands is continually ongoing and this reclamation plan can be expected to be revised as new information becomes available.

No final reclamation is planned for the end of this 5 year permit term except for No. 2 Mine areas.

Contemporaneous reclamation has been ongoing to some extent at Sunnyside Mines for many years before the 1977 Law and currently. Although there is no written records, plantings of crested wheatgrass were begun in the late 1950's. The stream-sides have been reseeded along channelized sections of Grassy Trail Creek, areas adjacent to roadsides, vacant areas next to building construction, the base of the coal stockpile, and large areas adjacent to the coal refuse pile. These areas all constitute pre-law revegetated areas (Plates 5-20, (1-4)). As Whitmore Canyon road and stream crossings are to remain, none of the riparian areas will be redisturbed.

Areas adjacent to any future disturbances, although none are planned at this time, would be revegetated as part of contemporaneous reclamation. Contemporaneous reclamation includes the following activities:

(1) Coarse refuse disposal area (D2 on Plate 7-4, (1 of 3)):

The coarse refuse pile is in a state of ongoing construction and reclamation as coal mining continues in operation. The pile is being built in approximately 2 foot lifts which are compacted. At 50 foot vertical increments, a 20 foot wide terrace is constructed for water runoff and erosion control. Grading of this structure is a continual process. Revegetation evaluation plots (Plate 7-4) are being monitored to determine the best reclamation and reve getation practice. After determining the best practice, revegetation will begin on the toe slope, progress upward, and be ongoing throughout the life of the Mines.

(2) Slaughter Canyon Portal Area:

This portal which provided access to the outside raise area of the No. 1 Mine (Plate 7-1), the adjacent materials storage facility, and the road from Sunnyside were reclaimed and revegetated in 1983 according to the plan submitted and approved by the Division.

(3) No. 2 Mine Portal Areas:

Reclamation of the Fan Canyon, Lower Water Canyon, and No.2 Canyon Fan Areas (portals) of No. 2 Mine has started with the underground sealing and portal sealing at the surface. Plans for surface reclamation activities are being formulated. Soil samples have been taken and sent for soil analysis.

The pre-law disturbed areas which have not subsequently been used are delineated from areas which have been used or disturbed since 1977 (Plates 5-20, (1-4)). These pre-law areas have also been revegetated pre-law, mostly with crested wheatgrass, and will not be reclaimed unless disturbed or special needs arise. Consultation with the Division concerning the special circumstances will be made prior to any planning or physical work.

5.42 Abandonment of Mine Openings and Disposal Areas

(1) Sealing of Mine Openings

Shaft openings at No. 2 Canyon Fan, Pole Canyon-Whitmore Fan Area, and the Upper Manshaft Area will be sealed by effectively capping the opening or filling the shaft. If the shaft is filled, such filling shall be for the entire depth of the shaft; and for the first 50 feet from the bottom of the coalbed, the fill material shall consist of non-combustible, non-toxic material. If the shaft opening is capped at the top of the shaft, the cap shall consist of a six inch thick concrete cap or other equivalent devices. The caps shall be equipped with a vent pipe at least 2 inches in diameter extending for a distance of at least 15 feet above the surface of the shaft.

Slope or drift openings at Fan Canyon, Lower Water Canyon, No. 3 Mine at the Main Complex, and No. 1 Mine Outcrop Fan Area will be sealed with solid, substantial, non-combustible material such as concrete blocks, bricks, or tile and built to plans submitted and approved by MSHA. The entries will be completely filled with non-combustible, non-toxic material for a distance of at least 25 feet into such openings.

The highwalls at these portals vary in size and amount of man made disturbance. The highwalls will be typically regraded to blend with the adjacent surroundings as rock outcrops or small vertical faces, except where a natural coal outrop exists. The rock outcrops and cliffs which are typical for the permit area and the region, Jensen et al. 1981, are mostly exposed sandstone and naturally vary in size from vast cliffs to small individual strata. Although not unique habitat, the elimination of these portal highwalls would in most cases only increase the extent of disturbance and could potentially decrease the stability of the adjacent slopes. Talus and bouldery slopes are also common. Sites near these areas will be regraded to blend with the natural steep slopes. Boulders and rock piles may be placed where appropriate for wildlife cover. Each specific site will be blended to the area characteristics.

All boreholes accessing the coal seam at the time of final reclamation, primarily for power cables, will be plugged and filled with cement.

(2) Reclamation of Disposal Areas

If the EPC project comes into operation the reclamation of the disposal areas will become EPC's responsibility and the transfer of the permitted area and bond will be finalized. If the EPC project becomes unviable, Sunnyside Mines will become responsible for reclamation of the disposal areas. The reclamation plan in that situation is as follows.

The coarse refuse disposal area is being contemporaneously reclaimed such that the final reclamation will be the last 50 foot increment and the surface area at the top of the slope. The surface area will need leveling and compacting. The remaining area will then be covered with eighteen inches of non-combustible, non-toxic material and revegetated.

The slurry refuse disposal ponds will be drained at the end of mining activities, filled, graded and contoured and covered with eighteen inches of non-combustible, non-toxic material if shown to be necessary by the test plot and then revegetated.

The industrial waste disposal area is generally contemporaneously reclaimed, but at final reclamation it will be treated as part of the slurry refuse disposal area since it is in the northeast part of that area.

Any non-coal waste including combustibles found, generated or discovered during the final reclamation activities will be disposed in the coarse refuse disposal area prior to its reclamation.

5.43 Removal of Facilities

(1) Buildings and Other Mining Structures

At the conclusion of mining all surface structures with the exception of those permanent structures marked on Plate 7-4 will be dismantled, removed and the land graded to blend with the surrounding areas. The major area will be the main complex which includes the preparation plant and ancillary facilities, the shops, warehouse and office building, bathhouse, mine tracks and supply yard facilities, and substations. These areas compose approximately 28 acres and were in existence prior to 1977, such that the soil reclamation plan will involve perhaps substitutes and/or amendments to be determined at that time. Outlying facilities, such as other portal areas, ventilation shafts, upper bathhouse, substations, equipment and storage areas, power trans-mission lines will also be dismantled, eliminated, and removed.

(2) Sediment Ponds and Ditches

All sediment ponds, mine water discharge ponds, and ditches no longer needed when the reclamation of the disturbed area is

completed will be re-contoured and revegetated. The exception is the clear water diversion ditch around the main complex which will be reclaimed near the end of the 10 year responsibility period with the prior approval of the Division.

(3) Roads, Culverts and Bridges

All roads and associated structures except those designated as permanent and having a post-mining land use will be reclaimed. The culverts will be dug up, removed, and disposed in the industrial waste disposal area. Similarly, bridges will be destroyed and the material disposed of properly. The roads and their ditches will be ripped, contoured and revegetated. Any silt fence structures will be removed and disposed properly.

(4) Permanent Facilities

Presently the designated permanent facilities (Plate 7-4) which will remain after reclamation are:

Whitmore Dam and Grassy Trail Reservoir, the road up Whitmore Canyon to the Dam, the water supply facilities associated with the above,

Other structures, roads and facilities may well become desirable as a permanent, post-mining feature before final reclamation is accomplished. In those cases Sunnyside Mines will submit the plans and justifications for such instances to the Division prior to final reclamation.

5.44 Backfilling, Grading, and Soil Replacement

Areas such as portals, ponds, and refuse disposal areas will be backfilled with non-combustible, nontoxic material to a rough grade equal to the original contour, if known, or to blend in with the adjacent undisturbed areas. Other areas will be roughly graded prior to soil replacement. Areas which have been compacted during mining activity use, such as roads, supply areas, etc., will be ripped before contouring. After the areas have been backfilled and rough graded, then the soil material will be replaced.

In some of the areas where portals are part of the natural coal and rock outcrop, the exposed coal seam and coal material will not be covered except for the portal. The remaining natural highwall will not be disturbed and will eliminate any additional disturbance.

Recontouring and regrading will be accomplished by dozer, grader, backhoe, front end loader and/or dump truck after removal of mine structures and buildings. Only a minimal amount of backfilling and grading is expected due to the small size of most of the areas.

The disturbed areas will be covered with one foot of soil or soil substitute. The coarse refuse disposal and slurry refuse ponds areas will be covered with eighteen inches of material unless the test plots or other technology and methods can show the effectiveness of less cover.

Most of the material used for backfilling, contouring, and rough grading is soil substitute material; and revegetation can be established using soil amendments. The common depth of topsoil for the described mapping units of the disturbed areas as is 3 inches. This thin A horizon directly overlies the C horizon. In areas where the topsoil has been stockpiled the topsoil will be replaced over the rough grade area to the same thin layer of 3 inches. In other pre-law areas, which have subsequently been used, but no topsoil was saved, available topsoil will be used where needed the most. Consultation with the Division will be made to prioritize those areas. Generally the available topsoil will come from borrow areas which are naturally vegetated or revegetated prior to 1977, and have the thin A horizon. During the reclamation process this topsoil will be saved to be used after the rough grading.

After the final grading and soil placement, the soil will be scarified and the surface left with a rough texture to promote rain fall retention and plant growth. At the same time any soil amendments and/or nutrients will be made based on soil analysis of samples taken after soil placement.

5.45 Schedules and Timetables

The final reclamation at Sunnyside Mines is not scheduled at this time for the duration of this permit period. Upon the decision to cease operations permanently the Division will be notified and coordination of reclamation plans and activities will begin. The general sequence of reclamation and revegetation is shown in Table 5-5. The projected timetable for the reclamation activities is shown in Table 5-6. The revegetation activities will begin in the next fall planting season after completion of backfilling, grading and soil placement. The revegetation schedule is shown in Table 5-7.

5.46 Management and Monitoring

Management and monitoring of the reclaimed areas will be maintained for the 10 year responsibility period. Records and reports will be submitted as required. Maintenance of the reclaimed areas will be done as needed. The reseeded areas will be protected from livestock grazing; weed, disease and pest control will be performed in conjunction with the Division and other appropriate State and Federal agencies.

The reclaimed site productivity will be determined during the last two years of the 10 year responsibility period.

5.47 Reclamation Cost Estimate

Estimates of the cost to reclaim Sunnyside Mines are made in Chapter 8 Bond Calculations.

List of Exhibits

Table	5-1	List of Surface Structures and Facilities
Table	5-2	Roads within the Permit Area
Table	5-3	Specification for Roads in the Permit Area
Table	5-4	Road Culvert Specifications
Table	5-5	Typical Sequential steps for Reclamation and Vegetation
Table	5-6	Projected Reclamation Timetable
Table	5-7	Revegetation Schedule in weeks in each month
Appendix	5-1	Designs of Sediment Control Structures
Appendix	5-2	Geotechnical investigation of Slurry Impoundments
Appendix	5-3	Purpose & design of Sunnyside Experimental Revegetation Plots on Coarse Refuse

List of Exhibits

Plate 5-1	Disposal Area Post Mine Contours
Plate 5-2	Haul Road Plan Profile
Plate 5-2	Haul Road Plan Profile
Plate 5-2	Haul Road Plan Profile
Plate 5-3	Permit Sign Location Map
Plate 5-4	Silt Fence Installation Typical
Plate 5-5	Twin Shafts (B.T.C.A. Area)
Plate 5-5	No. 2 Canyon Fan (B.T.C.A. Area)
Plate 5-5	Water Canyon Portals (B.T.C.A. Area)
Plate 5-5	Pole Canyon (B.T.C.A. Area)
Plate 5-5	Whitmore Fan (B.T.C.A. Area)
Plate 5-5	No. 2 Mine Fan (B.T.C.A. Area)
Plate 5-5	No. 1 Mine Outcrop Fan (B.T.C.A. Area)
Plate 5-5	Manshaft Substation (B.T.C.A. Area)
Plate 5-6	Rail Cut Sediment Pond (As-Built)
Plate 5-6a	Rail Cut Pond Drainage Plan
Plate 5-7	Pasture Pond Drainage Plan
Plate 5-7a	Pasture Pond Sediment Control Map (As-Built)
Plate 5-8	Old Coarse Refuse Road Sed. Pond (As-Built)
Plate 5-8	Old Coarse Refuse Road Sediment Pond Plan Map
Plate 5-9	No. 3 Mine Hoist House Pond Plan
Plate 5-9	Hoist House Sediment Pond Plan Map (As-Built)
Plate 5-10	No. 2 Canyon Drainage Plan
Plate 5-10	No. 2 Canyon Upper Pond (As-Built)

List of Exhibits
(Cont.)

Plate 5-10	No. 2 Canyon Lower Pond (As-Built)
Plate 5-11	Manshaft Drainage Plan
Plate 5-11	West Ridge & Manshaft Sed. Pond Access Crossing
Plate 5-11	Manshaft Sedimentation Pond (As-Built)
Plate 5-12 (1of3)	S.S.S.F. Pond (As-Built)
Plate 5-12 (2of3)	S.S.S.F. Drainage (As-Built)
Plate 5-12 (3of3)	S.S.S.F. Drainage (As-Built)
Plate 5-13	Whitmore Mine Water 002B Discharge Pond (As-Built)
Plate 5-13	Whitmore Mine Water 002B Discharge Pond (As-Built)
Plate 5-14	Twin Shafts Mine Water Discharge Pond (As-Built)
Plate 5-15	002A Mine Water Discharge Pond (As-Built)
Plate 5-16	Road & Utility Right of Ways
Plate 5-17	Typical Road Cross Sections
Plate 5-18	Borrow Area Pond Drainage
Plate 5-18	Borrow Area Sediment Pond (As-Built)
Plate 5-19	Topsoil Pile Cross Sections
Plate 5-20 (1of4)	Current Veg. & Pre Law Disturbed Areas
Plate 5-20 (2of4)	Current Veg. & Pre Law Disturbed Areas
Plate 5-20 (3of4)	Current Veg. & Pre Law Disturbed Areas
Plate 5-20 (4of4)	Current Veg. & Pre Law Disturbed Areas
Plate 5-21	East and West Slurry Cells
Plate 5-22	Existing Contours

List of Exhibits
(Cont.)

Plate 5-23	Final Contours High Wall Reduction
Plate 5-24 (1of2)	High Wall Reduction Cross Section
Plate 5-24 (2of2)	High Wall Reduction Cross Section
Plate 5-25	C.R.T.S. Pond (As-Built)
Plate 5-26	Transportation Facilities Location Map
Plate 5-27	Proposed Valves for 002A & 002B Mine Water Discharge Ponds

Table 5-1 List of Surface Structures and Facilities

I.D. Number	Surface Structure	Approximate Year Of Completion
B 1	Warehouse/office	1953, Office added in 1974
B 2	Main changehouse	1953
B 3	Shop	1953
B 4	Warehouse annex	1960's
B 5	Engineering office	1975-76
B 6.1,6.2, 6.3,6.4	Preparation plant, unit train loadout and rotary car dumper	Original structure pre-1950; modernized 1950's; unit train loadout 1968-69
B 7	Materials foreman's office	1978
B 8	No. 3 Mine hoist house	1956
B 9	Upper changehouse	1973
B10	Manshaft hoist house	1973
B11	Bulk rock dust tank	1977
D 1.1	New slurry ponds	1977
D 1.2	Old slurry ponds	
D 2	Coarse refuse disposal	
D 3a,3b	Number Two Canyon storage area	
D 4	Sedimentation pond at Manshaft	1979
D 5	Sedimentation pond, south slope, Coarse Refuse Haul Road	1980
D 6	Sedimentation pond, coarse refuse pile	1980
D 7	Sedimentation pond, Slaughter Canyon	1980
D 8	Methane vent	1979
E 1	Substation, No. 2 Mine Outcrop	Pre-1950
E 2	Substation, No. 1 Mine Outcrop	Pre-1950
E 3	Substation, above rotary dumper	Pre-1950
E 4	Substation, across road from prep plant	1979
E 5	Substation, near Whitmore Canyon fan	Late 1950's
F 1	No. 2 Mine fan	Early 1950's
F 2	No. 3 Mine fan	Early 1950's
F 3	No. 3 Mine fan, in Number Two Canyon	1977
F 4	No. 1 Mine Outcrop fan	Early 1950's
F 5	No. 1 Mine, Whitmore Canyon fan	Late 1950's
F 6	No. 1 Mine, Twin shaft fan	1975
M 1	Powder magazine	
M 2	Detonator caps magazine	
P 2.1,2.2	No. 2 fan area portals, Lower and Upper Sunnyside Seams	
P 3.1,3.2, 3.3,3.4	Water Canyon portals to No. 2 and No. 3 Mines	
P 4.1,4.2, 4.3	No. 3 Mine: Main portal, belt slope portal, and manway portal	
P 5	No. 1 Mine rock tunnel portal	1951
P 6.1,6.2, 6.3,6.4	No. 1 Mine fan area portals (left and right return portals)	
P 7	No. 1 Mine Whitmore Canyon return air shaft	Late 1950's
P 8	No. 1 Mine Pole Canyon shaft	1973
P 9	No. 1 Mine Slaughter Canyon portal	1973
R 1	Haul road, tipple to coarse refuse area	
R 2	Road to No. 2 fan and Water Canyon	
R 3	Road in Number Two Canyon to fan and shaft	
R 4	Road to No. 1 Outcrop fan	
R 5	Road to Slaughter Canyon	1973
R 6	Road to Pole Canyon shaft	1973
R 7	Road to Manshaft and twin shaft fans	1974
R 8	Road to Grassy Trail reservoir	
W 1	Mine water tanks	1955
W 2	Culinary water tank	1953
W 3a,3b	Grassy Trail Reservoir	1952

Table 5-2 Roads Within The Permit Area

R-1	Refuse Road. The road is used as a haul road for waste rock from the coarse refuse bin to the coarse refuse disposal area and as access to the Water Canyon Road.
R-2	Water Canyon Road. The road is used as an access road for the No. 2 Mine fan associated outcrop portals.
R-3	No. 2 Canyon Road. The road is used as an access for the No. 3 Mine Fan.
R-4	Fan Canyon Road. The road is used as an access road to the No. 1 Mine fan.
R-5	Slaughter Canyon Road. The road is used as an access for the Slaughter Canyon portal. This road was reclaimed in 1982.
R-6	Pole Canyon Road. The road is used as an access for the Pole Canyon exhaust shaft.
R-7	Manshaft Road. The road is used as an access for the upper bathhouse and manshaft.
R-8	Reservoir Road. The road is used as an access for the Whitmore Canyon Dam and as an access for private lands above the dam.
R-9	Railroad Access Road. The road is used for access to the railroad storage shed outside the permit area.
R-10	Complex Roads. The roads are used as an access around the mine offices, shop, bathhouse, and preparation plant.
R-11	Coarse Refuse Toe Road. The road is used for access to the Coarse Refuse Toe Sediment Pond, seep and sampling areas.
R-12	Class I Haul Road. The road is used to haul coal from the Coal Stockpile to State Highway 123.

Table 5-3 Specification for Roads in the Permit Area

A. Constructed of Dirt By Grading	Length	Ave. Grade	Max. Grade	Ave. Width	Length to be Reclaimed	Post Mine Road Use	Road Class
R-2	2.2 mi.	4.0%	33.0%	22'	2.2 mi.	None	2
R-4	1.5	13.0	16.0	20	1.5	None	3
R-6	0.7	6.0	20.0	18	0.2	Recreation and Grazing Access Water Haul road for stock during dry years	3
R-7	0.7	6.0	18.0	24	0.7	None	2
R-8	1.6	7.0	16.0	20	0.0	Dam maintenance, Recreation and Grazing Access	3
R-9	0.2	2.5	4.5	25	2.5	None	3
R-11	0.5	1.0	8.0	30	0.5	None	3
R-12	0.2	5.0	9.0	50	0.2	None	1
B. Constructed Using Local Fill As Base and 6" of Coarse Refuse for Surface							
R-1	2.5 mi.	4.0%	8.0%	30	2.5 mi.	None	2
R-3	1.7	5.0	20.0'	27	0.2	Recreation and Grazing Access Water Haul road for stock during dry years	2
R-5	0.8	13.0	26.0	21	0.8	None	reclaimed
R-7	0.7	6.0	18.0	24	0.7	None	2,3
R-10	2.2	3.0	6.0	26	2.2	None	2

ROAD CULVERT SPECIFICATIONS

Table 5-4

Number	Diameter	Length	Slope	Amount
RC 1-1	24"	60'	3%	1
RC 1-2	16"	80'	3%	1
RC 1-3	36"	80'	5%	1
RC 1-4	12"	40'	5%	1
RC 2-1	24"	40'	5%	1
RC 2-2	18"	40'	5%	1
RC 2-3	24"	40'	3%	1
RC 2-4	36"	20'	3%	1
RC 2-5	48"	40'	2%	1
RC 3-1	36"	25'	5%	1
RC 3-2	36"	25'	5%	1
RC 3-3	36"	25'	5%	1
RC 3-4	36'	25'	5%	1
RC 3-5	36"	30'	5%	1
RC 3-6	36"	40'	5%	1
RC 7-1	84"	60'	5%	1
RC 7-3	90"	31'	5%	
RC 7-4	18"	40'	5%	1
RC 10-1	36"	50'	1%	1
RC 10-2	24"	100'	15%	1
RC 10-3	24"	80'	3%	1
RC 10-4	144"	150'	10%	1

Table 5-5 Typical sequential steps for reclamation and vegetation

No.	Step	Equipment Needed	Men Needed	Hrs/ Acre	Man Hrs/A
1.	Removal of buidling or facility (optional=+)	Special contractor	-	-	-
	Removal of foundations (optional=+)	Special contractor	-	-	-
2.	Sealing entries	Truck	4	-	88 Man hr/portal
3.	Ripping				
4.	Grading	Dozer or motorgrader	1	6.2	6.2
5.	Borrow material replacement	Dozer, scraper (2)	3	2	2
6.	Finishing and disking, if necessary ++	Motorgrader, farm w/fertilizer spreader and disc	1	0.5	0.5
	P_2O_5 fertilization		2	0.5	1.0
7.	Soil testing		See estimate		
8.	N fertilization	Farm tractor, fertilizer spreader	1	0.5	0.5
9.	Revegetation:	Farm tractor w/drill dozer w/imprinter	2	0.5	1.0
	seeding	hydroseeder	2	0.5	1.0
	spread hay	flatbed w/hay blower	4	0.5	2.0
	tack hay	flatbed w/hydroseeder farm tractor w/crimper	1	0.25	0.25
10.	Monitoring		See estimate		

+ Step only necessary if building is present.

++ Do not want to disc unless absolutely necessary because topsoil is thin and mixing w/lesser quality subsoil is undesirable.

D9 L Dozer
637 D Wheel Tractor-Scraper
777 Off-Highway Truck
992 C Front End Loader
10-Ton Crane
5-Ton Flatbed Truck
35-Ton End-Dump Truck

Table 5-6

Projected Reclamation Timetable

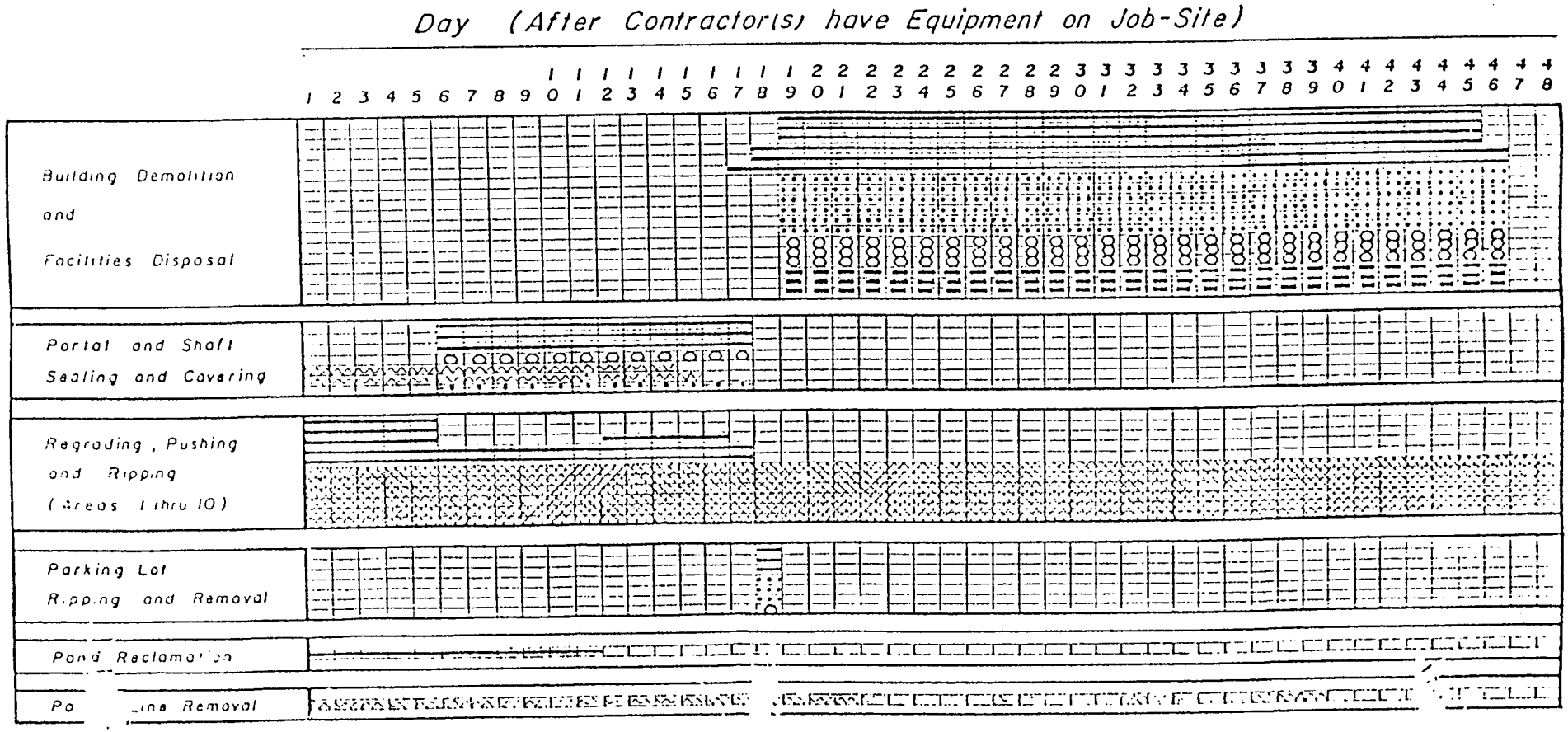


Table 5-7 Revegetation schedule in weeks in each month.

Operation	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Place Topsoil	anytime							
P-fertilization	2,3,4	1,2						
Disk	2,3,4	1,2						
Seed	3,4	1,2						1,2,3,4
Mulch	3,4	2,3						1,2,3,4
N-fertilization*							3,4	1,2
Transplant							1,2,3,4	1,2,3,4

*nitrogen fertilizer to be applied at beginning of second growing season following planting if necessary.

Appendix 5-1

Designs of Sediment Control Structures

INDEX

1. Coarse Refuse Toe

2. Rail Cut Pond

3. Pasture Road

4. Refuse Road I (Old Refuse Road)

5. No. 3 Hoisthouse

6. Upper No. 2 Canyon, Lower No. 2 Canyon

7. Slurry Ponds

8. No. 1 Mine Manshaft (001)

9. Sunnyside Surface Facilities (SSSF) and Interior Culverts

10. Manshaft Sediment Pond

11. Slurry Ditch and Surrounding Areas

12. Slurry Ponds and Coarse Refuse 100 Yr. 24 Hr. Diversions

13. Permanent Road Culverts

14. Summary of Ditch Designs

15. Culvert and Pond - Size and Outlet Protection

COARSE REFUSE TOE POND

COARSE REFUSE TOE SEDIMENT POND
(REVISED 2/25/87)

The Coarse Refuse Toe (CRT) drainage area is located at the base of the West Slurry Cell embankment. The drainage area covers the disturbed area between the bottom collection ditch and the first terrace. Soil type in the drainage area is NJF2 which is described and located on Plate VIII-1. Soil conditions were assumed to be poor (CN = 86).

The earthen dam was designed to contain the runoff from a 100-year 24-hour storm with SCS Type 2 distribution. Side slopes on the structure are 3h:1v for the upstream side and 2h:1v for the downstream side slope which yields a combined upstream and downstream side slope of 5h:1v. Width of the crest is 20 feet which exceeds the quotient (H+35)/5(10.2') where H, in feet, is the height of the embankment (16') as measured from the upstream toe of the embankment. Water will be removed from the structure after a 24-hour period with a 2-inch decant pipe. Material in the embankment fill will be compacted in 6" lifts using a rubber-tired loader. The construction elevation (6,186) is 1 foot or 5% higher than the design elevation of 6,185 feet.

Borrow material in the embankment will come from the pond site and from a borrow area located 50 feet northeast of the site or alternately, a borrow area approximately 400 feet northeast of the site. Approximately 3,400 cy of borrow will be used constructing the dam. The primary borrow site was previously approved by the Division. The alternate borrow area will be covered by the expanded refuse pile and will have no permanent environmental effects. Should the alternate borrow area be used but not covered by the refuse pile by December 31, 1988, it will be permanently reclaimed.

Twelve inches of top soil will be removed from the dam and borrow site (if used) prior to consruction and stored in a top soil pile drawn on Drawing D4-0142 (Plate III-5). The top soil will be protected from water erosion by building a ditch around the pile and seeding the soil. After the useful life of the sediment pond, the borrow material will be returned to the borrow site and the approximate original contour as shown on Drawing D4-0117 (Plate III-5). Rip rap will be buried under the material covering the borrow site. The top soils will then be redistributed. Vegetation will be planted as outlined in Section 3.5 of the Sunnyside Permit, Book 1.

Sediment control for the borrow area will be affected by a total containment berm surrounding the borrow area. Water and sediments will remain on site. The berm will be two feet high and five feet wide at the base. The site will be contained as depicted on Drawing D4-0117 (Plate III-5) to prevent runoff.

In the event the alternate borrow area is used, no topsoil will be removed from it. This is due to the steep slopes on which the borrow area is located. As previously stated, this borrow area will be buried

by the expanded coarse refuse pile so no lasting environmental effects will occur by its use. No additional sediment control will be required for this borrow area.

Runoff was calculated using a storm hydrograph computer program written by Richard H. Hawkins and Kim A. Marshall at Utah State University, Logan, Utah. The following information was used in the calculation:

Area	7.53 Acres (See Drawing D4-0142-Plate III-5)
Slope	20.01%
Channel Length	1,320 Feet
Curve Number	86
Storm	10 Year 24 Hour - 1.86 Inches
	25 Year 24 Hour - 2.20 Inches
	100 Year 24 Hour - 2.66 Inches
Distribution	SCS Type 2
Soil	NJF2 (See Plate VIII-1 for Description-Location)
Type	B-D (Use C)
Condition	Poor
Curve Number	86 (Table 9.1, National Engineering Handbook, Hydrology: Section 4)

INPUT SUMMARY
FOR W. S.: C. R. TOE AREA 1

STORM: 100 YR 24 HR			WATERSHED:		
DISTRIBUTION	=	SCS TYPE 2	LAND SLOPE	=	20.0010 PCT
			CURVE NUMBER	=	86.00
PRECIP. DEPTH	=	2.66 IN	CHANNEL LENGTH	=	1320 FT
			TIME OF CONC.	=	.1210 HR
DURATION	=	24.00 HR	AREA	=	7.53 AC
NUMBER OF LINES	=	1503	D	=	.0161 HR

OUTPUT SUMMARY

RUNOFF DEPTH	=	1.3697 IN	
INITIAL ABSTRACTION	=	.3256 IN	
PEAK FLOW	=	10.44 CFS	(1.3745 IPH)
AT T	=	12.52 HRS	

Runoff Volume -

43560 Ac. X 1.3697 In. X 7.53 Ac. - 12 In./Ft. = 37,447 $Ft.^3$

Sediment Load -

Using the Universal Soil Loss Equation $A = RKL_sC_p$ where:

R = 20
K = 0.22; % OM = 1.22, % Sand = 62.33; % Silt = 27.78; % Clay = 9.87
L_s = 12; Slope = 28%; Length = 280 Ft.
C_p = 0.54 Barfield, Appendix 5A, Seed and Fertilize After 6 Months

Gives a Loss of 28.5 Tons Per Acre or 3,904 $Ft.^3$ Per Year.
Volume of Sediment for a Three-Year Period is:

3,904 $Ft.^3$ X 3 Years = 11,712 $Ft.^3$

Maximum sediment level has been set at elevation 6,176. When sediment reaches 60% of allowed height (as indicated by a wooden stake as shown on Drawing D4-0142-Plate III-5, Typical Dam Section), the pond will be cleaned.

Volume of the pond is calculated by measuring the horizontal cross sections at five-foot intervals and then finding an equation which meets those conditions.

1. $\text{Area} = Ah^2 + Bh + C$

Cross-Sectional Area As A Function Of Height

0	=	3,825 $Ft.^2$
5	=	8,575 $Ft.^2$
10	=	14,500 $Ft.^3$

Substituting the known values into Equation 1 for h = 0,5 and 10 yields 3 equations which are:

2. 0, $C = 3{,}825$

3. 5, $25A + 5B + 3{,}825 = 8{,}575$

4. 10, $100A + 10B + 3{,}825 = 4{,}156$

Solving Equation 4 for A gives:

5. $A = 107.25 - .1B$

Substituting the value from Equation 5 into Equation 3 gives:

6. $B = 827.5$

Substituting the value from Equation 6 into Equation 5 gives:

7. $A = 24.5$

Equation 1 can then be expressed as:

$$8.\quad \text{Area} = 24.5h^2 + 827.5h + 3{,}825$$

Integrating Equation 8 gives the volume as a function of height h. (Calculus and Analytic Geometry, George B. Thomas, Section 5-4, p. 238.)

$$9.\quad \int_c^h \text{Area} = V = 8.37\ h^3 + 413.75\ h^2 + 3{,}825\ h$$

Height of sediment can then be calculated using Equation 9 at h = 1', V = 4,243 ft.^{3} which is greater than the expected yearly sediment volume of 3,904 ft.^{3}.

Height of the decant pipe is calculated by adding 3 feet to the maximum sediment level (1 foot) which yields h = 4 feet. Volume at 4 feet is 22,443 ft.^{3}.

Height of the 100-year 24-hour storm runoff volume is calculated by adding the volume at 4 feet (22,443 ft.^{3}) and the runoff volume (37,439 ft.^{3}) and then using Equation 9 at h = 8 ft., V = 61,263 ft.^{3} which is larger than the required volume of 59,887 ft.^{3}.

The course refuse toe ditch collects runoff from the bottom slope of the refuse pile as shown on the 1" = 200' drainage area insert on Drawing D4-0142 (Plate III-5).

Using the following information and the methodology presented in Summary of Ditch Design Calculations in Appendix III-1 of the Sunnyside Permit, the flow characteristic of the ditches shown on Drawing D4-0142 (Plate III-5) can be calculated:

	New	Existing
Slope	2%	28%
Width	6'	6'
Channel Side Slope	2h:1v	2h:1v
Depth of Water Flow	0.42 ft.	0.19 ft.
Velocity	3.59 ft./sec.	8.40
n	.03	.03

Headwater depth (1.6') was taken from a 1962 Portland Cement Culvert Capacity Chart for Circular Concrete Pipe (Figure 7A.1b., Page 9 of Culvert and Pond - Size and Outlet Protection in Appendix III-1, Sunnyside Permit). Assumptions used were as follows:

Slope	4.3%	$\frac{L}{100\ So} = 16.3$
Diameter	2.0'	
Discharge (CFS)	10.44 CFS	
Length	70'	

Two feet of freeboard will be used 100' upstream of the culvert to allow for headwater conditions.

Exit velocity (6.7 ft./sec.) was calculated using the methodology presented in Appendix III-1, Culvert and Pond - Size and Culvert Protection, Page 1, Sunnyside Permit). Assumptions used were as follows:

Slope	4.3%
Diameter	2.0'
Discharge (CFS)	10.44 CFS

Erosion protection for the culvert exit, pond entrance, emergency spillway, and decant outlet will be grouted rip rap. The rip rap will be dry set using mortar mix or wet set using a premixed slurry grout. This will prevent rolling of rip rap and erosion under the rocks. The decant outlet will use the stilling basin of the emergency spillway for protection. The grouted rip rap will be keyed in place with 12" deep by 12" wide keyways across the spillway, pond entrance, and culvert exit as indicated on Drawing D4-0121 (Plate III-35). Keyways will be every 10 linear feet.

Using the following information and the methodology present in Summary of Ditch Design Calculations in Appendix III-1 of the Sunnyside Permit, the flow characteristic of the emergency spillway crest section and side slope section can be calculated:

	Crest	Side Slope
Slope	0%	28%
Bottom Width	2	2
Channel Side Slope	2h:1v	2h:1v
Depth of Water Flow	1.49'	0.34'
Velocity	1.41 ft./sec.	11.3 ft./sec.
n	.03	.03

Channel flow was designed for the 100 year-24 hour event. The Manning's n value of 0.03 was used because the grouted rip rap surface is left rough with protruding rock faces.

The splash basin was designed using the following methodology:

$$V = 11.3 \text{ ft./sec.}$$

$$A = \frac{Q}{V} = \frac{10.5 \text{ CFS}}{11.3 \text{ ft./sec.}} = 0.9292 \text{ ft.}^2$$

$$d = A^{\frac{1}{2}} = 0.964 \text{ ft.}$$

$$I = \frac{V}{(gd)^{\frac{1}{2}}} = 2.03$$

$$\frac{W}{d} = 4.25 \text{ from Figure 6-10, small channel structures, p. 310}$$

$$W = d\left(\frac{W}{d}\right) = 0.964\ (4.25) = 4.09 \qquad 4.0'$$

Splash basin size is 4 ft. X 5.5 ft. X 1.5 ft. with a 6-inch adverse slope. Dimensions of the splash basin are after the installation of the rip rap.

COARSE REFUSE TOE BORROW AREA

The reconstruction plans for the Coarse Refuse Toe Pond require approximately 2,000 CY of borrow. A new borrow area 200 feet southwest of the pond (see drawing D4-0117) will be used for the fill material. Soil type, according to Plate VIII-1 of the Sunnyside permit is ILDEFONSO VERY STONY LOAM (IGC). Topsoil on the primary borrow site, 0.57 acres and on the seconary site (to be used only if needed), 0.45 acres will be stored were shown on Drawing D4-0117. The top twelve inches of soil will be removed and stored until the borrow site is finished. Then the soil will be redistributed and seeded as outlined in Section 3.5 of the permit application. The topsoil will be protected from water errosion by building a ditch around the pile. Further protection will not be needed because the soil will be replaced and seeded within a few weeks of disturbance.

Sediment contral will be effected by a total containment berm surrounding the disturbed area. Water and sediments will remain on site. The berm will be two feet high and five feet wide at the base. The site will be contoured as depicted on drawing D4-0117 to prevent runoff.

The additional bond required for the new disturbed area is calculated as follows:

Primary Site

Soil Testing, Fertilizer and Seed Bed Preperation-

$197.33* x 0.57 acres = $112.48

Revegetation-

$626.74** x 0.57 acres = $357.24

Total- $469.72

Secondary Site (only if needed)

Soil Testing, Fertilizer and Seed Bed Preperation-

$197.33 x 0.45 acres = $ 88.79

Revegetation-

$626.74 x 0.45 acres = $282.03

Total- $370.82

* p. 79, Section 3.5.7.1

** Table III-29

COARSE REFUSE TOE POND

AREA	5.14 ACRES (SEE PLATE III-6, DRAWING C4-0058)
SLOPE	22.24 PERCENT
CHANNEL LENGTH	1214 FEET
CURVE NUMBER	86
STORM	10 YEAR-24 HOUR 1.86 INCHES
	25 YEAR-24 HOUR 2.20 INCHES
DISTRIBUTION	SCS TYPE 2
SOIL	NJF2 (SEE PLATE VIII-1 FOR DISCRIPTION-LOCATION)
TYPE	B-D (USE C)
CONDITION	POOR
CURVE NUMBER	86 (TABLE 9.1, NATIONAL ENGINEERING HANDBOOK, HYDROLOGY: SECTION 4)

POND VOLUME

AREA AS A FUNCTION OF HEIGHT

1. $X = AX^2 + BX + C$

CROSS SECTIONAL AREA AT HEIGHT 0 = 629 FT^2
5 = 1787 FT^2
10 = 4156 FT^2

SUBSTITUTING THE THE KNOWN VALUES INTO EQUATION 1 FOR X = 0, 5, AND 10 YIELDS 3 EQUATIONS WHICH ARE:

2. 0, $C = 629$
3. 5, $25A + 5B + 629 = 1787$
4. 10, $100A + 10B + 629 = 4156$

SOLVING EQUATION 3 FOR B GIVES:

5. $B = 231.6 - 5A$

SUBSTITUTING THE VALUE FOR B FROM EQUATION 5 INTO EQUATION 4 GIVES:

6. $A = 24.22$

SUBSTITUTING THE VALUE FOR A FROM EQUATION 6 INTO EQUATION 5 GIVES:

7. $B = 110.50$

EQUATION 1 CAN THEN BE EXPRESSED AS:

8. $AREA = 24.22X^2 + 110.5X + 629$

INTEGRATING EQUATION 8 GIVES THE POND VOLUME AS A FUNCTION OF HEIGHT X.

SPILLWAY SIZE

USING EQUATION 4.4 FROM <u>APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS</u> AND SOLVING FOR H' GIVES THE FOLLOWING EQUATION:

$$H' = Q^2(1+K_e+K_b+K_cL)/(A^2 2G) \quad \text{WHERE}$$

$Q = 5.31$ CFS
$K_e = 1$
$K_b = 0.5$
$L = 270$ FT
$A = 7.0T$ FT^2 (36" CMP)
$K_c = 0.0246$

$H' = 0.08$ FT OK

TOTAL HEIGHT OF DAM

11 FEET + 1 FOOT = 12 FEET USE 14 FEET

INPUT SUMMARY
FOR W.S.: CRTOE POND

STORM: 10 yr/24 hr WATERSHED: CR TOE POND

DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 22.2400 PCT
	CURVE NUMBER = 86.00
PRECIP.DEPTH = 1.86 IN	CHANNEL LENGTH = 1214 FT
	TIME OF CONC. = .1073 HR
DURATION = 24.00 HR	AREA = 5.14 AC
NUMBER OF LINES = 1693	D = .0143 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .7407 IN
INITIAL ABSTRACTION = .3256 IN
PEAK FLOW = 4.00 CFS (.7721 IPH)
AT T = 12.52 HRS

INPUT SUMMARY
FOR W.S.: CRTOE POND

STORM: 25 yr/24 hr WATERSHED: CR TOE POND

DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 22.2400 PCT
	CURVE NUMBER = 86.00
PRECIP.DEPTH = 2.20 IN	CHANNEL LENGTH = 1214 FT
	TIME OF CONC. = .1073 HR
DURATION = 24.00 HR	AREA = 5.14 AC
NUMBER OF LINES = 1693	D = .0143 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .9984 IN
INITIAL ABSTRACTION = .3256 IN
PEAK FLOW = 5.31 CFS (1.0254 IPH)
AT T = 12.52 HRS

9. VOLUME = $8.1X^3 + 55.25X^2 + 629\ X$

VOLUME BY HEIGHT INCRIMENTS

0 - 4	3916 FT^3
4 - 5	1618 FT^3
5 - 6	1971 FT^3
6 - 7	2372 FT^3
7 - 8	2822 FT^3
8 - 9	3320 FT^3
9 - 10	3866 FT^3
10 - 11	4461 FT^3

10 YEAR-24 HOUR STORM RUNNOFF VOLUME

0.7407 IN X 5.14 AC X 43560 FT^2/AC / 12 IN/FT = 13,820 FT^3

25 YEAR-24 HOUR STORM RUNNOFF VOLUME

0.9984 IN X 5.14 AC X 43560 FT^2/AC / 12 IN/FT = 18,628 FT^3

THE POND WILL CONTAIN THE RUNNOFF FROM A 24 YEAR-24 HOUR STORM EVENT (VOLUME FROM 4 - 11 FEET IS 20,430 FT^3)

SEDIMENT LOAD

USING THE UNIVERSAL SOIL LOSS EQUATION $A = RKL_SC_P$
WHERE:

$R = 16$
$K = 0.28$
$L_S = 4.2$
$C_P = 0.54$

GIVES A LOSS OF 10.2 TONS PER ACRE OR 750 FT^3 PER YEAR

DEPTH OF SEDIMENT FOR A THREE YEAR PERIOD IS:

750 FT^3/YEAR X 3 YEARS = 2,250 FT^3

0 - 4 FOOT IN DEPTH HAS A VOLUME OF 3,916 FT^3 - USE 4 FEET

10 YEAR-24 HOUR STORM RUNNOFF DEPTH IN THE POND

RUNNOFF VOLUME	13820 FT^3	
VOLUME 4' - 10'	15969 FT^3	- USE 10 FEET

EMERGENCY SPILLWAY HEIGHT

10 FEET + 1 FOOT = 11 FEET

COARSE REFUSE NORTH DRAINAGE

PERMANENT CULVERT

CULVERT LENGTH	280	FT
DIAMETER	3	FT
SLOPE	7.14	FT
QUANITY	11.35	CFS
L/100S	39.21	

HEADWATER FORM FIGURE 7A.2a IN CULVERT AND POND SIZE AND OUTLET PROTECTION, APPENDIX III-1 IS 1.5 FEET, A 2 FOOT HEAD WALL IS PROVIDED. INLET PROTECTION WILL BE A METAL APRON. OUTLET PROTECTION IS PROVIDED BY A CONCRETE COLLAR PRESENTLY IN PLACE.

INPUT SUMMARY
FOR W.S.: CRTOE NORTH

STORM: 100 year - 24 hour WATERSHED: CR TOE NORTH

DISTRIBUTION = SCS TYPE 2
LAND SLOPE = 13.7600 PCT
CURVE NUMBER = 76.00
PRECIP.DEPTH = 2.66 IN
CHANNEL LENGTH = 2299 FT
TIME OF CONC. = .3135 HR
DURATION = 24.00 HR
AREA = 16.85 AC
NUMBER OF LINES = 590
D = .0418 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .7933 IN
INITIAL ABSTRACTION = .6316 IN
PEAK FLOW = 11.35 CFS (.6683 IPH)
AT T = 12.62 HRS

RAILCUT POND

Sediment Structure Worksheet

Sediment Structure: Area I, Ditch D1 Page 1 of 17

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86" 100/24 = 2.66"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 2.26 Acres

Slope of Area: Average = (375X.015+100X0.50) ÷ (375+100) = 0.117 , 11.7%

Length of Slope: 375 + 100 = 475'

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.628$$

10/24 $$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73"$$ Q_v10/24 = 5,989 ft^3

25/24 $$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00"$$ Q_v25/24 = _____

100/24 = 1.375"

A = R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area I, Ditch 01

Conditions:

Length of Drainage: 475'

Average Slope: 11.7%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= 0.042$

$$T_c = T_1/.6$$

$= 0.069$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1{,}000$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= 2.58 10/24 Storm

= 3.53 CFS 25/24 Storm

= 4.86 CFS 100/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area II, Ditch D2

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86" 100/24 = 2.66"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 2.96 Acres

Slope of Area: ((475 X .015) + (100 X 0.5)) ÷ (475 + 100) = 0.099 , 9.9%

Length of Slope: 475 + 100 = 575'

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.628$$

10/24 $$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73"$$ $Q_v 10/24$ = 7,843 ft^3

25/24 $$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00"$$ $Q_v 25/24$ = _____

100/24 = 1.375"

A = R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area II, Ditch D2

Conditions:

Length of Drainage: 575

Average Slope: 9.9%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.053}$

$$T_c = T_1/.6$$

$= \underline{0.088}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{1,000}$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= 3.37 CFS 10/24 Storm

= 4.62 25/24 Storm

= 6.36 100/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area III, Ditch D3 Page 5 of 17

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86" 100/24 = 2.66"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 3.31

Slope of Area: ((587 X 0.015) + (100 X .5)) ÷ (587 + 100) = 0.0856 , 8.56%

Length of Slope: 687

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73" \qquad Q_v 10/24 = 8,771\ ft^3$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00" \qquad Q_v 25/24 = \_\_\_\_\_$$

100/24 = 1.375"

A = R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area III, Ditch D3

Conditions:

Length of Drainage: 687

Average Slope: 8.56%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.065}$

$T_c = T_1/.6$

$= \underline{0.109}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{960}$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= \underline{3.62 \text{ CFS}}$ 10/24 Storm

$= \underline{4.96 \text{ CFS}}$ 25/24 Storm

$= \underline{6.83 \text{ CFS}}$ 100/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area IV, Ditch 04

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86 100/24 = 2.66"

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 7.69

Slope of Area: ((550X0.015) + (125X0.5) + (250X0.005)) ÷ (550+125+250) = 0.078,7.8%

Length of Slope: 925

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73"$$ $Q_v 10/24$ = 20,377 ft^3

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00"$$ $Q_v 25/24$ =

100/24 1.375"

A = R K LS CP =

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} =$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area IV, Ditch D4

Conditions:

Length of Drainage: 925

Average Slope: 7.8%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.087}$

$$T_c = T_1/.6$$

$= \underline{0.145}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{900}$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= 7.89 CFS 10/24 Storm

= 10.81 CFS 25/24 Storm

= 14.86 CFS 100/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area V, Ditch D5

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86" 100/24 = 2.66"

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 3.63

Slope of Area: ((587 X 0.015) + (100 X .5)) ÷ 687 = 0.085 , 8.5%

Length of Slope: 687

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73"$$ $Q_v 10/24$ = 9,619 ft^3

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00"$$ $Q_v 25/24$ = _____

100/24 = 1.375"

A = R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area V, Ditch D5

Conditions:

Length of Drainage: 687

Average Slope: 8.5%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.066}$

$T_c = T_1/.6$

$= \underline{0.11}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{960}$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= \underline{3.97 \text{ CFS}}$ 10/24 Storm

$= \underline{5.44 \text{ CFS}}$ 25/24 Storm

$= \underline{7.48 \text{ CRS}}$ 100/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area VI, Ditch D14

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 17.08 Acres

Slope of Area: ((1000 X .073) + (200 X 0.625)) ÷ 1200 = 0.165 , 16.5%

Length of Slope: 1,200'

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73''$$ $Q_v 10/24$ = _____

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00''$$ $Q_v 25/24$ = _____

A = R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area VI, Ditch D14

Conditions:

Length of Drainage: 1,200'

Average Slope: 16.5%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$$= \underline{0.074}$$

$$T_c = T_1/.6$$

$$= \underline{0.123}$$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$$= \underline{950}$$

$$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$$

= 18.51 CFS 10/24 Storm

= 25.35 CFS 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area VII, Ditch D12

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 15.61 Acres

Slope of Area: (1425 X 0.052 + 120 X .5) ÷ 1545 = 0.086 , 8.6%

Length of Slope: 1,545

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73"$$ $Q_v 10/24 = 41,364\ ft^3$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00"$$ $Q_v 25/24 =$ _____

$A = R\ K\ LS\ CP =$ _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} =$$ _____

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area VII, Ditch D12

Conditions:

Length of Drainage: 1,545

Average Slope: 8.6%

Curve Number: 86, S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.125}$

$$T_c = T_1/.6$$

$= \underline{0.209}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{795}$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= 14.16 CFS 10/24 Storm

= 19.39 CFS 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: Area VIII, Ditch D13

Conditions:

Soil Type: NJF2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.86

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 8.73

Slope of Area: 33.7%

Length of Slope: 420'

culations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.628$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.73 \qquad Q_v 10/24 = 23{,}133\ ft^3$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.00 \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area VIII, Ditch D13

Conditions:

Length of Drainage: 1,000'

Average Slope: 1.5%

Curve Number: 86 , S = 1.628

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.212}$

$T_c = T_1/.6$

$= \underline{0.353}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{625}$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= \underline{11.67 \text{ CFS}}$ 10/24 Storm

$= \underline{15.99 \text{ CFS}}$ 25/24 Storm

RAIL CUT POND VOLUME

As A Function of Height

h_0 Base area at 6250' = 42,236 ft^2

h_5 Base area at 6210' = 57,888 ft^2

h_{10} Base area at 6215' = 81,739 ft^2

$A = ah + b + c$

$= 195h^2 + 200h + 42,236$

$V = \int_0^h 195h^2 + 2000h + 42,236$

$= 65h^3 + 1000h^2 + 42,236h$

Sediment Volume

5 yr X 3,036 = 15,181 ft^3

h - .2' use 1'
or 43,301 ft^3 for sediments

10 Year 24 Hour Storm Volume

132,000 ft^3 + 43,301 = 175,301 ft^3 h = 3.8' or 178,503 ft^3

Spillway Height = 3.8' + 1 = 4.8'

Spillway Size

$$H = \frac{Q^2(1+Ke+Kb+KcL)}{a^2\ 2G}$$

Ke = 1
Kb = 5
L = 74.8'
Kc = .0246, .0201
a = 7.07, 9.62
Q = 71.69

36" H' = 6.9 too much
42" H' = 3.45' OK
10-(4.8 (4.8 + 3.45) = 1.75'

USE 42' cmp

1.75 freeboard

PASTURE POND

Sediment Structure Worksheet

Sediment Structure: Pasture Pond (New Haul Road)

Conditions:

Soil Type: IGC

Hydrologic Group: "B"

Land Use: Pasture or Range

Land Condition: ½ Fair, ½ Poor

Curve Number CN: (69 + 79)/2 = 74

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 7.58 Div.

Slope of Area: 4.09% for 1100' + 16.67 for 120' = 5.3%

Length of Slope: 1,100'

Registered Professional Engineer
G. A. FARNSWORTH
#760
State of Utah

Calculations of Runoff and Sediment Volume

$S = \frac{1,000}{CN} - 10 =$ 3.51

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .28 $V_{10/24} =$ 7.704 ft^3

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .45 $V_{25/24} =$ 12,382 ft^3

A=R K LS CP = .41 T/A

R=16
K=.28
LS=1.81
CP=.05

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v = \frac{A(Area)(2000)}{(140)} =$ 44.4 ft^3/yr

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Pasture Pond (New Haul Road)

Conditions:

Length of Drainage: 1,100'

Average Slope: 5.3%

Curve Number: 74

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .178$ s+ 3.51

$$T_c = T_1/.6$$

$= .296$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 671.8$

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

$= 2.23$ cfs 10/24 Storm

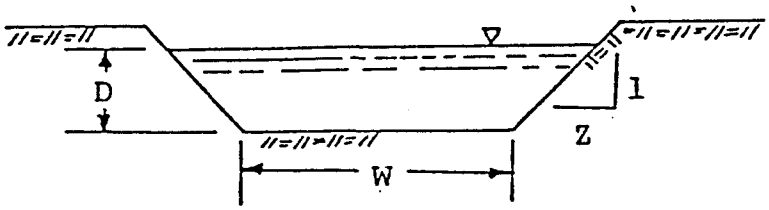
$= 3.58$ cfs 25/24 Storm

PROJECT Pasture Pond
(New Haul Road)

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 3.58 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 5.3% DECIMAL%

WIDTH OF CHANNEL 1' 2 FT

DEPTH OF CHANNEL Flow = 4.7' FT

COMMENTS: z = 1
Velocity - 5.11 ft/sec
Freeboard = .5'

Haulroad Culvert use 12" cmp

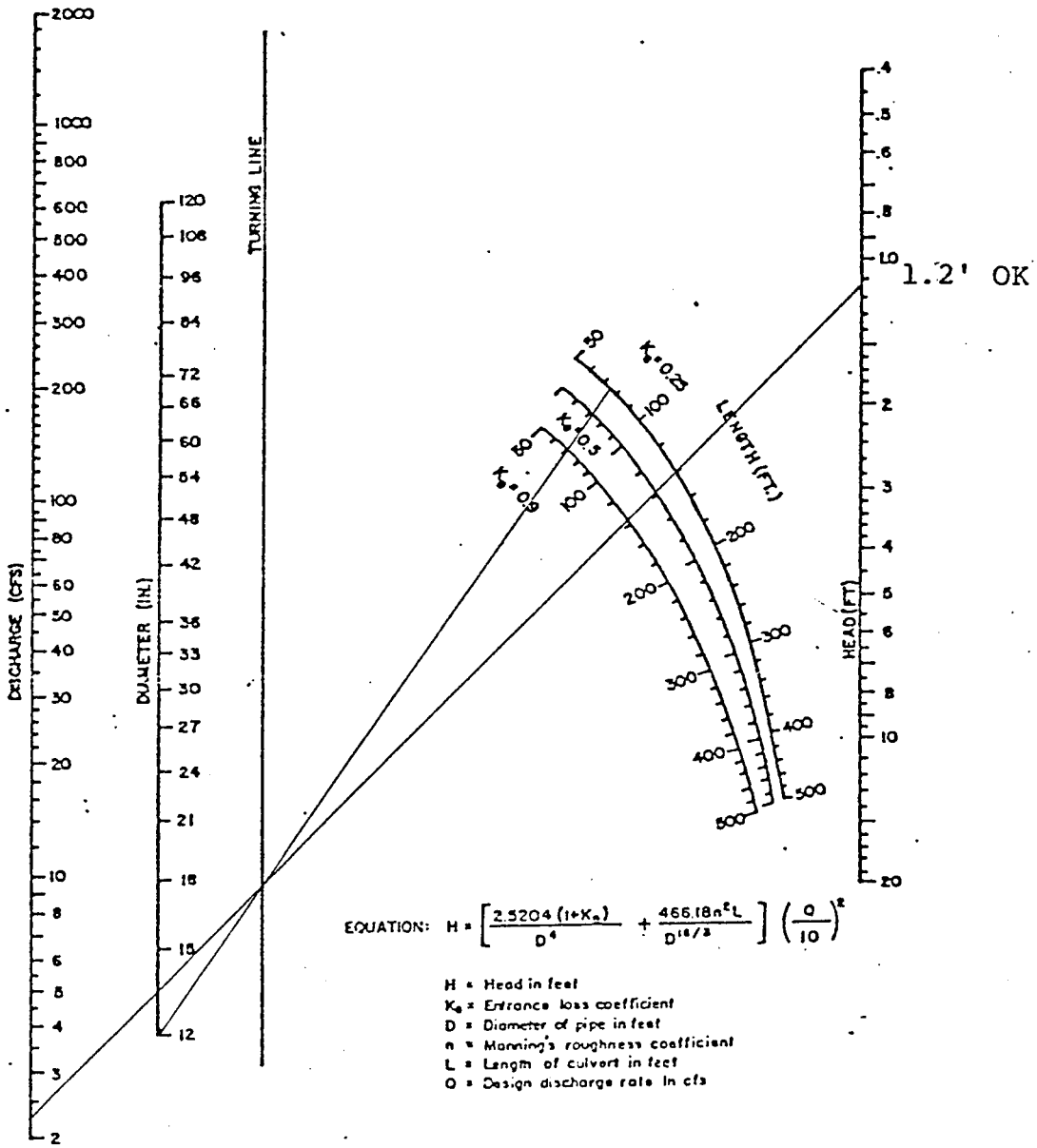


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Pasture Pond

h = 0 Base area 67 x 78 = 5226 ft^2

h = 5 Base area 87 x 98 = 8526 ft^2
89 x 78 = 6952

C = 660h + 5226

$$V = \int_0^h 660h + 5226$$

$$V = 330h^2 + 5226h$$

$$V = 330h^2 + 5226h$$

5 year sediment storage

5 x 44.4 = 222.0 ft^3

h = 648 ft^3 ok

10 year 24hr volume

7.704 ft^3 + 648 ft^3 = 8352 ft^3

h = 1.50' = 8581 ft^3

Emergency Spillway height

1.25 + 1 = 2.25'

Water Height over Spillway

$$H' = \frac{Q^2(1=Ke+kb+KcL)}{a^2\ 2G} = .49' - 16''\ \text{culvert}$$

Q = 3.58
Ke = 1
Kb = .5
Kc = .1067
L = 32.5
a = .785
G = 32.2

REFUSE ROAD I

Sediment Structure Worksheet

Sediment Structure: Refuse Road I

Conditions:

Soil Type: IGC over coarse refust waste

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 5.99

Slope of Area: 20%

Length of Slope: 117.5

Registered Professional Engineer
G. A. FARNSWORTH
#760
State of Utah

Calculations of Runoff and Sediment Volume

$S=\frac{1,000}{CN} - 10 =$ 1.63

$Q=\frac{(P-.2(S))^2}{P+.8(S)} =$ .729 $V_{10/24} =$ ~~15,851 ft^3~~

$Q=\frac{(P-.2(S))^2}{P+.8(S)} =$ 1.00 $V_{25/24} =$ 21,743 ft^3

A=R K LS CP = 10.16 T/A

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v=\frac{A(Area)(2000)}{(140)} =$ 869.5 ft^3

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Refuse Road I

Conditions:

Soil Type: IGC over coarse refust waste

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 86

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 5.99

Slope of Area: 20%

Length of Slope: 117.5

Registered Professional Engineer
G. A. FARNSWORTH
#760
State of Utah

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 1.63$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .729 \qquad V_{10/24} = 15,851\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 1.00 \qquad V_{25/24} = 21,743\ ft^3$$

$$A=R\ K\ LS\ CP = 10.16\ T/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 869.5\ ft^3$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Refuse Road I

Conditions:

Length of Drainage:	2,400	Area = 5.99
Average Slope:	15%	Q10/24 = 7.29 inches
Curve Number:	86	Q25/34 = 1.00 inches

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$$= \underline{\qquad\qquad} \qquad S = 1.63$$

$$T_c = T_1/.6$$

$$= \underline{\ .225\ }$$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$$= \underline{\ 761.03\ }$$

$$q_p = q_p' \ A \ Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 5.19 cfs 10/24 Storm

= 7.12 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Refuse Road I

Conditions:

Length of Drainage:	2,400	Area = 5.99
Average Slope:	15%	Q10/24 = 7.29 inches
Curve Number:	86	Q25/34 = 1.00 inches

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$$= \underline{\qquad\qquad} \qquad S = 1.63$$

$$T_c = T_1/.6$$

$$= \underline{\ .225\ }$$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$$= \underline{\ 761.03\ }$$

$$q_p = q_p' \ A \ Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 5.19 cfs 10/24 Storm

= 7.12 cfs 25/24 Storm

CMP Under Old Haul Road use 18"

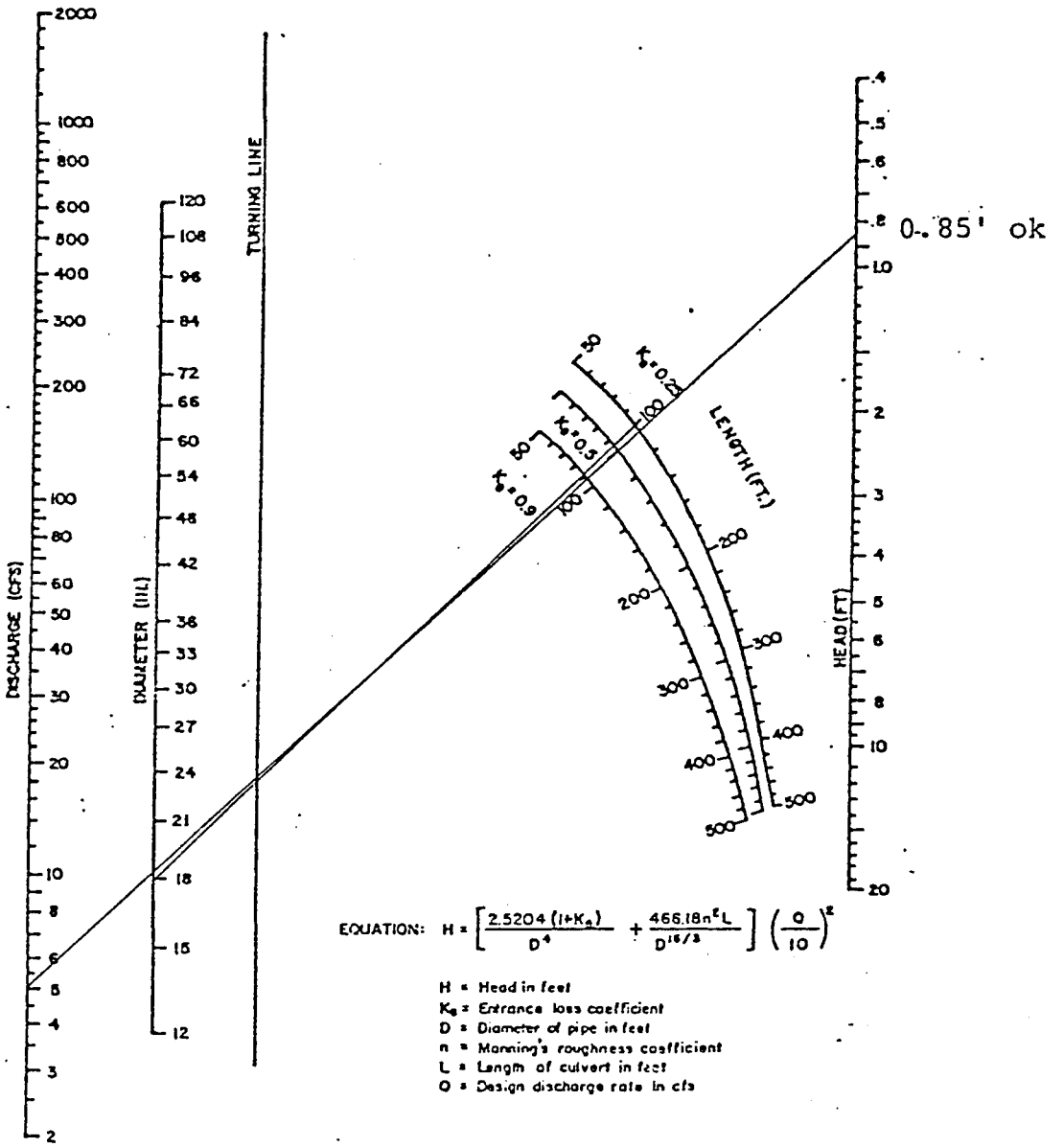


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

CMP Under Old Haul Road use 18"

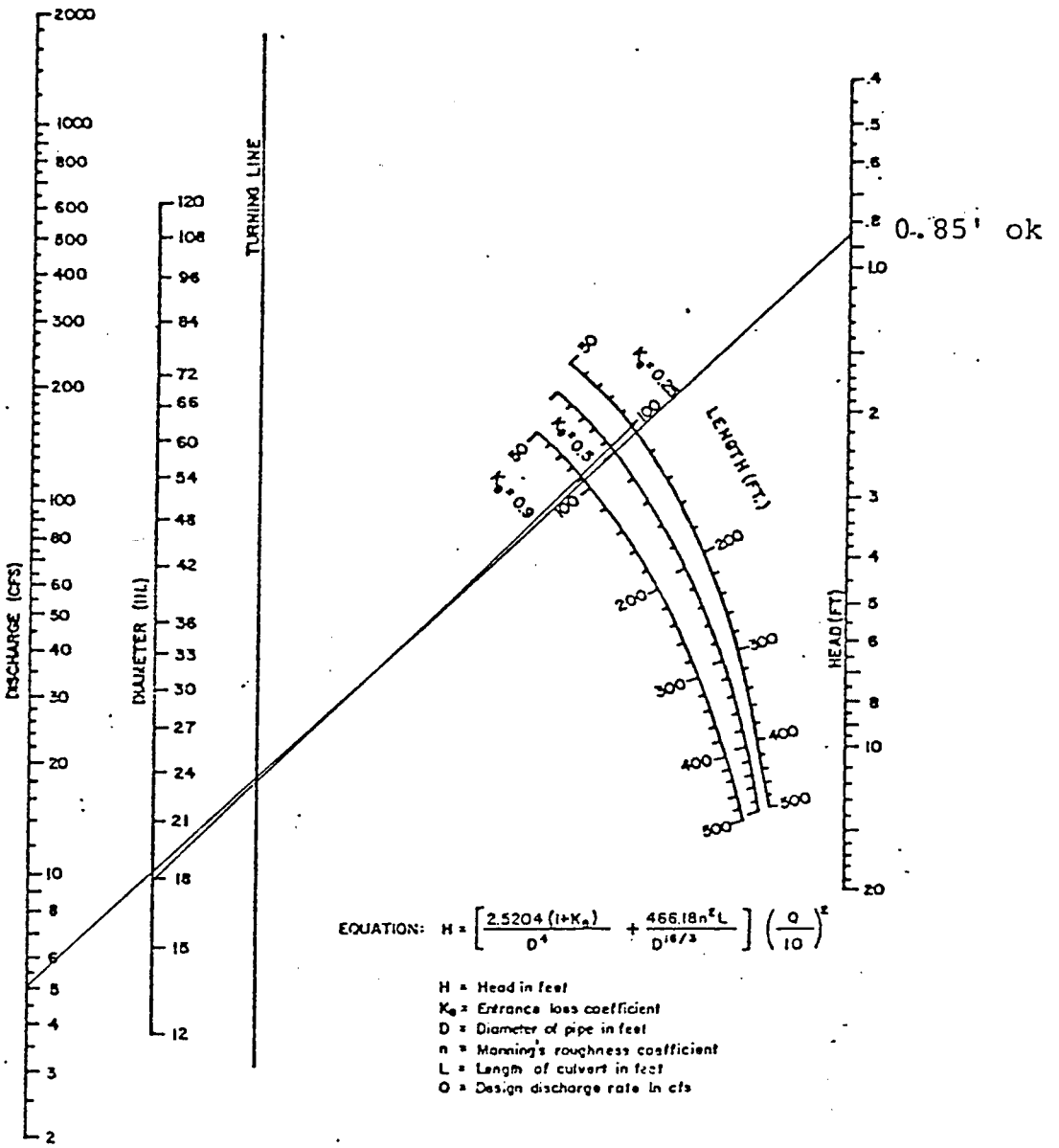


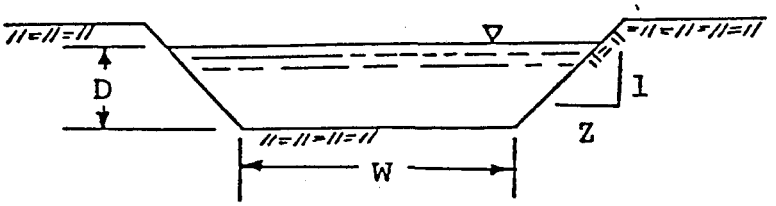
Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

PROJECT Refuse Road I

CALCULATION & DESIGN BY KAISER STEEL

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: $n = 0.030$

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH 7.12 CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 0.15 DECIMAL%

WIDTH OF CHANNEL 2.0' FT

DEPTH OF CHANNEL Flow .286' FT

COMMENTS: Velocity - 7.57ft/sec

Freeboard = .5'

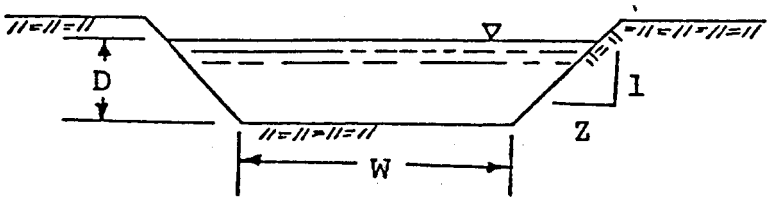
z = 1

PROJECT Refuse Road I

CALCULATION & DESIGN BY KAISER STEEL

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: $n = 0.030$

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH 7.12 CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 0.15 DECIMAL%

WIDTH OF CHANNEL 2.0' FT

DEPTH OF CHANNEL Flow .286' FT

COMMENTS: Velocity - 7.57ft/sec

Freeboard = .5'

z = 1

REFUSE ROAD I

Drop Inlet Spillway Design

18" cmp

$$Q = \frac{g(2gH)^{\frac{1}{2}}}{(1+Ke+Kb \pm KcL)^{\frac{1}{2}}}$$

Ke = 1
Kb - .5
Kc = .0621
L = 45 = 6.9 = 51.9
g = 32.2
a = 1.77 ft^2
H'=
Q = q_p = 7.12

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2}/2G$$

H' = 1.47'

h = 0	Base area	1,950 ft^2
h = 5	Base area	8.476 ft^2

C = 1,305h + 1950

$$V = \int_o^h 1{,}305h + 1950$$

$= 652h^2 + 1950h$

$V = 652h^2 + 1950h$

<u>Sediment</u> = 5(869.5) = 4,247.5 ft^3

h = 1.5' 4392 ft^3

<u>10 year 24hr storm</u> = 15,851 ft^3
total volume = 20,243

h = 5.0 <u>26,000 ft^3</u>

Spillway height = 5.0 + 1 = <u>6.0</u>

Freeboard = 6.0 + 1.47 = 7.5
10 - 7.5 = <u>2.5</u>

REFUSE ROAD I

Drop Inlet Spillway Design

18" cmp

$$Q = \frac{g(2gH)^{\frac{1}{2}}}{(1+Ke+Kb \pm KcL)^{\frac{1}{2}}}$$

Ke = 1
Kb - .5
Kc = .0621
L = 45 = 6.9 = 51.9
g = 32.2
a = 1.77 ft^2
H'=
Q = q_p = 7.12

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2}/2G$$

H' = 1.47'

h = 0	Base area	1,950 ft^2
h = 5	Base area	8.476 ft^2

C = 1,305h + 1950

$$V = \int_o^h 1{,}305h + 1950$$

$$= 652h^2 + 1950h$$

$$V = 652h^2 + 1950h$$

<u>Sediment</u> = 5(869.5) = 4,247.5 ft^3

h = 1.5' 4392 ft^3

<u>10 year 24hr storm</u> = 15,851 ft^3
total volume = 20,243

h = 5.0 <u>26,000 ft^3</u>

Spillway height = 5.0 + 1 = <u>6.0</u>

Freeboard = 6.0 + 1.47 = 7.5
10 - 7.5 = <u>2.5</u>

Sediment Structure Worksheet

Sediment Structure: Diversion Area I for Refuse Road I Pond

Conditions:

Soil Type: NJFZ

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Fair

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.8

Slope of Area: N/A

Length of Slope: N/A

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.66$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \quad V_{10/24}= \_\_\_\_\_$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .64" \quad V_{25/24}= 4,181\ ft^3$$

$$A=R\ K\ LS\ CP = N/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = N/A$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Diversion Area I for Refuse Road I Pond

Conditions:

Soil Type: NJFZ

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Fair

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.8

Slope of Area: N/A

Length of Slope: N/A

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.66$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \quad V_{10/24}= \_\_\_\_\_$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .64" \quad V_{25/24}= 4,181\ ft^3$$

$$A=R\ K\ LS\ CP = N/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = N/A$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Diversion Area I for Refuse Road I Pond

Conditions:

Length of Drainage: 270'

Average Slope: 35.2%

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .0194 $\qquad S = 2.66$

$$T_c = T_1/.6$$

= .0323

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$ if $Tc > .1$ then $q_p = 1000$

= 1000 $\qquad$ Formual regresses under that number

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= _____ 10/24 Storm

= 1.8 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Diversion Area I for Refuse Road I Pond

Conditions:

Length of Drainage: 270'

Average Slope: 35.2%

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .0194$ $\qquad S = 2.66$

$$T_c = T_1/.6$$

$= .0323$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$ if $Tc > .1$ then $q_p = 1000$

$= 1000$ Formual regresses under that number

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= _____ 10/24 Storm

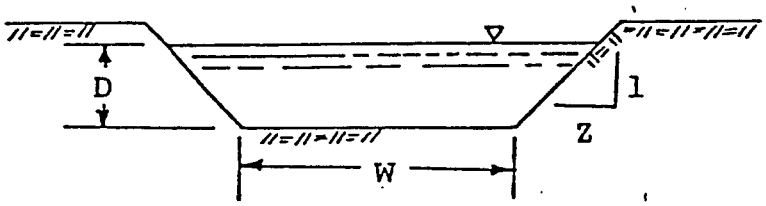
= 1.8 cfs 25/24 Storm

PROJECT Diversion Area I
for Refuse Road I Pond

CALCULATION
& DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.8 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 49% DECIMAL%

WIDTH OF CHANNEL 1" FT

DEPTH OF CHANNEL Flow = .329 FT

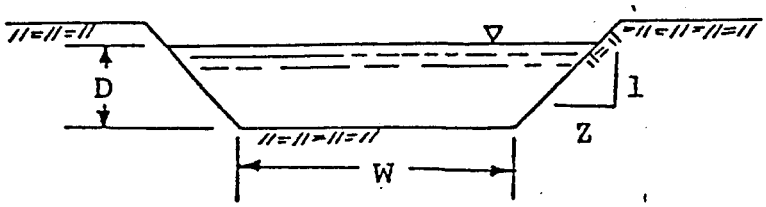
COMMENTS: W = 1, Z = 1
Velocity = 4.1'
Freeboard = .5'

PROJECT Diversion Area I
for Refuse Road I Pond

CALCULATION
& DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.8 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 49% DECIMAL%

WIDTH OF CHANNEL 1' FT

DEPTH OF CHANNEL Flow = .329 FT

COMMENTS: W = 1, Z = 1
Velocity = 4.1'
Freeboard = .5'

Peak Runoff Worksheet

Sediment Structure: Diversion Area II for Refuse Road I Pond

Conditions:

Length of Drainage: 200' Area = 1.25

Average Slope: 42.5% Q 25/24 = .64"

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .014 S = 2.66

$$T_c = T_1/.6$$

= .023

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

if Tc > .1 then q_p = 1000 formula regresses under that number

= 1000

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= _____ 10/24 Storm

= 1.25 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Diversion Area II for Refuse Road I Pond

Conditions:

Length of Drainage: 200' Area = 1.25

Average Slope: 42.5% Q 25/24 = .64"

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .014 S = 2.66

$$T_c = T_1/.6$$

= .023

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

if Tc > .1 then q_p = 1000 formula regresses under that number

= 1000

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= _____ 10/24 Storm

= 1.25 cfs 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: Diversion Area II for Refuse Road I Pond

Conditions:

Soil Type: NJFZ

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Fair

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.25

Slope of Area:

Length of Slope:

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = \underline{2.66}$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = \underline{\quad} \qquad V_{10/24}=\underline{\quad}$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = \underline{.64} \qquad V_{25/24}=\underline{2.2}$$

$$A=R\ K\ LS\ CP = \underline{\quad}$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_V=\frac{A(Area)(2000)}{(140)}=\underline{\quad}$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Diversion Area II for Refuse Road I Pond

Conditions:

Soil Type: NJFZ

Hydrologic Group: "C"

Land Use: Pasture or Range

Land Condition: Fair

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.25

Slope of Area:

Length of Slope:

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.66$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \quad V_{10/24}= \_\_\_\_\_$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .64 \quad V_{25/24}= 2.2$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)}= \_\_\_\_\_$$

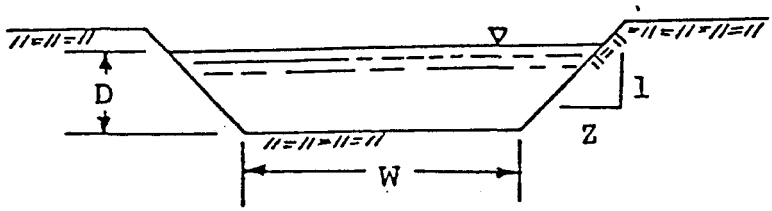
Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

PROJECT Diversion Area II for Refuse Road I Pond

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.25 CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 3.25% DECIMAL%

WIDTH OF CHANNEL 1' FT

DEPTH OF CHANNEL Flow = .295' FT

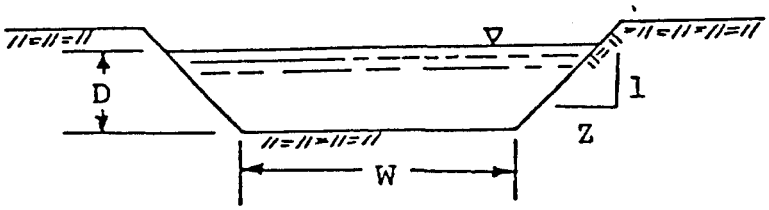
COMMENTS: Velocity = 3.27 ft/sec
Freeboard = .5'

PROJECT Diversion Area II for Refuse Road I Pond

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.25 CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 3.25% DECIMAL%

WIDTH OF CHANNEL 1' FT

DEPTH OF CHANNEL Flow = .295' FT

COMMENTS: Velocity = 3.27 ft/sec
Freeboard = .5'

CMP Under Road for Diversion Areas I & II

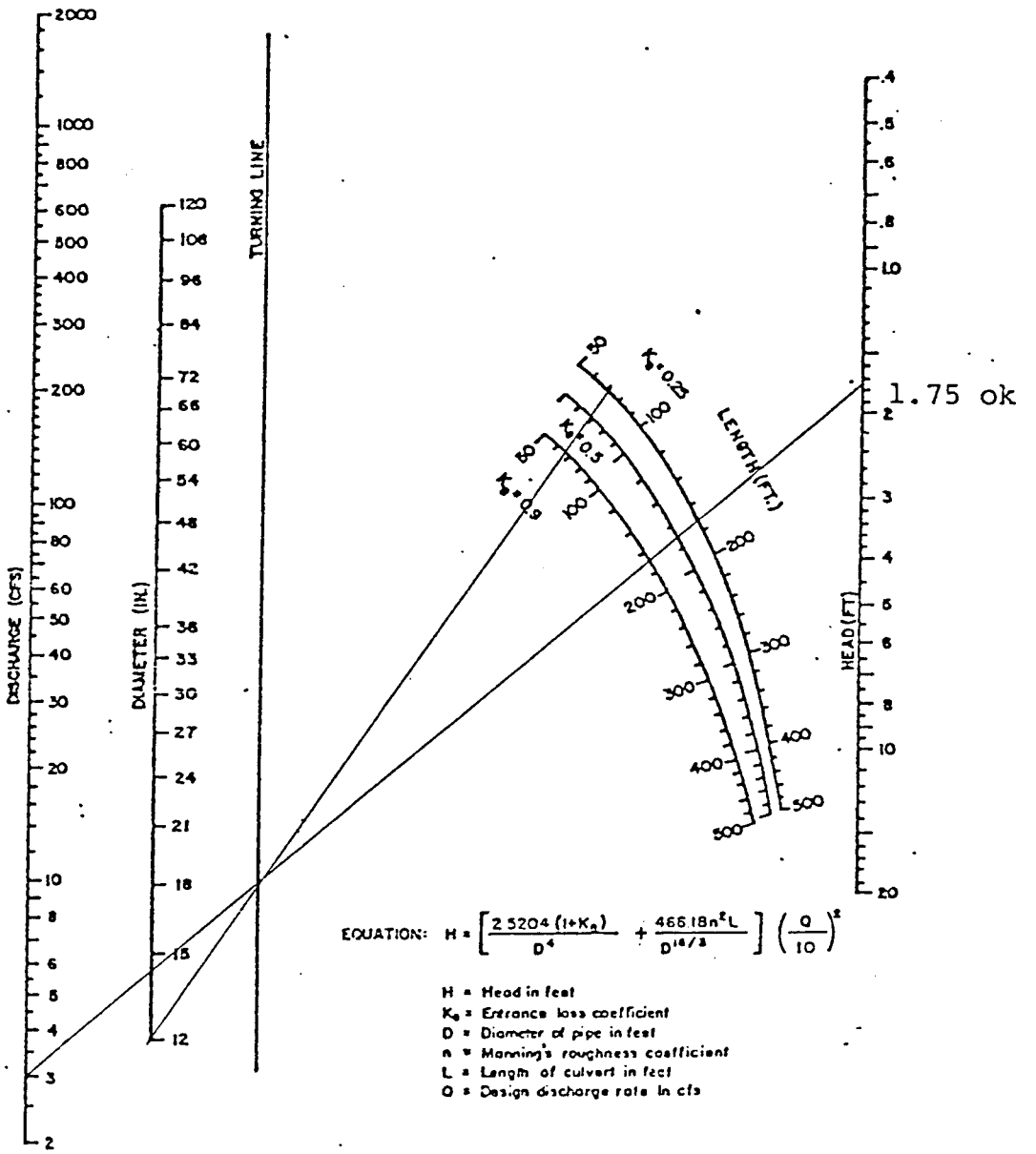


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

CMP Under Road for Diversion Areas I & II

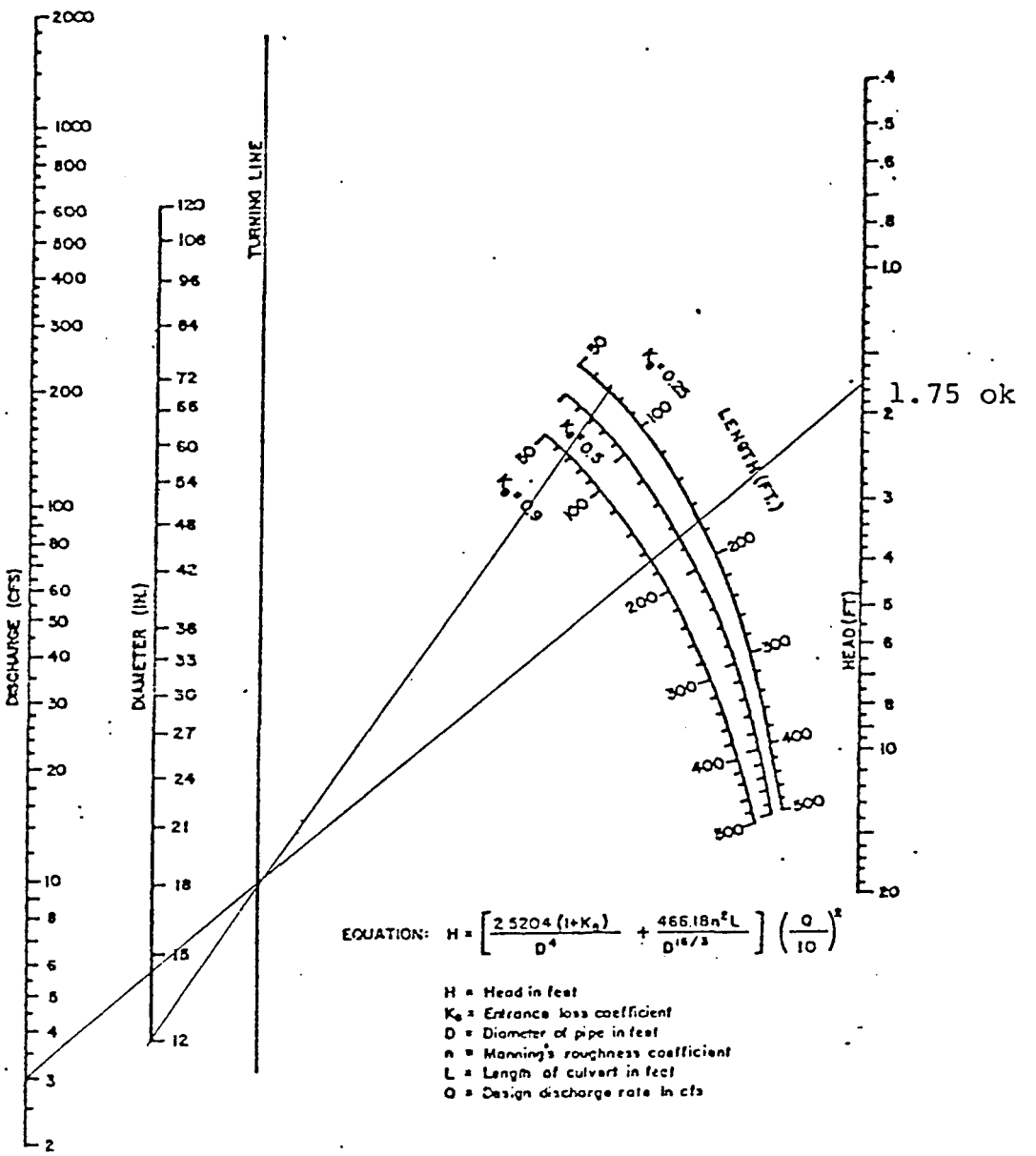


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

REFUSE ROAD I

see Plate III-8

NO. 3 HOISTHOUSE

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 1A Page ____ of ____

Conditions:

Soil Type: MTH

Hydrologic Group: C/B use C

Land Use: Pasture or range

Land Condition: Fair to Good

Curve Number CN: 76.5

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 4.02

Slope of Area: 58.7%

Length of Slope: 1150'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 3.07$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .35 \qquad V_{10/24} = 5,105\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .54 \qquad V_{25/24} = 7,884\ ft^3$$

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse Page ____ of ____

Conditions:

Soil Type: MRG

Hydrologic Group: C

Land Use: Pasture or range

Land Condition: Fair to good

Curve Number CN: 76.5

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 12.57 acres

Slope of Area: 66.2%

Length of Slope: 1,020'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 3.07$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .35 \qquad V_{10/24} = 15,970\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .54 \qquad V_{25/24} = 24,640\ ft^3$$

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 1C Page ____ of ____

Conditions:

Soil Type: MTH

Hydrologic Group: C/B use C

Land Use: Pasture or range

Land Condition: Fair to Good

Curve Number CN: 76.5

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 2.43 acres

Slope of Area: 57.9%

Length of Slope: 1,210'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 3.07$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .35 \qquad V_{10/24} = 3,087\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .54 \qquad V_{25/24} = 4,763\ ft^3$$

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 2 Page ____ of ____

Conditions:

Soil Type: MTH

Hydrologic Group: C/B use C

Land Use: Pasture or range

Land Condition: Fair to good

Curve Number CN: 76.5

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 0.27 acres

Slope of Area: 54.2%

Length of Slope: 60'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 3.07$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .35 \qquad V_{10/24} = 343\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .54 \qquad V_{25/24} = 529\ ft^3$$

A=R K LS CP = 38.7 T/A

R=16
K=.28
CP=.54
LS=16

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 149.3\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 3 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: poor poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.38

Slope of Area: 9.1%

Length of Slope: 110'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.99$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .36 \qquad V_{10/24} = 1,803\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .56 \qquad V_{25/24} = 2,805\ ft^3$$

$$A=R\ K\ LS\ CP = 4.83\ T/A$$

R=16
K=.28
CP=.90
LS=1.2

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 26.22\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 4 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 0.74 acres

Slope of Area: 13.3%

Length of Slope: 75'

Calculations of Runoff and Sediment Volume

$S = \frac{1,000}{CN} - 10 =$ 2.99

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .36 $V_{10/24} =$ ~~967 ft^3~~

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .56 $V_{25/24} =$ ~~1,504 ft^3~~

$A = R\ K\ LS\ CP =$ _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v = \frac{A(Area)(2000)}{(140)} =$ _____

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 5 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.34

Slope of Area: 3.2%

Length of Slope: 950'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.99$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.36 \qquad V_{10/24} = 1,651\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.56 \qquad V_{25/24} = 2,627\ ft^3$$

A=R K LS CP = 2.62 T/A

R=16
K=.28
CP=.90
LS=.65

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 50\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 6 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.83 acres

Slope of Area: 3.2%

Length of Slope: 870

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.99$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.36 \qquad V_{10/24} = 2,391\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.56 \qquad V_{25/24} = 3,720\ ft^3$$

A=R K LS CP = 2.36T/A

R=16
K=.28
CP=.90
LS=.58

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 61.14\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 hoisthouse 7 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture pr range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: .24 acres

Slope of Area: 6.7%

Length of Slope: 75'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.99$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.36 \qquad V_{10/24}= 313\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.56 \qquad V_{25/24}= 488\ ft^3$$

$$A=R\ K\ LS\ CP = 2.82$$

R=16
K=.28
CP=.90
LS=.7

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 9.67\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 8 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 0.24 acres

Slope of Area: 5.8%

Length of Slope: 85'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.99$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.36 \qquad V_{10/24} = 313.6\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.56 \qquad V_{25/24} = 487.9\ ft^3$$

$$A=R\ K\ LS\ CP = 2.82\ T/A$$

R=16
K=.28
CP=.90
LS-.7

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 9.68\ ft^3/yr$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 9 Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: poor

Curve Number CN: 77

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 0.09 acres

Slope of Area: 25%

Length of Slope: 50'

Calculations of Runoff and Sediment Volume

$S=\frac{1,000}{CN} - 10 =$ 2.99

$Q=\frac{(P-.2(S))^2}{P+.8(S)} =$ 0.36 $V_{10/24} =$ 117 ft^3

$Q=\frac{(P-.2(S))^2}{P+.8(S)} =$ 0.56 $V_{25/24} =$ 182.9 ft^3

A=R K LS CP = 16.53

R=16
K=.28
CP=.90
LS=4.1

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v=\frac{A(Area)(2000)}{(140)} =$ 21.25 ft^3/yr

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: No. 3 Hoisthouse 10 Page ____ of ____

Conditions:

Soil Type: MRG

Hydrologic Group: C

Land Use: Pasture or range

Land Condition: Fair to good

Curve Number CN: 76.5

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: .95 acres

Slope of Area: 91.22%

Length of Slope: 370'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 3.07$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .35 \qquad V_{10/24} = 1,206\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .54 \qquad V_{25/24} = 1,862\ ft^3$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

No. 3 Hoisthouse Pond Design

Sediment Pond Volume

0' Base area = 70 x 50 x .5 = 4,250 ft^2

5' Base area = 180 x 60 x .5 = 5,400 ft^2

2' Base area = 174 x 52 x .5 = 4,524 ft^2

$$A = 30X^2 + 80X + 4250$$

$$V = A = 30X^2 + 80X + 4250$$

$$V = 10X^3 + 40X^2 + 4250X$$

Sediment Volume

Areas

3 , 2 , 5 , 6

149.3 + 26.22 + 50 + 61.14 = 286.66 ft^3/yr

5 years of sediment = 5 x 286.66 = 1,433.3 ft^3

$$V = 10X^3 + 40X^2 + 4250X$$

V = 4300 ft^3 at 1' depth 4,300 > 1,433

use 1'

Areas

2 , 3 , 5 , 6

343 + 1803 + 1.751 + 2.391 = 6,288 ft^3

4,300 + 6,288 = 10,588 ft^3

$$V = 10X^3 + 40X^2 + 4250X$$

V = 11,031 ft^3 at 2.5' depth 11,031 > 10,588

use 2.5'

Spillway Size

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2/2G}$$

L=33.5'
Ke+.5
Kb=1
Kc=
a=

	a	Kc	H'
12"	.785	.1067	1.14'

$Q_{25/24}$=.23 + .65 + .77 + 1.08 = 2.73 cfs

use 12"cmp

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 1A Page____ of ____

Conditions:

Length of Drainage: 1150

Average Slope: 58.7

Curve Number: 76.5

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .051$ $\qquad S = 3.07$

$$T_c = T_1/.6$$

$= .086$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

$= 2.2$ cfs 10/24 Storm

$= 3.4$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 16 Page____ of ____

Conditions:

Length of Drainage: 1,020'

Average Slope: 66.2%

Curve Number: 76.5

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .044$ $\qquad S = 3.07$

$$T_c = T_1/.6$$

$= .073$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

$= 6.88$ cfs 10/24 Storm

$= 10.6$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 1C Page____ of ____

Conditions:

Length of Drainage: 1,210

Average Slope: 57.9%

Curve Number: 76.5

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .054$ $\qquad S = 3.07$

$$T_c = T_1/.6$$

$= .09$

$$q_p' = 10^{(2.50963 - 0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= 1.28 cfs 10/24 Storm

= 1.97 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 2 Page ____ of ____

Conditions:

Length of Drainage: 230'

Average Slope: 10.87%

Curve Number: 76.5

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .033$ $\qquad S = 3.07$

$$T_c = T_1/.6$$

$= .055$

$$q_p' = 10^{(2.50963 - 0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 10000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

$= .15$ cfs 10/24 Storm

$= .23$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 3 Page____ of ____

Conditions:

Length of Drainage: 700'

Average Slope: 1%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .26$

$$T_c = T_1/.6$$

$= .44$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 540$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= .42 cfs 10/24 Storm

= .65 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 4 Page____ of ____

Conditions:

Length of Drainage: 470'

Average Slope: 1%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .19$

$$T_c = T_1/.6$$

$= .32$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 650$

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

$= .27$ cfs 10/24 Storm

$= .42$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 5 Page____ of ____

Conditions:

Length of Drainage: 950'

Average Slope: 3.2%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .187$

$$T_c = T_1/.6$$

$= .311$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 660$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= .49 cfs 10/24 Storm

= .77 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 6 Page ____ of ____

Conditions:

Length of Drainage: 870

Average Slope: 3.2%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .174$

$$T_c = T_1/.6$$

$= .29$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= .675$ from chart

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

$= .69$ cfs 10/24 Storm

$= 1.08$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 7 Page____ of ____

Conditions:

Length of Drainage: 75'

Average Slope: 6.7%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .017$

$$T_c = T_1/.6$$

$= .028$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= .14cfs 10/24 Storm

= 21cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 8 Page____ of ____

Conditions:

Length of Drainage: 50'

Average Slope: 25%

Curve Number: 77

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .0063$ $\qquad S = 2.99$

$$T_c = T_1/.6$$

$= .011$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$ from chart

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

$= 0.05$ cfs 10/24 Storm

$= 0.08$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: No. 3 Hoisthouse 9 Page____ of ____

Conditions:

Length of Drainage: 520'

Average Slope: 91.22%

Curve Number: 76.5

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .002$ $\qquad S = 3.07$

$$T_c = T_1/.6$$

$= .036$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$ from chart

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

$= .53$ cfs 10/24 Storm

$= .83$ cfs 25/24 Storm

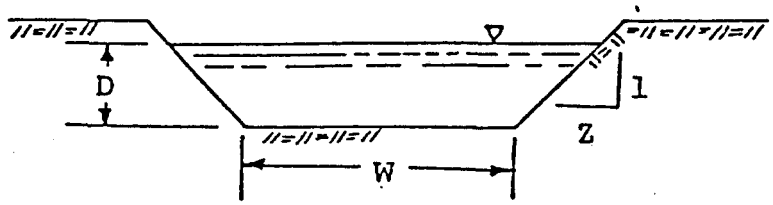
PAGE _____ OF _____

PROJECT _____ ID _____

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 7.41 CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 3.2% DECIMAL%

WIDTH OF CHANNEL W=6', Z=1 FT

DEPTH OF CHANNEL 1.16' FT

COMMENTS: free board = 1'

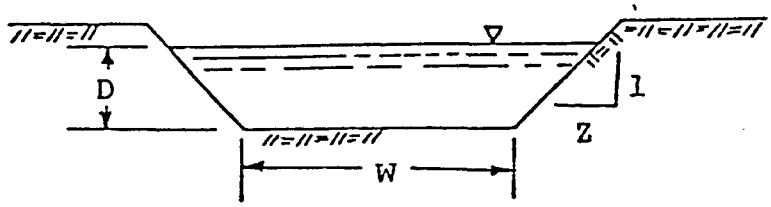
PAGE _____ OF _____

PROJECT 2D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: $n = 0.030$

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 2,2 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 1.0% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL ~~.87'~~ FT

COMMENTS: freeboard = 1'

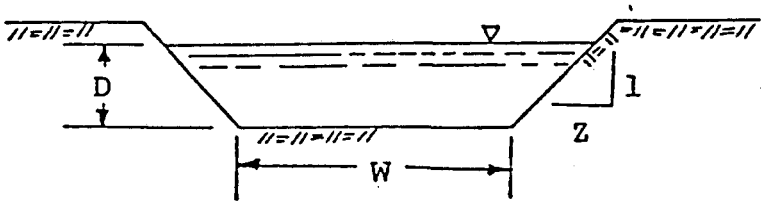
PAGE _____ OF _____

PROJECT 3D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: $n = 0.030$

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH ~~15 cfs~~ CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 10.87 % DECIMAL%

WIDTH OF CHANNEL W=0 , Z = 1 FT

DEPTH OF CHANNEL >.01' FT

COMMENTS: freeboard = 1' 1 - 2.5

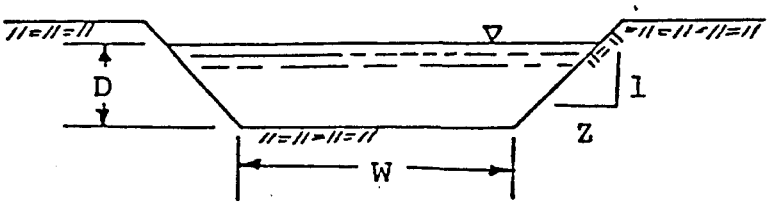
PAGE _____ OF _____

PROJECT 4D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.28 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 10.87% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL >.01 FT

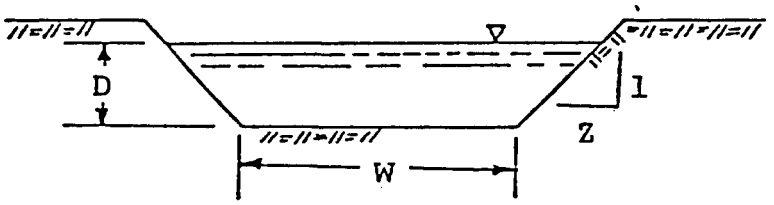
COMMENTS: free board = 1'

PROJECT 5D

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .27 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 1% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL >.01 FT

COMMENTS: freeboard = 1'

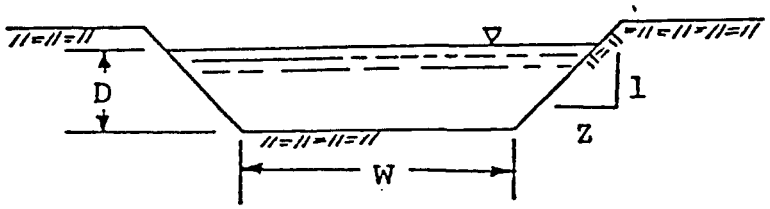
PAGE _____ OF _____

PROJECT 6D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

$$(1)\quad Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$$

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .69 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 3.2% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL >.01' FT

COMMENTS: free board = 1'

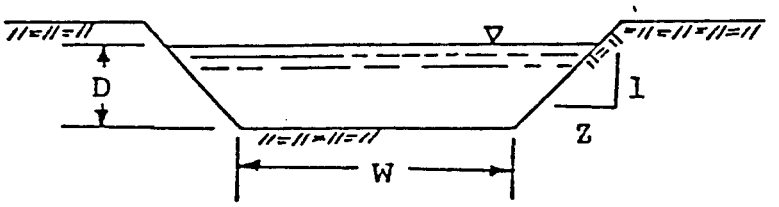
PAGE _____ OF _____

PROJECT 7D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .53 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 1% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL .21' FT

COMMENTS: freeboard = 1'

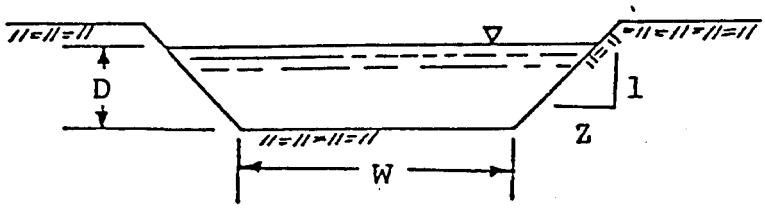
PAGE _____ OF _____

PROJECT 8D & 9D

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .14 CFS (FROM q_p CALCULATION)

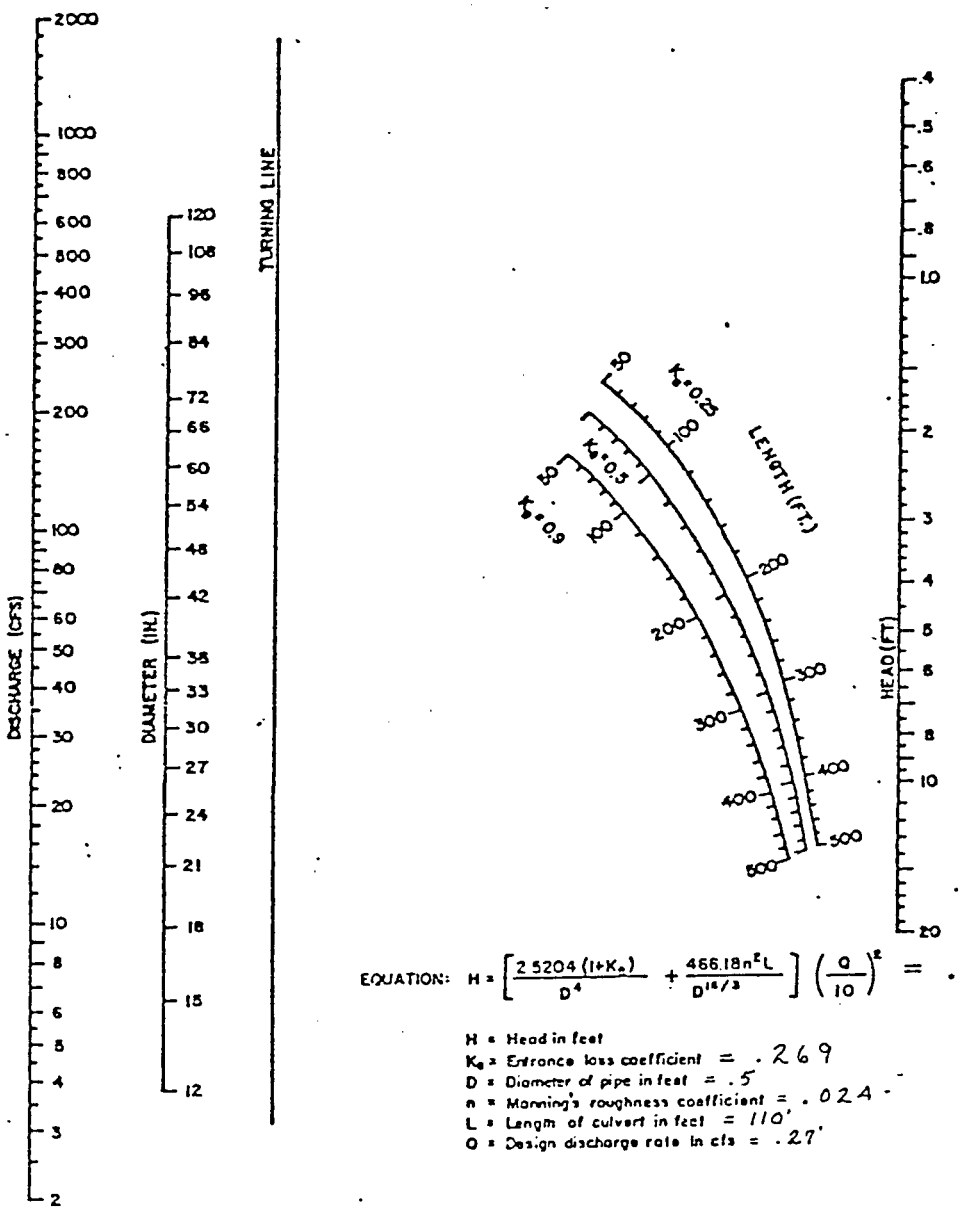
AVG. PERCENT SLOPE 1% DECIMAL%

WIDTH OF CHANNEL W=0, Z=1 FT

DEPTH OF CHANNEL >.01' FT

COMMENTS: free board = 1'

Culvert 1C 0.27 cfs use 6' cmp



EQUATION: $H = \left[\frac{2.5204(1+K_e)}{D^4} + \frac{466.18 n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2 = .905'$ ok

H = Head in feet
K_e = Entrance loss coefficient = .269
D = Diameter of pipe in feet = .5'
n = Manning's roughness coefficient = .024
L = Length of culvert in feet = 110'
Q = Design discharge rate in cfs = .27'

Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 2C ~~2.2~~ 7.6 cfs use 12" cmp

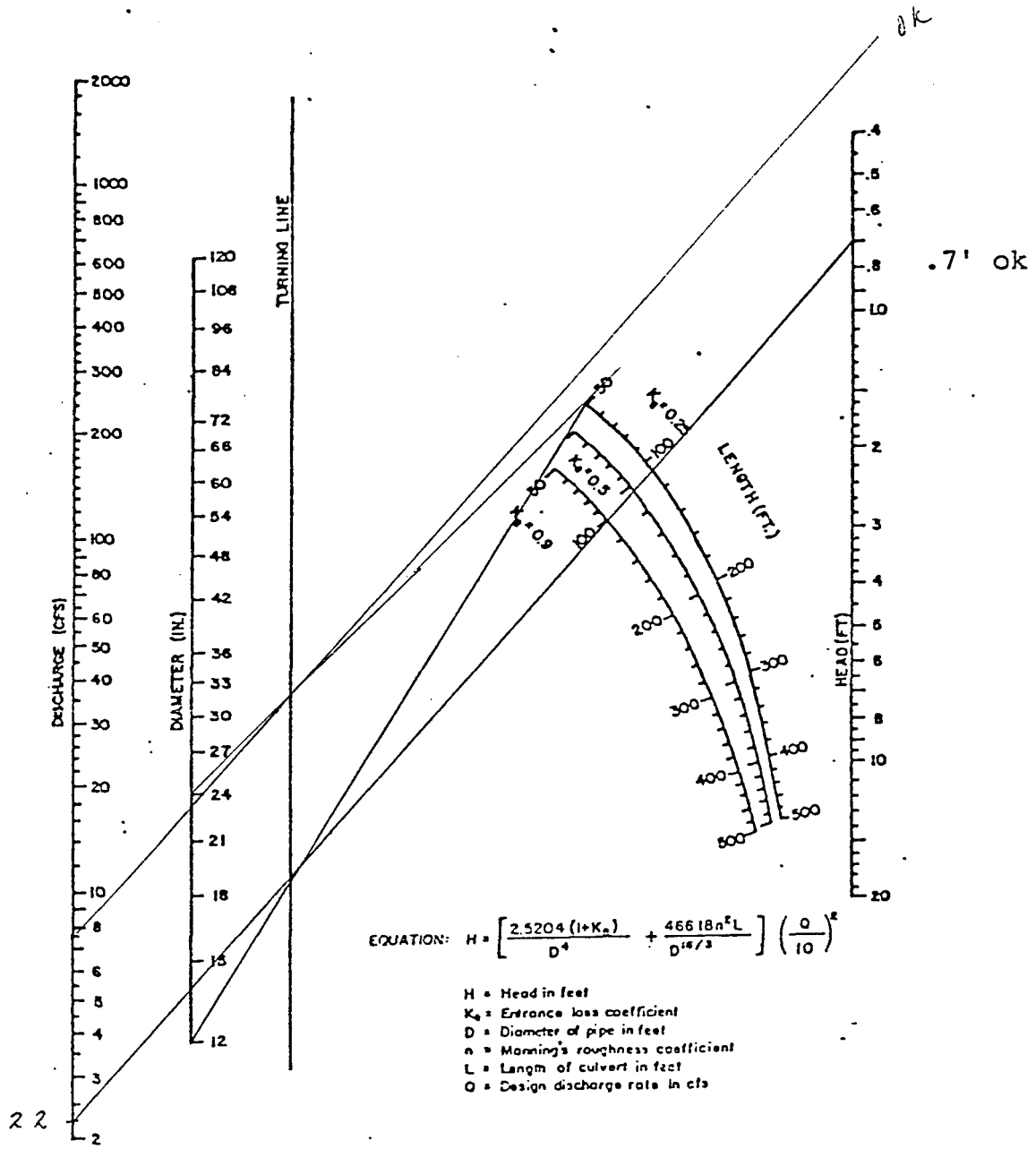
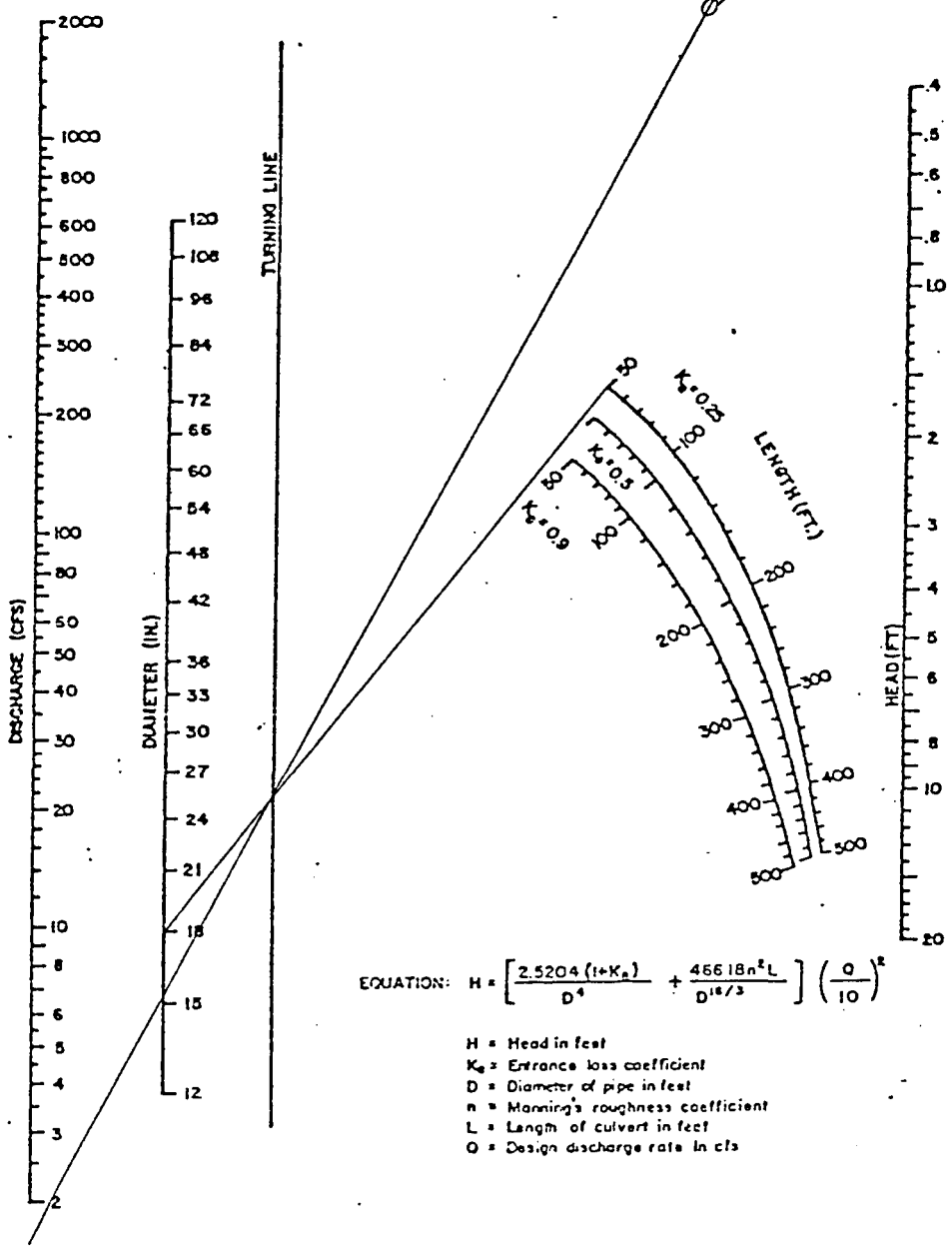


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 3C two 18" cmp in place use 1.1 cfs

0 off chart



1.1

Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 4C .05< .14 in 5C & 6 C use 6" cmp

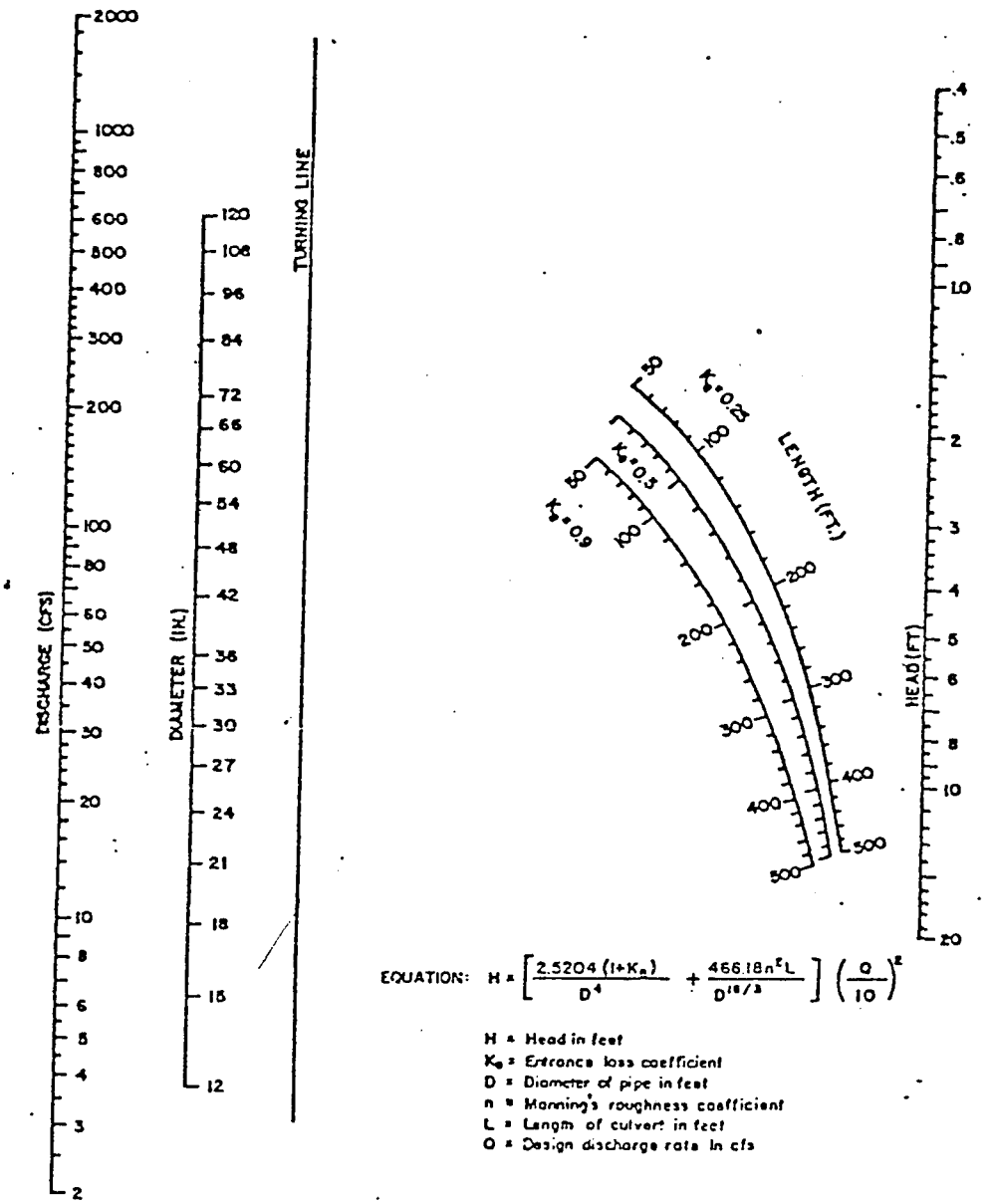
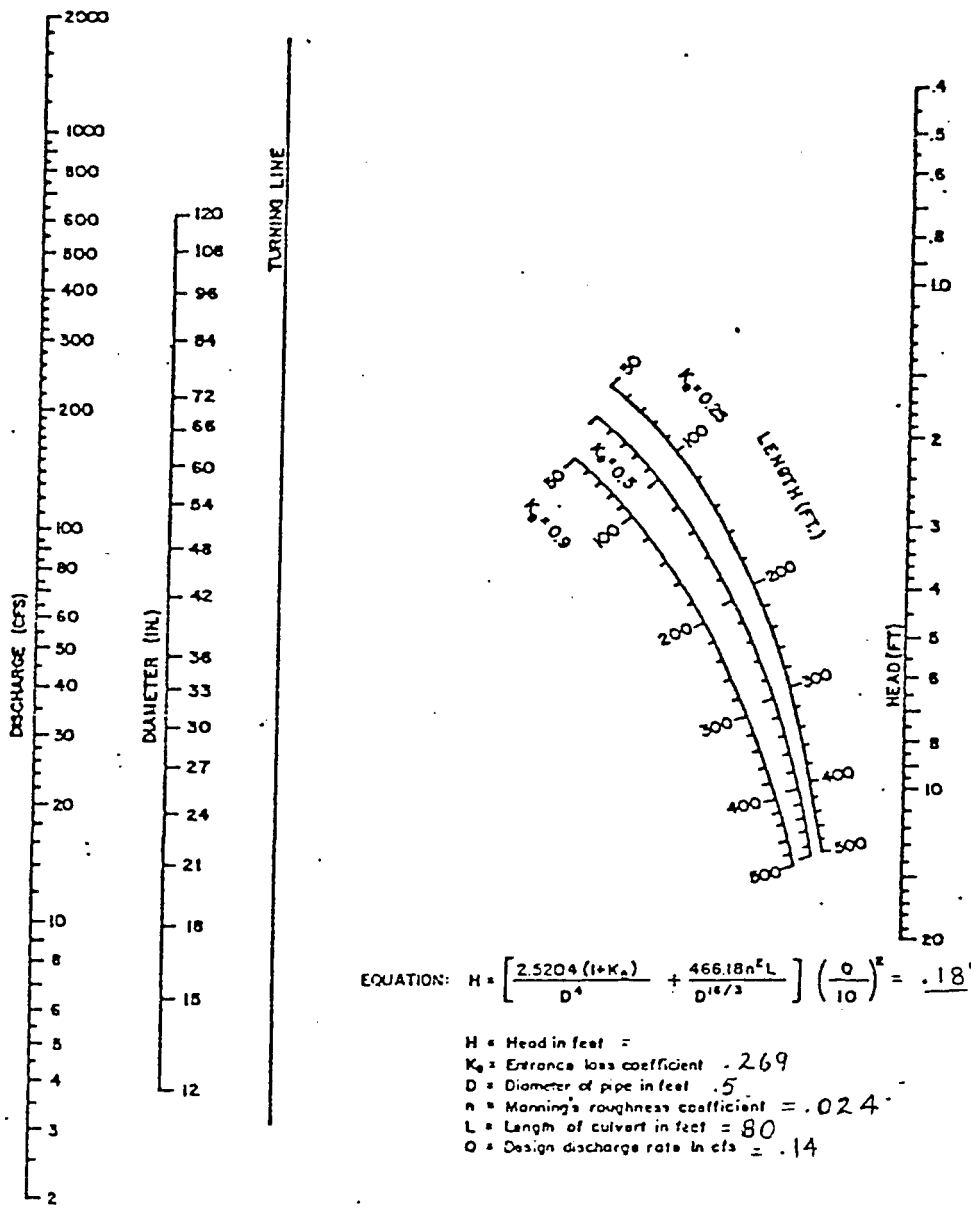


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 5C 10/24 .14 cfs use 6" cmp



EQUATION: $H = \left[\frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2 = \underline{.18'}$ .18'

H = Head in feet =
K_e = Entrance loss coefficient .269
D = Diameter of pipe in feet .5
n = Manning's roughness coefficient = .024
L = Length of culvert in feet = 80
Q = Design discharge rate in cfs = .14

Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 6C 0.14 cfs the same as 5C use 6"cmp

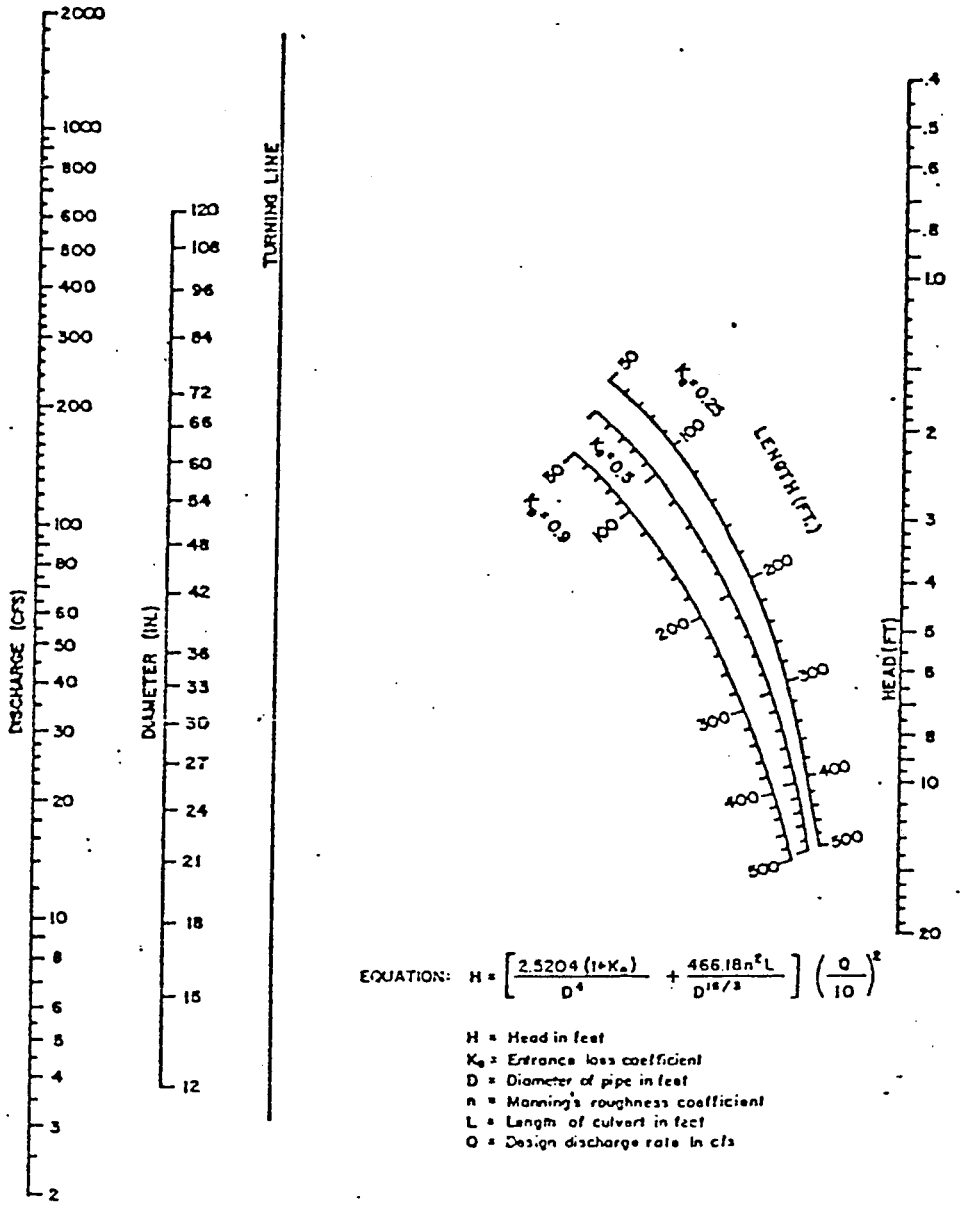


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

Culvert 7C 170' on the level use 30" cmp

.5' ok

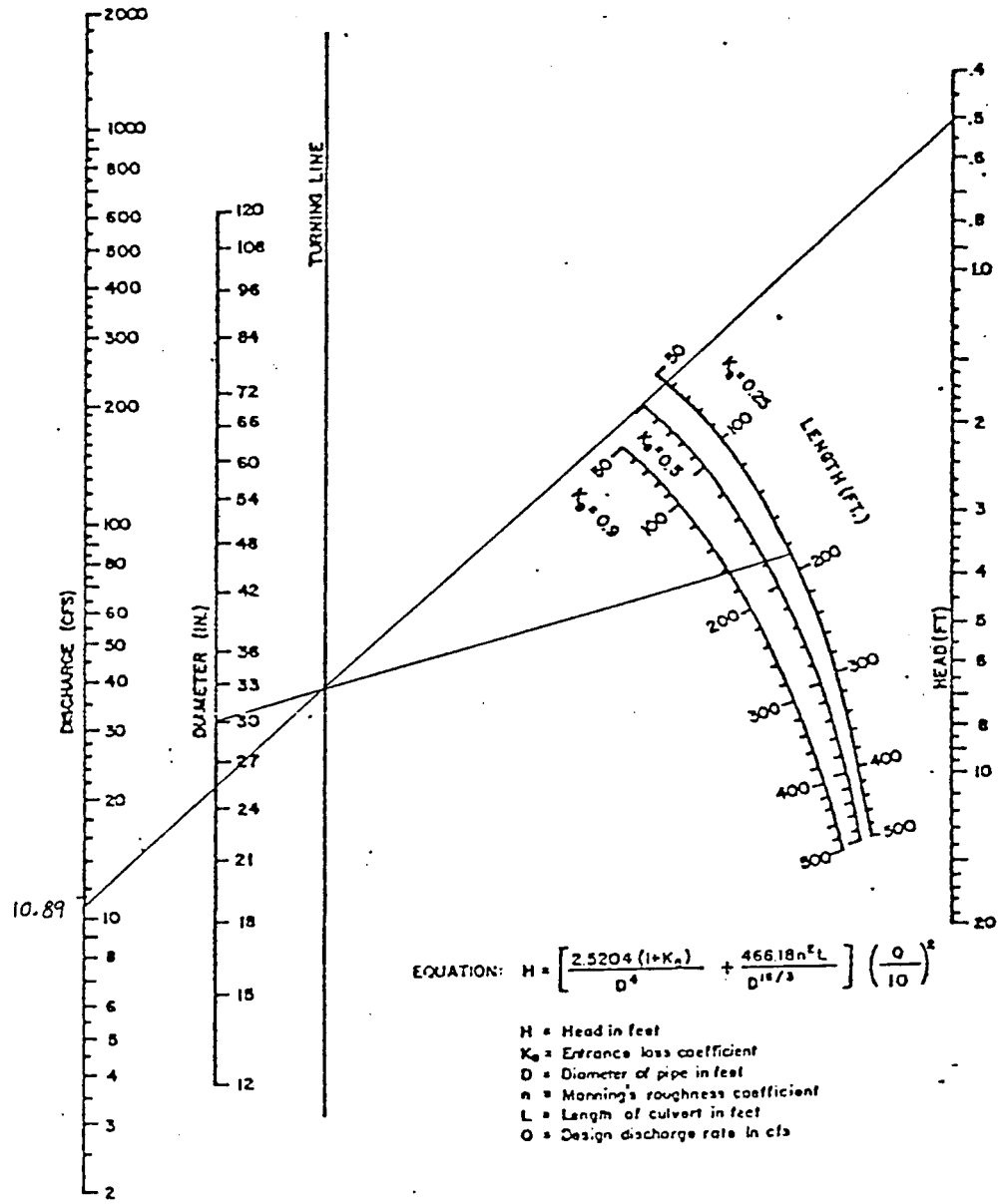


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

UPPER NO. 2 CANYON

Sediment Structure Worksheet

Sediment Structure: Area I, No. 2 Canyon Page____of____

Conditions:

Soil Type: PHS

Hydrologic Group: B

Land Use: Range or Pasture

Land Condition: Fair to Good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 7.86 acres

Slope of Area: 64.96%

Length of Slope: 1,270'

Calculations of Runoff and Sediment Volume

$S = \frac{1,000}{CN} - 10 =$ 5.38

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .095" $V_{10/24} =$ 2,710 ft^3

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .194" $V_{25/24} =$ 5,542 ft^3

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v = \frac{A(Area)(2000)}{(140)} =$ _____

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area II, No. 2 Canyon Page____ of____

Conditions:

Soil Type: PSH

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 22.09 acres

Slope of Area: 57.29%

Length of Slope: 1,920'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095 \qquad V_{10/24} = \cancel{7,616\ ft^3}$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194 \qquad V_{25/24} = 15,556\ ft^3$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area III, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: PSH

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 8.92 acres

Slope of Area: 60.90%

Length of Slope: 1,445'

Calculations of Runoff and Sediment Volume

$S = \frac{1,000}{CN} - 10 =$ 5.38

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .095" $V_{10/24} =$ 3,076 ft^3

$Q = \frac{(P-.2(S))^2}{P+.8(S)} =$ .194" $V_{25/24} =$ 6,282 ft^3

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$S_v = \frac{A(Area)(2000)}{(140)} =$ _____

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area IV, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: PSH

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 10.80 acres

Slope of Area: 62.24%

Length of Slope: 1,430

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095 \qquad V_{10/24} = \cancel{3,724\ ft^3}$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194 \qquad V_{25/24} = 7,605\ ft^3$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area V, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: PSH & DSG_2

Hydrologic Group: B & B

Land Use: Pasture or range

Land Condition: Fair to Good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 37.89 acres

Slope of Area: 45.63%

Length of Slope: 2,060'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095"$$ $V_{10/24}$ = 13,066 ft^3

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194"$$ $V_{25/24}$ = 26,683 ft^3

A=R K LS CP = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area VI, No. 1 Canyon Page ____ of ____

Conditions:

Soil Type: DSG_2

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: Fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 2.52 acres

Slope of Area: 59.52%

Length of Slope: 840

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095" \qquad V_{10/24} = 869\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194" \qquad V_{25/24} = 1,774\ ft^3$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area VII, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: DSG_2

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: Fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 12.36 acres

Slope of Area: 58.21%

Length of Slope: 1,340'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095"$$ $V_{10/24} = 4,469\ ft^3$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194"$$ $V_{25/24} = 9,127\ ft^3$

$A=R\ K\ LS\ CP$ = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area VIII, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: DSG_2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 6.91 acres

Slope of Area: 60.17%

Length of Slope: 1,180

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095"$$ $V_{10/24} = 2,383\ ft^3$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194"$$ $V_{25/24} = 4,866\ ft^3$

$A=R\ K\ LS\ CP$ = _____

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: Area IX, No. 2 Canyon Page ____ of ____

Conditions:

Soil Type: DSG_2

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Fair to good

Curve Number CN: 65

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 12.35 acres

Slope of Area: 52.50%

Length of Slope: 1000'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 5.38$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .095' \qquad V_{10/24} = 4,259\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .194" \qquad V_{25/24} = 8,697\ ft^3$$

$$A=R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Area I, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1270'

Average Slope: 64.96%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .073$ hrs

$$T_c = T_1/.6$$

$= .121$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 950$ (from chart)

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

$= 1.1$ cfs 10/24 Storm

$= 2.26$ cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area II, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,920'

Average Slope: 57.29%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .108$

$$T_c = T_1/.6$$

$= .108$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 845$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= 2.77 cfs 10/24 Storm

= 5.66 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area III, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,445'

Average Slope: 60.90%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .083$

$$T_c = T_1/.6$$

$= .139$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 900$

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 1.19 cfs 10/24 Storm

= 2.43 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area IV, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,430

Average Slope: 62.24%

Curve Number: 65'

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .082$

$$T_c = T_1/.6$$

$= .136$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 910$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= 1.46 cfs 10/24 Storm

= 2.98 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area V, No. 2 Canyon Page ____ of ____

Conditions:

Length of Drainage: 2,060

Average Slope: 45.63%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .128$

$$T_c = T_1/.6$$

$= 2.13$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 800$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= 4.49 cfs 10/24 Storm

= 9.19 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area VI, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 840'

Average Slope: 59.52%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .055$

$$T_c = T_1/.6$$

$= .091$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1{,}000$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= .37 cfs 10/24 Storm

= .37 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area VII Page____ of ____

Conditions:

Length of Drainage: 1,340

Average Slope: 58.21%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .080

$$T_c = T_1/.6$$

= .134

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

= 905

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 1.66 cfs 10/24 Storm

= 3.39 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area VIII, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,180'

Average Slope: 60.17%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .071$

$$T_c = T_1/.6$$

$= .120$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 950$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= .094 cfs 10/24 Storm

= .192 cfs 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Area IX, No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,000

Average Slope: 52.50%

Curve Number: 65

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

$= .067$

$$T_c = T_1/.6$$

$= .111$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 960$

$q_p = q_p' \, A \, Q$; A = Area in Sq. Mi. and Q = Storm runoff in inches

= 1.76 cfs 10/24 Storm

= 3.59 cfs 25/24 Storm

C1 = Area I + II = 3.87 cfs use 18" cmp

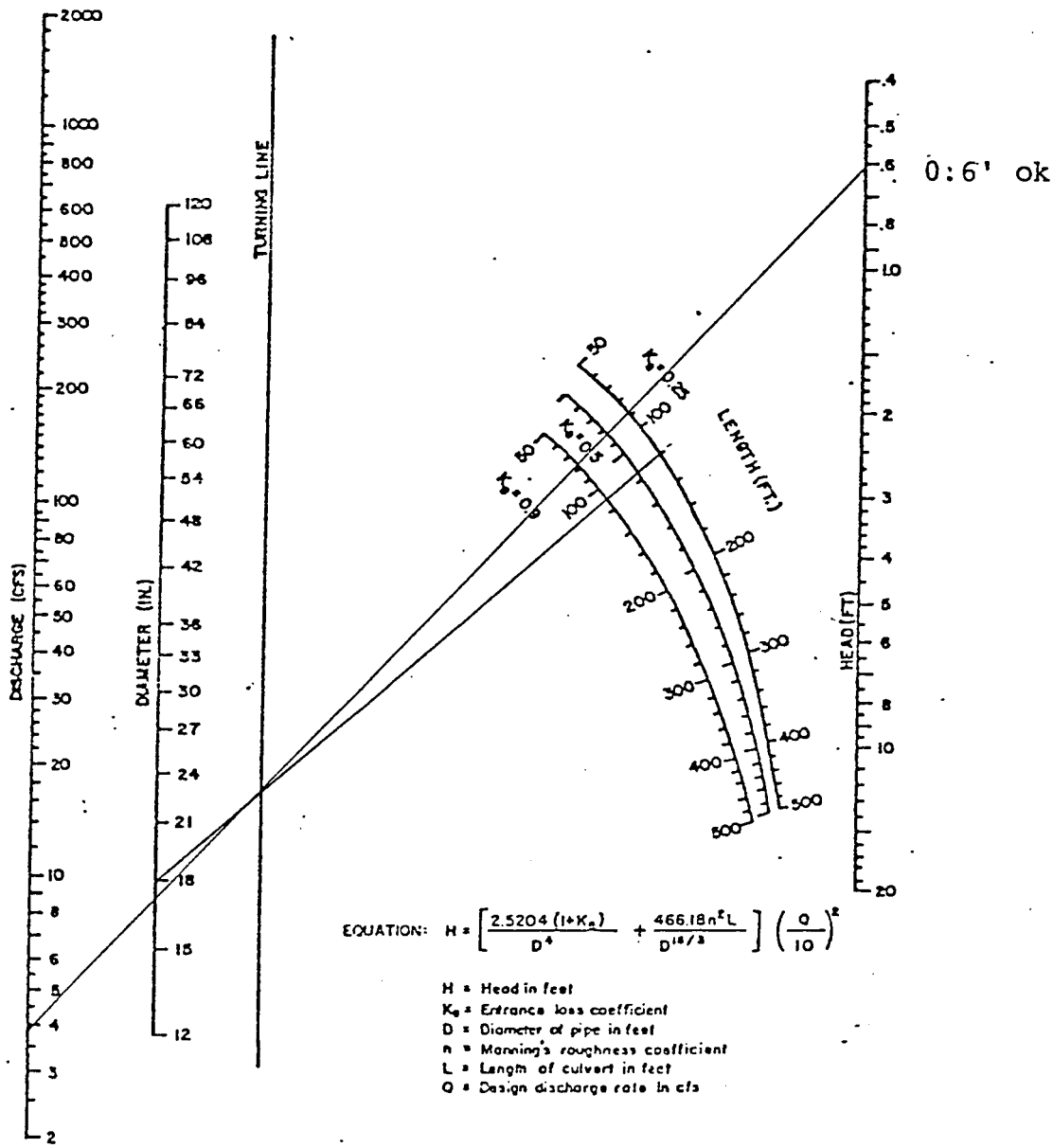


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

C2 = Area III = 1.19 cfs

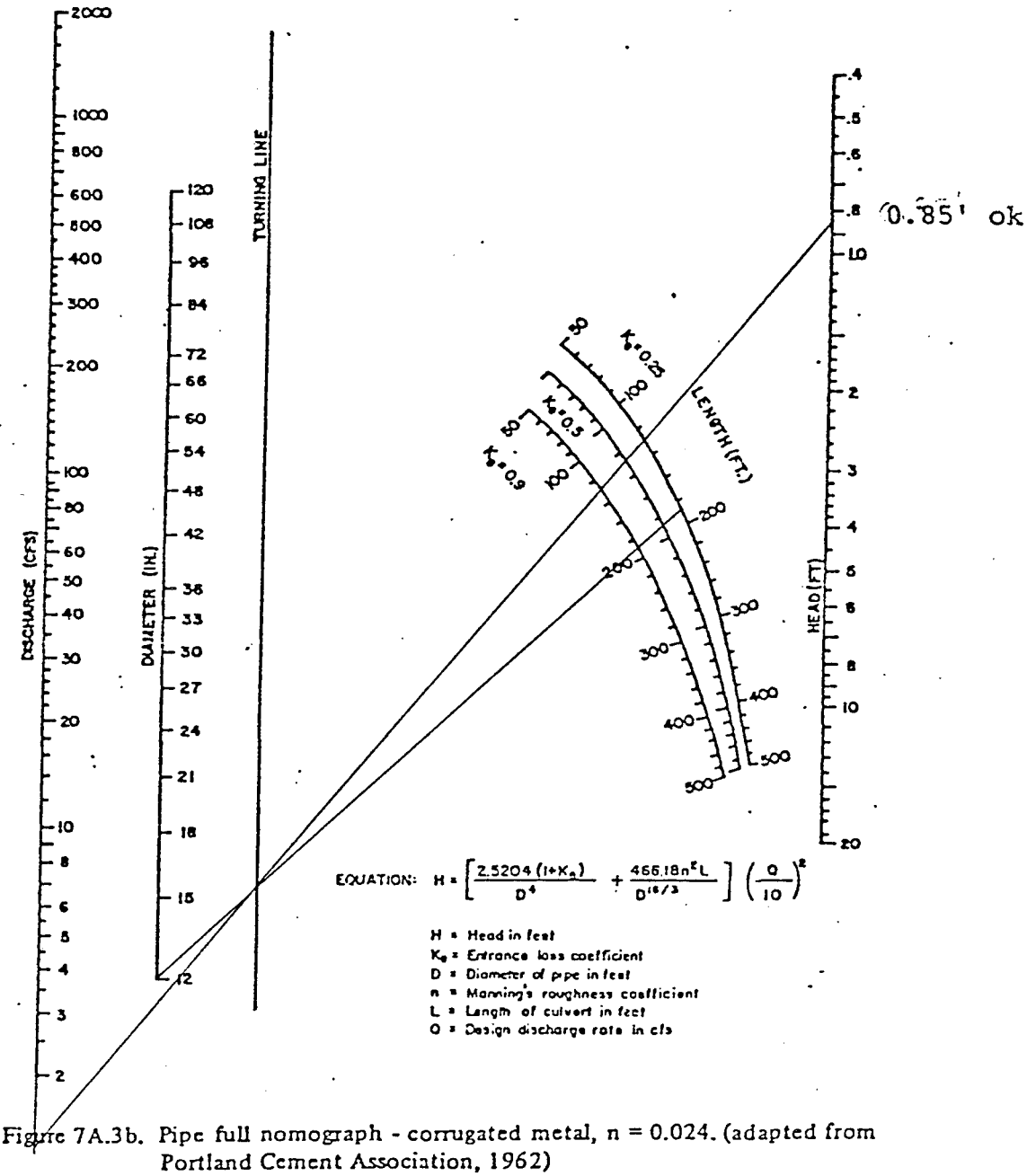


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

C2 = Area IV + V = 5.95 cfs

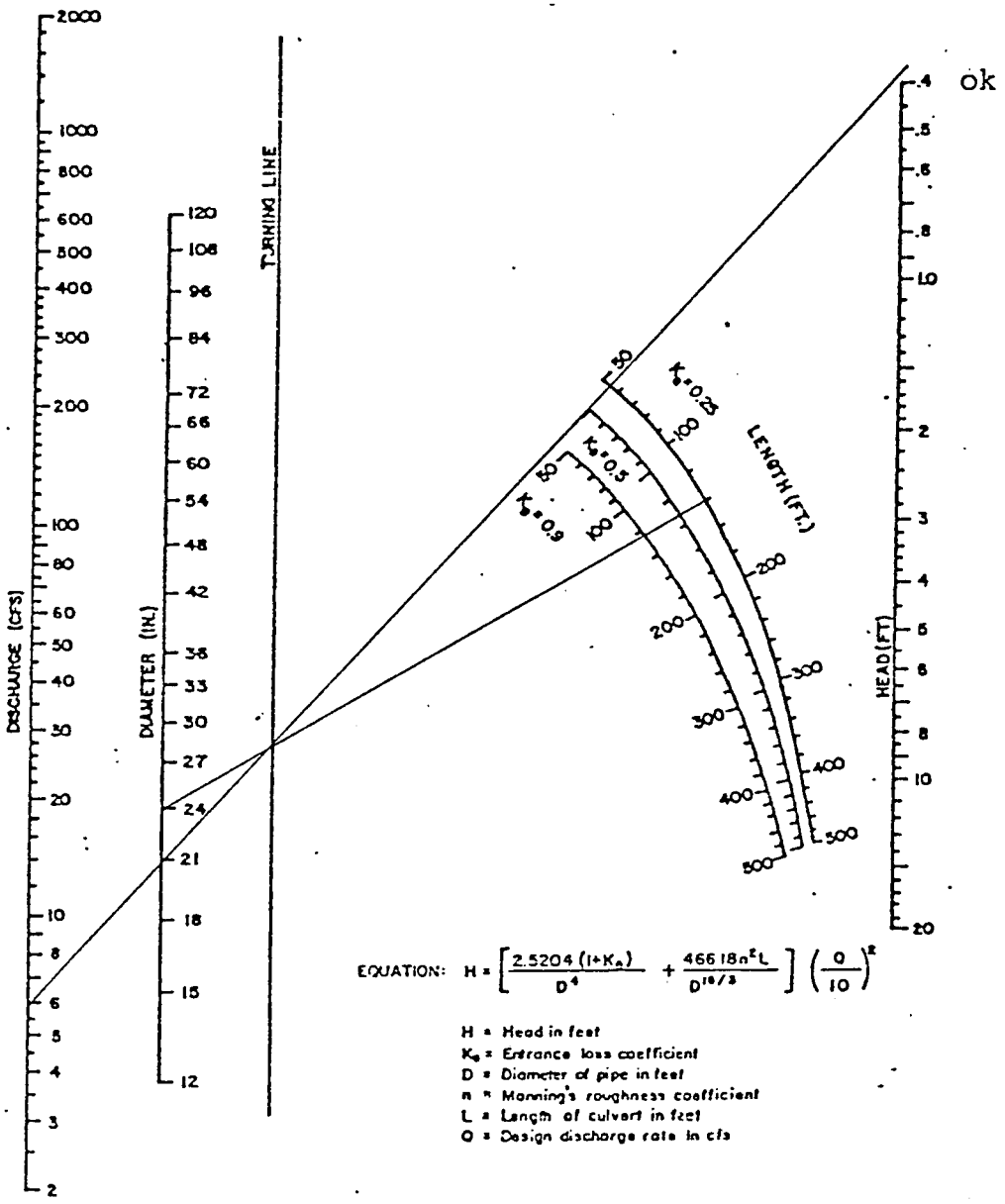


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

C4 = Area VI + VII = 2.03 cfs

ok

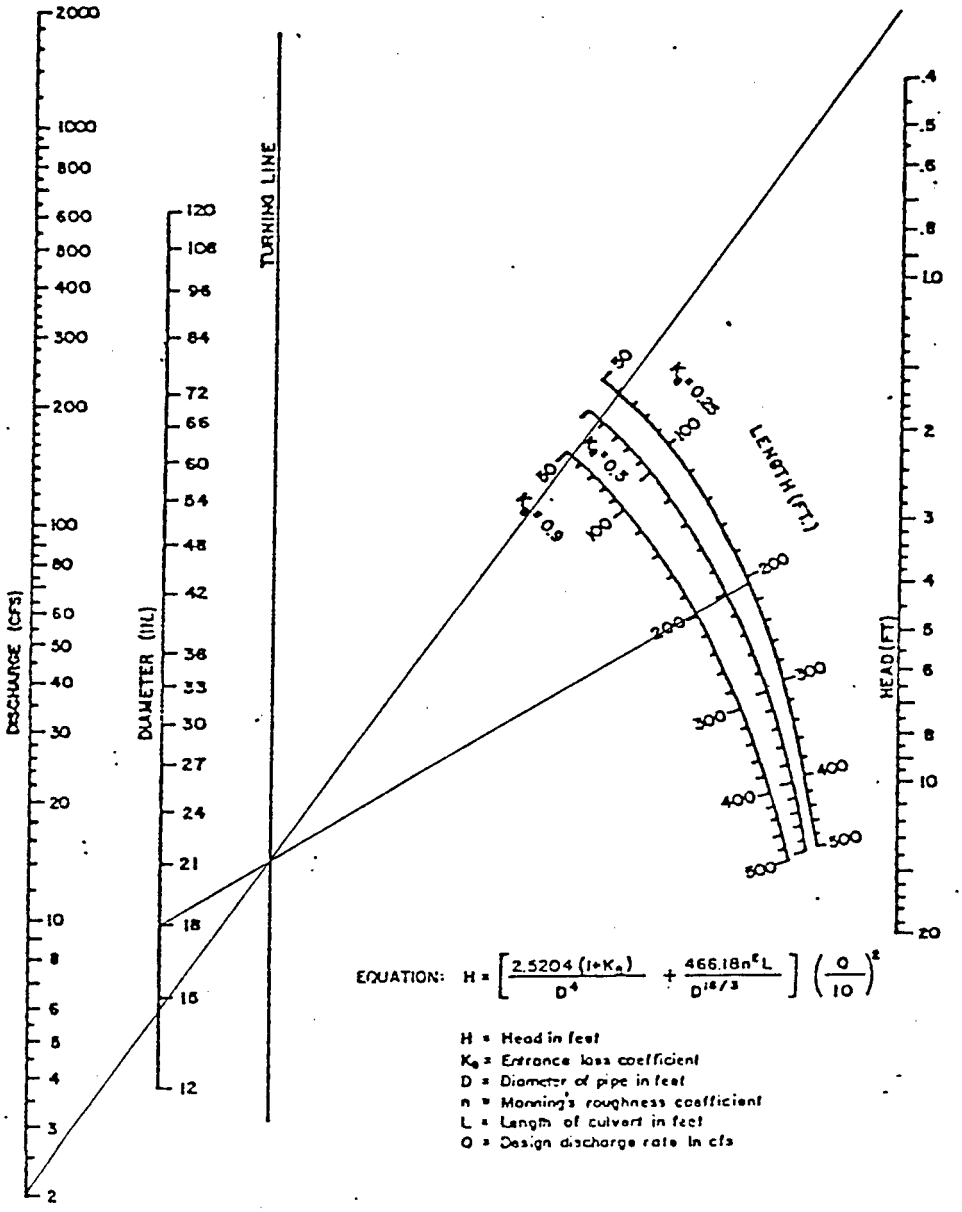


Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

C5 = Area VIII + IX = 1.85 cfs

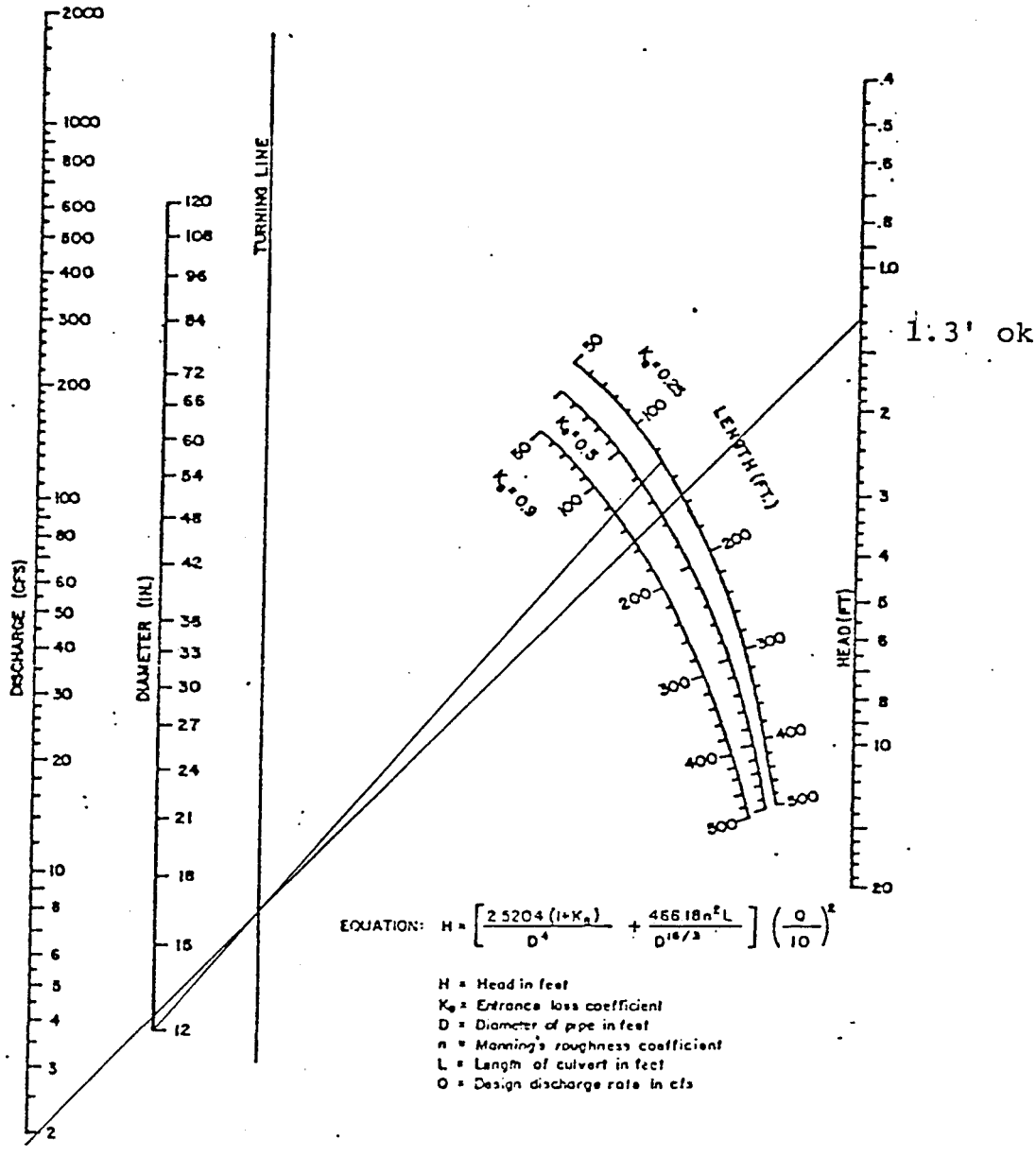


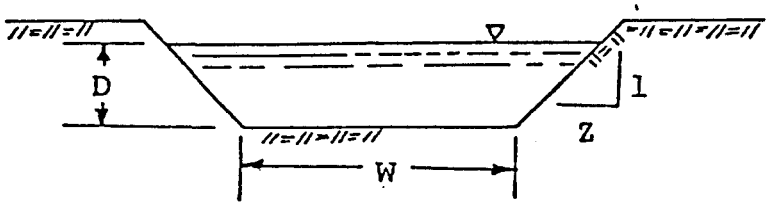
Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

PROJECT D1' - Area I = 1.1CFS

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.1 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 5.68%, .0568 DECIMAL%

WIDTH OF CHANNEL 0 FT

DEPTH OF CHANNEL Flow .53' FT

COMMENTS: Freeboard = .5' use 1'

Velocity = 3.9 fps

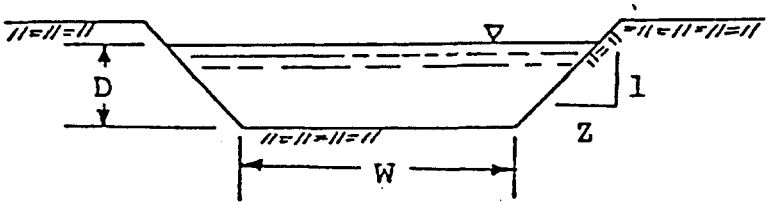
PAGE _____ OF _____

PROJECT D_2 = Area III - 1.19CFS

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.19 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 5.21% , .0521 DECIMAL%

WIDTH OF CHANNEL 0 FT

DEPTH OF CHANNEL Flow .55' FT

COMMENTS: Freeboard = .5' use 1'

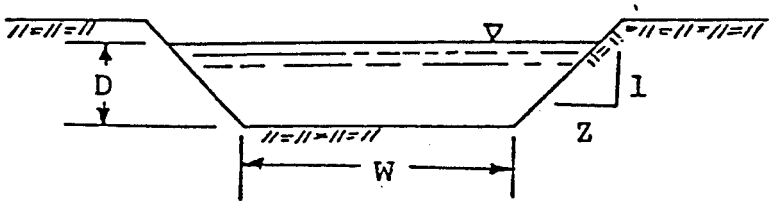
~~Velocity = 3.86 fps~~

PROJECT D_3 = Area IV = 1.46CFS

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE:
Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE:
W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.46 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 5.56%, .0556 DECIMAL%

WIDTH OF CHANNEL 0 FT

DEPTH OF CHANNEL Flow = .59' FT

COMMENTS: Freeboard = .5' USE 1'

Velocity = 4.15

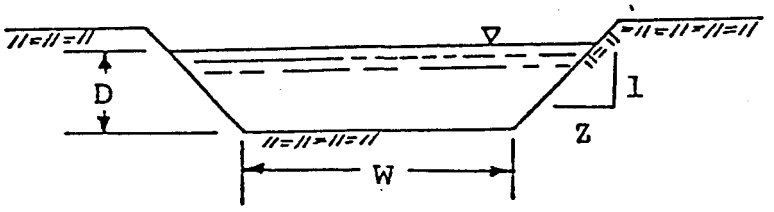
PAGE _____ OF _____

PROJECT D_4 = Area VI = .37CFS

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .37 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 4.84% , .0484 DECIMAL%

WIDTH OF CHANNEL 0 FT

DEPTH OF CHANNEL Flow = .36' FT

COMMENTS: Freeboard = .5' use 1'

Velocity - 2.84 fps

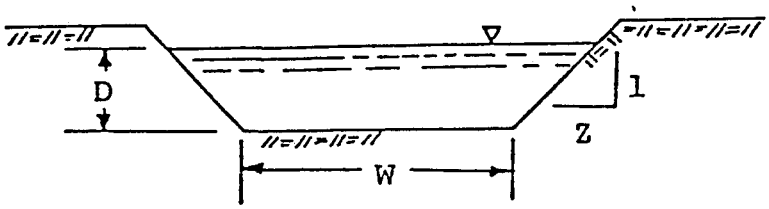
PAGE _____ OF _____

PROJECT D_5 = Area VIII - .094CFS

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH .094 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 1.35%, .0135 DECIMAL%

WIDTH OF CHANNEL Flow = .27' FT

DEPTH OF CHANNEL _____ FT

COMMENTS: Freeboard = .5' use 1'

Velocity = 1.28 fps

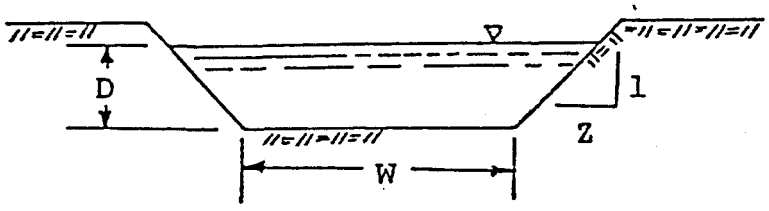
PAGE _____ OF _____

PROJECT D_6 = Area IX = 1.76CFS

CALCULATION & DESIGN BY _____

DATE _____

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

WHERE: Q = quantity in cfs
n = coefficient of roughness
A = area of channel in ft^2
R_h = hydraulic radius in ft
S = avg. slope of channel in dec.%

$Q = q_p$ from previous design calcs.

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \left[\frac{WD + ZD^2}{W + 2D\sqrt{Z^2 + 1}}\right]^{2/3}(WD+ZD^2)$$

WHERE: W = width of channel
D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES

RESULTS:

PEAK FLOW IN DITCH 1.76 cfs CFS (FROM q_p CALCULATION)

AVG. PERCENT SLOPE 1.5% DECIMAL%

WIDTH OF CHANNEL 0 FT

DEPTH OF CHANNEL Flow = .81' FT

COMMENTS: Freeboard = .5' use 1'

Velocity = 2.65 fps

NOTE: Maximum water flow depth is in D_6. All side hill ditches (D_1 - D_6) will be designed to this specification. Minimum freeboard will be 1' for all ditches.

LOWER NO. 2 CANYON

see Plate III-10

Sediment Structure Worksheet

Sediment Structure: Upper No. 2 Canyon - Area X Page____ of____

Conditions:

Soil Type: HBM Haverson Sandy Loam

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Poor

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 3.46 acres

Slope of Area: 4.95%

Length of Slope: 1,070'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.65$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .433"$$ $V_{10/24} = 5,438\ ft^3$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .646"$$ $V_{25/24} = 8,108\ ft^3$

A=R K LS CP = 10.52 T/A

R=16
K=.43
LS=1.7
CP=.90

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 520ft^3/yr$$

3 x 520 - $1560ft^3/3yrs$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Upper No. 2 Canyon - Area X Page____ of ____

Conditions:

Length of Drainage: 1,070

Average Slope: 4.95%

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .155hrs

$$T_c = T_1/.6$$

= .259

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

= 725

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 1.697 cfs 10/24 Storm

= 2.53 cfs 25/24 Storm

Volume - Upper No. 2 Canyon Pond

6820 elev. or 0

area = 25 x 60 - 1.500 ft^2

6822.5 elev. or 2.5

area = 35 x 70 = 2,450 ft^2

6825 elev or 5'

area = 45 x 80 = 3,600 ft^2

$A = AX^2 + BX + 1500$ where x = depth

$A = 14X^2 + 350X + 1500$

2087	B= 50	A= 74
2100	B= 60	A= 72
2175	B=120	A= 60
2650	B=500	A=-60
2510	B=400	A= 4
2462	B=350	A= 14

$V = 14X^2 + 350X + 1500$

$V = 4.67X^3 + 175X^2 + 1500X$

Sediment Load

$V = \int_0^h 4.67X^3 + 175X^2 + 1500X$

V = 1560 ft^3/3yrs (p. 32)

X = 1' V = 1679.67 ft^3 OK use 1'

10 year 24hr volume

V = 5,438 ft^3 (p. 32)
10/24

V = 5,438 + 1679 = 7.118 ft^3

X = 3.4' V = 7.306

Spillway Design

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2(2G)}$$

L = 44.4'

$Q_{25/24}$ = 2.53 cfs (p.33)

Ke = .5
Kb = 1

	30"	36"	24"	18"
Kc =	.0314	.0246	.0423	.0621
a =	4.91	7.07	3.14	1.77
H' =	.016'		.044'	.167

use a 18" cmp

Total Depth = 1 + 2.4 + 1 + .167 + 1 = 5.67'

Sediment Structure Worksheet

Sediment Structure: Lower No. 2 Canyon
Area XI, XII, & XIII

Page ____ of ____

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or range

Land Condition: Poor

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 6.11 acres

Slope of Area: 4.58%

Length of Slope: 1,200'

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.65$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .433 \qquad V_{10/24} = 9,604\ ft^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = .646 \qquad V_{25/24} = 14,328\ ft^3$$

$$A=R\ K\ LS\ CP = 10.52\ T/A$$

R=16
K=.43
LS=1.7
CP=.90

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 918.24\ ft^3$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

3 x 918.24 = 2,754.7 ft^3/3yrs.

Peak Runoff Worksheet

Sediment Structure: Lower No. 2 Canyon Page____ of ____

Conditions:

Length of Drainage: 1,200

Average Slope: 4.58% , .0458

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \quad ; \quad S = \frac{1000}{CN} - 10 \text{ and } y = \text{Slope}$$

= .177

$$T_c = T_1/.6$$

= .295

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

= 750

$$q_p = q_p' \, A \, Q \quad ; \quad A = \text{Area in Sq. Mi. and } Q = \text{Storm runoff in inches}$$

= 3.10 cfs 10/24 Storm

= 4.63 cfs 25/24 Storm

Volume of Pond by Depth

elev 6745' or base 0'

area = 1627.5 ft^2

elev. 6750' or base 5'

area = 5,125 ft^2

elev 6755' or base 10'

area = 10.275 ft^2

$A = AX^2 + BX + 1637.5$

$A = 31.375X^2 + 550X = 1637.5$

A	B	5' figure	
81.375	50	3,921.8	
76.375	100	4,046.875	
56.375	300	4,546.875	
36.375	500	5,046.875	
31.375	550	5,171.8	OK

$$V = \int_0^h A$$
$$= 10.46X^3 + 275X^2 + 1637.5X$$

Sediment Volume

$S_V = 2.754.7\ ft^3$ (p. 37)

$V = 10.46X^3 + 275X^2 + 1637.5X$

$V = 2.616$ at $x = 1.3'$ ok

10 year 24hr Volume

$V_{10/24} = 9{,}604\ ft^3$

$V_T = 9.604 + 2.616 = 12.220\ ft^3$

$V = 13{,}796$ at 6' ok

Spillway Calculation

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2(2G)}$$

a = .187' ok use 24" cmp

L = 1+6+65' = 72'

$Q_{25/24}$ = 4.63 cfs (p. 38)

Ke = .5

Kb = 1

Kc = .0423

Total Depth = 1.3 + 4.7 + 1 + .187 + 1 = 8.187'

NOTE: Volumes and culvert sizing for Areas XII, and SIII were not calculated. 12" cmp's will be sued to cross the wash.

NOTE: Sheet flow is assumed into the ponds from the drainage areas.

SLURRY POND

Slurry Pond Design

Effluent from the preparation plant and the water storage takns is to be filtered in the slurry ponds. The following is the design specification:

FLOWRATE - 300gpm

Solids - 15%

Size Slurry Pond 1 - 825,000 ft^3 empty, 206,250 full

Size Slurry Pond 2 - 550,000 ft^3 empty, 137,500 full

Size Clear Water Discharge - 199,500 ft^3

Retention time = $\frac{825{,}000\ ft^3 \times 7.48 g/ft^3}{(300gpm-(300x.15))x60min/hr}$

Slurry Pond 1

= <u>403 hours when empty</u>

= $\frac{(206{,}250\ ft^3)(7.48g/ft^3)}{(300-300x.15)x60\ min/hr}$

= <u>100 hours when full</u>

Retention time = $\frac{550{,}000 \times 7.48}{(300 - 300x.15) \times 60}$

Slurry Pond 2

= <u>268 hours when empty</u>

= $\frac{137{,}500 \times 7.48}{(300-300x.15) \times 60}$

= <u>70 hours when full</u>

The clear water pond is a storage pond for watering the alfalfa field.

Storage volume = $199{,}500 \times 7.48$
= 1.49×10^6 gallons

Side Slope - 2:1

Outlets - perferated vertical 8" standpipe

Filter - Coke Breeze

NO. 1 MINE MANSHAFT (001 DISCHARGE)

No. 1 Mine Manshaft

001 Discharge

001 Discharge

600 gpm Pump Rate

400 gpm Inflow Rate

Design Pond for 600 gpm Inflow Rate

600 gpm X 6- X 24 = 864,000 gpd

864,000 gpd ÷ 7.48052 gp ft^3 = 115,499.99 ft^3

8' X 100' X 144.37'

or

8' X 90' X 160.42'

bottom dimensions

2:1 side slopes, z' freeboard

10' X 130 X 200'

top dimensions

The access road ramp on the southeast corner of the pond blocks a small drainage. Calculations show that the impounded volume (3100 ft^3) is adequate to contain runoff from the drainage area (3.17 acres) during a 100-year 24-hour event.

Sediment Structure Worksheet

Sediment Structure: 001 Mine Water Discharge, Cutoff Area, SE Corner

Conditions:

Soil Type: CIC

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Good

Curve Number CN: 61

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20 100/24 = 2.66

Contributing Area: 3.17 Acres

Slope of Area: 5.43%

Length of Slope: 660'

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 6.39$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \qquad Q_v 10/24 = 522.8 \text{ CF}$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.116 \qquad Q_v 25/24 = 1{,}337.8 \text{ CF}$$

100/24 0.246 2,827.8 CF

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(\text{Area})\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

SUNNYSIDE SURFACE FACILITIES (SSSF) AND INTERIOR CULVERTS

SSSF Pond

The SSSF Pond will be an incised pond located on a prelaw disturbed site. Material from the pond (13,000 yd^3) will be stockpiled 300 feet south of the pond. The soil material with coal, etc., will be stripped from the surface of the pond and topsoil areas and placed in the spoil pile. Next, the suitable plant-growing soil material (approximately twelve inches deep) at the pond area will be stripped and stockpiled as topsoil. This topsoil will be protected from wind and water erosion by planting a quick growing, temporary seed mix and cutting a ditch around the pile. A sign will be posted on the topsoil pile which states, "Topsoil Pile - Do Not Disturb."

Water will be removed from the structure after a minimum 24-hour period with a 2-inch decant pipe. Backfill around the decant pipe will be mechanically compacted. An emergency spillway is provided which will convey from the pond the maximum runoff from a 25 year-24 hour storm event.

SSSF POND DRAINAGE

The SSSF pond drainage runs from the Engineering office to the southwest corner of the coal stockpile. Culverts 2 through 11 drain runoff inside the area. A weighted curve number was generated for each subdrainage area and then applied to the total area. Copies of the computer runoff calculations are attached.

	Area	CN	CN X Area	Weighted CN
Area 2	16.81 Acres Total			
MTH	7.74 Acres	74	572.76	
Roofs-Asphalt	3.95 Acres	98	387.10	
HBC-Industrial	5.12 Acres	88	450.56	
	16.81		1,410.42	83.90
Area 3	20.77 Acres Total			
MTH	15.70 Acres	74	1,161.80	
Roofs-Asphalt	1.33 Acres	98	130.34	
HBC-Industrial	3.74 Acres	88	329.12	
	20.77		1,621.26	78.06
Area 4	11.37 Acres Total			
MTH	10.82 Acres	74	800.68	
HBC-Industrial	0.55 Acres	88	48.40	
	11.37		849.08	74.67
Area 5	1.15 Acres Total			
HBC-Industrial	1.15 Acres	88		88.00
Area 6	2.34 Acres Total			
Roofs	0.08 Acres	98	7.84	
HBC-Industrial	2.26 Acres	88	198.88	
	2.34		206.72	88.34

	Area	CN	CN X Area	Weighted CN
Area 7	8.15 Acres Total			
Roofs	0.34 Acres	98	33.32	
HBC-Industrial	7.81 Acres	88	687.28	
	8.15 Acres		720.60	88.42
Area 8	7.66 Acres Total			
HBC-Industrial	7.66 Acres	88		88.00
Area 9	1.77 Acres Total			
HBC-Industrial	1.77	88		88.00
Area 10	1.10 Acres Total			
HBC-Poor	1.10	79		79.00
Area 11	0.81 Acres Total			
Asphalt-Roofs	0.81	98		98.00
TOTAL	71.93		5,905.40	82.10

Parameters used in the calculation of runoff are as follows:

Weighted CN	82.10
Reach	5,900'
Change In Elevation	980'
Slope	16.61%

Total runoff for the 10 year-24 hour storm is calculated as follows:

0.5499 in/12 in./ft. X 43560 ft^2 per acre X 71.93 acres = 143,582 ft^3

Sediment Load

Using the Universal Soil Loss Equation $A = RKL_sC_p$ where:

$R = 20$
$K = 0.22$; % OM = 1.22, % Sand = 62.33; % Silt = 27.78; % Clay = 9.87
$L_s = 23$; Slope = 16%; Length = .5900', M = 0.5
$C_p = .17$ Barfield, Table 5.A.3, 20% Cover

Gives a loss of 17.2 tons per acre or 22,512 ft^3 per year

Volume of sediment for a three-year period is:

22,512 ft^3 X 3 years = 67,536 ft^3

Maximum sediment level has been set at elevation 6,591. When sediment reaches 60% of allowed height as indicated by the top of a wooden marker set on the side embankment, the pond will be cleaned.

Pond Volume

Volume of the pond is calculated by measuring the horizontal cross sections at three-foot intervals and then finding an equation which meets those conditions. Elevation 6593 equals the zero height.

1. $\text{Area} = Ah^2 + Bh + C$
   Cross-sectional area as a function of height
   0 = 24,000 ft^2
   3 = 27,985 ft^2
   6 = 32,255 ft^3

Substituting the known values into Equation 1 for h = 0,3 and 6 yields 3 equations which are:

2. 0, $C = 24{,}000$

3. 3, $9A + 3B + 24{,}000 = 27{,}984$

4. 6, $36A + 6B + 24{,}000 = 32{,}256$

Solving Equation 4 for A gives:

5. $A = -0.333B + 442.667$

Substituting the value from Equation 5 into Equation 3 gives:

6. $B = 1280$

Substituting the value from Equation 6 into equation 5 gives:

7. $A = 16$

Equation 1 can then be expressed as:

8. $\text{Area} = 16h^2 + 1280h + 24{,}000$

Integrating Equation 8 gives the volume as a function of height h. (Calculus and Analytic Geometry, George B. Thomas, Section 5-4, p. 238.)

9. $\int_c^h \text{Area} = V = 5.33\ h^3 + 640\ h^2 + 24{,}000\ h$

Height of sediment can then be calculated using Equation 9 at h = 1', $V = 24{,}645\ ft^3$ which is greater than the expected yearly sediment volume of $22{,}512\ ft^3$.

Using the following information and the methodology present in Summary of Ditch Design Calculations in Appendix III-1 of the Sunnyside Permit, the flow characteristic of the emergency spillway crest section and side slope section can be calculated:

	Crest	Side Slope
Slope	1%	10%
Bottom Width	4	4
Channel Side Slope	2h:1v	2h:1v
Depth of Water Flow	1.50'	0.86'
Velocity	4.08 ft/sec	8.1 ft/sec
n	.035	.041
Total Depth	2'	1.5'

Erosion protection for the pond entrance, emergency spillway, and decant outlet will be grouted rip rap. The rip rap will be dry set using mortar mix or wet set using a premixed slurry grout. The grouted riprap will be keyed in at least 18 inches at transition areas. This will prevent rolling of rip rap and erosion under the rocks. The decant outlet will use the emergency spillway for protection.

Culverts

Expected runoff for the culverts was calculated using the following parameters. The methodologies used in the calculations are found in the Summary of Ditch Design and Culvert Size and Outlet Protection sections of Appendix III-1. Copies of the computer runoff calculations are attached. The culvert summary table shows the complete design information used to determine culvert adequacy.

Culvert C1 95.7 Acres Area 1

Soil - MTC - Good

CN	74	
Reach	3,250'	
Change In Elevation	1,020'	
Slope	31.38%	74.00

Culvert C2 0.81 Acres Area 11

Asphalt

CN	98	
Reach	320'	
Change In Elevation	8'	
Slope	2.5%	98.00

Culvert C3 11.37 Acres Area 4

Soil - MTH - HBC-Industrial

CN	74.67	
Reach	1,200'	
Change In Elevation	790'	
Slope	65.83%	74.67

Culvert C4 32.14 Acres Area 3 and Area 4

	CN	Area	CN X Area	
Area 3	78.06	20.77	1,621.31	
Area 4	74.67	11.37	848.99	
		32.14	2,470.30	76.86

Reach	2,400'
Change In Elevation	865'
Slope	36.04%

Culvert C5 1.15 Acres Area 5

CN	88
Reach	900'
Change In Elevation	28'
Slope	3.11%

Culvert C6 50.91 Acres Areas 2, 11, 3, 4, 5

	CN	Area	CN X Area	
Area 2	83.90	16.81	1,410.42	
Area 3	78.06	20.77	1,621.26	
Area 4	74.67	11.37	849.08	
Area 5	88.00	1.15	101.20	
Area 11	98.00	0.81	79.38	
		50.91	4,061.34	79.77

Reach	2,900'
Change In Elevation	895'
Slope	30.95%

Culvert C7 2.34 Acres Area 6

CN	88.34	88.34
Reach	1,020'	
Change In Elevation	35'	
Slope	3.43%	

Culvert C8 59.06 Acres Areas 2, 3, 4, 5, 7, 11

	CN	Area	CN X Area	
Area 2	83.90	16.81	1,410.42	
Area 3	78.06	20.77	1,621.26	
Area 4	74.67	11.37	849.08	
Area 5	88.00	1.15	101.20	
Area 7	88.42	8.15	720.60	
Area 11	98.00	0.81	79.38	
		59.06	4,781.94	80.97

Reach	3,770'
Change In Elevation	925'
Slope	24.54%

Culvert C9 27.9 Acres Area 12

Soil - DSG2 - Type B - Good

CN	61
Reach	2,400'
Change In Elevation	605'
Slope 25.20%	

Culvert C10 1.77 Acres Area 9

CN	88.00	
Reach	1,160'	
Change In Elevation	40'	
Slope	3.45%	88.00

Culvert C11 Areas 2, 3, 4, 5, 6, 7, 8, 9, 11

	CN	Area	CN X Area	
Area 2	83.90	16.81	1,410.42	
Area 3	78.06	20.77	1,621.26	
Area 4	74.67	11.37	849.08	
Area 5	88.00	1.15	101.20	
Area 6	88.34	2.34	206.76	
Area 7	88.42	8.15	720.60	
Area 8	88.00	7.66	674.08	
Area 9	88.00	1.77	155.76	
Area 11	98.00	0.81	79.38	
		70.83	5,818.54	82.15

Reach	4,970'
Change In Elevation	965'
Slope	19.42%

New or modified culvert installations will have a cover of at least one-half the culvert diameter. Culvert outlet protection will be as shown on Plate III-35.

Ditches

The ditches were designed using the methodologies outlined in the Summary of Ditch design in Appendix III-1. The following is a summary of information on the ditches:

Ditch D1

Q = 19 CFS
Slope = 5.0%
Bottom Width = 3 ft
Side Slope = 2h:1v
Depth of Water Flow = 0.9 ft
Total Ditch Depth = 2.0 ft
Velocity = 6.6 ft/sec
n = 0.035

Erosion protection is not needed because the ditch is well vegetated and is not eroding.

Main Runoff Ditch - Area 10

Q = 26.62 CFS
Slope = 1.3%
Bottom Width = 3 ft
Side Slope = 2h:1v
Depth of Water Flow = 1.1 ft
Total Ditch Depth = 1.6 ft
Velocity = 4.6 ft/sec
n = 0.030

INPUT SUMMARY
FOR W.S.: SSSF POND

10 Yr/24 Hr

STORM:	WATERSHED:
TRIBUTION = SCS TYPE 2	LAND SLOPE = 16.6100 PCT
	CURVE NUMBER = 82.10
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 5900 FT
	TIME OF CONC. = .5027 HR
DURATION = 24.00 HR	AREA = 71.93 AC
NUMBER OF LINES = 374	D = .0670 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .5499 IN
INITIAL ABSTRACTION = .4361 IN
PEAK FLOW = 26.62 CFS (.3670 IPH)
AT T = 12.80 HRS

INPUT SUMMARY
FOR W.S.: SSSF POND 25 Yr/24 Hr

STORM: WATERSHED:

STRIBUTION = SCS TYPE 2	LAND SLOPE = 16.6100 PCT
	CURVE NUMBER = 82.10
PRECIP.DEPTH = 2.20 IN	CHANNEL LENGTH = 5900 FT
	TIME OF CONC. = .5027 HR
DURATION = 24.00 HR	AREA = 71.93 AC
NUMBER OF LINES = 374	D = .0670 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .7889 IN
INITIAL ABSTRACTION = .4361 IN
PEAK FLOW = 39.85 CFS (.5494 IPH)
AT T = 12.74 HRS

INPUT SUMMARY
FOR W.S.: SSSF C1

STORM:	WATERSHED:
STRIBUTION = SCS TYPE 2	LAND SLOPE = 31.3800 PCT
	CURVE NUMBER = 74.00
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 3250 FT
	TIME OF CONC. = .2900 HR
DURATION = 24.00 HR	AREA = 95.70 AC
NUMBER OF LINES = 636	D = .0387 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .2781 IN
INITIAL ABSTRACTION = .7027 IN
PEAK FLOW = 19.00 CFS (.1969 IPH)
AT T = 12.65 HRS

UT SUMMARY
FOR W.S.: SSSF C2

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 2.5000 PCT
	CURVE NUMBER = 98.00
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 320 FT
	TIME OF CONC. = .0638 HR
DURATION = 24.00 HR	AREA = .81 AC
NUMBER OF LINES = 2838	D = .0085 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 1.6093 IN
INITIAL ABSTRACTION = .0408 IN
PEAK FLOW = 1.12 CFS (1.3669 IPH)
AT T = 12.50 HRS

INPUT SUMMARY

FOR W.S.: SSSF C3

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 65.8300 PCT
	CURVE NUMBER = 74.67
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 1200 FT
	TIME OF CONC. = .0885 HR
DURATION = 24.00 HR	AREA = 11.37 AC
NUMBER OF LINES = 2049	D = .0118 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .2937 IN
INITIAL ABSTRACTION = .6785 IN
PEAK FLOW = 3.53 CFS (.3078 IPH)
AT T = 12.51 HRS

INPUT SUMMARY
FOR W.S.: SSSF C4

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 36.0400 PCT
	CURVE NUMBER = 76.86
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 2400 FT
	TIME OF CONC. = .1955 HR
DURATION = 24.00 HR	AREA = 32.14 AC
NUMBER OF LINES = 936	D = .0261 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .3597 IN
INITIAL ABSTRACTION = .6021 IN
PEAK FLOW = 10.59 CFS (.3268 IPH)
AT T = 12.56 HRS

INPUT SUMMARY
FOR W.S.: SSSF C5

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 3.1000 PCT
	CURVE NUMBER = 88.00
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 900 FT
	TIME OF CONC. = .2100 HR
DURATION = 24.00 HR	AREA = 1.15 AC
NUMBER OF LINES = 872	D = .0280 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .8369 IN
INITIAL ABSTRACTION = .2727 IN
PEAK FLOW = .93 CFS (.8001 IPH)
AT T = 12.55 HRS

INPUT SUMMARY
FOR W.S.: SSSF C6

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 30.9500 PCT
	CURVE NUMBER = 79.77
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 2900 FT
	TIME OF CONC. = .2247 HR
DURATION = 24.00 HR	AREA = 50.91 AC
NUMBER OF LINES = 816	D = .0300 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .4586 IN
INITIAL ABSTRACTION = .5072 IN
PEAK FLOW = 21.39 CFS (.4166 IPH)
AT T = 12.58 HRS

INPUT SUMMARY
FOR W.S.: SSSF C7

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 3.4300 PCT
	CURVE NUMBER = 88.34
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 1020 FT
	TIME OF CONC. = .2178 HR
DURATION = 24.00 HR	AREA = 2.34 AC
NUMBER OF LINES = 842	D = .0290 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .8571 IN
INITIAL ABSTRACTION = .2640 IN
PEAK FLOW = 1.92 CFS (.8137 IPH)
AT T = 12.55 HRS

INPUT SUMMARY
FOR W.S.: SSSF C8

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 24.5400 PCT
	CURVE NUMBER = 80.97
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 3770 FT
	TIME OF CONC. = .2998 HR
DURATION = 24.00 HR	AREA = 58.06 AC
NUMBER OF LINES = 616	D = .0400 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .5045 IN
INITIAL ABSTRACTION = .4701 IN
PEAK FLOW = 24.78 CFS (.4232 IPH)
AT T = 12.63 HRS

INPUT SUMMARY
FOR W.S.: SSSF C9

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 25.2000 PCT
	CURVE NUMBER = 61.00
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 2400 FT
	TIME OF CONC. = .3587 HR
DURATION = 24.00 HR	AREA = 27.90 AC
NUMBER OF LINES = 517	D = .0478 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .0453 IN
INITIAL ABSTRACTION = 1.2787 IN
PEAK FLOW = .19 CFS (.0069 IPH)
AT T = 0.00 HRS

INPUT SUMMARY
FOR W.S.: SSSF C10

STORM:	WATERSHED:
DISTRIBUTION = SCS TYPE 2	LAND SLOPE = 3.4500 PCT
	CURVE NUMBER = 88.00
PRECIP.DEPTH = 1.84 IN	CHANNEL LENGTH = 1160 FT
	TIME OF CONC. = .2439 HR
DURATION = 24.00 HR	AREA = 1.77 AC
NUMBER OF LINES = 753	D = .0325 HR

OUTPUT SUMMARY

RUNOFF DEPTH = .8379 IN
INITIAL ABSTRACTION = .2727 IN
PEAK FLOW = 1.39 CFS (.7804 IPH)
AT T = 12.55 HRS

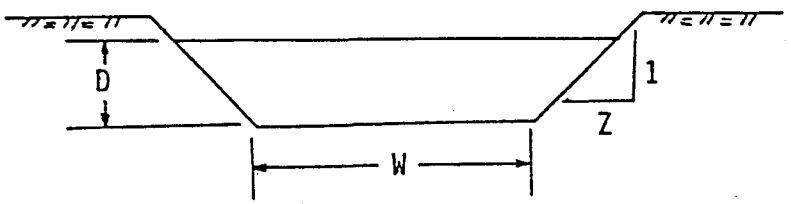
PROJECT SSSF Sediment Pond Final Collection

D1 Ditch

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\,Z^2 + 1}^{2/3}(WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	11.68	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	0.05	DECIMAL %
WIDTH OF CHANNEL	2.0	FT
DEPTH OF CHANNEL	Flow 0.74	FT

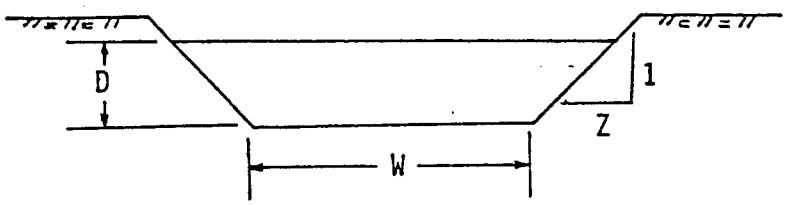
COMMENTS:
- Freeboard - 1'
- Total Depth = 1.74'
- Velocity - 5.73 FPS
- Z = 1
- W = 1

PROJECT SSSF OVERLOOKING HILLSIDE DIVERSION
2 DITCHES, 1/3 FLOW IN UPPER +
2/3 FLOW IN LOWER

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486 S^{1/2}} = \frac{WD + ZD}{W + 2D\,Z^2 + 1}^{2/3} (WD + ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	4.85, 9.70	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	.1850, .011	DECIMAL %
WIDTH OF CHANNEL	1, 2.0	FT
DEPTH OF CHANNEL	FLOW .397, 1.2'	FT

COMMENTS:
Freeboard - 1', 1'
Total Depth = 1.397', 2.2'
Velocity = 8.74, 3.69
Z = 1, 1

Sediment Structure Worksheet

Sediment Structure: SSSF NO. 2 CANYON HILLSIDE

Conditions:

Soil Type: DSG2 (Rabbitex - Patmos)

Hydrologic Group: B

Land Use: Pasture or Range Land

Land Condition: Good

Curve Number CN: 61

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 27.0 Acres

Slope of Area: 50%

Length of Slope: 900 ft.

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \qquad Q_v 10/24 = N/A$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.116 \qquad Q_v 25/24 = N/A$$

$$A = R\ K\ LS\ CP = N/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = N/A$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SSSF NO. 2 CANYON HILLSIDE

Conditions:

Length of Drainage: 900 ft.

Average Slope: 50%

Curve Number: 61

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .070$

$$T_c = T_1/.6$$

$= 0.116$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 960$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= 2.00$ 10/24 Storm

$= 5.17$ 25/24 Storm

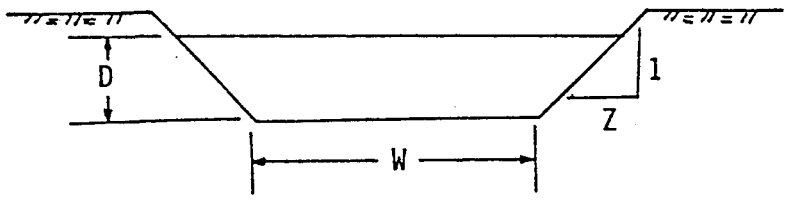
PROJECT SSSF NO. 2 CANYON

HILLSIDE DIVERSION D - 3

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\ Z^2 + 1}^{2/3} (WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	2.0	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	0.04	DECIMAL %
WIDTH OF CHANNEL	2.0	FT
DEPTH OF CHANNEL	FLOW 0.25	FT

COMMENTS:
Freeboard - 1.0'
Velocity - 3.51 FPS
Z = 1
Total Depth = 1.25'

Sediment Structure Worksheet

Sediment Structure: SSSF UPPER HILLSIDE

Conditions:

Soil Type: MTH (Cabba-Guben Rock Outcrop Complex)

Hydrologic Group: C

Land Use: Pasture or Range Land

Land Condition: Good

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 95.7 Acres

Slope of Area: 50%

Length of Slope: 2,000 ft.

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 2.658$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \qquad Q_v 10/24 = N/A$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.643 \qquad Q_v 25/24 = N/A$$

$$A = R\ K\ LS\ CP = N/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = N/A$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SSSF UPPER HILLSIDE

Conditions:

Length of Drainage: 2,000 ft.

Average Slope: 50%

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.080}$

$$T_c = T_1/.6$$

$= \underline{.134}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{930}$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= \underline{60.80}$ 10/24 Storm

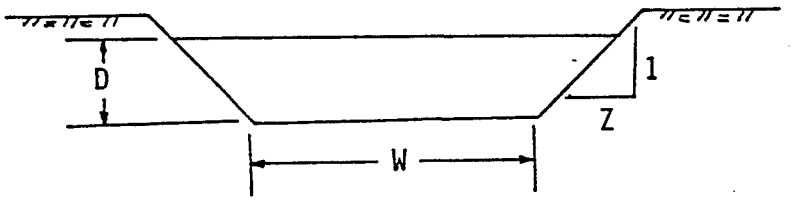
$= \underline{89.42}$ 25/24 Storm

PROJECT SSSF UPPER HILLSIDE DIVERSION D-4

CALCULATION & DESIGN BY

DATE

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\ Z^2 + 1}^{2/3} (WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	60.08	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	0.08	DECIMAL %
WIDTH OF CHANNEL	3.0	FT
DEPTH OF CHANNEL	FLOW 1.47	FT

COMMENTS: Freeboard = 0.5'

Velocity = 9.11 FPS

Z = 1' Total Depth = 2'

This particular ditch is constructed, vegetated, and shows no signs of erosion problems. Has been in place for over 20 years.

Sediment Structure Worksheet

Sediment Structure: SSSF OVERLOOKING HILLSIDE

Conditions:

Soil Type: MTH (Cabba-Guben Rock Complex)

Hydrologic Group: C

Land Use: Pasture or Range Land

Land Condition: Good

Curve Number CN: 74

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 33.5 Acres

Slope of Area: 68%

Length of Slope: 1,000

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 3.514$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.278 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.447 \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = N/A$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = N/A$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SSSF OVERLOOKING HILLSIDE

Conditions:

Length of Drainage: 1000'

Average Slope: 68%

Curve Number: 74

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= 0.460$

$$T_c = T_1/.6$$

$= .077$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1,000$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= 14.55$ 10/24 Storm

$= 23.39$ 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: SF1 CULVERT

Conditions:

Soil Type: Pavement

Hydrologic Group: D

Land Use:

Land Condition:

Curve Number CN: 98

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 2.1 Acres

Slope of Area: 4.5%

Length of Slope: 150 ft.

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 0.204$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.616 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SF1 CULVERT

Conditions:

Length of Drainage: 150'

Average Slope: 4.5%

Curve Number: 98

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= 0.0156$

$$T_c = T_1/.6$$

$= 0.0259$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1,000$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= 5.30 CFS 10/24 Storm

= _____ 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: SF2 Page 13 of 21

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Range

Land Condition: Poor

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event:

Contributing Area: 6.7 Acres

Slope of Area: (950 X .029 + 100 X .25) ÷ (950 + 100) = 0.05

Length of Slope: 1700/2 + 100 = 950 ft.

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 2.658$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SF2

Conditions:

Length of Drainage: 950'

Average Slope: 0.05

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.141}$

$T_c = T_1/.6$

$= \underline{0.234}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{750}$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= \underline{3.39 \text{ CFS}}$ 10/24 Storm

$= \underline{\qquad}$ 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: SF3 CULVERT SF2 AREA + SF3 AREA

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Range

Land Condition: Poor

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event:

Contributing Area: SF2 + SF3 = 7.8 Acres

Slope of Area: (1075 X .036 + 100 X .25) ÷ 1075 + 100 = 5.4%

Length of Slope: 1950/2 + 100 = 1,075

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 2.658$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SF3 CULVERT

Conditions:

Length of Drainage: 1075

Average Slope: 5.4%

Curve Number: 79

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= 0.149$

$T_c = T_1/.6$

$= 0.25$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 735$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= 3.87$ 10/24 Storm

$=$ _____ 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: SF4 CULVERT

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Range

Land Condition: Poor

Curve Number CN: (13.6 X 79 + 4.6 X 98) ÷ 18.2 = 83.8

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event:

Contributing Area: 18.2 Acres SF1 + SF2 + SF3 + SF4 = 18.2

Slope of Area: (1600 X 0.035 + 300 X 0.117) ÷ 1900 = 0.048, 4.8%

Length of Slope: (2600÷2) + 300 = 1600 ft.

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 1.905$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.633 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SF4 CULVERT

Conditions:

Length of Drainage: 1600 ft.

Average Slope: 4.8%

Curve Number: 83.8

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= 0.185$

$T_c = T_1/.6$

$= 0.309$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 650$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

= 11.70 CFS 10/24 Storm

= _____ 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: SF5 CULVERT

Conditions:

Soil Type: HBC and Pavement

Hydrologic Group: B, D

Land Use:

Land Condition: Poor

Curve Number CN: (22.89 X 79 + 4.6 X 98) ÷ 27.49 = 82.18

10 Year 24 Hour Storm Event: 1.84

25 Year 24 Hour Storm Event:

Contributing Area: 27.49 Acres

Slope of Area: (2050 X 0.034 X 300 X .11) ÷ 2350 = 0.044, 4.4%

Length of Slope: 3500 ÷ 2 + 300 = 2,050 ft.

lculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 2.168$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.553 \qquad Q_v 10/24 = \_\_\_\_\_$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = \_\_\_\_\_ \qquad Q_v 25/24 = \_\_\_\_\_$$

$$A = R\ K\ LS\ CP = \_\_\_\_\_$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = \_\_\_\_\_$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: SF5 CULVERT

Conditions:

Length of Drainage: 2,050 ft.

Average Slope: 4.4%

Curve Number: 82.18

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.251}$

$T_c = T_1/.6$

$= \underline{0.418}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{570}$

$q_p = q_p' \, A \, Q \qquad A = \text{Area in Sq. Mi. and } Q = \text{Storm Runoff In Inches}$

$= \underline{13.54 \text{ CFS}}$ 10/24 Storm

$= \underline{\qquad}$ 25/24 Storm

Sediment Structure Worksheet

REVISED
SSSF SEDIMENT POND
PAVED AREAS

Sediment Structure: PAVED AREAS

Conditions:

Soil Type: Pavement

Hydrologic Group: D

Land Use: Parking Lot

Land Condition: Poor

Curve Number CN: 98

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 6.8 Acres

Slope of Area: 5% Average

Length of Slope: 100 Feet

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 0.204$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 1.616 \quad Q_v 10/24 = 39,889\ FT^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 1.973 \quad Q_v 25/24 = 48,702\ FT^3$$

$$A=R\ K\ LS\ CP = 0$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 0$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

REVISED
SSSF SEDIMENT POND
UNPAVED BOTTOM AREAS

Sediment Structure:

Conditions:

Soil Type: HBC

Hydrologic Group: B

Land Use: Pasture or Range Land

Land Condition: Poor

Curve Number CN: 79

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 34.7 Acres

Slope of Area: 5% Average

Length of Slope: 2,000 Ft. Average

Calculations of Runoff and Sediment Volume

$$S=\frac{1,000}{CN} - 10 = 2.658$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \qquad Q_v 10/24 = 54,415\ FT^3$$

$$Q=\frac{(P-.2(S))^2}{P+.8(S)} = 0.643 \qquad Q_v 25/24 = 80,993\ FT^3$$

$$A=R\ K\ LS\ CP = 13.21\ T/A$$

R---Figure 5.3 Page 314 (16)
K---Page 331 (.43)
LS--Figure 5.15 Page 334 (2.4)
C---Table 5.A.1 Page 390 (0.8)

See attached copies of the mentioned pages.

$$S_v=\frac{A(Area)(2000)}{(140)} = 6,548\ FT^3$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Sediment Structure Worksheet

Sediment Structure: SSSF Sediment Pond

Conditions:

Soil Type: HBC (Halverson Sandy Loam)

Hydrologic Group: B

Land Use: Pasture or Range Land

Land Condition: Poor

Curve Number CN: 79/34.7 Acres, 98/6.8 Acres - 82 Avg.

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.20"

Contributing Area: 41.5 Total

Slope of Area: 5% Average

Length of Slope: 3575+ Average

Calculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = 2.195$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.546 \qquad Q_v 10/24 = 39{,}989^* + 54{,}415^* = 94{,}304$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.784 \qquad Q_v 25/24 = 48{,}702^* + 80{,}993^* = 129{,}695 \text{ ft}^3$$

$$A = R\ K\ LS\ CP = 13.21 \text{ T/A}$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(\text{Area})\ (2000)}{(140)} = 6{,}548$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

* From SSSF Paved and Unpaved Areas
\+ Total Length of the Flow Path Divided by 2 and Added to the Right Angle Slope Distance

Peak Runoff Worksheet

Sediment Structure: SSSF SEDIMENT POND

21d

Conditions:

Length of Drainage: 6000', Average 3,575

Average Slope: 2.2%

Curve Number: 82, S = 2.195

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= \underline{0.557}$

$$T_c = T_1/.6$$

$= \underline{0.928}$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= \underline{330}$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= \underline{11.68 \text{ CFS}}$ 10/24 Storm

$= \underline{16.78 \text{ CFS}}$ 25/24 Storm

VOLUME CAPACITY - SSSF SEDIMENT POND

6615 Elev. or 0

Area = 40 X 160 = 6400 Ft^2

6620 Elev. or 5'

Area = 60 X 180 = 10,800 Ft^2

6625 Elev. or 10'

Area = 80 X 200 = 16,000 Ft^2

$A = AX^2 + BX + 6400$

$A = 30X^2 + 730X + 6400$

Integrating:

$A = 30X^2 + 730X + 6400$

$V = 10X^3 + 365X^2 + 6400X$

Sediment Load

$V = 10X^3 + 365X^2 + 6400X$ = Sediment Volume

V = 6548 Ft^3/Yr = 19,644 Ft^3/3 Yrs

@ X = 2.65 Ft V = 19,709 Ft^3 OK USE 2.65'

10 Yr/24 Hr Volume

V = 94,304 Ft^3

V = 94,304 + 19,644 = 113,948 Ft^3

@ X = 10.21 Ft V = 114,036 Ft^3 OK USE 10.2'

Spillway Design

$$H' = \frac{Q^2 (1 + K_e + K_b + K_c L)}{A^2 (2G)}$$

L	=	80.0'	
$Q_{25/24}$	=	16.78 CFS	
K_e	=	0.5	
K_b	=	1.0	
		30"	36"
K_c	=	.0314	.0246
A	=	4.91	7.07
H'	=	0.903	0.391

Use A 36" CMP

Height of Pond Volumes

Sediment and Runoff Volume	-	10.21'
Freeboard	-	1.00'
Head to Pass 25 Yr/24 Hr	-	0.39'
Freeboard	-	1.00'
TOTAL HEIGHT		12.60'

MANSHAFT SEDIMENT POND

See Plate III-11

Sediment Structure Worksheet

Sediment Structure: Manshaft Area I, II

Conditions:

Soil Type: PSH. Zillion Complex

Hydrologic Group: B

Land Use: Pasture or Range

Land Condition: Good

Curve Number CN: 61

10 Year 24 Hour Storm Event: 1.84"

25 Year 24 Hour Storm Event: 2.02"

Contributing Area: 20.22 Acres, 8.41 Acres

Slope of Area: 47.5% , 40.32%

Length of Slope: 1000 , 350

Calculations of Runoff and Sediment Volume:

$$S = \frac{1,000}{CN} - 10 = 6.39$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = .045"$$

$Q_v 10/24$ = Area II , 1,373 ft^3

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = .077"$$

$Q_v 25/24$ = Area II, 2,350 ft^3

$$A = R\ K\ LS\ CP = na$$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = na$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Manshaft Area 1

Conditions:

Length of Drainage: 950' S = 6.39

Average Slope: 47.5, Slope of Drainage - 17.8%

Curve Number: 61

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .0746$

$$T_c = T_1/.6$$

$= .124$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 950$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= 1.35$ 10/24 Storm

$= 2.31$ 25/24 Storm

Peak Runoff Worksheet

Sediment Structure: Manshaft Area II

Conditions:

Length of Drainage: 350' S = 6.39

Average Slope: 40.32

Curve Number: 61

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .036$

$$T_c = T_1/.6$$

$= .06$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

= .59 CFS 10/24 Storm

= 1.01 CFS 25/24 Storm

Sediment Structure Worksheet

Sediment Structure: Manshaft Area III

Conditions:

Soil Type: Asphalt or PSH, Zillion Complex

Hydrologic Group: B

Land Use: Parking Lot

Land Condition: Good

Curve Number CN: 95 (See Roads, Soil Type 0, Hard Surfaced)

10 Year 24 Hour Storm Event: 1.82

25 Year 24 Hour Storm Event: 2.20

Contributing Area: 1.07 Acres

Slope of Area: 4.76%

Length of Slope: 1.05'

lculations of Runoff and Sediment Volume:

$$S = \frac{1{,}000}{CN} - 10 = .526$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.31''$$

$Q_v 10/24 = 5{,}170.43\ ft^3$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.67''$$

$Q_v 25/24 = 6{,}492.19\ ft^3$

$A = R\ K\ LS\ CP = na$

R---Figure 5.3 Page 314
K---Page 331
LS--Figure 5.15 Page 334
C---Table 5.A.1 Page 390

See Attached Copies of the Mentioned Pages.

$$S_v = \frac{A(Area)\ (2000)}{(140)} = na$$

Area---Area in Acres
2000---2000 lbs/ton
140----140 lbs/cu. ft.

Peak Runoff Worksheet

Sediment Structure: Manshaft Area III

Conditions:

Length of Drainage: 100'

Average Slope: 5%

Curve Number: 95

Calculations of Peak Runoff:

$$T_1 = \frac{1^{.8}(S+1)^{.7}}{1900(y)^{.5}} \qquad S = \frac{1000}{CN} - 10 \quad \text{and } y = \text{Slope}$$

$= .0126$

$$T_c = T_1/.6$$

$= .02$

$$q_p' = 10^{(2.50963-0.6995 \log T_c - 0.14808 (\log T_c)^2 + 0.07074 (\log T_c)^3}$$

$= 1000$

$q_p = q_p' \, A \, Q$ A = Area in Sq. Mi. and Q = Storm Runoff In Inches

$= 2.22$ 10/24 Storm

$= 2.79$ 25/24 Storm

Pond Volume

0'	Base Area	- 1782	= 7,128 ft^2
2'	Base Area	- 1198	= 9,192 ft^2
4'	Base Area	- 2862	= 11,448 ft^2

$$A = ah^2 + bh + c$$

$$A = ah^2 + bh + 7,128$$

$$A = 25h^2 + 980h + 7128$$

$$V = \frac{h}{o} 25h^2 = 980 + 7128$$

3 Year Sediment Volume = 10,656

0 to 1	V	= 5716.33
1 to 2	V	= 6646.33
2 to 3	V	= 7626.33
3 to 4	V	= 8656.33
4 to 5	V	= 9736.33
5 to 6	V	= 10866.33

Sediment Level 0 - 1.8' 1 = 10,956 ft^3

10 yr. 24 hr. 1.8 - 3.6' V = 17,500.19 ft^3, 6,543 ft^3 needed

Spillway

$$H' = \frac{Q^2(1+Ke+Kb+KcL)}{a^2(2G)}$$

Ke = 1
Kb = .5

Q = 2.79 + 1.01 = 3.80 CFS

12" Culvert
Kc = .0621
a = 1.770
L = 70'
H' = 1.86'

18" Culvert
Kc = .0621
a = 1.770
L = 70'
H' = 0.49'

Note: Use 18" or larger CMP

PROJECT Manshaft

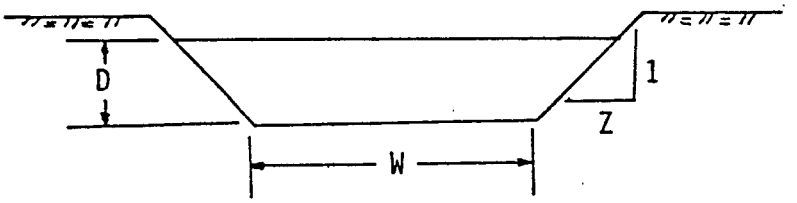
D1

See Plate III-1

CALCULATION & DESIGN BY D. C. Pearce

DATE 09-04-84

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\ Z^2 + 1}^{2/3} (WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	1.35	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	.083	DECIMAL %
WIDTH OF CHANNEL	1	FT
DEPTH OF CHANNEL	Flow 0.256	FT

COMMENTS:
V = 4.2 ft/sec
Z = 1
Fb = 1
Td = 1.25'

PROJECT Manshaft

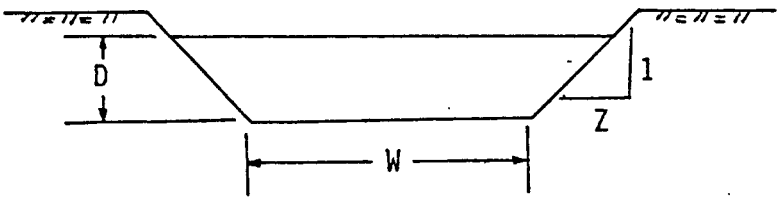
D2

1/2 Flow from Area III

CALCULATION & DESIGN BY D. C. Pearce

DATE 09-04-84

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\ Z^2 + 1}^{2/3} (WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	0.295	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	0.01	DECIMAL %
WIDTH OF CHANNEL	1	FT
DEPTH OF CHANNEL	Flow 0.18	FT

COMMENTS:
V = 1.37 ft/sec
Z = 1
Fb = 1
Td = 1.18'

PROJECT Manshaft

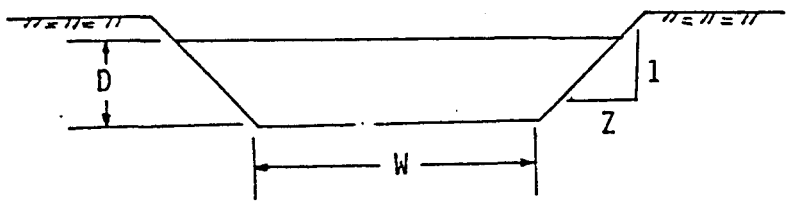
D3

Area 2 + Area 3

CALCULATION & DESIGN BY D. C. Pearce

DATE 09-04-84

DITCH DESIGN AND SIZING



For an earth ditch,
ASSUME: n = 0.030

FLOW THROUGH OPEN CHANNEL IS DERIVED FROM CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A(R_h)^{2/3} S^{1/2}$

$Q = q_p$ from previous design calcs.

WHERE:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft^2
- R_h = hydraulic radius in ft
- S = avg. slope of channel in dec. %

DERIVATION FOR SOLUTION OF CHANNEL DEPTH FROM EQ. (1) GIVES:

$$\frac{Q(n)}{1.486S^{1/2}} = \frac{WD + ZD}{W + 2D\sqrt{Z^2 + 1}}^{2/3} (WD+ZD^2)$$

WHERE:
- W = width of channel
- D = depth of channel

EQUATION (2) IS SOLVED BY TRIAL USING A KNOWN (W) AND TRIAL (D) VALUES.

RESULTS:

PEAK FLOW IN DITCH	2.22 + 0.59 = 2.81	CFS (FROM q_p CALCULATION)
AVG. PERCENT SLOPE	.01	DECIMAL %
WIDTH OF CHANNEL	2	FT
DEPTH OF CHANNEL	Flow 0.46	FT

COMMENTS:

V = 2.44 ft/sec

Z = 1

Fb = 1

Td = 1.5

SLURRY DITCH AND SURROUNDING AREAS

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	West facing hillside, see Plate III-27
Soil Type:	Menefee-rock outcrop complex (MRG)
Hydrologic Group:	C
Land Use:	Range
Land Condition:	Good
Curve Number:	74
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	77.3 acres
Slope of Area:	71%
Length of Drainage:	2,800 feet
Slope of Drainage:	71%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 3.51$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.278$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.03$$

$$T_c = T_1/.6 = 1.712$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 218$$

$$q_p = q_p'(\text{Area Square Miles})Q = 7.33 \text{ cfs}$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3.0 feet
L = 100 feet
Q = 7.33 cfs
H = 0.07 feet

The existing 3.0 foot culvert is adequate to handle the runoff.

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1
Z = 1:1
D = 0.50 feet
V = 2.76 ft/sec
F_b = 3.5 feet
T_d = 4 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequately sized for the flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Lower Loop Area 1 (LL1), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	5.0 acres
Slope of Area:	4.3 %
Length of Drainage:	470 feet
Slope of Drainage:	4.3%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.414$$

$$T_c = T_1/.6 = 2.356$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 171$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.060 \text{ cfs}$$

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Slurry Area 2 (SA 2), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	61
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1.70 acres
Slope of Area:	3.0%
Length of Drainage:	70 feet
Slope of Drainage:	3.0%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 0.369$$

$$T_c = T_1/.6 = 0.615$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 447$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.053 \text{ cfs}$$

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Upper Loop Area 2 (UL 2), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	5.5 acres
Slope of Area:	3.7%
Length of Drainage:	600 feet
Slope of Drainage:	3.7%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(\text{Slope}).5} = 1.853$$

$$T_c = T_1/.6 = 3.088$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 138$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.053 \text{ cfs}$$

.53

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{[W+2D(Z^2+1)^{.5}]}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1
Z = 1:1
D = 0.5 feet
V = 1.06 ft/sec
F_b = 1 foot
T_d = 1.5 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequately sized to handle the expected flow.

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1 foot
L = 40 feet
Q = 0.05 cfs
H = 0.0 feet

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Upper Loop Area 1 (UL 1), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	15.0 acres
Slope of Area:	5.0%
Length of Drainage:	700 feet
Slope of Drainage:	5.0%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.803$$

$$T_c = T_1/.6 = 3.005$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 141$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.149 \text{ cfs}$$

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1 foot
Z = 1:1
D = 0.07 feet
V = 1.92 ft/sec
F_b = 1 foot
T_d = 1.07 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	West Facing Hillside Collector (WFC), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	3.90 acres
Slope of Area:	5.0%
Length of Drainage:	100 feet
Slope of Drainage:	5.0%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(\text{Slope}).5} = 0.38$$

$$T_c = T_1/.6 = 0.634$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 438$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.120 \text{ cfs}$$

DITCH CALCULATIONS

Peak flow in the ditch comes from WFC and WFH, see Plate III-27.

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1 feet
Z = 1:1
D = 0.3 feet
V = 3.94 ft/sec
F_b = 2.2 feet
T_d = 2.5 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Lower Loop Area 2 (LL 2), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	11.0 acres
Slope of Area:	4.3%
Length of Drainage:	700 feet
Slope of Drainage:	4.3%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.944$$

$$T_c = T_1/.6 = 3.241$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 133$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.103 \text{ cfs}$$

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Int. Ditch Hillside (IDH), see Plate III-27
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	7.7 acres
Slope of Area:	17.5%
Length of Drainage:	200 feet
Slope of Drainage:	17.5%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(\text{Slope}).5} = 0.354$$

$$T_c = T_1/.6 = 0.590$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 459$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.355 \text{ cfs}$$

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 2 feet
Z = 1:1
D = 0.11 feet
V = 1.51 ft/sec
F_b = 1 foot
T_d = 1.11 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel
The existing ditch adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Slurry Area 1 (SA 1), see Plate III-12
Soil Type:	HBC
Hydrologic Group:	B
Land Use:	Pasture
Land Condition:	Poor
Curve Number:	79
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1.7 acres
Slope of Area:	4.0%
Length of Drainage:	50 feet
Slope of Drainage:	4.0%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 2.658$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 0.149$$

$$T_c = T_1/.6 = 0.249$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 729$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.837 \text{ cfs}$$

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 2 feet
Z = 1:1
D = 0.168 feet
V = 2.29 ft/sec
F_b = 1 foot
T_d = 1.17 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequate for the area and runoff.

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1.0 feet
L = 50 feet
Q = 0.837 cfs
H = 0.12 feet

Existing culvert is adequate for the area and runoff.

DITCH CALCULATIONS

Isolated ditch flows in the upper reach of the slurry ditch are 0.668 cfs from the prep-plant and runoff from SA1 of 0.837 cfs for a total of 1.505 cfs.

$$Q = \frac{1.486}{n} A(R_h)^{.666} S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{[W+2D(Z^2+1)^{.5}]}\right]^{.666} (WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 3.5 feet
Z = 1:1
D = 0.17 feet
V = 2.42 ft/sec
F_b = 2 feet
T_d = 2.2 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch adequately handles the expected flow.

CULVERT CALCULATION

Slurry Upper Reach (SUR) culvert, 1.5 cfs, see Plate III-12.

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 2.0 feet
L = 900 feet
Q = 1.5 cfs
H = 0.14 feet

The existing culvert is sized adequatly for the flow.

DITCH CALCULATIONS

Slurry ditch middle reach (SMR), see Plate III-12. Flow consists of 1.5 cfs from the upper reach and 0.056 cfs from the SA2 for a total of 1.56 cfs.

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 3.5 feet
Z = 1:1
D = 0.211 feet
V = 2.02 ft/sec
F_b = 1.3 feet
T_d = 1.5 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3.0 feet
L = 240 feet
Q = 1.56 cfs
H = 0.0 feet

Existing culvert is adequatly sized for the flow.

DITCH CALCULATIONS

Flows in the slurry ditch lower reach consist of 1.56 cfs from the middle reach, 0.149 cfs from UL1 and 0.06 cfs from LL1 for a total of 1.767 cfs.

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 7 feet
Z = 1:1
D = 0.152 feet
V = 1.62 ft/sec
F_b = 2.85 fet
T_d = 3.0 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequatly sized for expected flows.

CULVERT CALCULATION

Slurry ditch lower reach (SLR) see Plate III-12.

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3.0 feet
L = 50 feet
Q = 1.8 cfs
H = 0.0 feet

The existing culvert is adequatly sized for the flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	G.T. Collection Area (GTC), see Plate III-12
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	12.6 acres
Slope of Area:	6.0%
Length of Drainage:	900 feet
Slope of Drainage:	6.0%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 2.013$$

$$T_c = T_1/.6 = 3.354$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 129$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.115 \text{ cfs}$$

DITCH CALCULATIONS

Grassy Trail Creek Collection Area (GTC) flows consists of 0.115 cfs from GTC, 0.355 cfs from IDH, 0.156 cfs from UL2 and LL2 and 7.45 cfs from WFC for a total of 8.076 cfs.

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = (overland flow) 20 feet
Z = 1:1
D = 0.13 feet
V = 3.08 feet
F_b = greater than 1 foot
T_d = greater that 1.13 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequatly sized for the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Slurry Area 3 (SA3), see Plate Plate III-12
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Poor
Curve Number:	79
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	9.5 acres
Slope of Area:	5.8%
Length of Drainage:	600 feet
Slope of Drainage:	5.8%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 2.658$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.432 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 0.904$$

$$T_c = T_1/.6 = 1.507$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 240$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.541 \text{ cfs}$$

DITCH CALCULATIONS

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 4 feet
Z = 1:1
D = 0.155 feet
V = 2.38 ft/sec
F_b = 1.45 feet
T_d = 1.5 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

The existing ditch is adequatly sized for the expected flow.

SLURRY PONDS AND COARSE REFUSE DUMP

100 YEAR 24 HOUR DIVERSIONS

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	Coarse Refuse Crest Ditch, see Plate III-24
Soil Type:	Borrow material
Hydrologic Group:	C
Land Use:	Reclaimed Area
Land Condition:	Fair
Curve Number:	79
Storm Event:	
10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
x 100-year 24-hour:	2.66"
Contributing Area:	20.62 acres
Slope of Area:	0.4%
Length of Drainage:	1,200 feet
Slope of Drainage:	0.25%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 2.66$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 1.02"$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 0.76$$

$$T_c = T_1/.6 = 1.26$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 270$$

$$q_p = q_p'(\text{Area Square Miles})Q = 8.87 \text{ cfs}$$

DITCH CALCULATIONS

$$Q = \frac{1.486}{n} A(R_h)^{.666} S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{W+2D(Z^2+1)^{.5}}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1 foot
Z = 1:1
D = 1.63
V = 2.07 ft/sec
F_b = 1 foot
T_d = 2.63 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient = 0.024
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1.5 feet
L = 200 feet
Q = 8.87 cfs
H = 5.45 feet OK, actual fall 28 feet

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	WSC 1 Ditch, West Slurry Cell, see Plate III-24
Soil Type:	Borrow
Hydrologic Group:	C
Land Use:	Reclaimed area, range
Land Condition:	Fair
Curve Number:	79
Storm Event:	
10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
x 100-year 24-hour:	2.66"
Contributing Area:	45.91 acres
Slope of Area:	
Length of Drainage:	1,800 feet
Slope of Drainage:	4.17%

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 0.2569$$

$$T_c = T_1/.6 = 0.4282$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 555$$

$$q_p = q_p'(\text{Area Square Miles})Q = 40.60 \text{ cfs}$$

DITCH CALCULATIONS

Icelander ditch is a combination of runoff from the coarse refuse crest ditch and culvert and the WSC 1 ditch for a combined volume of 49.47 cfs. See Plate III-24.

$$Q=\frac{1.486}{n}A(R_h)^{.666}S^{.5}$$

Where A = area of the channel
n = coefficient of roughness .030
Q = quantity in cfs
R_h = hydraulic radis in feet
S = average slope as a decimal

Derivaration for solution of channel depth for a trapizoid cross section gives:

$$\frac{Q(n)}{1.486S^{.5}} = \left[\frac{WD+ZD^2}{[W+2D(Z^2+1)^{.5}]}\right]^{.666}(WD+ZD^2)$$

Where W = width of channel
D = depth of channel flow
Z = side slope of channel

This equation is solved by trial and error using known W and trial D values.

W = 1 foot
Z = 1:1
D = 2.11 feet
V = 7.58 ft/sec
F_b = 1 foot
T_d = 3.11 feet

Where V = velocity
F_b = freeboard
T_d = total depth of the channel

PERMANENT ROAD CULVERTS

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC-1, see Plate III-28
Soil Type:	HBC, MRG, IGC
Hydrologic Group:	B-C
Land Use:	Range
Land Condition:	Good
Curve Number:	65
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	20.9 acres
Slope of Area:	60%
Length of Drainage:	2000 feet
Slope of Drainage:	60%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 5.385$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.095 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.088$$

$$T_c = T_1/.6 = 1.813$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 209$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.648 \text{ cfs}$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1.3333 feet
L = 80 feet
Q = 0.648 cfs
H = 0.02 feet

Existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC1-3, see Plate III-28
Soil Type:	MRG
Hydrologic Group:	C
Land Use:	Range
Land Condition:	Good
Curve Number:	74
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	77.3 acres
Slope of Area:	71%
Length of Drainage:	2800 feet
Slope of Drainage:	71%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 3.514$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.278 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_l = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.027$$

$$T_c = T_l/.6 = 1.712$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 218$$

$$q_p = q_p'(\text{Area Square Miles})Q = 7.33 \text{ cfs}$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3.0 feet
L = 80 feet
Q = 7.33 cfs
H = 0.06 feet

Existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC1-4, see Plate III-28
Soil Type:	IGC
Hydrologic Group:	B
Land Use:	Range
Land Condition:	Good
Curve Number:	61
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	5.50 acres
Slope of Area:	3.7%
Length of Drainage:	600 feet
Slope of Drainage:	3.7%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} 10 = 6.393$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.045 \text{ inches}$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.853$$

$$T_c = T_1/.6 = 3.088$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 1,38.04$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.053 \text{ cfs}$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1.0 feet
L = 40 feet
Q = 0.05 cfs
H = 0.0 feet

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC2-1, see Plate III-28
Soil Type:	NJF2,IGC, IEE, MUE
Hydrologic Group:	B-C
Land Use:	Woods
Land Condition:	Good
Curve Number:	64
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	317 acres
Slope of Area:	20%
Length of Drainage:	6000'
Slope of Drainage:	20%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 5.625$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.081$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 4.657$$

$$T_c = T_1/.6 = 7.761$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 66.02$$

$$q_p = q_p'(\text{Area Square Miles})Q = 2.65$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 2'
L = 40'
Q = 2.65
H = 0.04'

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure: RC2-2 & RC2-3, see Plate III-28

Soil Type:	Various Types
Hydrologic Group:	C-D
Land Use:	Range
Land Condition:	Good
Curve Number:	74
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	50.5 acres
Slope of Area:	40%
Length of Drainage:	2000'
Slope of Drainage:	40%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 3.514$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.278$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.045$$

$$T_c = T_1/.6 = 1.742$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 215.48$$

$$q_p = q_p'(\text{Area Square Miles})Q = 4.73$$

CULVERT CALCULATION

RC2-2 culvert

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 1.5'
L = 40'
Q = 4.73
H = .44'

The existing culvert adequately handles the expected flow.

CULVERT CALCULATION

RC2-3 culvert

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 2'
L = 40'
Q = 4.73
H = .11'

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC-4, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	B-D
Land Use:	Woods
Land Condition:	Good
Curve Number:	57
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,455 acres
Slope of Area:	40%
Length of Drainage:	2200'
Slope of Drainage:	40%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 7.544$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.014$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 1.763$$

$$T_c = T_1/.6 = 2.939$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 143.53$$

$$q_p = q_p'(\text{Area Square Miles})Q = 4.57$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 20'
Q = 4.57
H = .013'

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-1, see Plate III-28
Soil Type:	Various Types
Hydrologic Group:	B-D
Land Use:	Woods
Land Condition:	Good
Curve Number:	56
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	2,352 acres
Slope of Area:	50%
Length of Drainage:	2200'
Slope of Drainage:	50

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} 10 = 7.857$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0089$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 1.617$$

$$T_c = T_1/.6 = 2.696$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 153.66$$

$$q_p = q_p'(\text{Area Square Miles})Q = 5.03$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 25'
Q = 5.03
H = .0166

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-2, see Plate III-28
Soil Type:	JT6, MR6, PSM
Hydrologic Group:	B-C
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,425 acres
Slope of Area:	60%
Length of Drainage:	2500'
Slope of Drainage:	60%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 1.677$$

$$T_c = T_1/.6 = 2.795$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 149.33$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.63$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 25'
Q = 1.63
H = .0017

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-3, see Plate III-28
Soil Type:	PSH, JT6, MR6
Hydrologic Group:	B-C
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,338 acres
Slope of Area:	60%
Length of Drainage:	2500'
Slope of Drainage:	60%¼R

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 1.677$$

$$T_c = T_1/.6 = 2.795$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 149.33$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.53$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 25'
Q = 1.53
H = .0015'

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-4, see Plate III-28
Soil Type:	JT6, PSH
Hydrologic Group:	B
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,294 acres
Slope of Area:	60%
Length of Drainage:	2500'
Slope of Drainage:	60%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} 10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(Slope).5} = 1.677$$

$$T_c = T_1/.6 = 2.795$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 149.33$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.48$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 25'
Q = 1.48
H = .0014'

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-5, see Plate III-28
Soil Type:	PSH, JT6, HU6, VOH
Hydrologic Group:	B
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,165 acres
Slope of Area:	60%
Length of Drainage:	2500'
Slope of Drainage:	60%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} 10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(Slope).5} = 1.677$$

$$T_c = T_1/.6 = 2.795$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 149.33$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.33$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 30'
Q = 1.33
H = 0

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC3-6, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	B-C
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,049 acres
Slope of Area:	60%
Length of Drainage:	3000'
Slope of Drainage:	60%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 1.941$$

$$T_c = T_1/.6 = 3.234$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 133.03$$

$$q_p = q_p'(\text{Area Square Miles})Q = 1.07$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 3'
L = 40'
Q = 1.07
H = 0

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC7-2, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	A-C
Land Use:	Woods
Land Condition:	Good
Curve Number:	57
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	1,689 acres
Slope of Area:	35%
Length of Drainage:	2500'
Slope of Drainage:	34%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 7.544$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.014$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 2.118$$

$$T_c = T_1/.6 = 3.531$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 124.05$$

$$q_p = q_p'(\text{Area Square Miles})Q = 4.58$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 4'
L = 40'
Q = 4.58
H = 0

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC7-3, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	B
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	3,354 acres
Slope of Area:	35%
Length of Drainage:	3000'
Slope of Drainage:	35%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0049$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(\text{Slope})^{.5}} = 2.541$$

$$T_c = T_1/.6 = 4.235$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 107.25$$

$$q_p = q_p'(\text{Area Square Miles})Q = 2.75$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}} \left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 4'
L = 20'
Q = 25.69
H = 0

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC-1, see Plate III-28
Soil Type:	CIC, JT6
Hydrologic Group:	A-B
Land Use:	Woods
Land Condition:	Good
Curve Number:	50
Storm Event:	
x 10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	30.0 acres
Slope of Area:	57%
Length of Drainage:	1500'
Slope of Drainage:	57%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 10{,}000$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0026$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(\text{Slope}).5} = 1.298$$

$$T_c = T_1/.6 = 2.163$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 182.53$$

$$q_p = q_p'(\text{Area Square Miles})Q = 0.022$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 5'
L = 60'
Q = 100.022

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	RC10-4, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	B-D
Land Use:	Woods
Land Condition:	Good
Curve Number:	56
Storm Event:	
10-year 24-hour:	1.84"
x 25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
100-year 24-hour:	2.66"
Contributing Area:	2,587 acres
Slope of Area:	50%
Length of Drainage:	2200'
Slope of Drainage:	50%

RUNOFF CALCULATIONS

$$S = \frac{1000}{CN} - 10 = 7.857$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.0486$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1).7}{1900(\text{Slope}).5} = 1.617$$

$$T_c = T_1/.6 = 2.696$$

$$q_p' = 10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 153.66$$

$$q_p = q_p'(\text{Area Square Miles})Q = 30.19$$

CULVERT CALCULATION

$$H = \frac{2.5204(1+K_e)}{D^4} + \frac{466.18n^2L}{D^{16/3}}\left[\frac{Q}{10}\right]^2$$

Where H = head in feet
K_e = entrance loss coefficient = 0.5
D = diameter of pipe in feet
n = Manning's roughness coefficient
L = length of culvert in feet
Q = design discharge rate in cfs

D = 12.0 feet
L = 150 feet
Q = 30.19 cfs
H = 0.002 feet

The existing culvert adequately handles the expected flow.

SEDIMENT STRUCTURE WORKSHEET

Sediment Structure:	M-BR, see Plate III-28
Soil Type:	Various types
Hydrologic Group:	A-D
Land Use:	Woods
Land Condition:	Good
Curve Number:	55
Storm Event:	
10-year 24-hour:	1.84"
25-year 24-hour:	2.20"
50-year 24-hour:	2.49"
x 100-year 24-hour:	2.66"
Contributing Area:	10,180 acres
Slope of Area:	15%
Length of Drainage:	7125
Slope of Drainage:	15%

RUNOFF CALCULATIONS

$$S=\frac{1000}{CN}-10 = 8.182$$

$$Q = \frac{(P-.2(S))^2}{P+.8(S)} = 0.138$$

PEAK RUNOFF CALCULATION

$$T_1 = \frac{1.8(S+1)^{.7}}{1900(Slope)^{.5}} = 7.753$$

$$T_c = T_1/.6 = 12.922$$

$$q_p'=10^{(2.50963)-(0.6995)(\log T_c)-(0.14808)(\log T_c)^2+(0.07074)(\log T_c)^3}$$

$$q_p' = 44.31$$

$q_p = q_p'$(Area Square Miles)Q = 97.26, add 100 cfs for maximum reservoir outflow, total flow is 197.26 cfs

SUMMARY OF DITCH DESIGN CALCULATIONS

Ditches are designed for open channel flow by using the Chezy-Manning Equation.

(1) $$Q = \frac{1.486}{n} A (R_h)^{2/3} S^{1/2}$$

Where Q = maximum CFS

n = coefficient of roughness

A = area of channel in ft^2

R_h = hydraulic radius in ft

S = average slope of the channel in decimal percent

Derivation for solution of channel depth from equation (1) and a trapazodial channel give the following equation.

(2) $$\frac{Q(n)}{1.486S^{1/2}} = \left(\frac{WD+ZD^2}{W+2D\left(Z^2+1\right)^{1/2}}\right)^{2/3} (WD + ZD^2)$$

Where W = width of channel

D = depth of channel

Z = side slope ratio

Equation (2) is solved by trial using a known (W) and an assumed (D).

Q = quantity in cfs

S_{max} = maximum slope

S_{ave} = average slope

V_{max} = maximum velocity

V_{min} = minimum velocity

D_w = depth of water flow

F_b = freeboard

D_t = depth total

SUMMARY OF DITCH AND RIPRAP DESIGN CALCULATIONS

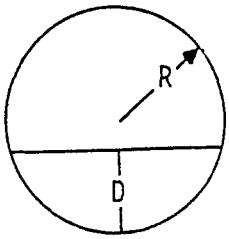
Ditch Description	Q (cfs)	S_{max}	S_{ave}	W (ft)	Z (ft)	V_{max}	V_{min}	D_w (ft)	F_b (ft)	D_t (ft)
R Toe	8.55	0.31	0.20	1.0	4	10.01	8.50	0.35	1.0	1.35
Pasture-New Haul Rd	3.58	0.053		2.0	2	4.41		0.31	1.0	1.31
Refuse Road I	7.12	0.125	0.052	10.0	1	4.37	3.66	0.19	1.0	1.19
Div. Area I	1.80	0.110	0.052	2.0	1	4.32	4.19	0.32	1.0	1.32
Div. Area II	1.25	0.071	0.033	1.0	1	3.95	3.21	0.29	1.0	1.29
Hoisthouse										
1D	7.41	0.032		2.0	1	4.59		0.62	1.0	1.62
2D	2.20	0.010		0.0	1	2.69		0.90	1.0	1.90
3D	0.15	0.019		0.0	1	3.27		0.23	1.0	1.23
4D	1.28	0.091		1.0	1	4.61		0.23	1.0	1.23
5D	0.27	0.050		1.0	1	2.31		0.10	1.0	1.10
6D	0.69	0.032		1.0	1	2.66		0.21	1.0	1.21
7D	0.53	0.010		1.0	1	1.63		0.26	1.0	1.26
8D	0.14	0.010		0.0	1	1.08		0.12	1.0	1.12
9D	0.14	0.010		0.0	1	1.08		0.12	1.0	1.12
No. 2 Canyon										
D1	1.10	0.083	0.057	1.0	1	3.98	3.74	0.24	1.0	1.24
D2	1.90	0.052		1.0	1	4.25		0.33	1.0	1.33
D3	1.46	0.100	0.078	1.0	1	4.47	4.19	0.27	1.0	1.27
D4	0.37	0.0484		1.0	1	2.53		0.13	1.0	1.13
D5	0.09	0.014		1.0	1	1.07		0.08	1.0	1.08
D6	1.76	0.015		1.0	1	2.65		0.45	1.0	1.45
SSSF										
D1	11.68	0.050	0.022	2.0	1	5.73		0.74	1.0	1.74
D2a	4.85	0.313	0.185	1.0	1	7.91	6.89	0.47	1.0	1.47
D2b	9.70	0.011		1.0	1	3.69		1.19	1.0	2.19
D3	2.00	0.050	0.040	2.0	1	3.66	3.51	0.25	1.0	1.25
D4	60.08	0.080		3.0	1	9.11		1.47	1.0	2.47
Manshaft										
D1	1.35	0.083		1.0	1	4.20		.256	1.0	1.26
D2	.295	0.010		1.0	1	1.37		0.18	1.0	1.18
D3	2.81	0.010		2.0	1	2.44		0.46	1.0	1.46
Slurry Ditch										
Surrounding Areas	28.54	0.010		1.0	1	2.76		0.50	3.5	4.00
UL 2	0.386	0.022		1.0	1	1.95		0.16	1.0	1.16
UL 1	0.712	0.050		1.0	1	1.97		0.07	1.0	1.07
WFC	28.66(2)	0.035				3.13		0.19	1.0	1.19
IDH	0.54	0.019		2.0	1	1.75		0.14	1.0	1.14
SA1	0.15	0.027		2.0	1	2.55		0.20	1.0	1.20
SUR	1.82(3)	0.028		3.5	1	2.59		0.19	1.0	1.19
SMR	1.94(4)	0.015		3.5	1	2.17		0.23	1.0	1.23
SLR	2.91(5)	0.014		7.0	1	1.97		0.20	1.0	1.20
GTC(7)	30.65(6)	0.060		25.0	1	4.10		0.19	1.0	1.19
SA3	5.64	0.03		4.0	1	3.78		0.33	1.0	1.33

NOTES:
(1) DH4 has the maximum flow of all the ditches on this line
(2) WFC + W. F. Hillside and W. F. Collector
(3) SUR = Slurry (0.668 cfs) + SA1
(4) SMR = SUR + SA2
(5) SLR = SMR + UL1 + LL1
(6) GTC = GTC + IDH + UL2 + LL2 + WFC

	Q	S	W	Z	V	D_w	F_b	D_t
1cut								
D1	4.86	0.015	4	1	2.89	0.380	0.620	1.0
D2	6.36	0.015	4	1	3.18	0.449	0.551	1.0
D3	6.83	0.015	4	1	3.25	0.468	0.532	1.0
D4	14.86	0.015	5	1	4.02	0.653	0.347	1.0
D5	7.48	0.015	4	1	3.36	0.495	0.505	1.0
D12	14.16	0.052	20	1	3.69	0.190	0.810	1.0
D13	52.06	0.010	8	1	4.80	1.180	0.820	2.0
D14	18.50	0.073	4	1	8.58	0.770	0.230	1.0
Slurry Ponds & Coarse Refuse Dump 100/24 Diversions								
Cr Crest	8.87	0.003	1	1	2.63	1.630	1.000	2.6
WSC1	40.60	0.042	19	1	7.58	0.430	1.000	4.9

CULVERT AND POND - SIZE AND OUTLET PROTECTION

CULVERT AND POND - SIZE AND OUTLET PROTECTION



for culvert assume
n = 0.024

Flow through open channel is derived from CHEZY-MANNING EQUATION:

(1) $Q = \frac{1.486}{n} A (Rh)^{2/3} S^{1/2}$

Where:
- Q = quantity in cfs
- n = coefficient of roughness
- A = area of channel in ft
- R_h = hydraulic radius in ft
- S = slope in decimal percent
- P_w = wetted perimeter

$Q = q_p$ from previous design calculations

(2) $R_h = \frac{A}{P_w}$

(3) $\frac{Q(n)}{1.486S^{\frac{1}{2}}} = \frac{A}{P_w}^{2/3} A$

where

(4) $A = \text{arc cos} \left[\frac{R-D}{R}\right] R^2 - (R-D)(2RD-D^2)^{\frac{1}{2}}$

(5) $P_w = 2R \text{ arc cos } \frac{R-D}{R}$

Equation (3) is solved by trail using known (w) and trial (d) values.

Culvert size is determined by using a culvert capacity charge (see attached charts) to determine the type of culvert flow. Culvert flow may have inlet, outlet, or full pipe control. The index valve of the chart is determined by equation (6).

(6) $I = \frac{L}{100S_0}$

Where: L = culvert length
S_0 = decimal slope

If the index is less than the chart number on the solid lines, the control is inlet. If the index is less than the dashed line, the control is outlet. Index numbers greater than the dash line are full pipe flow, and the pipe flow nomograph (see attached nomograph) is used. Flow in 12" culverts is not shown on the culvert capacity charts. Flow must be determined on the pipe full nomograph.

Erosion protection is usually needed when exit velocities are in excess of 5 feet per second. If the culvert inspection program in Section 3.4.3.2 shows the need for protection at culvert discharges, the operator will correct the problem with anchored rip rap, concrete, u.v. resistant plastic, or other protective channel liners with minimum size specifications as shown on Plate III-35. Protection at sediment pond outlets when needed will consist of the above measures. Plate III-35 shows the minimum size specifications for the protective apron.

CULVERT SIZE AND OUTLET PROTECTION

Q = Quantity in CFS	O = Outlet	V = Velocity in FPS
S_1 = Slope	P = Pipefull	$I_n = \frac{L}{100\ S}$ = Index Number
S_2 = Alternate Slope	Dia. = Diameter, Culvert	W = Ditch Width
I = Inlet	H_w = Height of Water	Z = Side Slope

CULVERT	Q	S_1	S_2	I	I,O,P	Dia.	H_w	V
Railcut C1(1)	14.16	0.27	0.015	1.16	O	24"	2.3'	11.63(8)
C2	7.48	0.33		3.63	I	36"	1.3	
C3	22.34	0.28	0.08	34.70	I	36"	2.2	
C4	29.20	0.28		6.50	I	36"	2.5	
C5	35.53	0.26		6.46	I	36"	2.9	
C6	40.39	0.44	0.08	55.1	I	36"	3.1	13.50(8)
Pa[illegible]re Haul Road	2.50	0.06		12.5	O	12"	1.2'	6.13
Refuse Road I (Old Coarse Refuse Rd)								
Old Haul Road	5.00	0.71		25.0	O	12"	1.3'	18.35(8)
D. Area I + II	3.00	0.06		11.6	O	24"	1.8'	6.13(8)
No. 3 Hoisthouse								
1C	0.27	0.50		2.0	I	12"	1.0'	7.74(8)
2C	2.20	0.025		8.0	O	12"	1.0'	4.24
3C	1.10	0.06		8.3	I	18"	1.0'	4.74
4C,5C,6C	0.14	0.02		50.0	O	12"	1.0'	1.90
7C	10.89	0.05		48.0	I	30"	1.7'	(7)

CULVERT SIZE AND OUTLET PROTECTION

Q = Quantity in CFS	O = Outlet	V = Velocity in FPS
S_1 = Slope	P = Pipefull	$I_n = \frac{L}{100\ S}$ = Index Number
S_2 = Alternate Slope	Dia. = Diameter, Culvert	W = Ditch Width
I = Inlet	H_w = Height of Water	Z = Side Slope

CULVERT	Q	S_1	S_2	I	I,O,P	Dia.	H_w	V
No. 2 Canyon								
C1	3.87	0.04		26.0	O	18"	1.1'	5.83(8)
C2	1.19	0.03		60.0	O	12"	0.9'	3.92
C3	5.95	0.04		33.8	O	24"	1.3'	6.44(8)
C4	2.03	0.03		66.6	O	18"	1.0'	4.40
C5	1.85	0.12		10.8	O	12"	1.3'	7.33(8)
Slurry Ponds and Coarse Refuse Dump 100/24 Diversions								
CR Crest	8.87	0.14		14.3	I	18"	2.1'	7.13(8)

CULVERT SIZE AND OUTLET PROTECTION

Q = Quantity in CFS
S_1 = Slope
S_2 = Alternate Slope
I = Inlet
O = Outlet
P = Pipefull
Dia. = Diameter, Culvert
H_w = Height of Water
V = Velocity in FPS
$I_n = \frac{L}{100\ S}$ = Index Number
W = Ditch Width
Z = Side Slope

CULVERT	Q	S_1	S_2	I	I,O,P	Dia.	H_w	V
SSSF								
C1	14.55	0.10		36.00	O	24"	2.9'	11.46 (8)
C2	2.00	0.10		4.00	O	12"	0.5'	7.00 (8)
C3	60.08	0.08		12.50	I	48"	–	15.04 (8)
Surface Facilities Interior Culverts								
SF1	5.30	0.05		7.00	P	12"	2.5'	6.75
SF2	3.39	0.05		10.00	I	18"	1.0'	6.10
SF3	3.87	0.09		10.00	I	24"	1.0'	7.62
SF4	11.70	0.03		15.00	I	24"	2.0'	6.90
SF5	13.54	0.03		6.66	I	36"	1.2'	7.07
Slurry Ditch and Surrounding Areas								
W. Facing Hillside	28.54	0.02		40.00	I	36"	2.9'	7.42 (8)
UL2	0.386	0.02		7.14	O	12"	1.0'	0.25
SA1	1.15	0.02		25.00	O	12"	1.0'	3.34
SUR	1.82	0.03		300.0	O	24"	1.0'	4.14
SMR	1.94	0.03		80.00	O	36"	1.0'	4.01
SLR	2.91	0.03		16.66	I	36"	1.0'	4.52

CULVERT SIZE AND OUTLET PROTECTION

Q = Quantity in CFS
O = Outlet
V = Velocity in FPS
S_1 = Slope
P = Pipefull
$I_n = \frac{L}{100\ S}$ = Index Number
S_2 = Alternate Slope
Dia. = Diameter, Culvert
W = Ditch Width
I = Inlet
H_W = Height of Water
Z = Side Slope

CULVERT	Q	S_1	S_2	I	I,O,P	Dia.	H_W	V	
Permanent Road Culverts									
RC1-2	2.75	0.03		26.66	O	16"	1.0'	4.79	
RC1-3	8.54	0.05		16.00	I	36"	1.2'	7.40	(8)
RC1-4	.26	0.05		8.00	O	12"	1.0'	3.14	
RC3-1	23.06	0.05		5.00	I	36"	2.4'	9.85	(8)
RC3-2	7.64	0.05		.00	I	36"	1.3'	7.19	(8)
RC3-3	7.17	0.05		5.00	I	36"	1.2'	7.06	(8)
RC3-4	6.94	0.05		5.00	I	36"	1.0'	6.99	(8)
RC3-5	6.24	0.05		6.00	I	36"	1.0'	6.78	(8)
RC3-6	5.14	0.05		8.00	I	36"	1.0'	6.41	(8)
RC7-3	100.00	0.05		6.00	I	7.5"	4.0'	13.75	(8)
RC10-4	30.19	0.10		15.00	I	144"	4.0'	11.50	(8)
M-CV	111.45	0.03		13.3		90"	4.0'	11.83	(8)

CULVERT SIZE AND OUTLET PROTECTION

Q = Quantity in CFS
S_1 = Slope
S_2 = Alternate Slope
I = Inlet
O = Outlet
P = Pipefull
Dia. = Diameter, Culvert
H_w = Height of Water
V = Velocity in FPS
$I_n = \frac{L}{100\ S}$ = Index Number
W = Ditch Width
Z = Side Slope

CULVERT	Q	S_1	S_2	I	I,O,P	Dia.	H_w	V
Sediment Pond Discharges								
Cr. Toe (9)	11.72	0.01	0.500			48"		4.45
Railcut (2)	71.69	0.01	0.097			48."		7.02 (8)
Refuse Rd. I	7.12	0.02				18"		5.14 (8)
Pasture	3.58	0.01				18"		3.40
Hoisthouse (3)	13.62		0.002			36"		2.56
No. 2 Canyon Upper	2.53	0.01				18"		3.13
No 2 Canyon Lower	4.63	0.01				24"		3.63
001 Mine Water	4.58	0.06				36" (4)		6.60 (8)
SSSF	16.78	0.02				36"		6.47 (8)
Manshaft (6)	3.80	0.01				18" (5)		3.45
Clear Water (004)	0.67	0.01				8"		2.24
002 Mine Water	1.37	0.018				15"		3.33

(1) An elbow and one length (20') of culvert will be run at 1.5% at the bottom of the hill to act as an energy break.

(2) Riprap size was controlled by ditch conditions. Velocity from the culvert was 7.02 ft/sec which is 1.96 ft/sec less than the velocity of the ditch. Slope S_2 is the ditch slope.

(3) An elbow and one length (20') of culvert will be run at 0.2% at the bottom of the hill to act as an energy break.

(4) Approximation of oval cross section when laying on long axis and water flow depth is small. Actual flow depth is 0.25 feet.

(5) Oval tubing will be on edge and shows an approximate 9-inch radius for water depths under 1'0. Water depth will be 0.98 feet.

(6) The oval tubing will be run down stream at 1% slope for 20 feet to slow the water velocity.

(7) Discharge is combined with the Hoisthouse Sediment Pond (36") Culvert.

(8) Requires erosion protection.

(9) Velocity based on a 5 foot vertical drop, May 25, 1985 letter to Wayne Hedberg, DOGM

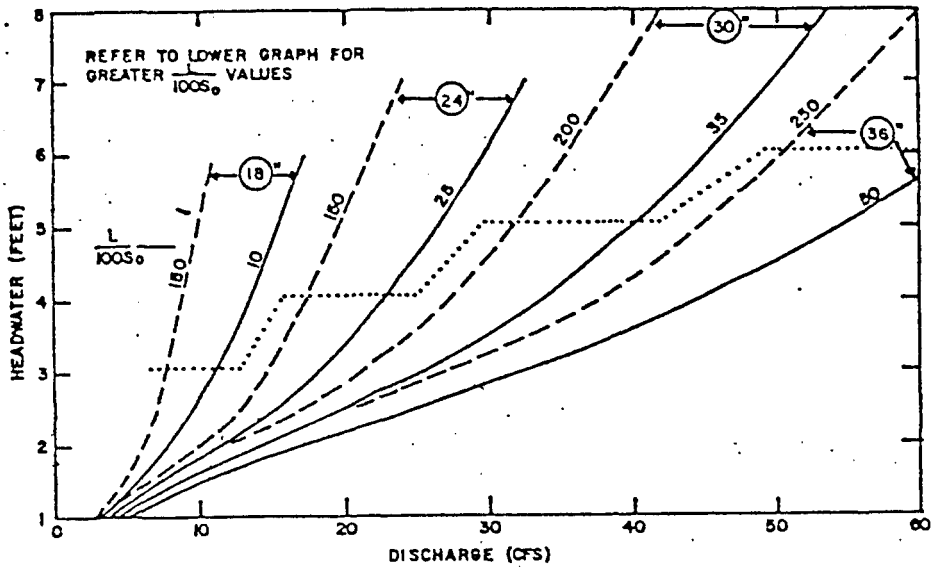


Figure 7A.2a. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 18-36 in diameter. (adapted from Portland Cement Association, 1962)

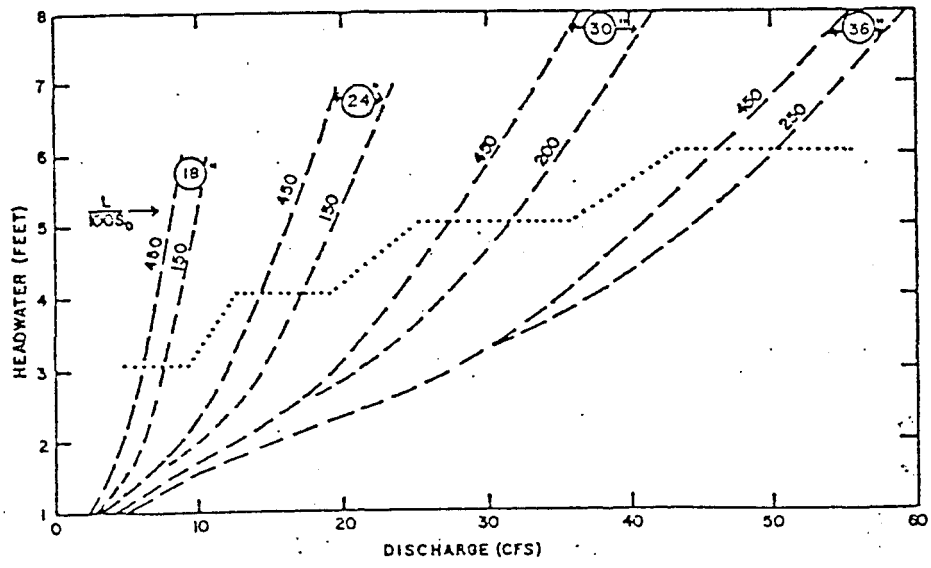


Figure 7A.2b. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 18-36 in diameter. (adapted from Portland Cement Association, 1962)

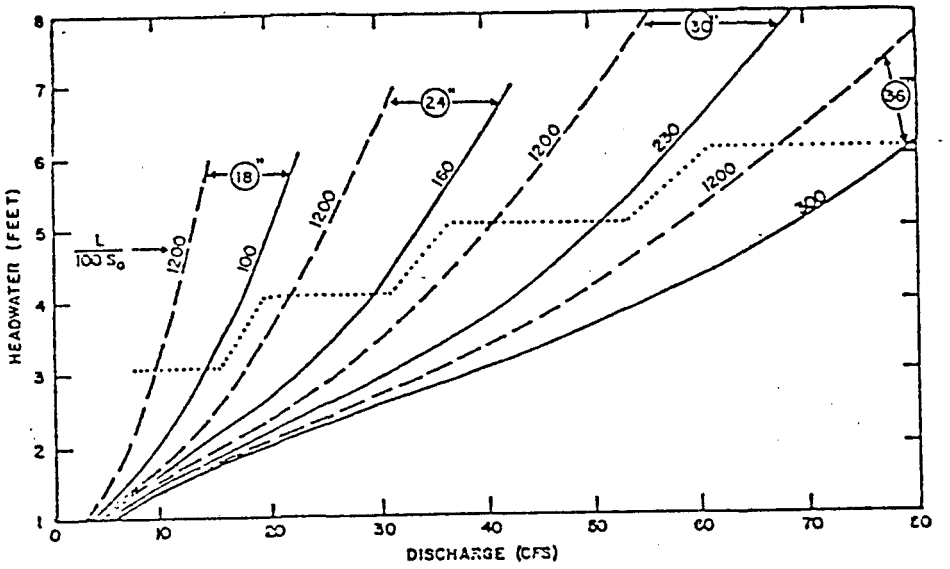


Figure 7A.1a. Culvert capacity chart - circular concrete pipe, groove-edged entrance, 18-36 in diameter. (adapted from Portland Cement Association, 1962)

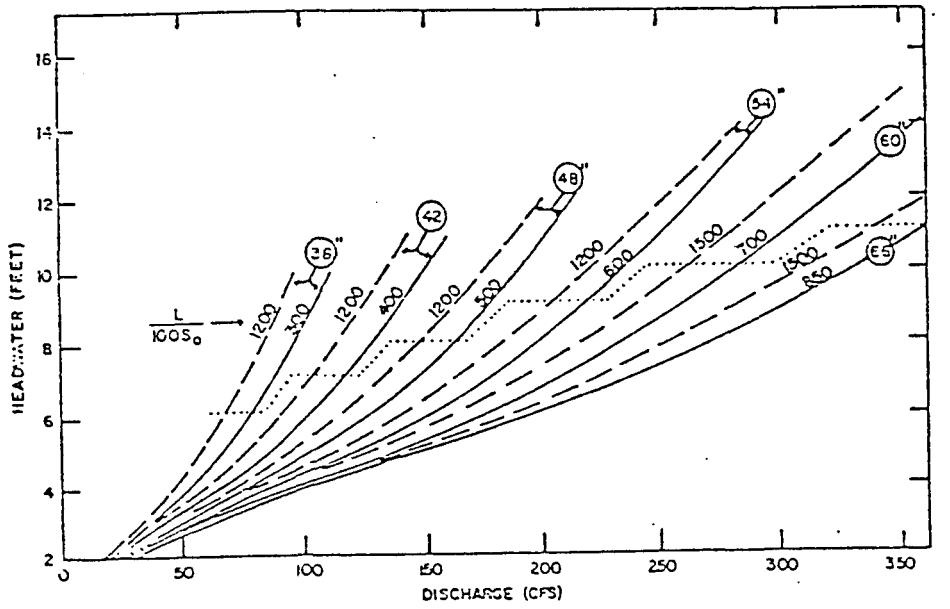


Figure 7A.1b. Culvert capacity chart - circular concrete pipe, groove-edged entrance, 36-66 in diameter. (adapted from Portland Cement Association, 1962)

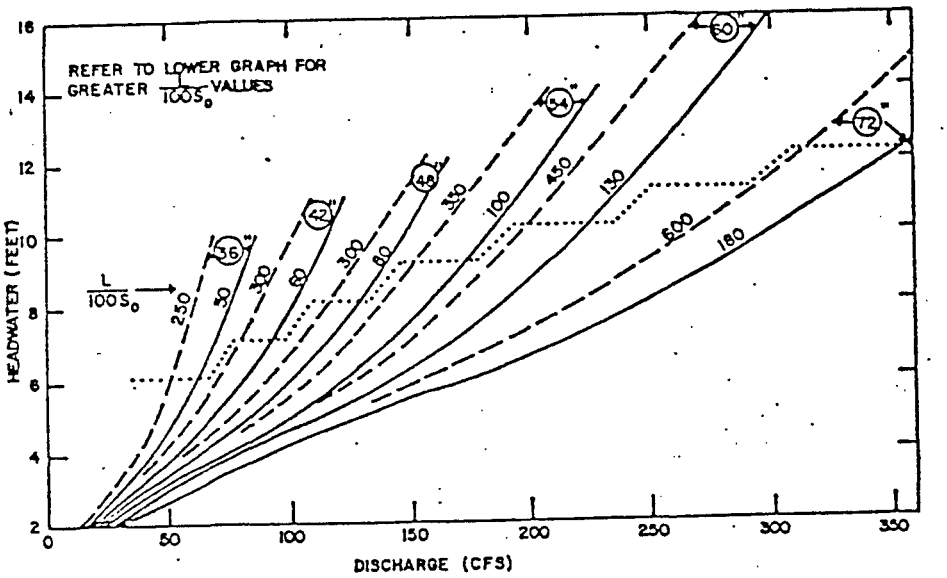


Figure 7A.2c. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 36-72 in diameter. (adapted from Portland Cement Association, 1962)

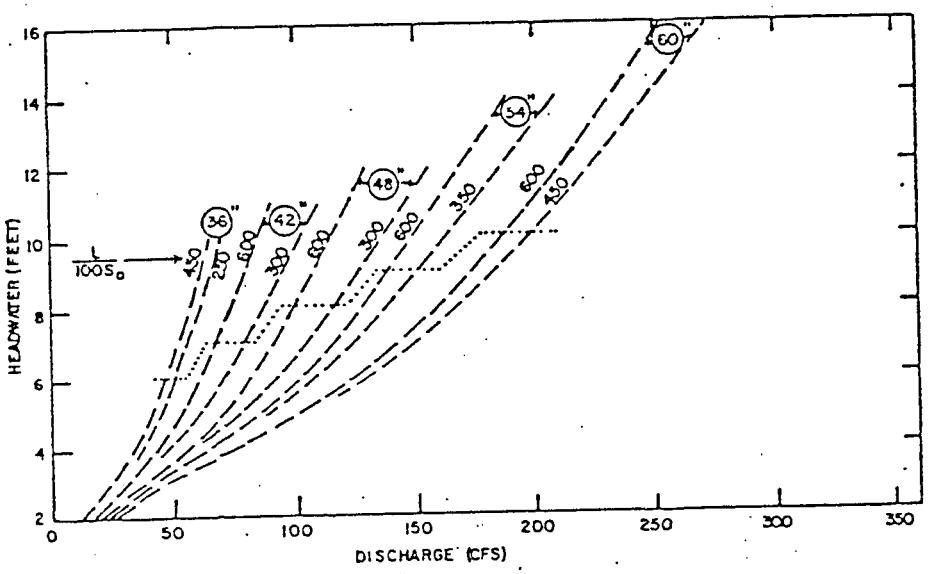


Figure 7A.2d. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 36-60 in diameter. (adapted from Portland Cement Association, 1962)

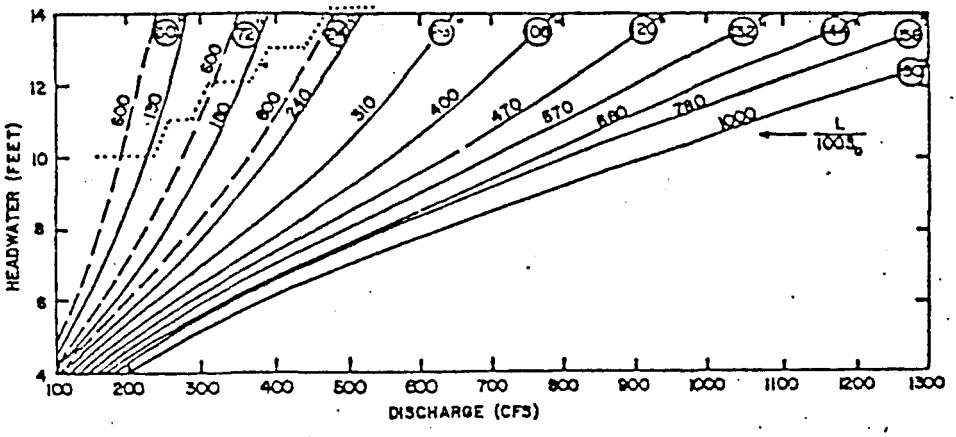


Figure 7A.2e. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 60-180 in diameter. (adapted from Portland Cement Association, 1962)

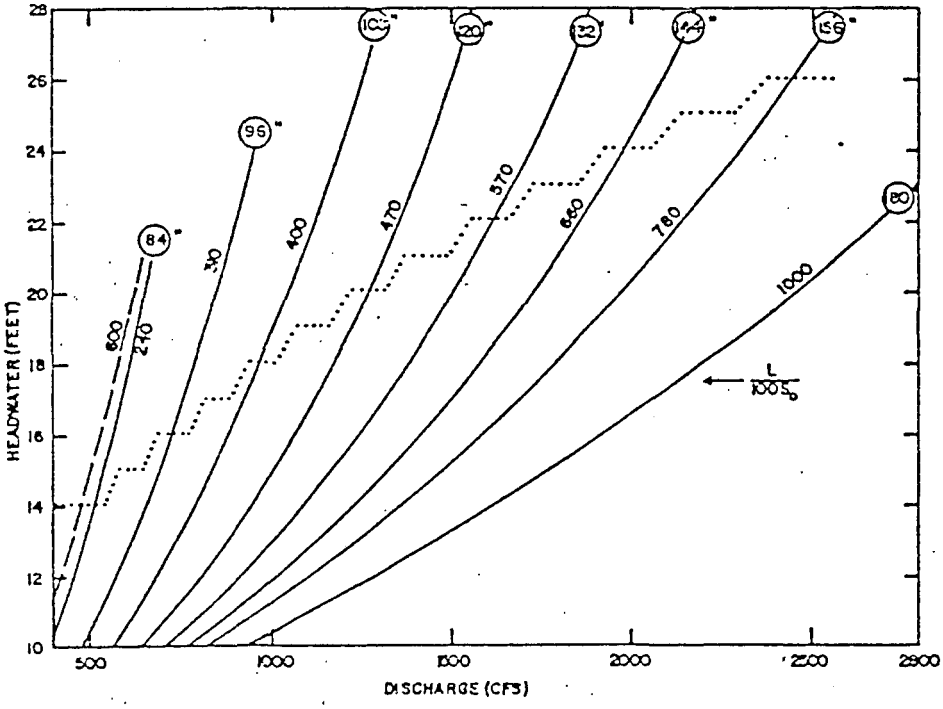
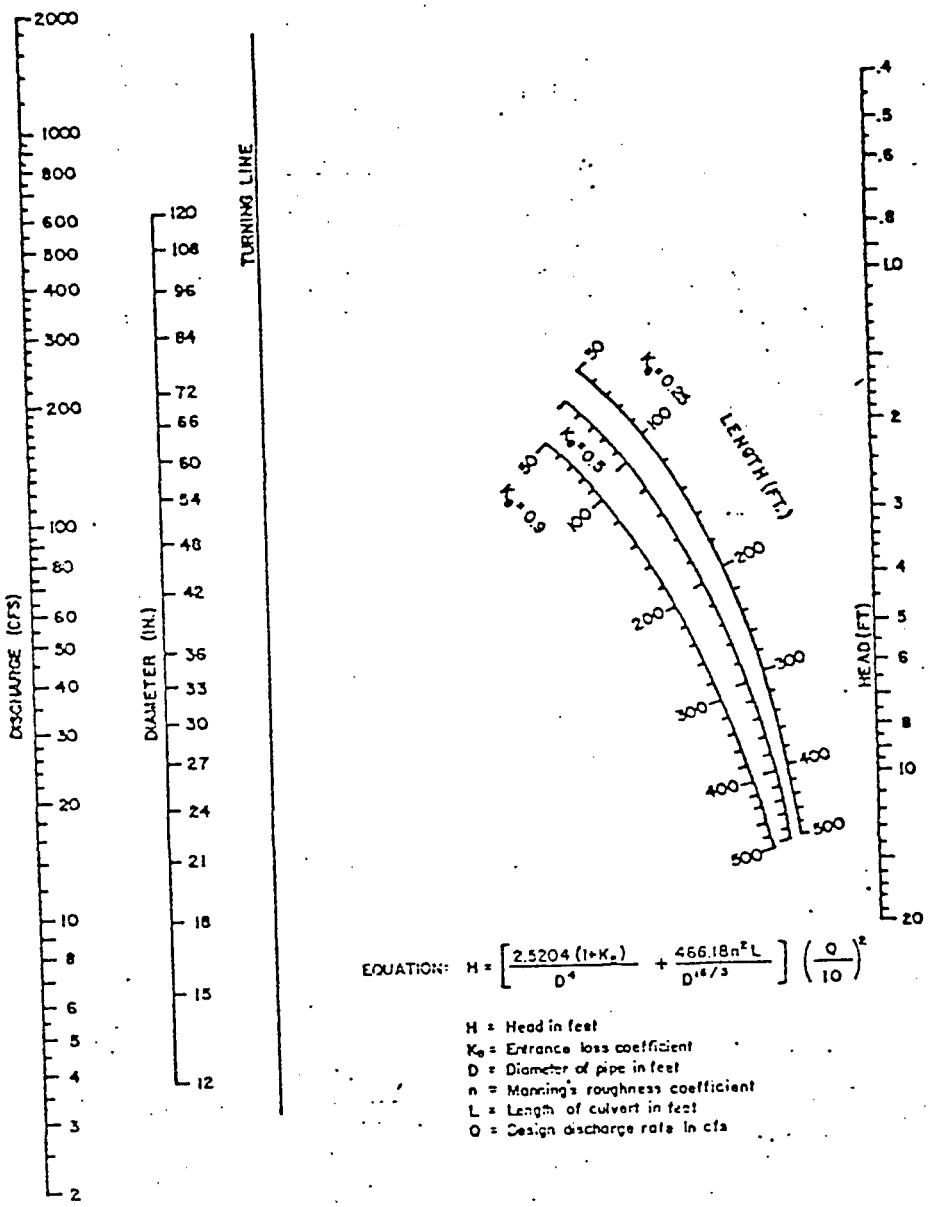


Figure 7A.2f. Culvert capacity chart - circular corrugated metal pipe, projecting entrance, 84-180 in diameter. (adapted from Portland Cement Association, 1962)



EQUATION: $H = \left[\frac{2.5204\,(1+K_e)}{D^4} + \frac{466.18 n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2$

H = Head in feet
K_e = Entrance loss coefficient
D = Diameter of pipe in feet
n = Manning's roughness coefficient
L = Length of culvert in feet
Q = Design discharge rate in cfs

Figure 7A.3b. Pipe full nomograph - corrugated metal, n = 0.024. (adapted from Portland Cement Association, 1962)

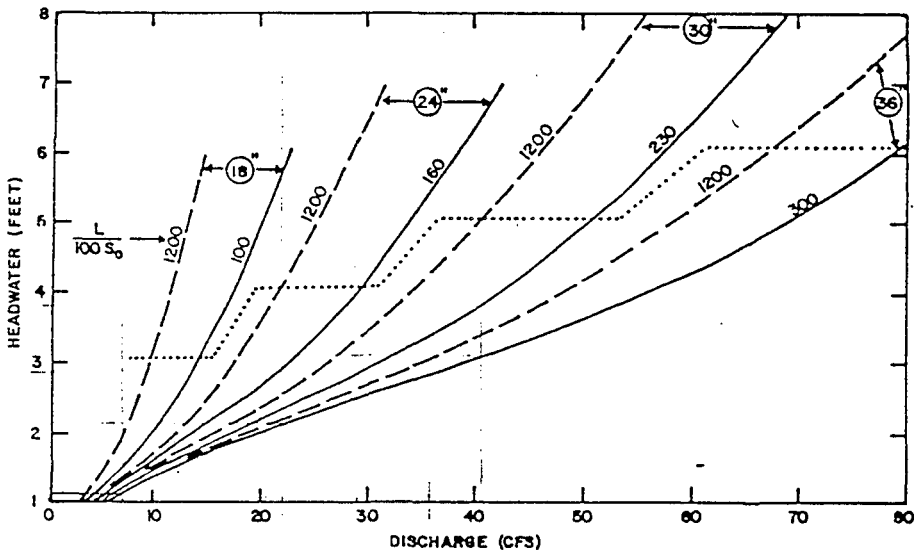


Figure 7A.1a. Culvert \capacity chart - circular concrete pipe, groove-edged entrance, 18-36 in diameter. (adapted from Portland Cement Association, 1962)

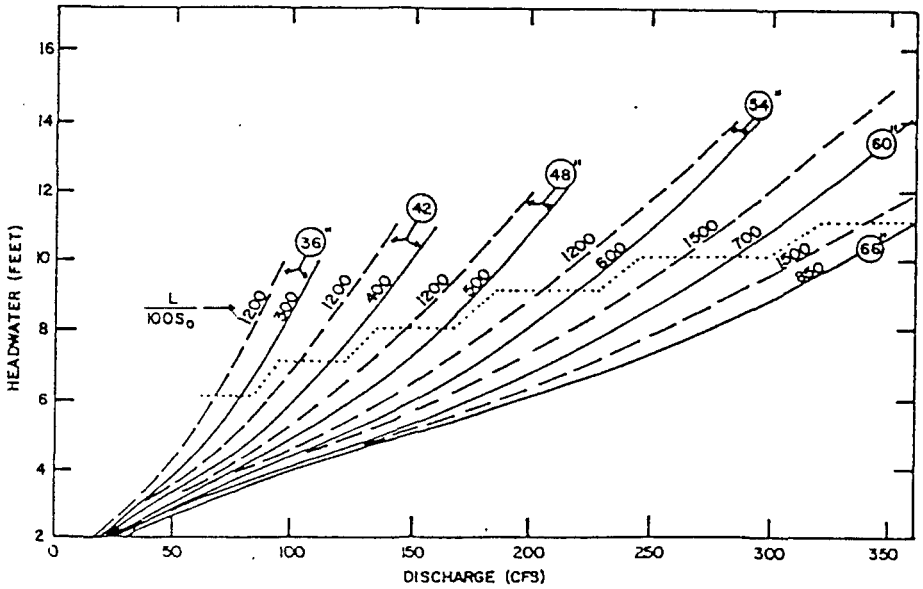


Figure 7A.1b. Culvert capacity chart - circular concrete pipe, groove-edged entrance, 36-66 in diameter. (adapted from Portland Cement Association, 1962)

Appendix 5-2

Geotechnical Investigation of Slurry Impoundments

REPORT OF MATERIAL AND STABILITY INVESTIGATION
COAL REFUSE DISPOSAL AREA
SUNNYSIDE, UTAH
FOR KAISER STEEL COMPANY

Dames & Moore Job No. 2074-010-06

REPORT OF MATERIAL AND STABILITY INVESTIGATION

COAL REFUSE DISPOSAL AREA

SUNNYSIDE, UTAH

FOR KAISER STEEL COMPANY

INTRODUCTION

This report presents the results of our slope stability studies performed on the existing coal slurry pond embankment at Kaiser Steel Company's Sunnyside Mine. The general location of the site with respect to nearby towns and roads is shown on Plate 1, Vicinity Map.

PURPOSE AND SCOPE

The purpose and scope of this study were developed through discussions between Mr. Harold Linke of Templeton-Linke & Alsup and Mr. George Toland of Dames & Moore. A detailed description of the purpose and scope of this study is outlined in our proposal dated January 30, 1973. The scope of work outlined in this proposal was later revised during subsequent discussions between the aforementioned men.

The purpose of these studies is to define the characteristics of the material in the disposal area, to evaluate the present stability of the embankment and to recommend modifications, if necessary, to the present system which would insure its continued stability. To accomplish this purpose, the following scope of work was performed:

1. Discussions with Kaiser Steel Company personnel familiar with the construction of the slurry pond embankment and the materials used for construction.

2. A field investigation program which included the drilling, logging and sampling of one boring to a depth of 121 feet and visual inspection of the slurry pond facility.
3. Laboratory testing to define the pertinent engineering characteristics of the waste material.
4. Engineering analyses to evaluate the stability of the present embankment and the necessity of remedial measures to improve the embankment stability.
5. Preparation of this written report, which includes a plot plan, description of the site conditions, summary of field explorations and laboratory test data, description of engineering analyses, and stability recommendations.

SITE CONDITIONS

SURFICIAL FEATURES:

The coal slurry pond is located at the head of a steep, narrow valley which is situated approximately one-half mile south of Sunnyside, Utah. Because of the steepness of this valley, the depth of waste material varies considerably across the pond. This depth ranges from a maximum of approximately 280 feet near the southwest portion of the pond to only a few tens of feet on the eastern and northern extremities of the pond.

In plan dimensions, the level portion of the pond contains about 25 acres. The pond is contained by 15- to 20-foot-high dikes which are constructed of broken coal. In the deepest portion the dike extends in a relatively smooth slope the entire 280 vertical feet. The inclination of the

dike at this location, which is the slope stability study area, is slightly over 37 degrees from horizontal.

In the vicinity of the high slope, Mr. John Beck of Templeton-Linke & Alsup supervised the construction of a ramp which extends approximately 200 feet into the pond. This ramp was constructed to provide access the pond for drilling since the coal slurry materials would not support d. .ling equipment. The location of the ramp, exploration boring and high slope are shown on Plate 2, Plot Plan.

We understand that present planning calls for the development of a new waste disposal area in the immediate future. Therefore, little more waste will be discharged into the subject site.

SUBSURFACE CONDITIONS:

Because of the access ramp, we encountered four feet of loose, black, fine to coarse sand and gravel-sized coal waste material at the surface. This material is underlain by very soft, black, silt-sized coal tailings with sand and gravel-sized coal fragments in lenticular layers. These silt-sized coal tailings are similar to the material which covers all of the slurry pond with the exception of the perimeter dikes which are constructed from the same material as the ramp. At our boring location the silt-sized coal tailings are approximately 7-1/2 feet thick and are underlain by very loose, black, fine to medium, sand-sized coal tailings with occasional layers of silt-sized coal tailings. With depth, the silty layers grade less frequent. At a depth of 31 feet, loose, black, fine to coarse sand and gravel-sized coal waste material was encountered. This gravel-sized material continues to at least a depth of 121 feet, which is the maximum

depth of our exploration boring. Based on discussions with Kaiser Steel Company personnel and our observations, we believe this same material extends to the canyon bottom. The characteristics of this material are very uniform except for occasional six-inch to two-foot-thick layers where sandstone gravel, cobbles and boulders were encountered. These sandstone materials probably came from borrow pits located near the site and were used to cover areas of the waste dump which began burning spontaneously. The sandstone material was encountered at depths of 38.5 to 40.5 feet, 48.0 to 49.0 feet, 68.0 to 69.0 feet, and 73.0 to 73.5 feet.

Two forms of deposition have been used in the waste disposal area. The silt and sand-sized materials encountered near the top of the boring have been placed hydraulically. In contrast, the gravel-sized material which forms the bulk of the waste dump was placed with dump trucks. Although both forms of deposition are currently being used at the site, the hydraulic transportation of silt and sand-sized materials has only been used recently, whereas the dump truck haulage has been used since the beginning of the coal waste dump. This accounts for the fact that only 30 feet, more or less, of slurry is located on the surface and the rest of the waste consists of sand and gravel-sized coal fragments.

GROUND WATER:

Except for the water which is located on the surface of the coal slurry pond and saturates the upper few feet of tailings, the rest of the coal waste dump is not saturated. The ground water level at the site probably corresponds closely to the contact between the waste coal and canyon bottom.

There is no evidence of seepage through the perimeter dikes or the high slope. The only visible seepage occurs where the toe of the high slope intersects the bottom of the canyon. At this location several gallons per minute of water was flowing during our field explorations. Most of this water undoubtedly comes from the coal slurry although some may be from natural drainage. Apparently, the slurry transport water percolates through the fine-grained tailings and runs through the sand and gravel-sized material without forming any type of water table due to the very high permeability of these latter materials.

DISCUSSIONS AND RECOMMENDATIONS

GENERAL:

The results of our stability analyses indicate that the coal slurry pond embankment is stable under the present conditions and that it should remain stable after the pond is no longer in use. These analyses were performed for both a static condition and dynamic loading condition which simulate earthquake forces. Detailed discussions regarding the seismicity of the locality, the method of slope stability analysis, the results of the slope stability analyses and recommendations based on the results of our study are discussed in detail in the following paragraphs.

SEISMICITY OF LOCALITY:

The Sunnyside area has had a history of earthquakes. Records of earthquakes go back as far as 1850 and from that date to the present, at least 12 seismic events of Richter Magnitude 4.0 to 4.9 have been recorded near Sunnyside. In addition to these moderate events, many smaller seismic events have also occurred and have been published through 1965 by the

Seismological Society of America.[1] Earthquakes which have occurred since 1965 are published annually in the May issue of the "Quarterly Review" prepared by the Utah Geological and Mineralogical Survey.

It is commonly believed that most of the earthquakes recorded in and around Sunnyside, Utah are caused by rock bursts in the underground coal mines. This explanation would at least partially explain the concentration of earthquake epicenters in the immediate vicinity of Sunnyside, Utah. Because of this concentration, we have assumed in our analyses that the coal waste embankment could be subjected to an earthquake whose epicenter is at the dam site.

Based on correlation charts prepared by the U. S. Geological Survey[2] and our past experience with similar seismic situations, we have estimated that the maximum probable ground acceleration at the embankment would be 0.05 times gravity. This factor was used in our stability analyses. However, to investigate the result of a more serious earthquake, we also evaluated the slope using an earthquake factor of 0.10 times gravity. The effects that these earthquake coefficients have on the stability calculations are discussed in a later paragraph.

---

1. "Seismicity in Utah, 1850 through June 1965," Kenneth L. Cook and Robert B. Smith, Bulletin of the Seismological Society of America, Volume 57, No. 4, pp. 689-718, August 1967.

2. "Use of Seismic Intensity Data to Predict the Effects of Earthquakes and Underground Nuclear Explosions in Various Geologic Settings," Patrick J. Barosh, United States Geological Survey Bulletin 1279, United States Government Printing Office, Washington, 1969.

METHOD OF SLOPE STABILITY ANALYSIS:

Because of the relatively homogeneous and soil-like characteristics of the gravel-sized broken coal fragments which constitute the coal slurry pond embankment, we analyzed the slope stability using the Fellenius Method of Slices. This is one of many limiting equilibrium methods of calculating the stability of a soil slope in which the failure surface is assumed to occur along a circular arc. The degree of stability is calculated by dividing the summation of resisting forces (cohesion and friction developed along the failure arc) by the summation of driving forces (total tangential components along the failure arc).

To aid in performing the stability calculations which are tedious and time-consuming, a Dames & Moore computer program and computer facilities were used. The computer program provides the flexibility of investigating the entire slope to determine the location of the most critical failure surface in the slope, that is, the failure surface with the lowest factor of safety. In addition, it provides the factor of safety calculation with a much higher degree of accuracy than would be feasible by hand calculation.

RESULTS OF STABILITY ANALYSES:

A graphical representation of the slope geometry and soil parameters used in our stability analyses is presented on Plate 3, Stability Analyses. This plate also shows the failure surface which was determined by the computer to have the lowest factor of safety of any in the slope. As shown on the right side of this plate, three minimum factor of safeties were determined. These factor of safeties each represent the same slope geometry and soil conditions; however, each one is for a different earthquake coefficient.

The data clearly shows, as would be expected, that the most stable slope condition is the static condition and the least stable slope condition is the situation which would occur with an earthquake induced acceleration equal to 10 percent of gravity. The stability data are summarized in the following table:

Analysis No.	Earthquake Coefficient (In Percent Of Gravity)	Factor of Safety
1	0	1.622
2	5	1.479
3	10	1.353

For structures such as the coal slurry pond embankment which we are analyzing, a factor of safety of 1.25 for static conditions and of 1.0 for the worst probable earthquake condition is generally considered satisfactory. Therefore, the results of our stability analyses indicate that even with an earthquake greater than has ever been recorded in the vicinity of the site, the embankment is stable.

RECOMMENDATIONS:

Because of the apparent stability of the subject embankment as evidenced by both our stability calculations and the past performance of the embankment through several earthquakes, it is our opinion that no remedial measures are required to either insure or improve the stability of the embankment. Although present planning calls for discontinued use of this pond as a disposal area for the near future, we believe, based on our stability analyses, that it is not necessary to curtail further use of this area for stability reasons at this time.

oOo

The following plates and appendix are attached and complete this report:

Plate 1 - Vicinity Map

Plate 2 - Plot Plan

Plate 3 - Stability Analyses

Appendix - Field Explorations and Laboratory Tests.

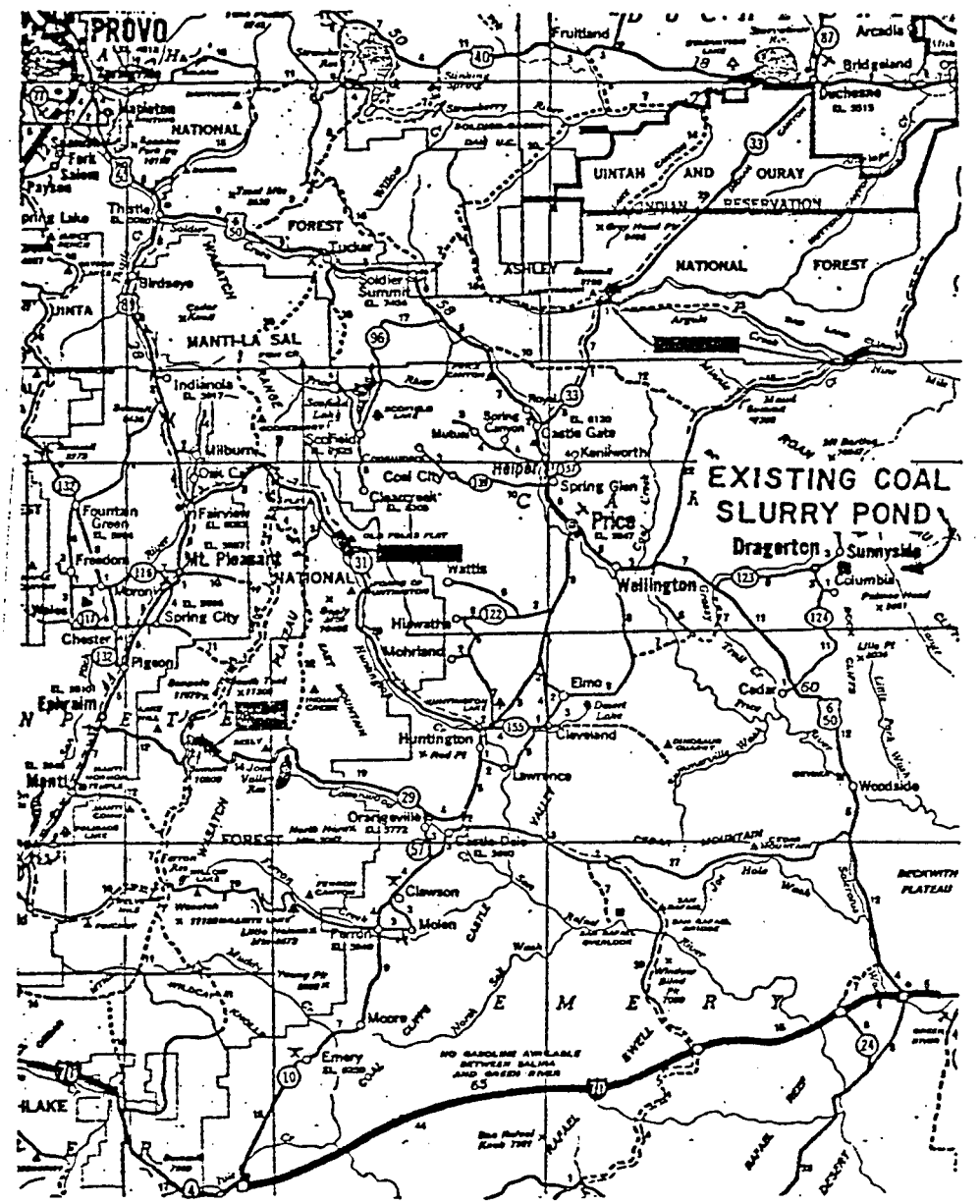
Respectfully submitted,

DAMES & MOORE

George C. Toland
Consulting Partner
Professional Engineer No. 2311
State of Utah

GCT/REV:ab

Attachments



VICINITY MAP

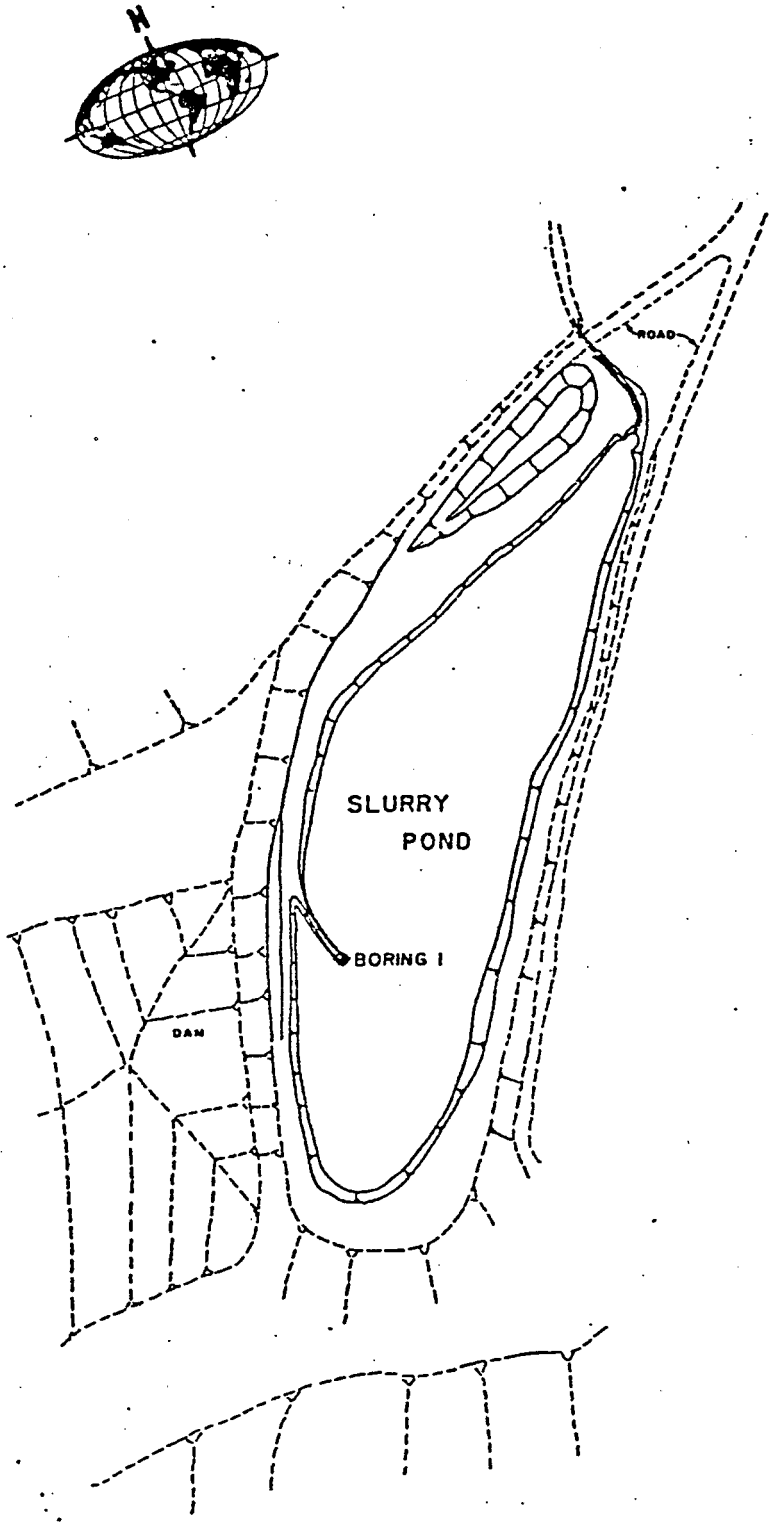
REFERENCE:
ROAD MAP OF THE STATE OF UTAH.

SCALE: 1" EQUALS APPROX. 17.6 MILES

DAMES & MOORE

PLATE

CKED BY KEV FILE ER SUNNYSIDE BY DATE

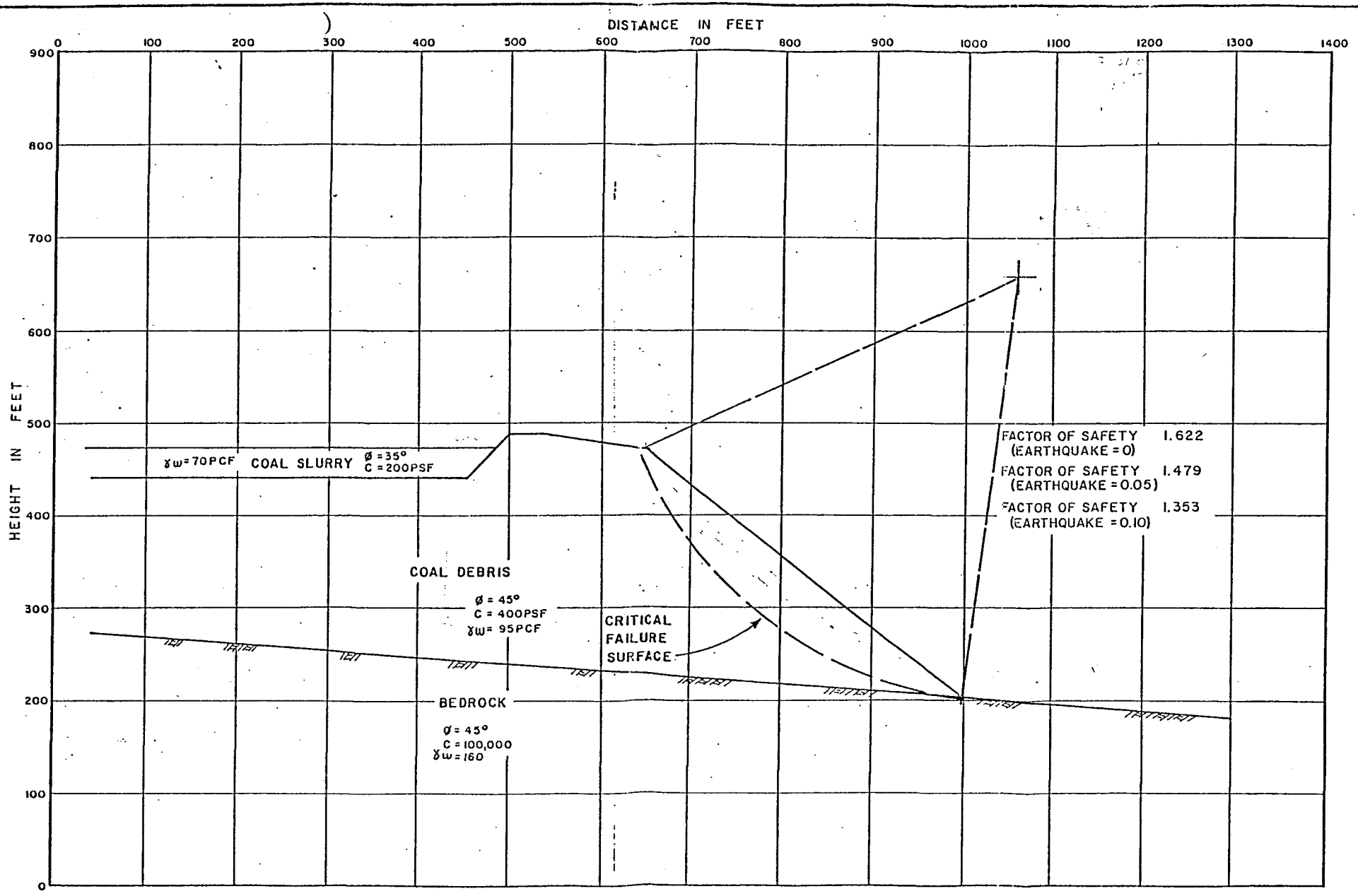


REFERENCE
PRINT TITLED, "KAISER STEEL CORP. – COAL SLURRY POND – SUNNYSIDE, UTAH". BY TEMPLETON, LINKE & ALSUP, CONSULTING ENGINEERS, SALT LAKE CITY, UTAH.

PLOT PLAN

FEET
500 0 500 1000

DAMES & MOORE



STABILITY ANALYSES

APPENDIX

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS:

The subsurface soil and ground water conditions at the site were explored by drilling an exploration boring in the deeper portion of the waste dump. The boring was 121 feet in depth and was drilled with a truck-mounted rotary wash drilling rig. Relatively undisturbed samples of the soils encountered were obtained with a Dames & Moore soil sampler as shown on Plate A-3, Soil Sampler Type U.

The field exploration program was conducted and supervised by an experienced soils engineer from our staff. The materials encountered were classified by visual and textural examination in the field. These classifications were later supplemented by inspection and testing in our laboratory. A complete log was maintained in the field of the test boring. Graphical representation of the soils encountered in the test boring is shown on Plate A-1, Log of Boring. The nomenclature used to describe the soil types appears on Plate A-2, Unified Soil Classification System.

LABORATORY TESTING:

Two types of laboratory tests, moisture and density determinations and direct shear tests, were performed to determine the engineering parameters necessary to calculate the stability of the existing coal slurry pond embankment.

The moisture and density determinations were performed to aid in classifying the soils and to help correlate the direct shear test data. The moisture and density test data are presented on the left side of the boring log on Plate A-1.

The shear strength parameters of the waste materials were determined by performing direct shear tests on representative, relatively undisturbed samples. The tests were performed at in-situ moisture content and confining pressures which simulate the existing conditions in the embankment. The procedure used for testing is described on Plate A-4, Method of Performing Direct Shear and Friction Tests.

The results of the direct shear tests are shown in tabular form below:

Boring No.	Depth In Feet	Soil Type	Confining Pressure In PSF	Peak Shearing Strength in PSF
1	16.5	SP	500	1,200
1	16.5	SP	3,000	2,975
1	20.0	SP	1,000	1,450
1	20.0	SP	4,000	2,800
1	25.5	SP	2,000	2,475
1	25.5	SP	5,000	4,400
1	45.5	GP	500	2,500
1	60.5	GP	1,000	4,575
1	70.5	GP	1,500	3,700
1	80.0	GP	2,000	6,000+
1	90.0	GP	2,500	4,500
1	100.0	GP	3,000	4,875
1	110.0	GP	4,000	6,000+
1	120.0	GP	5,000	6,000+

The following plates are attached and complete this appendix:

Plate A-1 - Log of Boring

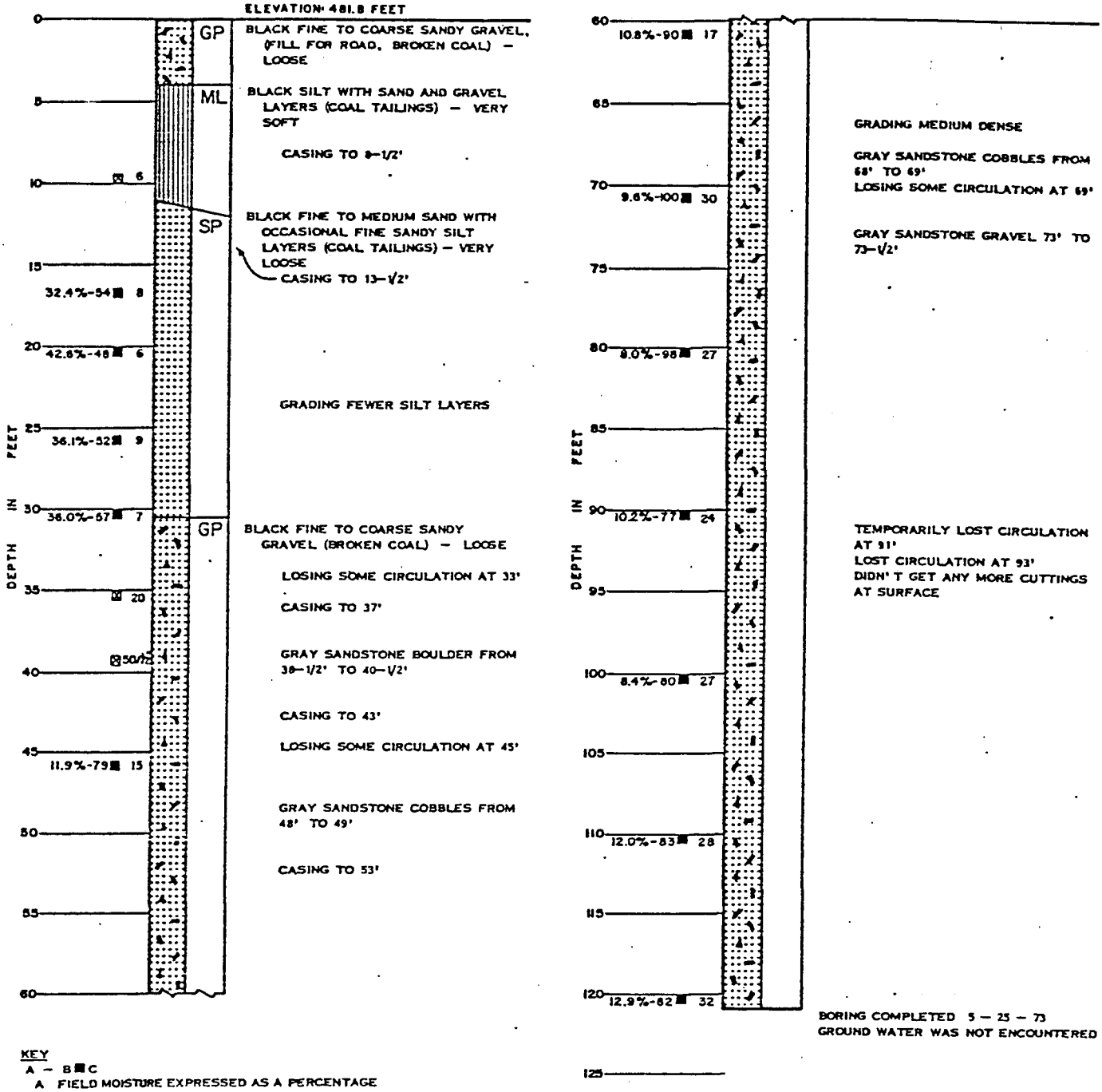
Plate A-2 - Unified Soil Classification System

Plate A-3 - Soil Sampler Type U

Plate A-4 - Method of Performing Direct Shear and Friction Tests.

BORING I

ELEVATION: 481.8 FEET



KEY

A — B ■ C

A FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL

B DRY DENSITY EXPRESSED IN LBS. PER CUBIC FOOT

C BLOWS PER FOOT OF PENETRATION USING A 140 LB. HAMMER DROPPING 30 INCHES

■ DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED

⊠ DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED

NOTES

THE DISCUSSION IN THE TEXT UNDER THE SECTION TITLED, "SITE CONDITIONS, SUBSURFACE", IS NECESSARY TO A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS

ELEVATION DATA TAKEN FROM PRINT TITLED, "KAISER STEEL CORP. — COAL SLURRY POND — SUNNYSIDE, UTAH", BY TEMPLETON, LINKE & ALSUP, CONSULTING ENGINEERS, SALT LAKE CITY, UTAH.

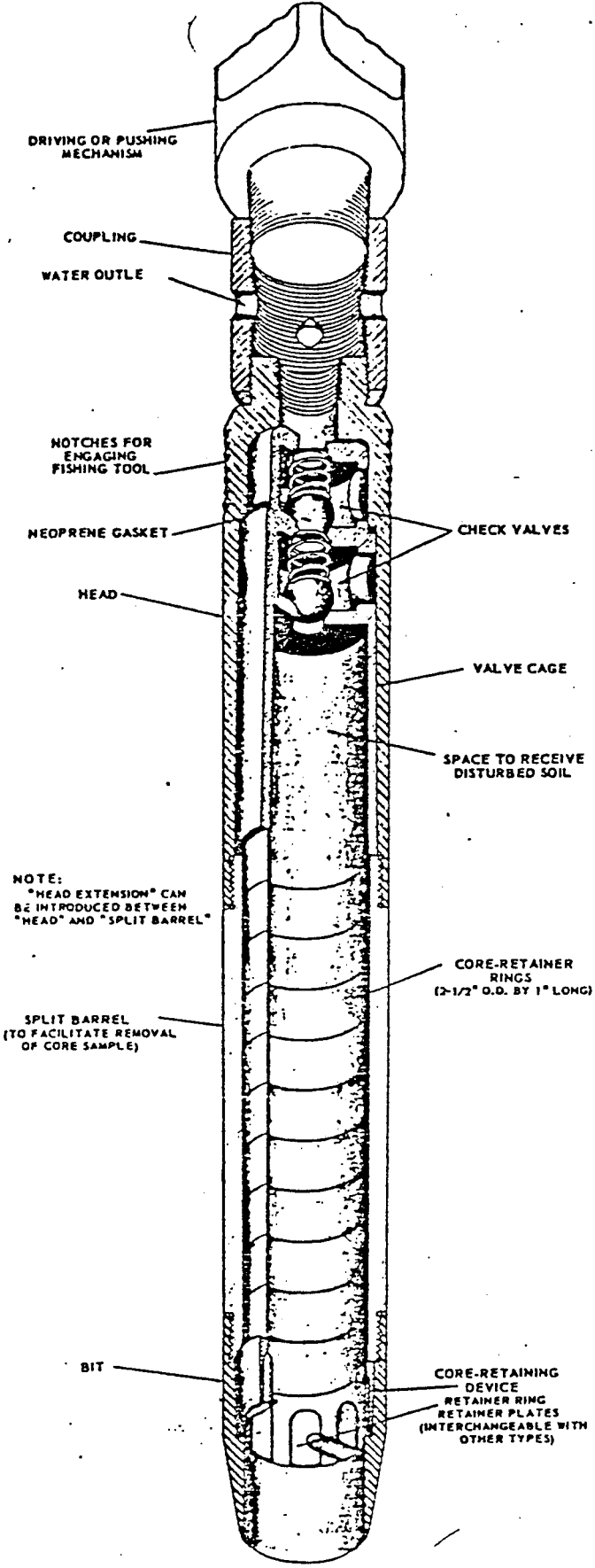
LOG OF BORING

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

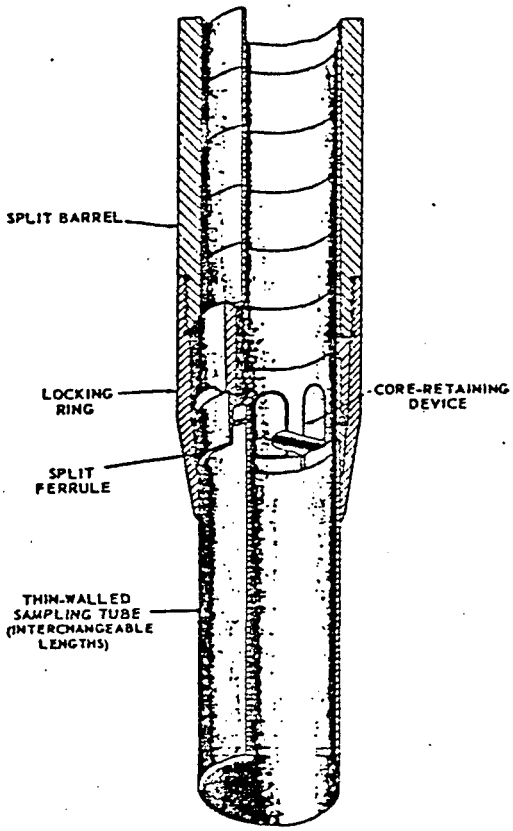
NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.

SOIL CLASSIFICATION CHART

UNIFIED SOIL CLASSIFICATION SYSTEM



ALTERNATE ATTACHMENTS



SOIL SAMPLER TYPE U

U. S. PATENT NO. 2,318,062

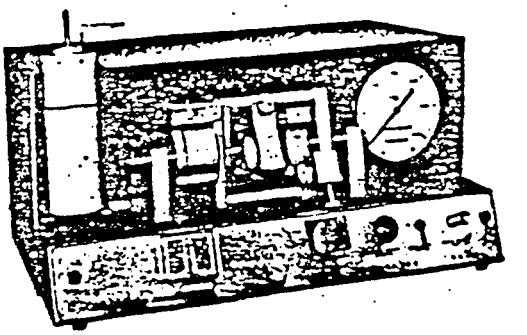
DAMES & MOORE

REVISIONS BY ____ DATE ____

FILE ____

ED BY ____

DIRECT SHEAR TESTS ARE PERFORMED TO DETERMINE THE SHEARING STRENGTHS OF SOILS. FRICTION TESTS ARE PERFORMED TO DETERMINE THE FRICTIONAL RESISTANCES BETWEEN SOILS AND VARIOUS OTHER MATERIALS SUCH AS WOOD, STEEL, OR CONCRETE. THE TESTS ARE PERFORMED IN THE LABORATORY TO SIMULATE ANTICIPATED FIELD CONDITIONS.



DIRECT SHEAR TESTING & RECORDING APPARATUS

EACH SAMPLE IS TESTED WITHIN THREE BRASS RINGS, TWO AND ONE-HALF INCHES IN DIAMETER AND ONE INCH IN LENGTH. UNDISTURBED SAMPLES OF IN-PLACE SOILS ARE TESTED IN RINGS TAKEN FROM THE SAMPLING DEVICE IN WHICH THE SAMPLES WERE OBTAINED. LOOSE SAMPLES OF SOILS TO BE USED IN CONSTRUCTING EARTH FILLS ARE COMPACTED IN RINGS TO PREDETERMINED CONDITIONS AND TESTED.

DIRECT SHEAR TESTS

A THREE-INCH LENGTH OF THE SAMPLE IS TESTED IN DIRECT DOUBLE SHEAR. A CONSTANT PRESSURE, APPROPRIATE TO THE CONDITIONS OF THE PROBLEM FOR WHICH THE TEST IS BEING PERFORMED, IS APPLIED NORMAL TO THE ENDS OF THE SAMPLE THROUGH POROUS STONES. A SHEARING FAILURE OF THE SAMPLE IS CAUSED BY MOVING THE CENTER RING IN A DIRECTION PERPENDICULAR TO THE AXIS OF THE SAMPLE. TRANSVERSE MOVEMENT OF THE OUTER RINGS IS PREVENTED.

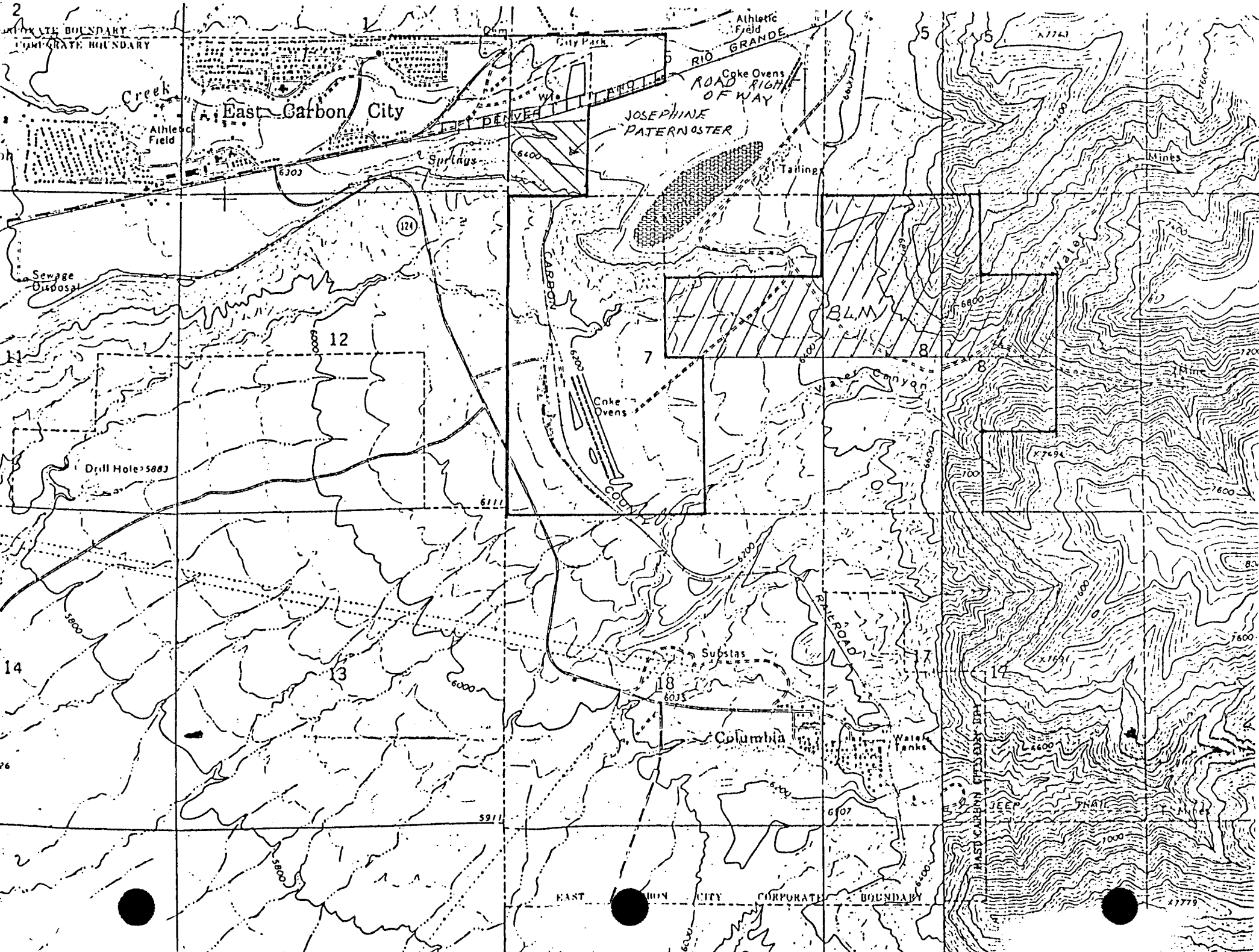
THE SHEARING FAILURE MAY BE ACCOMPLISHED BY APPLYING TO THE CENTER RING EITHER A CONSTANT RATE OF LOAD, A CONSTANT RATE OF DEFLECTION, OR INCREMENTS OF LOAD OR DEFLECTION. IN EACH CASE, THE SHEARING LOAD AND THE DEFLECTIONS IN BOTH THE AXIAL AND TRANSVERSE DIRECTIONS ARE RECORDED AND PLOTTED. THE SHEARING STRENGTH OF THE SOIL IS DETERMINED FROM THE RESULTING LOAD-DEFLECTION CURVES.

FRICTION TESTS

IN ORDER TO DETERMINE THE FRICTIONAL RESISTANCE BETWEEN SOIL AND THE SURFACES OF VARIOUS MATERIALS, THE CENTER RING OF SOIL IN THE DIRECT SHEAR TEST IS REPLACED BY A DISK OF THE MATERIAL TO BE TESTED. THE TEST IS THEN PERFORMED IN THE SAME MANNER AS THE DIRECT SHEAR TEST BY FORCING THE DISK OF MATERIAL FROM THE SOIL SURFACES.

METHOD OF PERFORMING DIRECT SHEAR AND FRICTION TESTS

REVISIONS BY DATE
FILE
DATE BY



CORPORATE BOUNDARY
Creek
East Carbon City
Athletic Field
City Park
Athletic Field
RIO GRANDE
Coke Ovens
ROAD RIGHT OF WAY
DENVER
JOSEPHINE PATERNOSTER
Springs
Tailings
Mines
Sewage Disposal
CARBON
BLM
Water Canyon
Coke Ovens
Drill Hole 5883
RAILROAD
Substas
Columbia
Water Tanks
JEEP TRAIL
EAST CARBON CITY CORPORATE BOUNDARY

Direct Shear Tests

ATLANTA NEW ORLEANS
BILLINGS NEWPORT BEACH
BOCA RATON NEW YORK
BOSTON PHOENIX
CHICAGO PORTLAND
CINCINNATI SALT LAKE CITY
DENVER SAN FRANCISCO
DENVER SANTA BARBARA
FAIRBANKS SEATTLE
HONOLULU SYRACUSE
HOUSTON WASHINGTON, D.C.
LEXINGTON, KY WHITE PLAINS

DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

ATHENS PERTH
CALGARY RIYADH
JAKARTA SINGAPORE
KUWAIT SYDNEY
LONDON TEHRAN
MADRID TOKYO
MELBOURNE TORONTO
VANCOUVER, B.C.

SUITE 200, 250 EAST BROADWAY · SALT LAKE CITY, UTAH 84111 · (801) 359-8764
CABLE: DAMEMORE TWX: 910-925-5692

June 3, 1977

Kaiser Steel Corporation
Box D
Sunnyside, Utah 84539

Attention: Mr. J. T. Paluso,
Assistant Chief Mining
Engineer

Gentlemen:

Refuse Pile & Slurry Pond
Report
I. D. No. 1211-UT-9-0017
Sunnyside Mines Nos. 1, 2 & 3
I. D. Nos. 42-00093, 42-00094
& 42-00092

Gentlemen:

In compliance with your letter of May 24, 1977, our response to the technical review questions of the subject Refuse Pile and Slurry Pond is provided herewith. Our responses are directed to the stability analyses portion of the MESA letter and are as follows:

QUESTION 1 - At the time of our stability analyses, the present MESA regulations had not been developed. The test boring was selected at a location 200 feet in from the crest of the embankment in order to evaluate the most critical conditions anticipated in the pond for both the phreatic water surface condition and material strength condition.

QUESTION 2 - Copies of the direct shear tests performed on samples of the materials encountered in the exploration boring are attached to this letter. As noted in the report, all samples were two and one-half inch in diameter and were tested as described in the report. The attached shear test summary shows

the values selected for analyses. It is our opinion that the shear strength data presented are appropriate for shearing strength within the normal pressure range that would exist along the failure circle shown in the report.

QUESTION 3 - The statement on the phreatic surface was based on the results of the test boring which was drilled out in the pond area to reflect the phreatic surface in a critical location. Observations of the embankments indicated that water was flowing essentially vertical from the pond area and was not present at any location except at the bottom of the embankment.

QUESTION 4 - We would welcome a meeting at the site to discuss the 1973 investigation and to investigate current programs that might be undertaken.

oOo

We appreciate being asked to respond to these questions. Please contact us if you require additional information.

Yours very truly,

DAMES & MOORE

George C. Toland (gw)

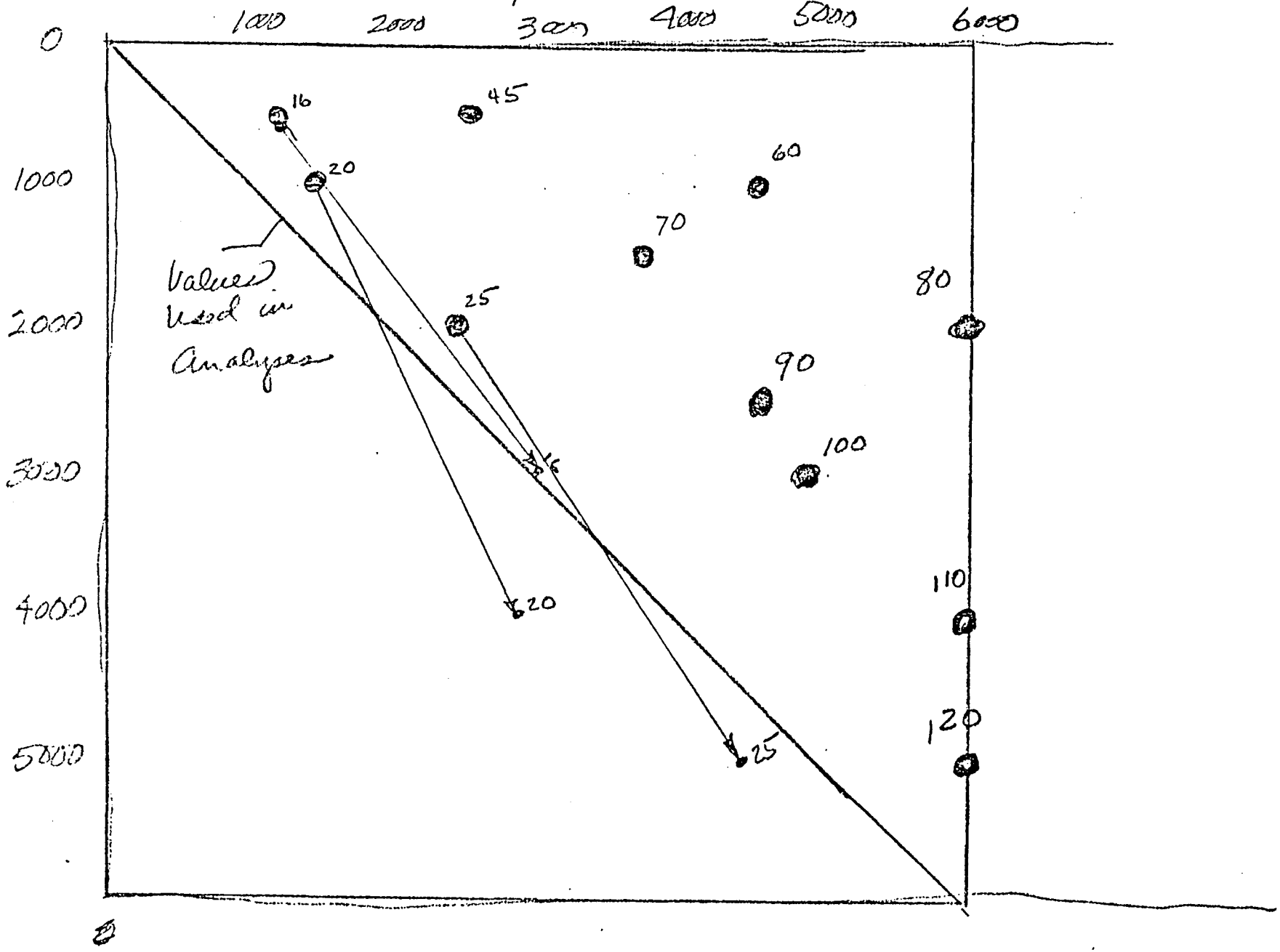
George C. Toland
Partner
Professional Engineer No. 2311
State of Utah

GCT/jw

Attachments

DATE
CHECKED BY
COPY TO EO

REVISIONS
BY GCT DATE 6/20/73 TO EO
BY [illegible] DATE TO EO



FILE 2074-710 Kaiser Sunny
SUBJECT Strength
SHEET ___ OF ___

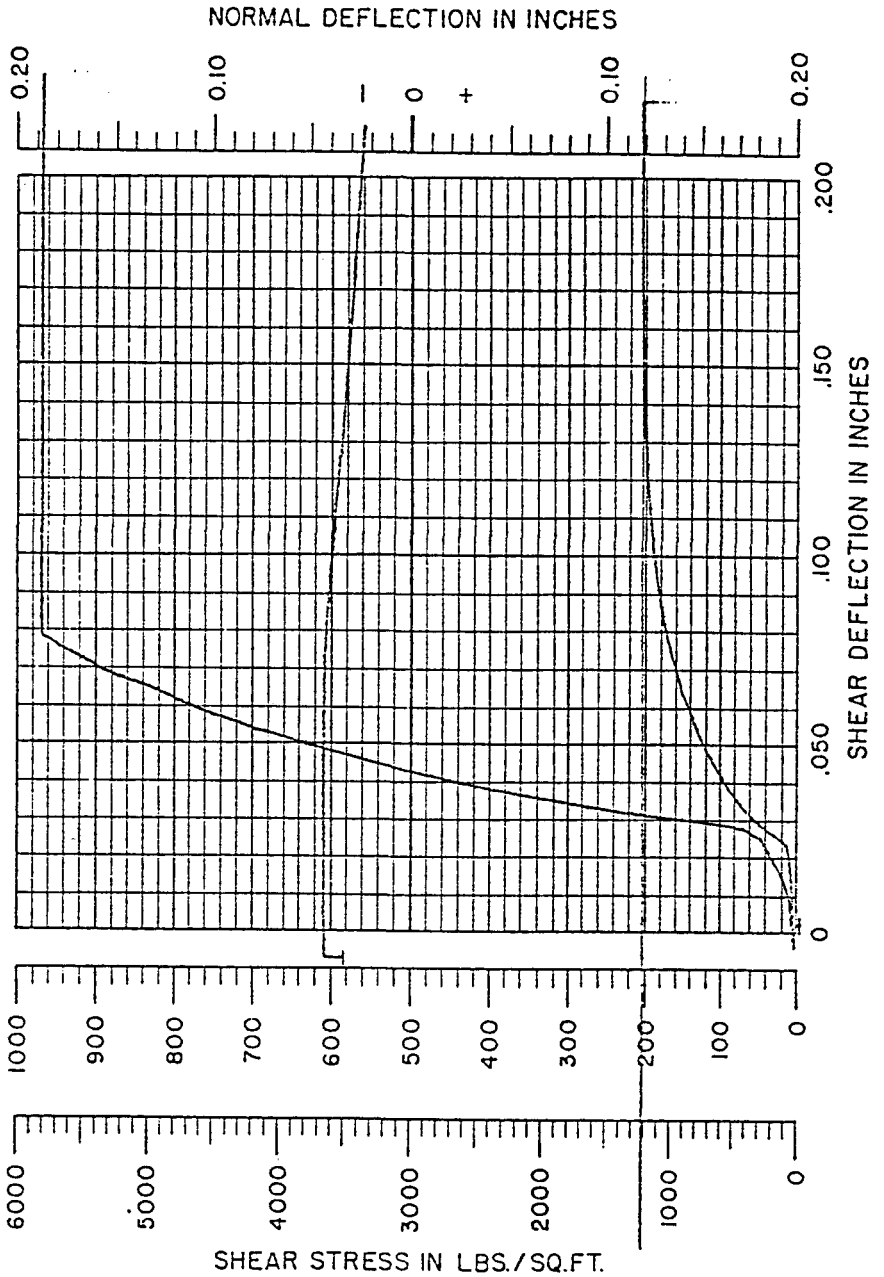
DAMES & MOORE

FRICTION TEST SOIL TYPE SP ( ) BORING 12

DATA SHEET LAB IDENT. DEPTH 16.5

SAMPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 2 RINGS	257.5	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	69.7	
WT. DISH # 57 & SOIL	168.4	
DRY WT. SOIL & DISH	127.1	
NET LOSS OF MOISTURE	41.3	
WT. DISH	15.5	
NET WT. OF DRY SOIL	111.6	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED	0.02		INCHES/MIN.

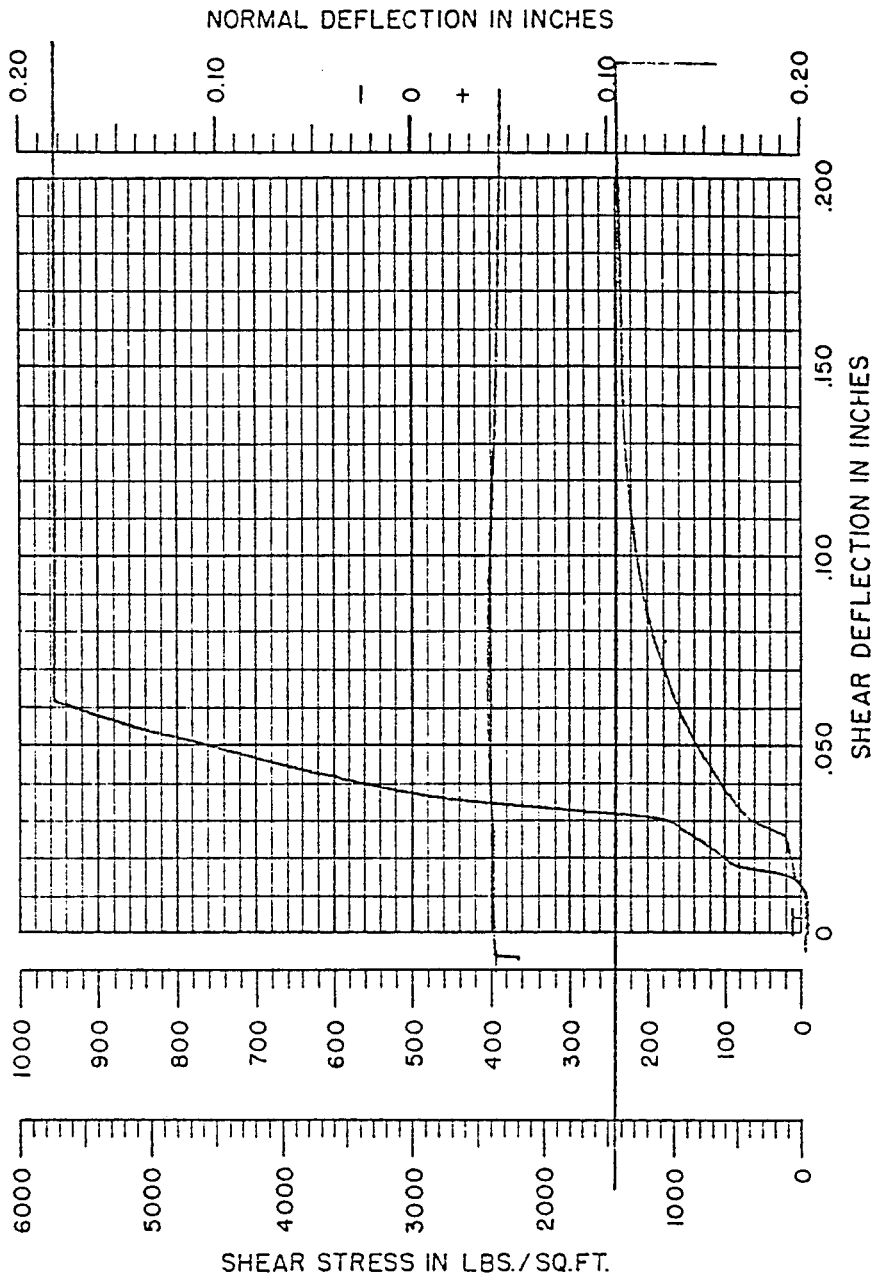
TEST SUMMARY	
NORMAL PRESS. 500 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 50.9 LBS./CU. FT.	PEAK STRENGTH 1200 LBS./SQ. FT.
FIELD MOISTURE 37.0 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

FRICTION TEST SOIL TYPE SP BORING B3

DATA SHEET LAB IDENT. DEPTH 20

MPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	389.7	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	70.3	
WT. DISH # 9 & SOIL	157.4	
DRY WT. SOIL & DISH	133.9	
NET LOSS OF MOISTURE	23.5	
WT. DISH	15.0	
NET WT. OF DRY SOIL	118.9	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 1000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 58.7 LBS./CU. FT.	PEAK STRENGTH 1450 LBS./SQ. FT.
FIELD MOISTURE 19.8 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ~~19.8~~ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

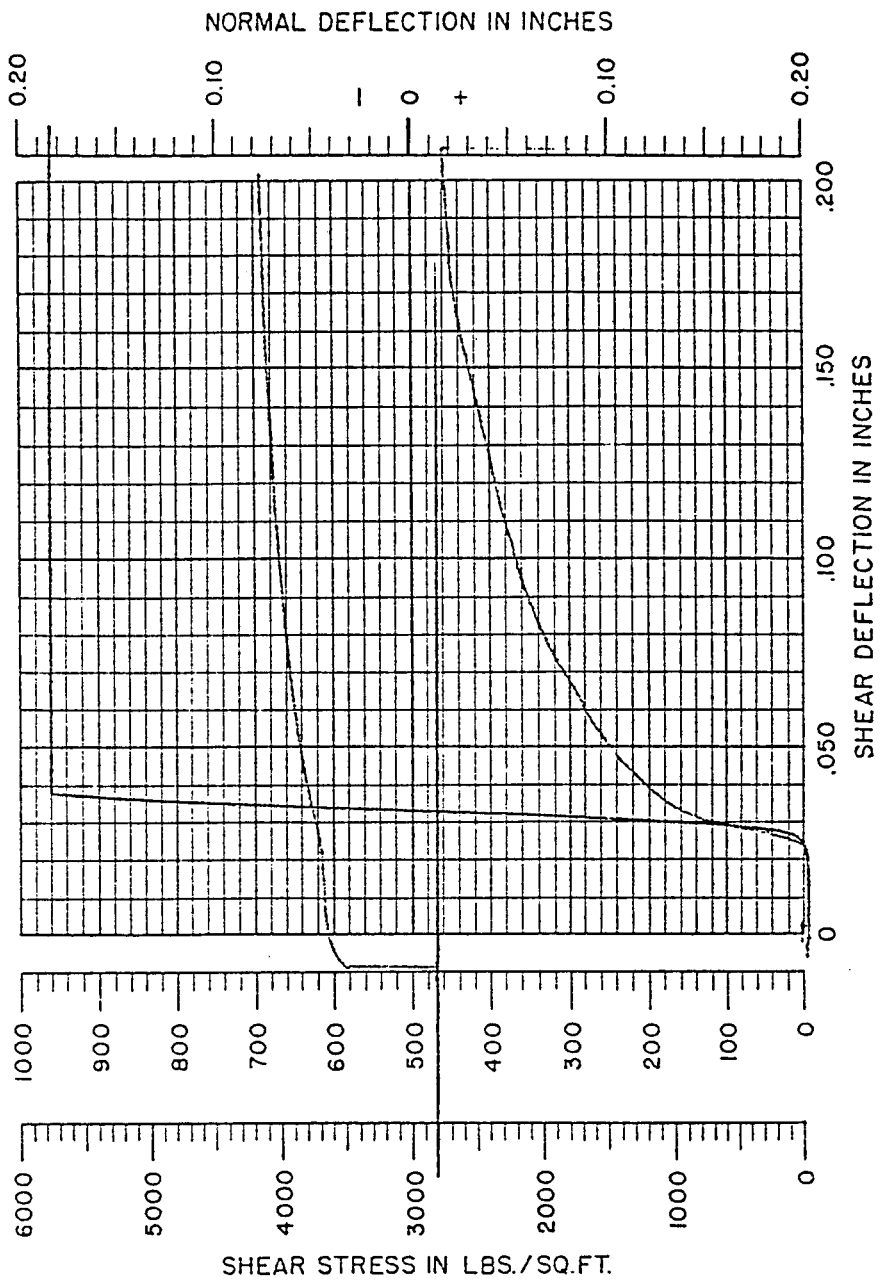
DIRECT SHEAR TEST

_____ FRICTION TEST SOIL TYPE SP BORING 3

DATA SHEET LAB IDENT. _____ DEPTH 20

SAMPLED ✓ / / SET-UP _____ / / TESTED _____ / / (____ OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	379.8	
WT. ____ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	67.9	
WT. DISH & SOIL 15	140.2	
DRY WT. SOIL & DISH	102.9	
NET LOSS OF MOISTURE	37.3	
WT. DISH	15.3	
NET WT. OF DRY SOIL	87.6	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 4000 LBS./SQ. FT.	YIELD STRENGTH ____ LBS./SQ. FT.
DRY DENSITY 47.6 LBS./CU. FT.	PEAK STRENGTH 3800 LBS./SQ. FT.
FIELD MOISTURE 42.6 % OF DRY WT.	ULTIMATE STR. ____ LBS./SQ. FT.
TEST MOISTURE ____ % OF DRY WT.	FRICTION STR. ____ LBS./SQ. FT.

DAMES & MOORE

DIRECT SHEAR TEST — OWNER _____ LOCATION _____ JOB _____

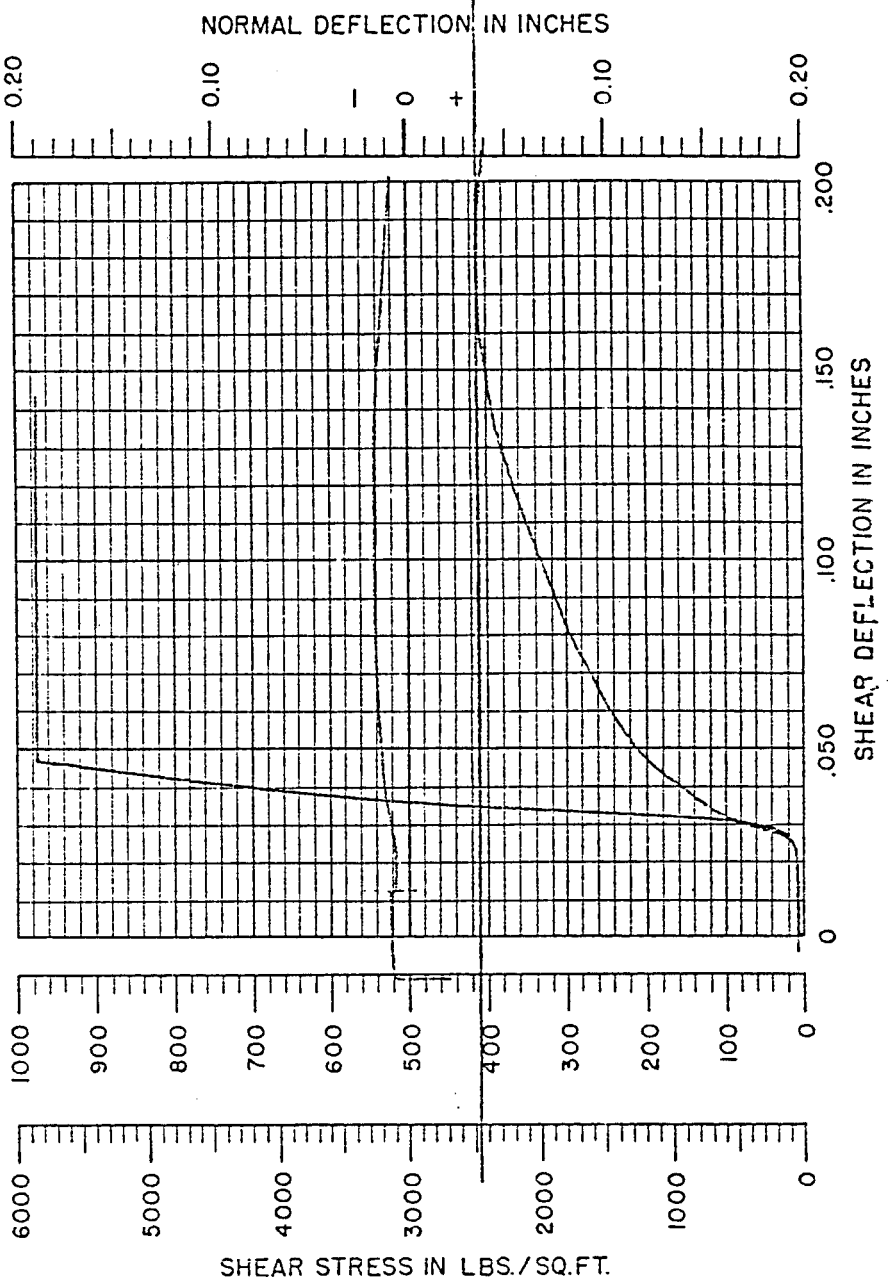
_____ FRICTION TEST — SL. TYPE sp — BORING 1#

DATA SHEET — LAB IDENT. _____ DEPTH 25.5

SAMPLED _____ / / SET-UP _____ / / TESTED _____ / / (____ OFFICE)

6

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 2 RINGS	391.9	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	71.2	
WT. DISH # 61 & SOIL	105.2	
DRY WT. SOIL & DISH	81.4	
NET LOSS OF MOISTURE	23.8	
WT. DISH	15.5	
NET WT. OF DRY SOIL	65.9	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED	0.07		INCHES/MIN.

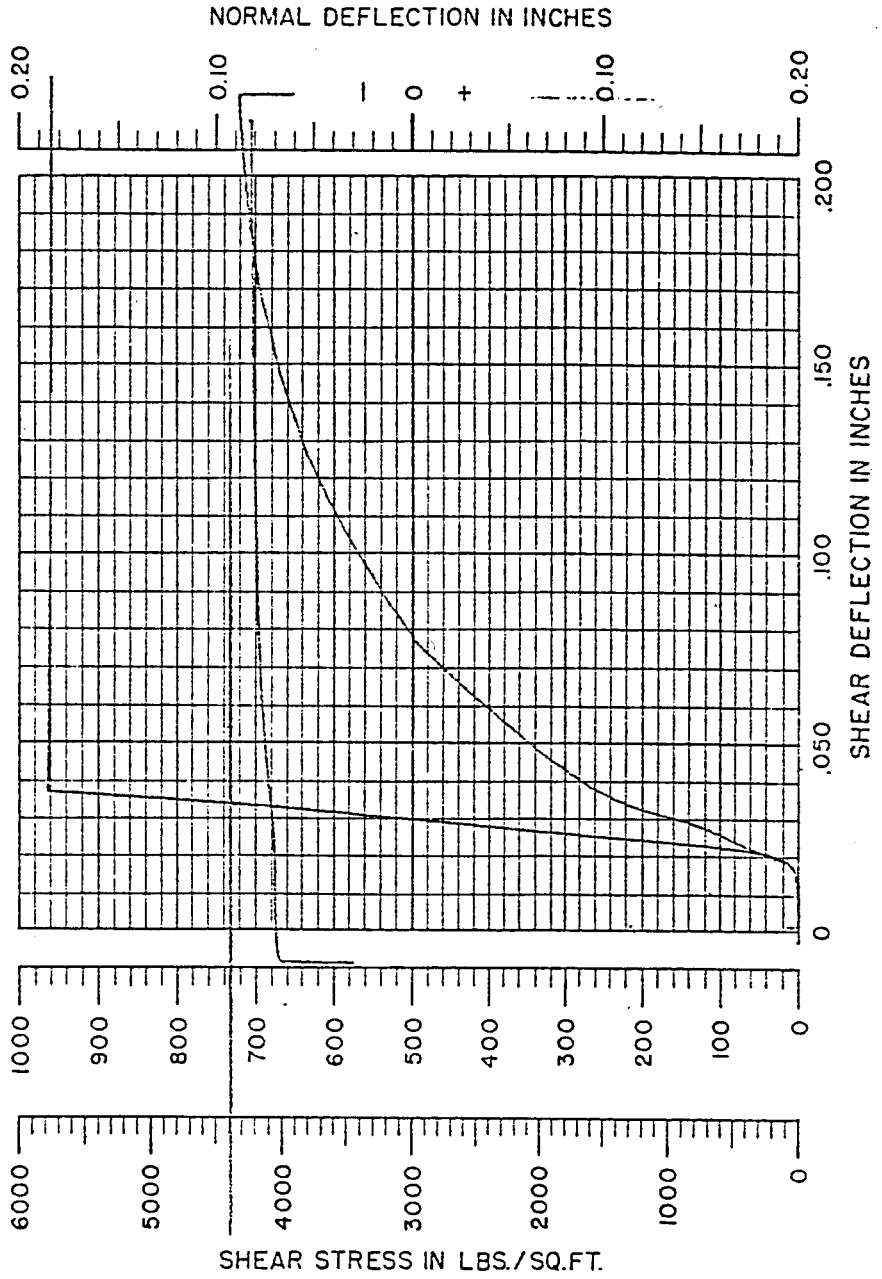
TEST SUMMARY	
NORMAL PRESS. 2000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 52.3 LBS./CU. FT.	PEAK STRENGTH 2475 LBS./SQ. FT.
FIELD MOISTURE 36.1 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

FRICTION TEST SC.. .YPE Sp BORING 14

DATA SHEET LAB IDENT. DEPTH 25.5

.PLED / / SET-UP / / TESTED / / (OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	371.0	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	165.3	
WT. DISH # ___ & SOIL	176.3	
DRY WT. SOIL & DISH	139.2	
WET LOSS OF MOISTURE	37.1	
WT. DISH	15.9	
NET WT. OF DRY SOIL	123.3	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED	0.02		INCHES/MIN.

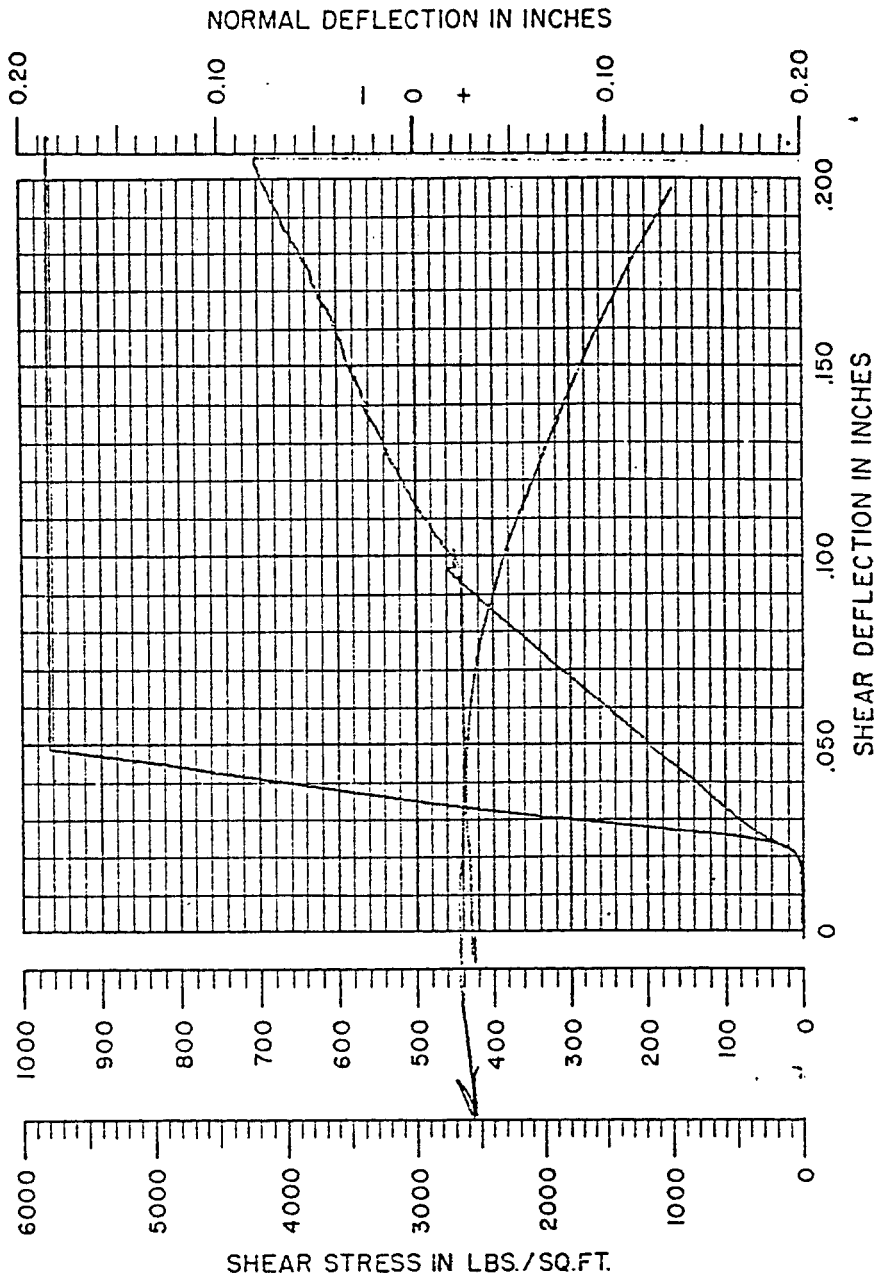
TEST SUMMARY	
NORMAL PRESS. 5000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 102 LBS./CU. FT.	PEAK STRENGTH 4400 LBS./SQ. FT.
FIELD MOISTURE 30.1 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

FRICTION TEST SC. TYPE 6P ( ) BORING 18

DATA SHEET LAB IDENT. 6M/5M DEPTH 45.5

SAMPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	452.8	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	87.9	
WT. DISH # 25 & SOIL	215.3	
DRY WT. SOIL & DISH	194.0	
NET LOSS OF MOISTURE	21.3	
WT. DISH	15.3	
NET WT. OF DRY SOIL	178.7	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 500 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 78.6 LBS./CU. FT.	PEAK STRENGTH 2500 LBS./SQ. FT.
FIELD MOISTURE 11.9 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

657.345

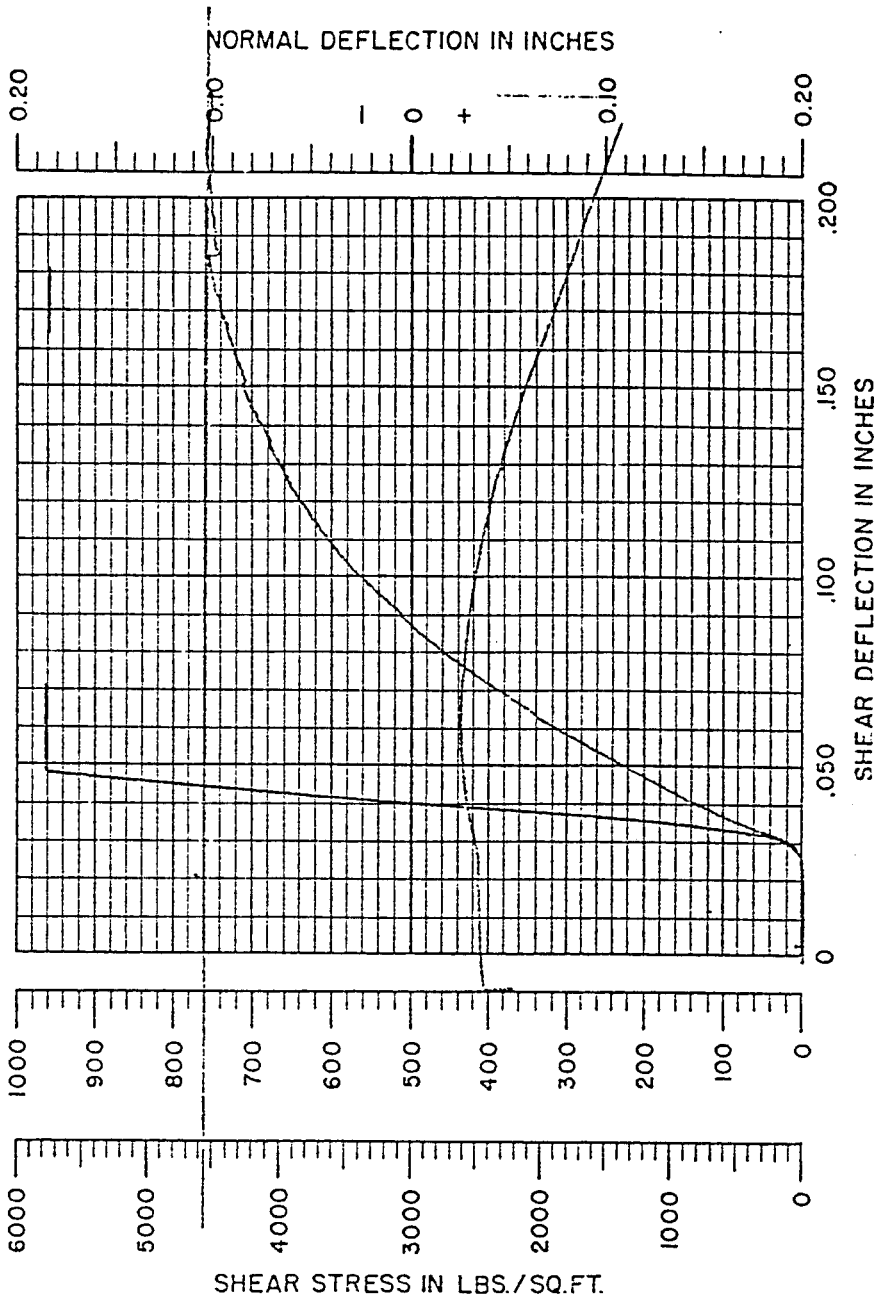
DAMES & MOORE

FRICTION TEST SO. .YPE 6P ( ) BORING 19

DATA SHEET LAB IDENT. 5m/6m DEPTH 60.5

MPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES 8



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	497.7	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	99.3	
WT. DISH & SOIL	185.5	
DRY WT. SOIL & DISH	167.1	
NET LOSS OF MOISTURE	16.4	
WT. DISH	15.3	
NET WT. OF DRY SOIL	151.8	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 1000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 89.6 LBS./CU. FT.	PEAK STRENGTH 4575 LBS./SQ. FT.
FIELD MOISTURE 10.8 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

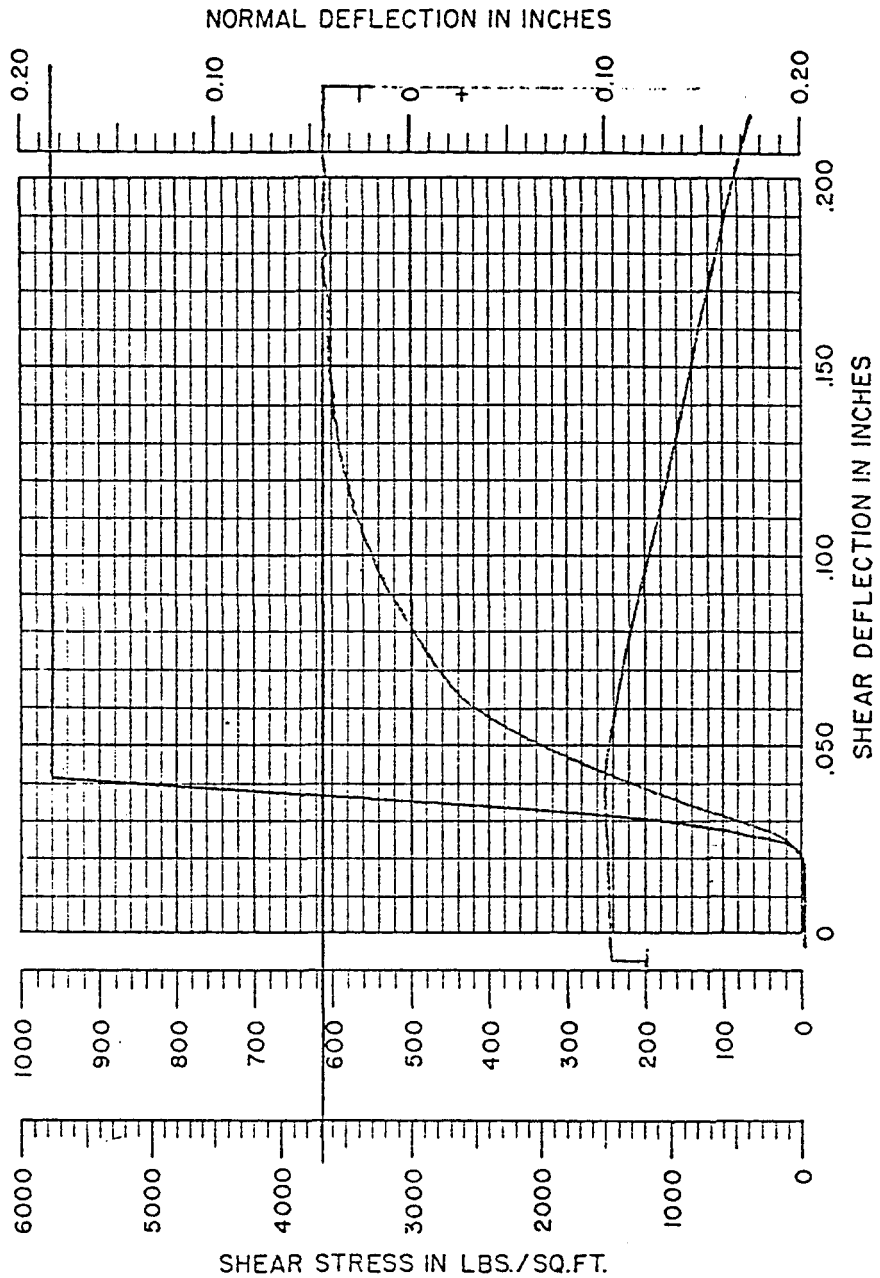
DIRECT SHEAR TEST — OWNER _____ LOCATION _____ JOB _____

_____ FRICTION TEST — SOIL TYPE GP — BORING 1'10

DATA SHEET — LAB IDENT. SM — DEPTH 70.5

SAMPLED _____ / / SET-UP _____ / / TESTED _____ / / (____ OFFICE)

NOTES 9



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 2 RINGS	577.1	
WT. ____ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	109.3	
WT. DISH & SOIL 26	146.9	
DRY WT. SOIL & DISH	135.4	
NET LOSS OF MOISTURE	11.5	
WT. DISH	15.9	
NET WT. OF DRY SOIL	119.5	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 1500 LBS./SQ. FT.	YIELD STRENGTH ____ LBS./SQ. FT.
DRY DENSITY 99.7 LBS./CU. FT.	PEAK STRENGTH 3700 LBS./SQ. FT.
FIELD MOISTURE 9.6 % OF DRY WT.	ULTIMATE STR. ____ LBS./SQ. FT.
TEST MOISTURE ____ % OF DRY WT.	FRICTION STR. ____ LBS./SQ. FT.

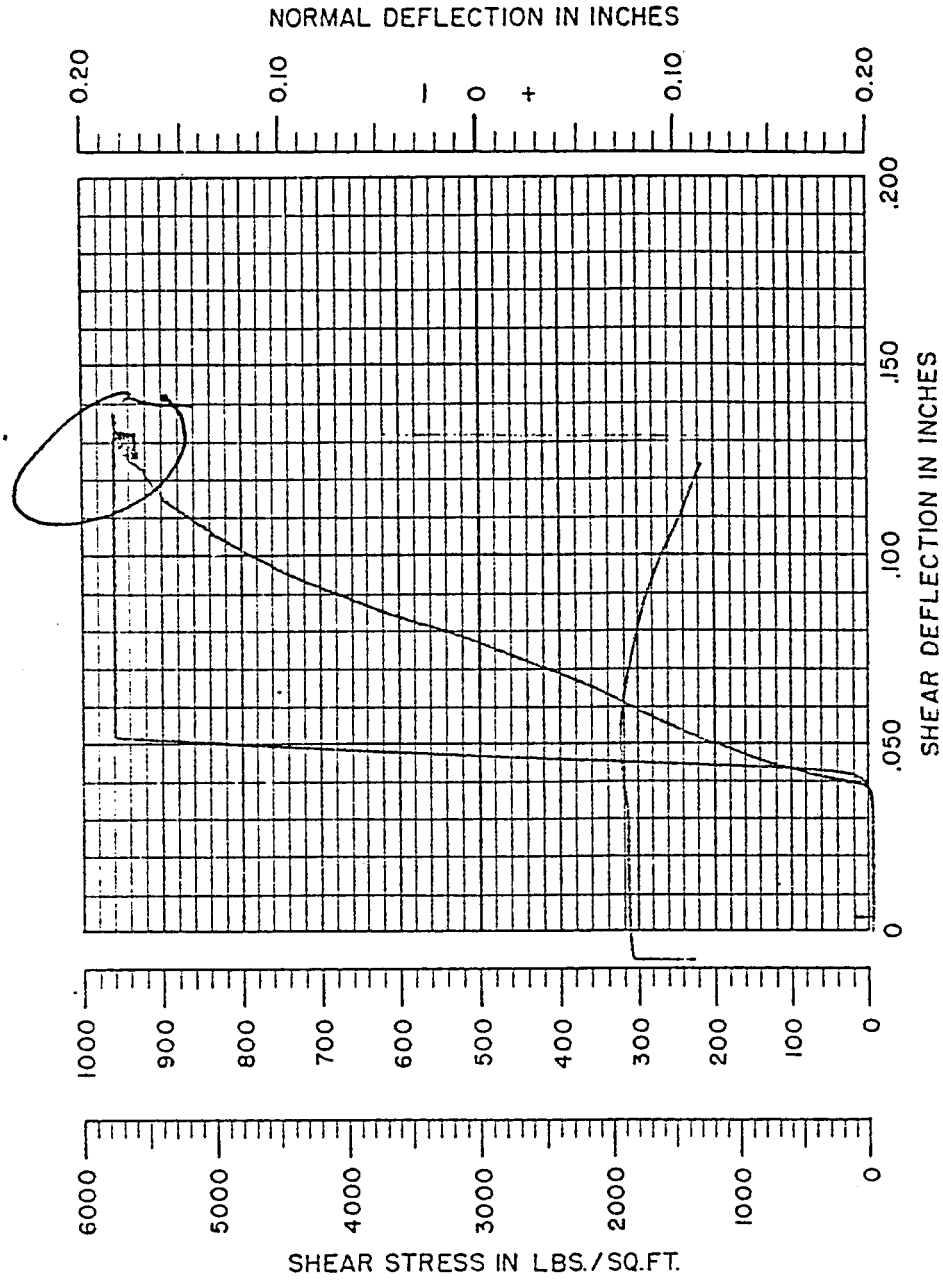
FRICTION TEST SC. TYPE 6P BORING 1"

DATA SHEET LAB IDENT. 5m/5m DEPTH 80

SAMPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES

10



exceeded capac. of machine

MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	518.3	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	105.3	
WT. DISH # 57 & SOIL	198.0	
DRY WT. SOIL & DISH	184.6	
NET LOSS OF MOISTURE	13.4	
WT. DISH	16.1	
NET WT. OF DRY SOIL	168.5	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 2000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 98.4 LBS./CU. FT.	PEAK STRENGTH 6000+ LBS./SQ. FT.
FIELD MOISTURE 8.0 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

857.345

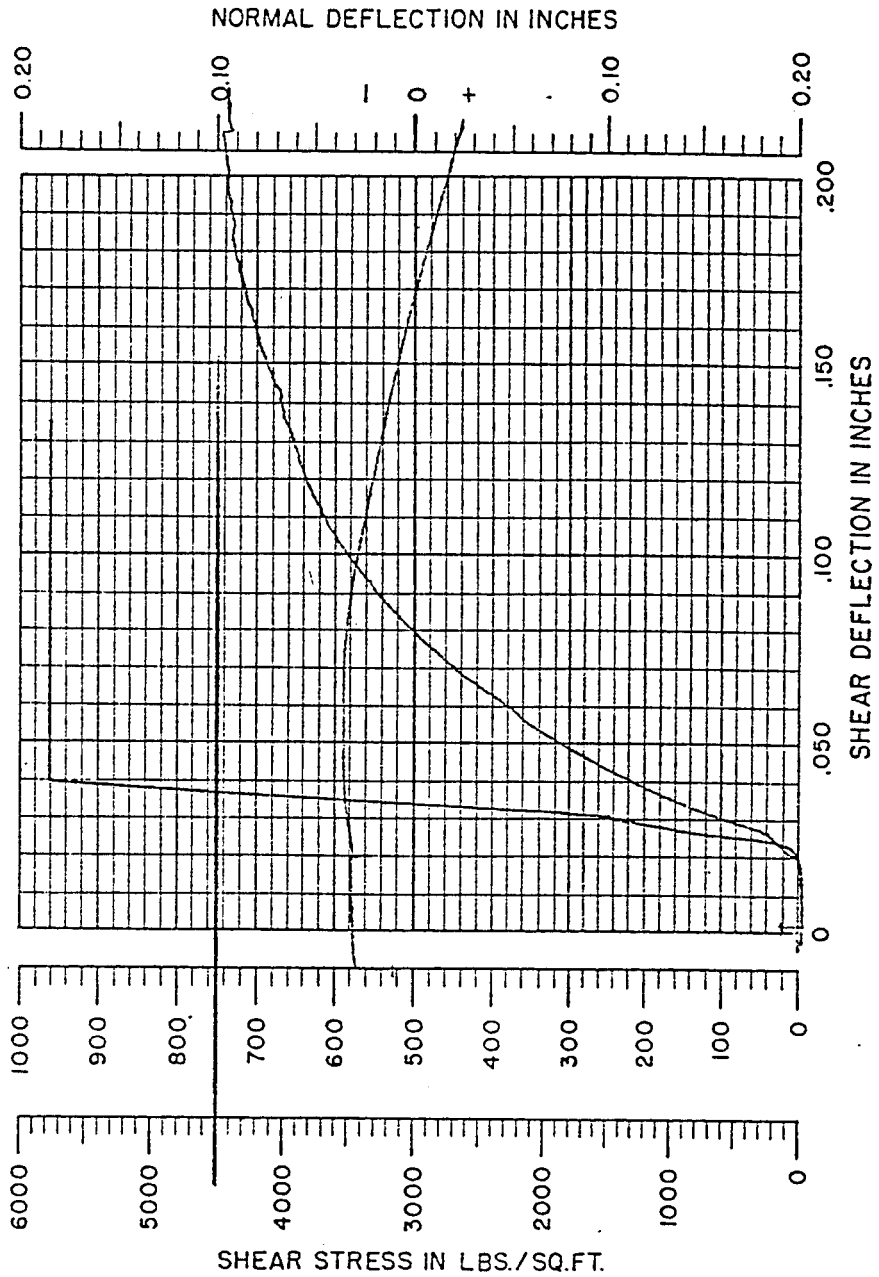
DAMES & MO

FRICTION TEST SC. .YPE 6P BORING 1'2

DATA SHEET LAB IDENT. 5m/6m DEPTH 90

MPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 2 RINGS	293.7	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	54.8	
WT. DISH # 10 & SOIL	202.5	
DRY WT. SOIL & DISH	185.4	
NET LOSS OF MOISTURE	17.4	
WT. DISH	14.9	
NET WT. OF DRY SOIL	170.5	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 2500 LBS./SQ. FT.	YIELD STRENGTH LBS./SQ. FT.
DRY DENSITY 770 LBS./CU. FT.	PEAK STRENGTH 4500 LBS./SQ. FT.
FIELD MOISTURE 10.2 % OF DRY WT.	ULTIMATE STR. LBS./SQ. FT.
TEST MOISTURE % OF DRY WT.	FRICTION STR. LBS./SQ. FT.

857.345

DAMES & MO

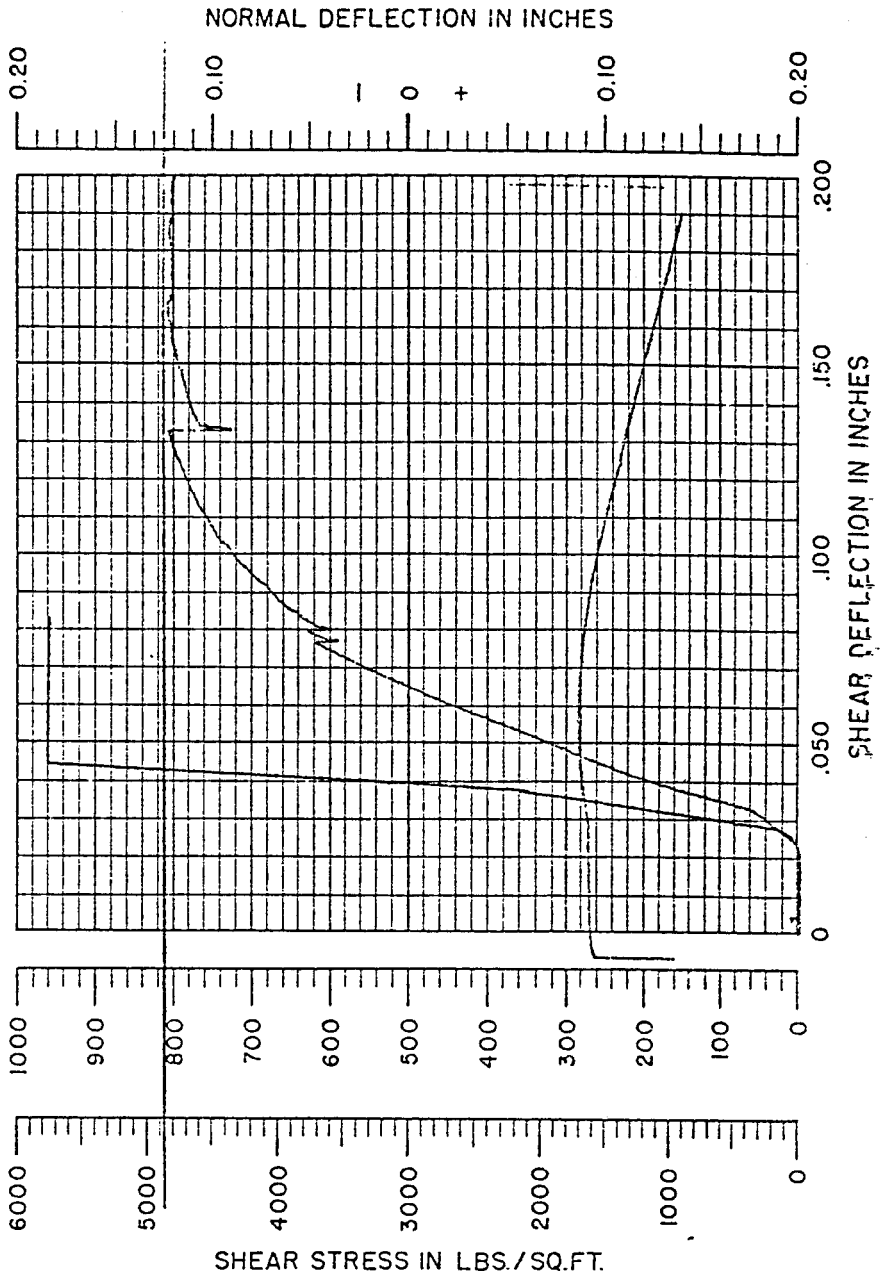
FRICTION TEST SO. TYPE 6P BORING 13

DATA SHEET LAB IDENT. Sm/6m DEPTH 100

SAMPLED / / SET-UP / / TESTED / / (OFFICE)

NOTES

12



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	449.6	
WT. ___ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	87.1	
WT. DISH # 1 & SOIL	137.7	
DRY WT. SOIL & DISH	128.0	
WET LOSS OF MOISTURE	9.4	
WT. DISH	15.1	
NET WT. OF DRY SOIL	112.1	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 3000 LBS./SQ. FT.	YIELD STRENGTH ___ LBS./SQ. FT.
DRY DENSITY 80.3 LBS./CU. FT.	PEAK STRENGTH 4875 LBS./SQ. FT.
FIELD MOISTURE 8.4 % OF DRY WT.	ULTIMATE STR. ___ LBS./SQ. FT.
TEST MOISTURE ___ % OF DRY WT.	FRICTION STR. ___ LBS./SQ. FT.

DIRECT SHEAR TEST — OWNER _____ LOCATION _____ JOB _____

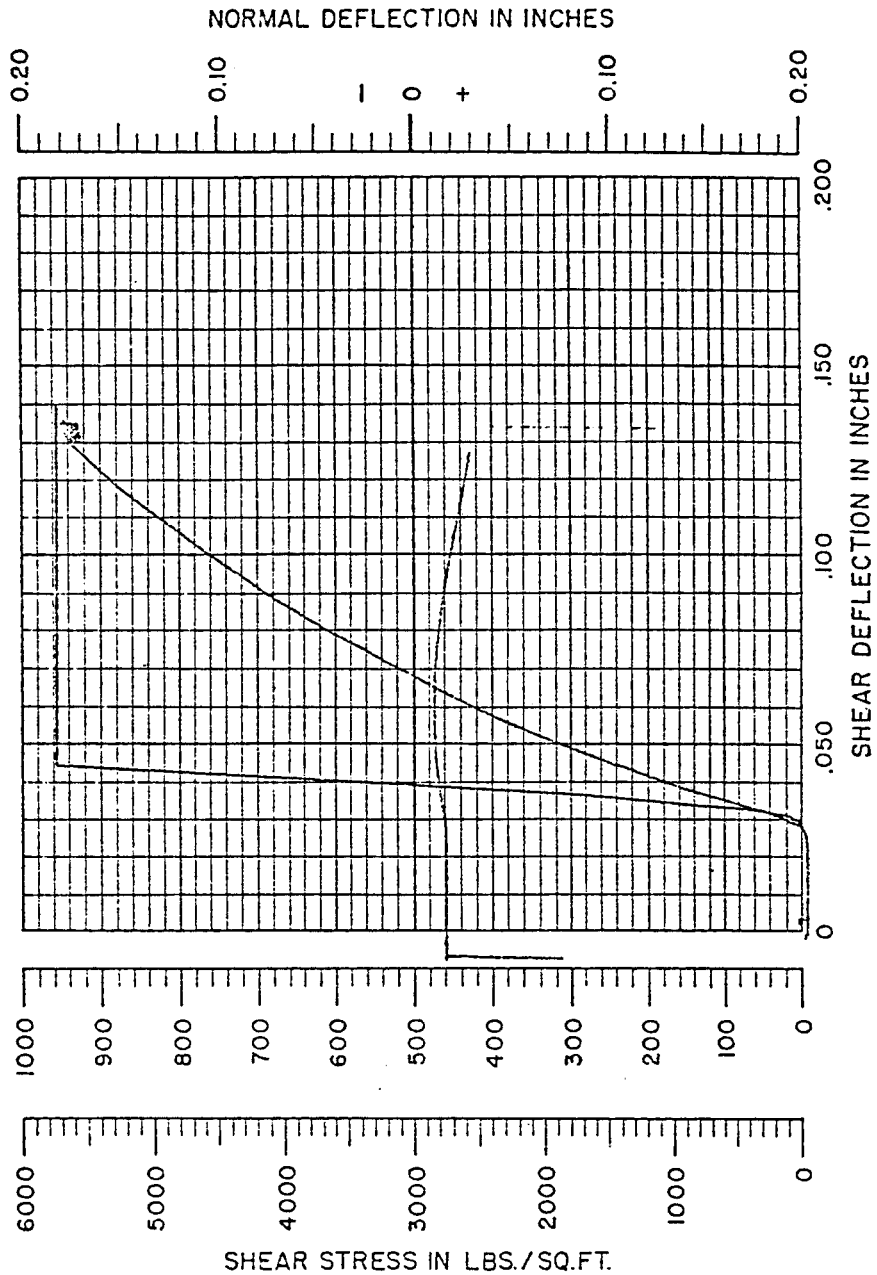
FRICTION TEST — SOIL TYPE GP — BORING 114

DATA SHEET — LAB IDENT. Sm/Sm — DEPTH 110

SAMPLED ____ / / SET-UP ____ / / TESTED ____ / / (____ OFFICE)

NOTES

13



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 3 RINGS	470.2	
WT. ____ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	92.9	
WT. DISH + 1 & SOIL	135.6	
DRY WT. SOIL & DISH	122.1	
NET LOSS OF MOISTURE	12.9	
WT. DISH	15.0	
NET WT. OF DRY SOIL	107.1	

TEST SET-UP			
LOAD		V	DEFLECTION
CONTINUOUS	V		INCREMENT
INCREASE	V		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 4000 LBS./SQ. FT.	YIELD STRENGTH ____ LBS./SQ. FT.
DRY DENSITY 82.9 LBS./CU. FT.	PEAK STRENGTH 6000+ LBS./SQ. FT.
FIELD MOISTURE 12.0 % OF DRY WT.	ULTIMATE STR. ____ LBS./SQ. FT.
TEST MOISTURE ____ % OF DRY WT.	FRICTION STR. ____ LBS./SQ. FT.

857.343

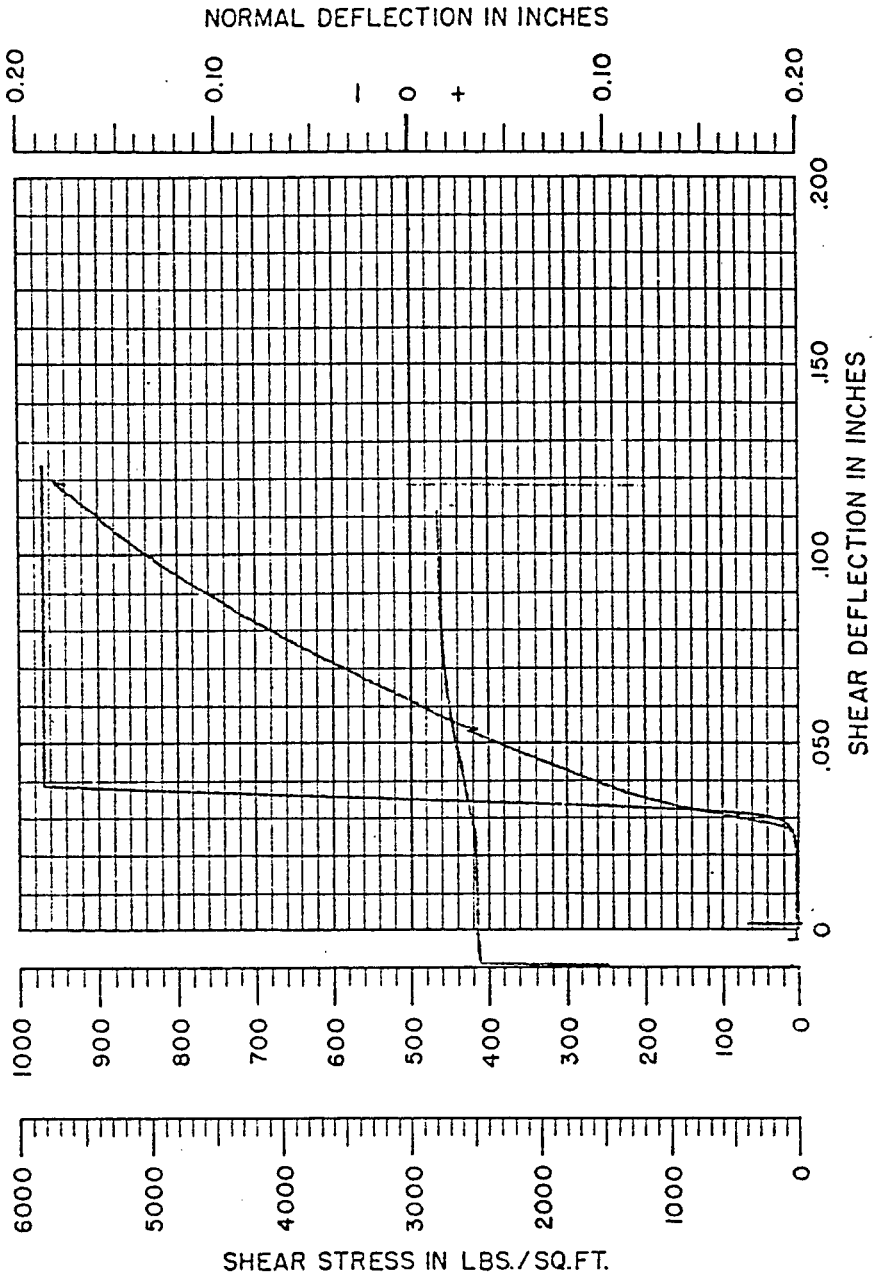
DAMES & MC

FRICTION TEST SO. .YPE _____ BORING 1'S

DATA SHEET LAB IDENT. 5m/5m DEPTH 120

MPLED _____ / / SET-UP _____ / / TESTED _____ / / (____ OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & 7 RINGS	312.7	
WT. ____ RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	92.6	
WT. DISH # 22 & SOIL	219.5	
DRY WT. SOIL & DISH	196.2	
NET LOSS OF MOISTURE	23.3	
WT. DISH	15.3	
NET WT. OF DRY SOIL	180.9	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED			INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 5000 LBS./SQ. FT.	YIELD STRENGTH ____ LBS./SQ. FT.
DRY DENSITY 81.9 LBS./CU. FT.	PEAK STRENGTH 6000+ LBS./SQ. FT.
FIELD MOISTURE 12.9 % OF DRY WT.	ULTIMATE STR. ____ LBS./SQ. FT.
TEST MOISTURE ____ % OF DRY WT.	FRICTION STR. ____ LBS./SQ. FT.

DAMES & MC

887.345

KAISER STEEL CORPORATION
SUNNYSIDE COAL MINES
SUNNYSIDE, UTAH 84539
TELEPHONE 801-888-4421

May 24, 1977

Mr. George Toland
Dames & Moore
250 East Broadway
Salt Lake City, Utah 84111

Re: Report on Material and Stability Investigation of Kaiser Steel's Coal Refuse Disposal Area

Dear Mr. Toland:

As per our telephone conversation last week, I am enclosing a letter from the Mining Enforcement and Safety Administration. The actual questions that need to be answered by your firm are circled.

I appreciate any help you can give us on this problem. If there will be any fees for your services please let me know.

Sincerely yours,

KAISER STEEL CORPORATION

J. T. Paluso
Assistant Chief Engineer

JTP:dm

Enclosure

PROBABLE MAXIMUM THUNDERSTORM 1-HOUR

All calculations were made using the reference "Design of Small Dams" by the Bureau of Reclamation.

Calculations:

A. From Figure 20, P. 53, the probable maximum thunderstorm 1-hour rainfall is 6.0 inches.

B. From Table A-5, P. 538, the runoff curve number is found to be 90.

C. From Figure A-4, P. 541, the direct runnoff is found to be 4.85 inches.

D. The drainage area affecting the slurry pond is 138 acres. The total runoff will be 4.85" x 138 acres = 669.3 acre-inches or 55.78 acre-feet.

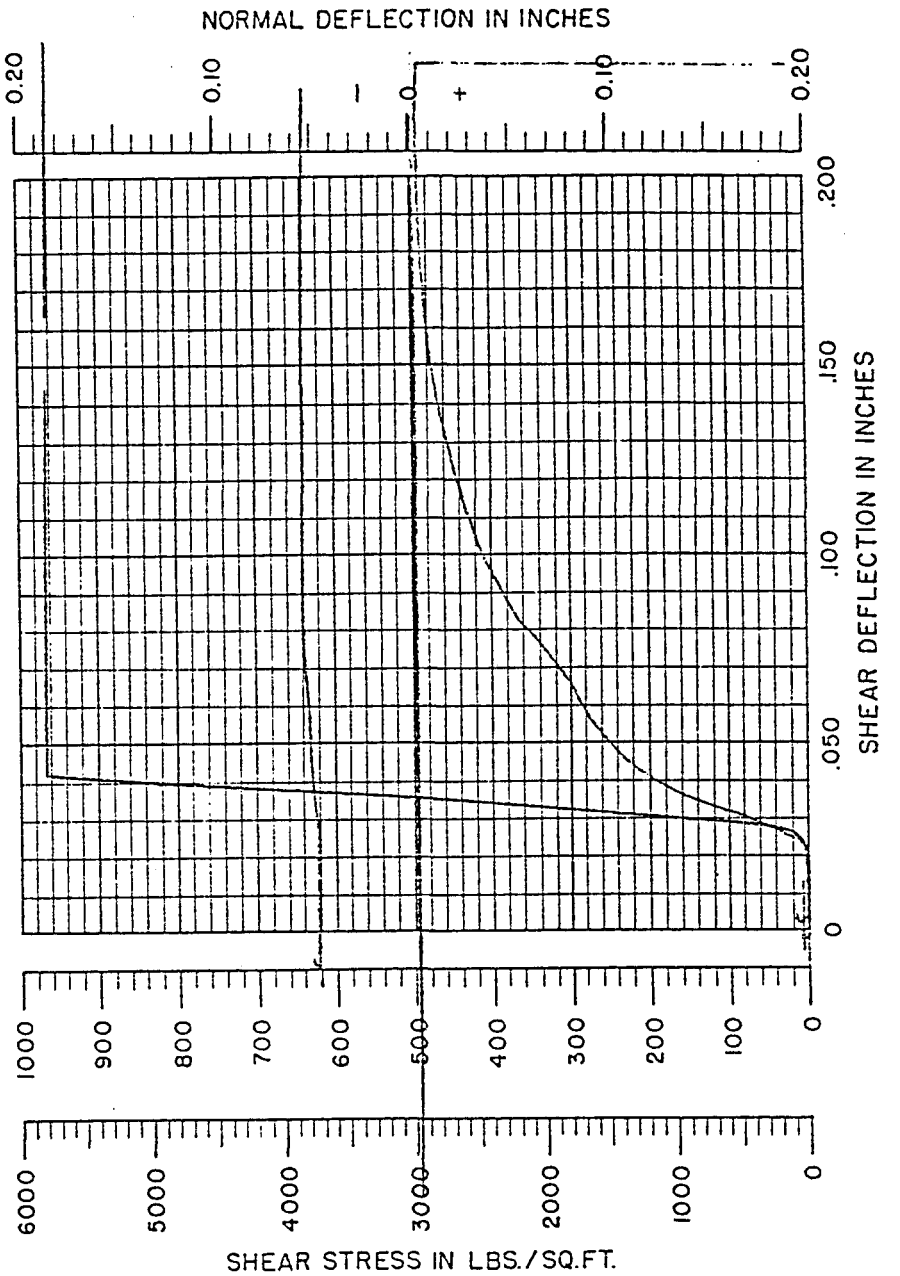
DIRECT SHEAR TEST

FRICTION TEST SOIL TYPE _____ BORING 12

DATA SHEET LAB IDENT. 3P DEPTH 16.5

SAMPLED _____ / / SET-UP _____ / / TESTED _____ / / (____ OFFICE)

NOTES



MOISTURE & DENSITY	FIELD	TEST
WT. SOIL & RINGS	260.4	
WT. RINGS		
NET WT. SOIL		
WET DENSITY LBS./CU./FT.	70.9	
WT. DISH # 52 & SOIL	109.7	
DRY WT. SOIL & DISH	86.6	
NET LOSS OF MOISTURE	23.1	
WT. DISH	15.3	
NET WT. OF DRY SOIL	71.3	

TEST SET-UP			
LOAD		✓	DEFLECTION
CONTINUOUS	✓		INCREMENT
INCREASE	✓		DECREASE
INCREMENT INTERVAL			MIN.
RECORDING INTERVAL			MIN.
LOAD INCREMENT			LBS./SQ. FT.
DEFLECTION INCREMENT			INCHES
LOADING SPEED			LBS./SQ.FT./MIN.
DEFLECTING SPEED	0.02		INCHES/MIN.

TEST SUMMARY	
NORMAL PRESS. 3000 LBS./SQ. FT.	YIELD STRENGTH ____ LBS./SQ. FT.
DRY DENSITY 53.1 LBS./CU. FT.	PEAK STRENGTH 2975 LBS./SQ. FT.
FIELD MOISTURE 32.4 % OF DRY WT.	ULTIMATE STR. ____ LBS./SQ. FT.
TEST MOISTURE ____ % OF DRY WT.	FRICTION STR. ____ LBS./SQ. FT.

DAMES & MC[illegible]E

857.345