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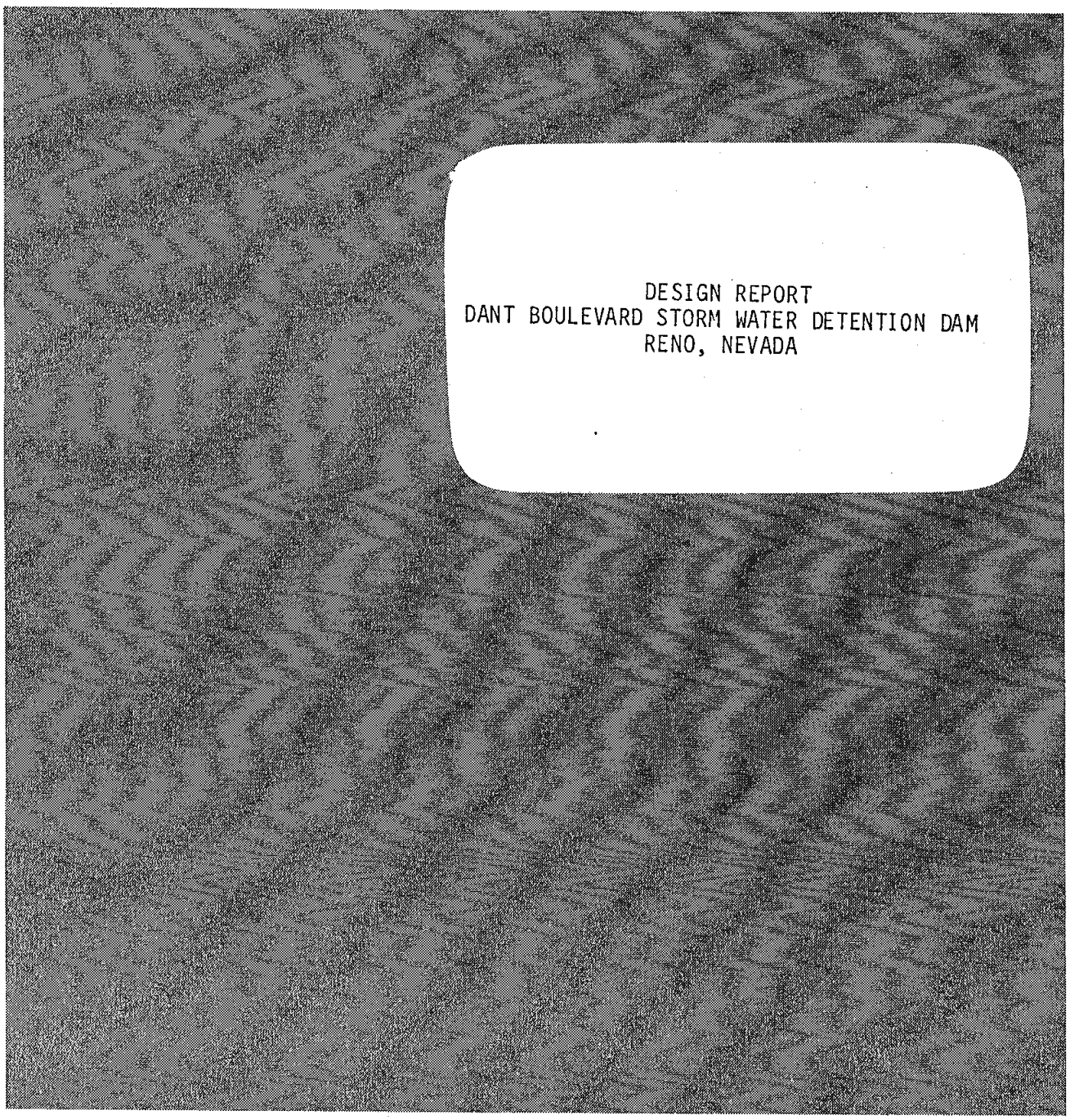
11/22/88

Kennedy/Jenks/Chilton



DESIGN REPORT
DANT BOULEVARD STORM WATER DETENTION DAM
RENO, NEVADA

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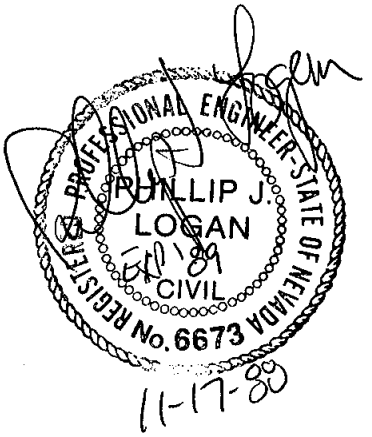

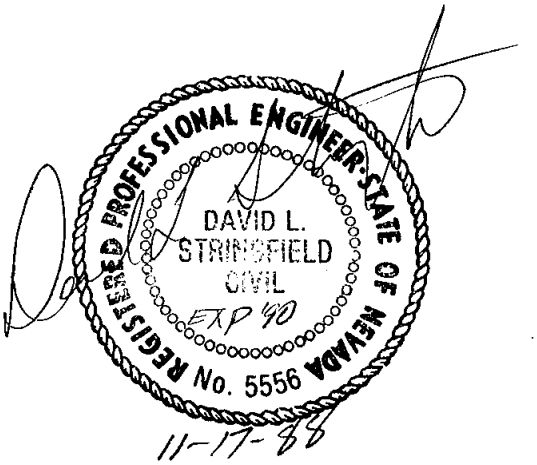

DESIGN REPORT

DANT BOULEVARD STORM WATER DETENTION DAM
RENO, NEVADA

Prepared for:

CITY OF RENO
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November, 1988

DANT BOULEVARD STORM WATER DETENTION DAM
DESIGN REPORT
TABLE OF CONTENTS

A. INTRODUCTION

In January of 1988, Kennedy/Jenks/Chilton was contracted by the City of Reno to provide preliminary design analysis of a storm drainage system to convey flood flows through the Plumas/Moana project site. The project site is bordered to the south by Moana Lane; to the north by Virginia Lake; to the west by Plumas Street; and to the east by Lakeside Drive. Tributary to the project site are two drainage basins which extend to the southwest and cover over 1.9 square miles of steeply sloping ground. The project scope entailed the evaluation of alternatives of combining existing storm drainage system components together with new facilities to convey 100-year, 24 hour run-off flows to Virginia Lake. The following 100-year runoff values were supplied by the City:

- 575 cfs at Plumas and Glenda
- 230 cfs at Lakeside and Moana

These values were developed using the "Rational Method".

The project area has a mix of new and older developments, primarily multi-residential units. The existing underground storm drainage system appeared to have been built without master planning and without allowance for significant off-site inflows. Kennedy/Jenks/Chilton's preliminary design study concluded that the existing storm drainage system provided too little capacity to convey the 100-year flows and that a new system needed to be constructed. However, the costs developed for this new system proved to be substantial, between 2.5 and 3.0 million dollars.

B. DANT BOULEVARD SITE SELECTION

By amendment to the original agreement, the City requested that Kennedy/Jenks/Chilton evaluate the tributary areas upstream of the project site for possible reductions in the 100-year runoff amounts. The hydrology of the tributary areas was re-analyzed using HEC-1 modeling. This was done to develop more site specific runoff values and to provide hydrographs of the floods. Also, potential storm water detention dam sites were investigated to attenuate the runoff and reduce the peak flows to be carried through the project site to Virginia Lake. A target value for the reduction of the peak flows was not set. Any significant amount of upstream attenuation of the peak flow would reduce the size of the facilities on-site and thus reduce costs.

HEC-1 modeling was performed on both tributary areas to the Plumas/Moana project. The 100-year flow to the intersection of Lakeside and Moana was reduced from the City supplied value of 230 cfs to 153 cfs. However, the HEC-1 modeled flow at Plumas and Glenda increased from 575 cfs to 972 cfs. This increase can be explained by the steep terrain and the impermeable soils that overlay most of the sub-basin.

Due to the significant reduction to flows from the Lakeside/Moana tributary area, detention sites within that sub-basin were not explored. Detention dam sites in the Plumas/Glenda sub-basin were initially thought important in reducing the peak flows. With the sharp increase computed by the HEC-1 modeling, a viable detention site within the Plumas/Glenda sub-basin became imperative.

Kennedy/Jenks/Chilton reviewed three potential dam sites within the Plumas/Glenda sub-basin area which runs to the southwest adjacent to and east of Skyline Boulevard. These three sites are located at:

- McCarran Boulevard crossing
- Dant Boulevard (southern projected extension)
- Washoe County Golf Course

The Dant Boulevard site was deemed most suitable for several reasons. The site is in a well defined channel with adequate storage potential for the 100-year runoff volumes. The storage reservoir would be relatively deep and require less inundation area than the lower, flatter Washoe County Golf Course site. The Dant Boulevard site is lower in the watershed than McCarran and can capture more of the tributary runoff. However, the predominate reason that the Dant site was selected was due to the fact that the developers of the Manzanita Estates to the south were willing to share costs to construct this detention dam as part of their subdivision improvements. The developers have tentative plans to construct a roadway embankment across the channel to serve their subdivision to include a major storm water conveyance structure to pass the 100-year flood flows.

The Dant Boulevard dam site lies adjacent to the intersection of Pioneer Drive and Dant Boulevard. It captures approximately 63 percent of the total land area tributary to the Plumas/Moana project study area. There are no immediate downstream dwellings, the channel widens and becomes less well-defined, however, several homes have been built and are most likely subject to flooding during extreme rainfall events.

C. DESIGN CRITERIA

On October 24, 1988, the City of Reno authorized Kennedy/Jenks/Chilton to begin design of the Dant Boulevard Storm Water Detention Dam. The detention dam was to be designed to meet the requirements of the State of Nevada regarding dam safety and to function as a residential collector street. Furthermore, the dam was to be designed to significantly attenuate the 100-year flood flows from the 24 hour rainfall event while able to pass the project design flood without damage to the dam. Kennedy/Jenks/Chilton was to design all the improvements including the roadway section, sanitary sewer, storm drainage facilities, public safety items such as guardrail, fences, etcetera and to provide an Engineer's estimate of construction costs.

Through correspondence with the State of Nevada, the following preliminary design requirements were set:

- Emergency spillway capacity for 1/2 Probable Maximum Flood (1/2 PMF).
- 1/2 PMF flows can be discharged over the top of the dam.
- Low level outlet pipe to a minimum of 24 inches in diameter and capable of draining reservoir within 24 hours. This assumes a single rainfall event.
- Homogenous embankment with upstream erosion protection acceptable.
- 3 feet of storage above the 100-year flood pool elevation required.
- This dam will be classified as high risk.

Preliminary plans indicated that floods exceeding the reservoir capacity would

be routed over the top of the dam through a depressed section. This depressed section would serve as the emergency spillway capable of discharging the 1/2 PMF. However, since the dam also serves as a residential collector street, the City requested that an analysis be made of passing the 1/2 PMF flows under the road through some type of box culvert spillway structure. The City does not want to assume the risk of having the public attempt to drive across the dam during periods of discharge over the top of the dame (computed overtopping probability of 1 to 200 years with a depressed section set at elevation 4705.00 and 200 feet wide).

D. FACILITY DESCRIPTION

1. Embankment

The Dant Boulevard Storm Water Detention Dam will be located just south of the intersection of Pioneer Drive and Dant Boulevard. The dam centerline at the flowline of the channel is located in Section 27, T19N R19E, MDM approximately 3293.69 feet from the corner of Sections 27, 26, 34, 35 on a bearing of N02°-35'-48" E. The dam axis is along the same line as Dant Boulevard extended to the south and is at a skew to the bearing of the drainage channel. The general project location and plan of the dam are shown on drawings C-1 and C-3 respectively.

The total length of the dam is approximately 550 feet with a maximum height above the drainage channel of approximately 59 feet (as measured from the

downstream toe to the maximum dam crest elevation). The dam section is shown on Drawing C-4.

Harding Lawson Associates provided field and laboratory analysis of the proposed dam site and embankment materials. Their recommendations have been incorporated herein. The Geotechnical Investigation Report prepared by Harding Lawson is attached in appendix I.

Generally, the section includes about 6 inches of foundation grubbing and stripping. After grubbing and stripping of surface organics, the foundation will be scarified to a depth of 12 inches (for a total of 18 inches below original ground elevation) and compacted to 90% relative compaction. Areas uncovered during this initial foundation work that are soft or otherwise unsuitable will be excavated to competent material and backfilled with the dam embankment borrow material. The natural stream channel crossing the dam foundation will be closely watched during the early stages of the clearing and grubbing operations. The natural channel may require special treatment to remove pervious, soft zones of stream detritus. Additionally, the left (north) abutment is overlain with unengineered fill which must be removed to native material. The depth of this fill is unknown, but appears to extend from top of the abutment just south of Pioneer Drive to the toe of the slope at the bottom. It is expected that most of this fill material will be suitable for reuse in the dam embankment. Detail 3 on Drawing C-6 shows the proposed excavation and treatment of the unengineered fill area. All foundation excavations and treatments should be carried out under the direct observation of an engineer experienced in this type of work.

The dam will have slopes of 3.0 horizontal to 1.0 vertical (3h:1v). The crest will be 59 feet in width to include a 41 foot wide roadway section (back of curbs) with a 4 foot side-walk on both sides and 5 feet of level area to the top of the dam-face slope. The embankment will be constructed of material available from a borrow source within 1/2 of a mile from the dam site to the southwest and will be of a homogeneous design. Both faces of the dam will be protected with a blanket of angular rock rip rap, 12 inches thick (measured perpendicular to the face). The borrow source contains varying amount of fine grained material. Because of this, material placed within 2 feet of the roadway subgrade or any structure shall be free of appreciable amounts of fine grained material. Additionally, the roadway subgrade material within 2 feet will have a minimum "R" value of 60.

The crest elevation varies from 4711.81 to 4710.00. At the maximum pool elevation of 4706.94 (routed 1/2 PMF through the low level outlet works and emergency spillway, shown rounded to 4707.00 on the plans), the dam has a freeboard of 3.06 feet assuming that both the low level outlet works and the emergency spillway function at full capacity. The emergency spillway upstream inlet will be at elevation 4699.75 and the control section at elevation 4700.00. The inlet to the low level outlet works will be at elevation 4672.00. The control section in the outlet works intake will be at elevation 4667.00.

2. Outlet Works

The low level outlet works will consist of an inlet structure and a concrete

pipe conduit. The conduit will discharge directly into the emergency spillway stilling basin. The spillway terminates in a USBR Type II stilling basin, constructed of reinforced concrete. The outlet works conduit will penetrate the sidewall of the stilling basin structure and energy dissipation of the outlet flows will be accomplished in this structure.

The inlet structure is sized to route the 100-year flood flows by maximizing storage in the reservoir and discharging reduced flows downstream. Using SCS methodology, the computed 100-year, 24 hour rainfall event will produce a peak flow in the channel at the dam site of approximately 742 cfs. The routing of this storm through the reservoir reduces the peak outflow to approximately 98 cfs. The inlet will be submerged during almost all rainfall events, the upper sill is set at elevation 4672.00. This is 2 feet above natural ground. A 1'-9-1/8" diameter regulating orifice is located within the structure, below the sill at elevation 4667.00. The bottom of the inlet is set at elevation 4662.00. The low level outlet conduit penetrates the box and its invert elevation is also at 4662.00. A sealed manhole access will be provided to the inlet structure, which will enable access to the conduit for inspection and maintenance.

Above the sill is enclosed by a 4 foot by 5 foot by 5 foot high trash rack open on all four sides and on the top. The total open area of the trash racks equals approximately 92 square feet, which is over 50 times the area of the control orifice of 1.77 square feet. This opening area allows the velocities through the trash racks to less than 2 feet per second assuming that the racks are totally open. The trash rack is constructed of an angle iron frame with 1-1/2" steel pipe racks that is attached to the inlet structures' embedded

anchor bolts. Also, a 12 foot long by 5 foot high by 3/8 inch thick steel anti-vortex plate is attached to the trash rack above the sill opening.

The outlet works conduit will be built using 36 inch diameter RCP pipe, Class V with "C" walls. The pipe will be single gasketed, bell and spigot, all concrete with integrally cast bells. The outlet pipe will be bedded in select materials, with the following requirements:

Well graded	
1" sieve	100% passing
No. 200 sieve	15% to 40% passing
Liquid Limit	Less than 40
Plasticity Index	Less than 10
Compaction	95% Relative Compaction

Cutoff collars will be constructed at 40 foot intervals along the conduit length. The collars will be constructed so that at least 12 inches of the collar is poured into the trench sidewalls and bottom against undisturbed ground. Expansion joint material will be installed between the pipe and the collars to allow movement without point loading the pipe.

The 36 inch diameter was chosen for this conduit so that exit velocities could be lowered and so that flow would be less than full. Therefore, due to the basically open channel flow within the pipe, no considerations were given to providing air to the inlet to maximize flows and to reduce cavitation potentials. The low level outlet works is designed to discharge 98 cfs at the

100-year pool elevation of 4698.00 and 111.5 cfs at the 1/2 PMF pool elevation of 4707.00.

3. Emergency Spillway

The emergency spillway consist of the following components:

- Inlet, flat slopes, sloping upward at 1% from the inlet to the box culvert and 0.5% sloping downstream to beginning of the chute.
- Chute, steeply sloping 33.3%
- Stilling basin, flat slope 0.1%
- Discharge Channel, flat slope 0.1%

The spillway will be a reinforced concrete structure from the inlet through the stilling basin. The discharge channel will be lined with heavy rip rap to its confluence with the natural channel downstream.

The inlet will be 24 feet wide narrowing to 23 feet 4 inches through a double box culvert that runs under the roadway. The spillway then again transitions to 24 feet and remains this width through the stilling basin. Wall heights vary from 4 feet to 8 feet high through the inlet; from 8 feet to 4 feet along the upper portion of the chute and from 4 feet to 15 feet in the lower portion of the chute. The stilling basin walls will be 15 feet in height. The double box culvert will span 11 feet 8 inches and rise 8 feet high. The floor slabs of the open channel portions of the spillway are 1 feet thick through the inlet and most of the chute. The lower portion of the chute and all of the stilling basin will have floor slabs 2 feet thick.

The spillway is sized to accommodate routed flood flows of the 1/2 PMF without overtopping the dam. The inlet was analyzed as a broadcrested weir with a coefficient "C" of 3.1. At the peak inflow of 2053 cfs (1/2 PMF peak), the routed reservoir pool will reach elevation 4706.94. This equates t the low level outlet works discharging 111.5 cfs and the emergency spillway discharging 1326.5 cfs at their peaks.

The spillway was hydraulically analyzed assuming that its maximum discharge would be 1400 cfs. The discharge (combined spillway and outlet works) out of the reservoir during the 1/2 PMF must be 1438 cfs to maintain the desired (maximum) elevation of the pool. The spillway flow of 1400 cfs allows for clogging of the outlet works intake while only raising the pool 0.27 feet above the unclogged situation. All of the spillway dimensions were based on this maximum flow of 1400 cfs, including the floor width and wall heights. The first 110 feet of the spillway (inlet) will be constructed on a flat grade; therefore slows will be subcritical through this reach. Using the weir formula:

$$A = C \times W \times H^{1.5}$$

with C = 3.1

W = 23.33'

Q = 1400

The depth of water equals 7.21 feet. This set the height of 8 feet in the box culvert and walls of the open channel through the inlet section. The discharge will transition from subcritical to supercritical at the change in slope from the inlet to the chute. The depth of flow in the chute section with the floor width at 24 feet and the bottom slope at 33% will be 1.02

feet. The velocity will be 57.2 feet per second (fps). Due to relatively short length of the chute and the magnitude of the hydraulic jump in the stilling basin, width transitions in the chute were not attempted. The sidewalls of the chute section are set at 4 feet high. This allows for unusual wave patterns that may develop during extremely high flows such as standing waves.

The stilling basin was designed in accordance with USBR criteria and is of the "type II" variety (See Design of Small Dams). The stilling basin is 60 feet long, 24 feet wide with 15 foot high walls. The floor of the basin will be constructed with a flat slope. The computed hydraulic jump height is 14.03 feet. Additional wall freeboard was not included because of the return frequency associated with the maximum jump depth and due to the downstream location of the stilling basin. The basin will be constructed downstream of the toe of the dam and water leaving the stilling basin during high flows should not undermine the dam embankment.

The spillway discharge channel will be completely lined with heavy rock rip rap to a depth of 18 inches. The channel width transitions from 24 feet to 10 feet, turns through a 48 degree curve and will be approximately 80 feet long. The channel will be excavated nearly flat, with a slope of approximately 0.1% and have side slopes of 2 horizntal to 1 vertical (2h:1v). The width transition and channel slope allows for a normal depth of flow at 1400 cfs to approximately 10.6 feet. This downstream depth is necessary to allow the hydraulic jump to form and to allow the stilling basin to function efficiently. A depth that exactly matches the conugate dpeth of the jump is

desirable, however practicality led to the acceptance of the somewhat lower depth of flow through the discharge channel.

It should be expected that some damage will occur to the spillway structure during the highest flows. The velocity of the water down the chute will possibly cause some form of cavitation erosion at irregularities in the concrete floor and walls. The turbulence of the hydraulic jump may also create some cavitation damage. Water jumping out of the stilling basin may cause localized erosion of the backfill material adjacent to the structure. The discharge channel will potentially have the greatest chance for damage under moderate to high flows. Rip rap is not resistant to high flow velocities. High velocities can be expected as the flow leaves the end of the rip rapped channel and spread out into the natural drainage channel.

4. Roadway and Other Miscellaneous Improvements

Kennedy/Jenks/Chilton utilized the City of Reno's standard roadway section for setting the width of the road right-of-way and thus the crest width of the dam. Dant Boulevard will be considered a residential collector street and the 50 foot right-of-way was used. Due to the 3h:1v upstream and downstream slopes, standard double corrugated guardrail is recommended to be installed on both sides of the road. Also, to provide adequate room to install the guardrail behind the sidewalks, the crest width was increased 5.0 feet on each side. The total crest width of the dam is set at 59.0 feet.

The roadway structural section utilizes the City's minimum standard of 4

inches of asphaltic concrete on 6 inches of engineered base material. As stated in Section 4.1, the 2 feet below the roadway subgrade will be comprised o material having an "R" value of at least 60. The roadbed grade on the dam will slope downward towards Pioneer Drive at a grade of 0.4%.

A 8-inch sanitary sewer line was included in this design to allow for sewage flows from the proposed subdivision to the southwest. The sewer line will connect into an existing sanitary sewer manhole located in the intersection of Pioneer Drive and Dant Boulevard. The 8-inch line will pass under the emergency spillway structure to provide adequate hydraulic grades, ideal depths and capacity. It is recommended that the sanitary sewer line be encased in concrete under the spillway structure. This would prevent breakage or other damage to the sanitary sewer due to differential settlement of the embankment or spillway. Additionally, the trench for the sanitary sewer should not be excavated until at least three feet of embankment material has been placed over the proposed invert elevation of the pipe.

Storm water runoff from the Dant Boulevard roadway section on the dam will be handled via the gutters. A catch basin will be installed on the southwest curb return of Dant at Pioneer. This will capture flows along the west side of dam roadway as well as the flows coming down the south side of Pioneer Drive. These flows will be discharged to the upstream side of the dam. Flows running along the east side of Dant on the dam will be taken to Pioneer Drive in the gutter and turned down the south side of Pioneer towards the east. Storm drainage coming from the south on Dant Boulevard extended should be di-

verted prior to coming onto the dam. This unknown runoff quantity was not taken into account in the local storm drainage facilities.

Other utilities such as gas, electrical, water and street lighting were not included in this project due to unknown requirements and conditions. However, Kennedy/Jenks/Chilton recommends that high pressure mains such water and gas be excluded from the dam embankment. A leak in these lines, especially a water line, could severely damage the embankment and possibly the spillway structure and sanitary sewer main. Underground telephone and electricity should not pose any problems to the dam and could easily be installed; with exception of adjacent to the spillway structure. It may be necessary for those lines to be installed below the spillway box culvert.

E. HYDROLOGY

1. General

Kennedy/Jenks/Chilton was directed by the City of Reno to perform HEC-1 computer modeling of the tributary area above the Plumas/Moana study area described in Section 1 above. This hydrology study was to determine SCS runoff values for the sub-basins and to allow for the development of flood hydrographs for routing purposes. The overall hydrology study is summarized in the report titled "Plumas/Moana Storm Drain Project, Draft Preliminary Hydrologic Analysis" which as prepared for the City of Reno by Kennedy/Jenks/Chilton in September 1988 (see attached copy, Appendix III). From that study, the local

hydrology pertinent to the Dant Boulevard Detention Dam was further refined for use in the design of the dam and appurtenant structures.

2. Drainage Area

The drainage area tributary to the Dant Boulevard detention dam site was sub-divided into four sub-basins as follows:

No.1 0.35 sq. mi. Highest, western most area, due south of the Mount Rose Electrical Substation.

No.2 0.20 sq. mi. Parallel to No. 1 on its east side.

No.3 0.26 sq. mi. Located on the drainage mainstem, above McCarran Boulevard.

No.4 0.40 sq. mi. Mainstem area between McCarran and Dant Boulevards.

A map of the sub-basins is shown as Figure 2 and overall watershed boundary is delineated on Sheet C-1.

The Manning coefficient "n" of 0.20 for overland flow runoff was assigned for brush conditions in the sub-basins except near Dant Boulevard. A slightly larger value of 0.24 was used to represent the impervious and lawn areas in that reach. Land slopes were found to be 15% to 20% in the upper areas, but only approximately 2% in the reach adjacent to the Dant Boulevard Dam site.

3. Storm Recurrence Interval

For purposes of designing the low level outlet works, a 100-year, 24-hour

storm was used. The precipitation from this event is 2.7 inches, distributed by a standard SCS 24-hour Type II distribution.

For the spillway evaluation, the State Engineer's office directed the use of a 1/2 Probable Maximum Flood (correspondence dated September 2, 1988, See Appendix II). In a follow-up conversation, this criterion was further defined to mean the rainfall event which results in a peak flow equal to one-half of the PMF peak (telecon on September 28, 1988). The 6-hour Probable Maximum Precipitation (PMP) was estimated to be 10 inches based on averaging published values from NOAA and the California Department of Water Resources. The resulting PMF peak was computed to be 4,060 cfs; the rainfall which produces 1/2 of this peak is 5.8 inches in 6 hours.

4. Runoff Calculation Method

Watershed runoff was calculated using the HEC-1 computer model, utilizing a kinematic wave representation f runoff from a single storm event. Two key results are:

- o 100-year, 24-hour storm of 2.7 inches results in a peak flow of 742 cfs.
- o 1/2 PMF, 6-hour storm of 5.8 inches causes a peak flow of 2,053 cfs.

Flood routing through the reservoir was accomplished by a modified Puls method under the HEC-1 model. Results include:

- o 100-year reservoir pool peaks at elevation 4697.98 with 98 cfs of outflow.

- 1/2 PMF reservoir pool peaks at elevation 4706.94 with 1438 cfs of combined outflow from the spillway and low level outlet works.

During flood events, discharge occurs through the low level outlet works continuously. The only active discharge of flow during the 100-year event is through the low level outlet works; during the 1/2 PMF, the emergency spillway passes additional flows.

BIBLIOGRAPHY

Harding Lawson Associates, October 2988, "Geotechnical Investigation, Proposed Dant Boulevard Detention Dam, Reno, Nevada".

U.S. Army Corps of Engineers, Water Resources Support Center, September 1981, "HEC-1 Flood Hydrograph Package, User's Manual".

U.S. Department of Commerce, Soil Conservation Service, June 1986, "Urban Hydrology for Small Watersheds", a National Technical Information Service Publication.

U.S. Department of the Interior, Bureau of Reclamation, 1987, "Design of Small Dams", a Water Resources Technical Publication.

QUANTITY ESTIMATE
AND
ENGINEER'S CONSTRUCTION COST ESTIMATE

Engineer's Cost Estimate

Kennedy/Jenks Engineers

By JNB/PL Date 10-25-88 Project PANT BOULEVARD DETENTION DAM K/J Job No. 877041.04 Sheet 1 of 3

Bldg., Structure, or Area _____ Subdivision of Work _____

Type of Estimate ☐Conceptual ☐Prelim. (w/o plans) ☒Takeoff (w/plans) ☐Verify Contractor's Estimate ☐Construction Change ☐Current at ENR _____ ☐Escalated at ENR _____

Exhibit A

Item No.	Description	Quantity	Unit	Material		Labor & Equip		Subcontract		Total Cost	
				Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension
	Roadway + Utility Impr.										
1	A.C. Pavement (4")	20,250	S.F.					0.78	15,795	0.95	19237.50
2	Aggregate Base, Type 2 Cl. B	700	Tons					9.84	6,888	11.00	7,700
3	Type I Curb + Gutter	1115	L.F.					6.90	7,693.50	8.20	9,143
4	Sidewalk	1110	L.F.					7.70	8,547	9.25	10,267.50
5	Sawcut	100	L.F.					1.00	100	1.00	100
6	Type I Catch Basin	1	EA					567	567	1500	1,500
7	12" ϕ RCP, Class III	120	L.F.					19.70	2,364	33.00	3,960
8	8" ϕ PVC Sewer	572	L.F.					14.90	8,522.80	16.00	9,152
9	48" ϕ Manhole	2	EA					1085	2,170	2000	4,000
10	Guardrail	1040	L.F.					15.00	15,600	17.00	17,680.00
	Sub Total								68,247.30		82,740.00
								City	of Reno		K/J/C
								Rev.	1-16-87		
								* NOT	INCL.		

Engineer's Cost Estimate

Kennedy/Jenks Engineers

By JNB&RL Date 10-25-88 Project DART BOULEVARD DETENTION DAM K/J Job No. 87041.04 Sheet 2 of 3

Bldg., Structure, or Area _____ Subdivision of Work _____

Type of Estimate ☐Conceptual ☐Prelim. (w/o plans) ☒Takeoff (w/plans) ☐Verify Contractor's Estimate ☐Construction Change ☐Current at ENR _____ ☐Escalated at ENR _____

Item No.	Description	Quantity	Unit	Material		Labor & Equip		Subcontract		Total Cost	
				Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension
	Spillway										
1	Concrete	767	C.Y.							200	153,400
2	Reinforcing Steel	60	Tons							920	55,200
3	SELECT BACKFILL	435	Tons							11.00	4,785
4	96" Chain Link Fence	360	L.F.							17.00	6120
5	Rip Rap - 18" THICK	380	C.Y.							30.00	11,400.00
6	Excavation	5050	C.Y.							2.00	10,100
7	Embankment	2450	C.Y.							4.00	9,800
	SubTotal										$250,805.00
	Outlet Works										
1	42" RCP Cl. V, C-Wall	423	L.F.							80	33,840
2	Concrete	8	C.Y.							500	4,000
3	Reinforcing Steel	0.5	Tons							1200	600
4	Trash Rack	1	L.S.							2500	2,500
5	Cut-off Collars	9	EA							450	4,050
6	SELECT BEDDING	760	Tons							11.00	8360
	SUB TOTAL										$ 53,350

Engineer's Cost Estimate

Kennedy/Jenks Engineers

By JNB&PL Date 10-25-88 Project DANT BOULEVARD DETENTION DAM K/J Job No. 871104.04 Sheet 3 of 3

Bldg., Structure, or Area _____ Subdivision of Work _____

Type of Estimate ☐Conceptual ☐Prelim. (w/o plans) ☒Takeoff (w/plans) ☐Verify Contractor's Estimate ☐Construction Change ☐Current at ENR _____ ☐Escalated at ENR _____

Item No.	Description	Quantity	Unit	Material		Labor & Equip		Subcontract		Total Cost	
				Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension	Unit Cost	Extension
	Dam										
1	Clear and Grub	3	Acre							700	2,100
2	Foundation Preparation	12,500	S.Y.							0.25	3,125
3	Embankment	80,000	C.Y.							4.00	320,000
4	Slope Protection 12" THICK	3070	C.Y.							30.00	92,100.00
	RIP-RAP										
5.	SLOPE PROTECT. BEDDING TYPE II, CL. B	2600	TON							11.00	28,600.00
	SUB TOTAL										$445,925.00
	SUMMARY										
	ROADS										$87,740.00
	SPILLWAY										$250,805.00
	OUTLET WORKS										$53,350.00
	DAM										$445,925.00
	TOTAL EST.										$832,820.00

SPECIFICATIONS

Note: The "Standard Specifications for Public Works Construction", 1978 govern the construction of this project unless modified by the technical specifications contained herein.

SECTION 02201

EARTHWORK

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SECTION 02201

EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. General: The Contractor shall perform all excavation, shoring, dewatering, backfilling, compaction and grading necessary or required for the construction of the work as covered by these Specifications and indicated on the Drawings. The excavation shall include, without classification, the removal and disposal of all materials of whatever nature encountered, including water and all other obstructions, that would interfere with the proper construction and completion of the required work.

B. Site Access: Access to the site will be over public and private roads. The Contractor shall exercise care in the use of such roads and shall repair at his own expense any damage thereto caused by his operations. Such repair shall be to the satisfaction of the owner or agency having jurisdiction over the road. The Contractor shall take whatever means are necessary to prevent tracking of mud onto existing roads.

C. Barriers: Barriers shall be placed at each end of all excavations and at such places along excavations as may be necessary to warn all pedestrian and vehicular traffic of such excavations. Lights shall also be placed along excavations from sunset each day to sunrise of the next day until such excavation is entirely restored.

D. Demolition of Pavement: Where trenching or excavation occurs in paved areas, the pavement shall be sawcut ahead of the trenching or excavation operation. The extent of paving removed shall be limited to the minimum necessary for the excavation.

E. Dust Control: Take proper and efficient steps to control dust.

F. Storage of Materials: Neatly place excavated materials suitable for backfill far enough from the excavation to prevent stability problems. Keep the materials shaped so as to cause the least possible interference with operations and drainage.

1.02 QUALITY ASSURANCE

A. Source Quality Control: Contractor shall test import materials proposed for use to demonstrate that the materials conform to the specified requirements. Tests shall be performed by an independent testing laboratory.

B. Field Quality Control:
   1. The Engineer will:
      a. Review and test materials proposed for use.
      b. Inspect foundations, site grading and borrow operations.
      c. Inspect placement and compaction of fill.
   2. Contractor shall be responsible for costs of testing and additional inspection and re-testing resulting from non-compliance.

C. Testing Methods:
   1. Laboratory Compaction: ASTM D1557, Method A or C.
   2. In-place Density: ASTM D1556 or ASTM D2922.
   3. Particle Size Analysis of Soils: ASTM D422.
   4. Plastic Limit and Plasticity Index: ASTM D424.
   5. Soil Classification: ASTM D2487.
   6. In-place Moisture Content: ASTM D3017.

1.03 SUBMITTALS

A. Test Results: The Contractor shall furnish necessary facilities for sampling and testing of all materials and workmanship. Submit test results for import materials. All material furnished and all work performed shall be subject to rigid inspection, and no material shall be delivered to the site until it has been favorably reviewed by the Engineer, or used in the construction work until it has been inspected in the field by the Engineer.

1.04 EXPLOSIVES

A. The use of explosives will not be permitted on this project, unless specifically authorized, in writing, by the Engineer.

1.05 SUBSURFACE INVESTIGATIONS

A. Geotechnical investigations for design purposes for this project were made for the City of Reno by Harding Lawson & Associates in a report dated October 27, 1988.

B. This report is available for examination from the City Engineer at 450 Sinclair St., Reno, NV 89501. While the records of data obtained may be considered by the Contractor to be correct, any conclusions or recommendations made in the reports are for information to the Design Engineer and are not a part of the Contract Documents. Copies of the test pit logs are shown on the Drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Select Backfill:

1. Well Graded - Outlet works pipe and spillway above elevation 4700': well graded soil with liquid limit no greater than 40 percent and a plasticity index no greater than 10 percent, free from clods or rocks larger than 1 inch in greatest dimensions, between 15 and 40 percent passing the No. 200 sieve, and free from organic material.

2. Free Draining - Outlet works inlet structure and spillway below elevation 4700': Drain backfill.

Sieve Size	Percentage by Weight Passing Sieve
2 Inch	100
1-1/2 Inch	90-100
1 Inch	.....
3/4 Inch	50-80
3/8 Inch	.....
No. 4	20-40
No. 16	10-24
No. 100	0-4
No. 200	0-2

B. Native Backfill and Dam Embankment Material: Native soil prepared as necessary to be free from clods or rocks larger than 8 inches in greatest dimension, and free from organic material.

C. Water: The water used shall be reasonably free of objectionable quantities of silt, oil, organic matter, alkali, salts and other impurities. Water quality must be acceptable to the Engineer.

D. Aggregate Base: Type 2, Class B, Standard Specifications 201.01.03.

PART 3 - EXECUTION

3.01 CONTROL OF WATER

A. All excavations shall be kept free from water and all construction shall be in the dry.
1. It should be presumed that the presence of groundwater will require dewatering operations. The Contractor shall furnish, install, maintain, and operate all necessary pumping

and other equipment for dewatering all excavations. The Contractor shall at all times have on the project sufficient pumping equipment for immediate use, including standby pumps for use in case other pumps become inoperable.

2. Provide a sufficient number of pumps so as to hold the groundwater level at an elevation of not less than one foot below the lowest elevation of the pipe or other material to be placed.
3. Dispose of water in such a manner as to cause no injury or nuisance to public or private property, or be a menace to the public health.
4. The dewatering operation shall be continuous, so that the excavated areas shall be kept free from water during construction, while concrete is setting and achieves full strength, and until backfill has been placed to a sufficient height to anchor the work against possible flotation.
5. Continue dewatering during backfilling operations such that the groundwater is at least one foot below the level of the compaction effort at all times. No compaction of saturated materials will be allowed.
6. Dewatering devices must be adequately filtered to prevent the removal of fines from the soil.
7. The Contractor shall be responsible for any damage to the foundations or any other parts of existing structures or of the new work caused by failure of any part of the Contractor's protective works. After temporary protective works are no longer needed for dewatering purposes, they shall be removed by the Contractor.
8. Prevent disposal of sediments from the soils to adjacent lands or waterways by employing whatever methods are necessary, including settling basins.

B. The Contractor shall be responsible for furnishing temporary drainage facilities to convey and dispose of surface water falling on or passing over the site.

3.02 EXISTING UTILITIES

A. General: The known existing utilities and pipelines are shown on the Drawings in their approximate location. The Contractor shall exercise care in avoiding damage to all utilities as he will be held responsible for their repair if damaged. There is no guarantee that all utilities or obstructions are shown, or that locations indicated are accurate. Utilities are piping, manholes, overhead power lines and the like, located at the project site and adjoining said site.

B. Interferences: If interferences occur at locations other than shown on the Drawings, the Contractor shall notify the Engineer, and a method for correcting said interferences shall be supplied

by the Engineer. Payment for interferences that are not shown on the plans, nor which may be inferred from surface indications, shall be in accordance with the provisions of the General Conditions.

Any necessary relocations of utilities, whether shown on the Drawings or not, shall be coordinated with the affected utility. The Contractor shall perform the relocation only if instructed to do so in writing from the utility and the Engineer.

C. Shutdowns: Planned utility service shutdowns shall be accomplished during period of minimum use. In some cases this may require night or weekend work, at no additional cost to the City. Program work so that service will be restored in the minimum possible time, and shall cooperate with the utility companies in reducing shutdowns of utility systems to a minimum.
   1. Disconnections: No utility shall be disconnected without prior written approval from the utility owner. When it is necessary to disconnect a utility, the Contractor shall give the utility owner not less than 72 hours notice when requesting written approval. The Contractor shall program his work so that service will be restored in the minimum possible time.

E. Overhead Facilities: There are existing overhead electric and telephone transmission lines at the site. Extreme caution shall be used when working in the vicinity of overhead utilities so as to prevent injury to workmen or damage to the utilities.

3.03 SITE GRADING

A. Stripping: Areas upon which embankment or structures are to be placed shall be cleared, grubbed, and stripped to remove brush, roots, organic soils, and any existing improvements. Stripping depth shall be 6 inches. The artificial fill soils overlying the left abutment shall be removed to native, natural dense soils. The artificial fill may be re-used in the dam embankment with the approval of the engineer.

B. Scarifying: Scarify to a minimum 12-inch depth (18 inches below original ground levels) all areas where fills are required. Moisture condition the scarified surface to within two percent of optimum water content, and compact to minimum 90 percent of the maximum dry density as determined by ASTM D1557-78. If the scarification turns up a significant amount of boulders, the subgrade can be prepared by proof-rolling to a non-yielding surface. Proof-roll by passing over all required areas with a loaded scraper, front-end loader with loaded bucket, or other heavy rubber tired vehicle with high tire pressure, in the presence of the Engineer.

C. Fills:

1. Do not place any fill until the Engineer has inspected, tested to his satisfaction, and favorably reviewed the prepared subgrade.
2. Construct fills as shown on the Drawings, true to line, grade and cross-section. Construct with dam embankment material fill. Place material in approximately 8-inch thick horizontal layers measured before compaction, and carried across the entire width to the required slopes. Remove all rocks larger than 8 inches and push them to the sides of the embankment. Compact all fills to a maximum dry density of at least 90% as determined by ASTM D1557-78 unless otherwise specified. Properly moisture condition before compaction to plus 4% or minus 2% of optimum.
3. Where fills are to be made and compacted on sloping ground surfaces, steeper than 5:1, such slopes shall be benched a minimum of 5 feet horizontally as the work is brought up. Recompact material thus removed by benching along with the new embankment material.
4. Clay materials used in native backfill shall not be closer than 2 feet from any structure, structure backfill, or road base material.

3.04 EXCAVATION FOR STRUCTURES

A. All excavation for structures shall be done to the dimensions and levels indicated on the Drawings or specified herein. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms and the protection of the work.

B. Take care to preserve the foundation surfaces shown on the Drawings in an undisturbed condition. If the Contractor overexcavates or disturbs the foundation surfaces shown on the Drawings or specified herein, without written authorization of the Engineer, he shall replace such foundations with concrete fill or other material approved by the Engineer in a manner which will show by test an equal bearing value with the undisturbed foundation material. No additional payment will be made for the added quantity of concrete fill or other material used because of overexcavation.

C. Inspection of Excavation: Notify the Engineer when excavation for the structure is complete. No forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation has been inspected by the Engineer.

D. If the Contractor wishes to stockpile excavated material, he shall provide adequate facilities for drainage of water from the

material and adequate facilities for handling of storm drainage from the area.

E. Where unsatisfactory material is encountered below the grades shown, for structural excavations, it shall be removed and replaced and compacted with aggregate base as directed by the Engineer. Payment for removal and replacement of such unsatisfactory material directed by the Engineer shall be made in accordance with the provisions of the General Conditions.

3.05 SUPPORT OF EXCAVATIONS

A. Adequately support excavation for trenches and structures to meet all applicable requirements in the current rules, orders and regulations. Excavation shall be adequately shored, braced and sheeted so that the earth will not slide or settle and so that all existing structures and all new pipe and structures will be fully protected from damage.

B. Take all necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from the high groundwater table and the nature of the soil excavated.

C. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting and bracing shall be carefully removed so that there shall be no voids created and no caving, lateral movement or flowing of the subsoils.

3.06 STRUCTURAL BACKFILL

A. Structural Subgrade: Place a layer of aggregate base, compacted to at least 95 percent relative compaction under structures to the lines, grades and minimum thicknesses shown on the Drawings. Unless shown specifically otherwise in the Drawings, do not use aggregate base as backfill above the elevation of the highest base slab of the structure.

B. Backfill Adjacent to Structures:
   1. Backfill shall be Select Backfill compacted to at least 95 percent relative compaction.
   2. Do not place backfill against structures until the concrete has been patched and cured.
   3. Do not place backfill against structures until at least 28 days after the concrete was placed, or until the concrete has achieved a strength of at least 2,500 psi, whichever is earlier. Concrete strength shall be demonstrated by field cured cylinders tested at the Contractor's cost, prepared and tested in accordance with ASTM C31 and ASTM C39.

4. Place backfill in uniform, level layers, not exceeding 8 inches thick measured before compaction. Bring backfill up uniformly on all sides of the structure, and on both sides of buried walls.

3.07 COMPACTION

A. Add water to the backfill material or dry the material as necessary to obtain a moisture content within two percent of optimum. Employ such means as may be necessary to secure a uniform moisture content throughout the material of each layer being compacted.

B. After the material has been moisture conditioned, compact it with compaction equipment appropriate for the use to achieve specified compaction.

C. If the backfill material becomes saturated from rains or any other source because it was not compacted to the specified density or was not backfilled and compacted to surface grade, through negligence or otherwise, remove the faulty material and replace it with suitable material compacted to the specified density. No additional payment will be made for doing such work or removal and replacement.

D. Compaction of embedment and backfill materials by flooding, ponding or jetting will not be permitted.

E. When densities of compacted materials do not meet the requirements, remove and/or recompact the material until the requirements are met. The Contractor will bear the cost of retesting all failing tests, including the initial retest.

3.08 DISPOSAL OF EXCAVATED MATERIAL

A. Dispose of unsuitable material or excavated material in excess of that needed for backfill or fill offsite.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

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SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Requirements specified in Division 1 form a part of this Section. Provide cast-in-place concrete work, complete as indicated, specified and required.

B. Work Included in This Section. Principal items are:
1. All cast-in-place concrete including spillway, intake structure, and box culverts.
2. Concrete shoring, formwork, patching, grouting, sealants and crack repair.
3. Concrete curing.

1.02 REQUIREMENTS OF REGULATORY AGENCY

A. General: Unless specifically noted otherwise in this Section, all work on concrete shall conform to the Uniform Building Code, latest edition.

1.03 REFERENCE STANDARDS

A. General: Where materials and methods are indicated in this Section, or on the Drawings, as being in conformance with a standard specification, it shall in all cases refer to the latest edition of that specification and shall include all interim revisions. Listing of a standard specification without further reference indicates that the particular material or method shall conform with such listed specifications.

1.04 SOURCE QUALITY CONTROL

A. General: All tests specified herein shall be performed at the Contractor's expense (except as noted), by an independent commercial testing laboratory favorably reviewed by the Engineer.
1. Sampling: Provide safe access to materials for sampling.
2. Submittals: Submit samples of aggregates to testing laboratory 45 days prior to initial concrete placement.
3. Tests Not Required: The following tests for aggregate tested in accordance with ASTM C33 are not required:

ASTM C29
ASTM C78
ASTM C123
ASTM C235
ASTM C666

B. Material Tests:

1. Cement: Submit certified mill reports or testing laboratory report showing conformance with ASTM C150.
2. Fine Aggregate: The testing laboratory shall perform the standard test on each fine aggregate proposed for use.
   a. Fine Aggregate Test Methods:

Test	ASTM Method	Requirement
Aggregates	C33	Conform
Organic impurities in sands for concrete	C40	Not darker than reference standard
Effect of organic impurities in fine aggregate on strength of mortar	C87	Not less than 95%
Sand equivalent	D2419	75 minimum

   b. Organic Impurities: Fine aggregates developing a color darker than the reference standard color solution may be acceptable if it is determined by the Engineer from mortar strength tests paid for by the Contractor that a darker color is acceptable.
   c. Sand Equivalent: If the results of a single "Sand Equivalent" test falls below 75, but not below 70, two additional samples representative of material entering the work shall be taken immediately for testing. The average of the three test results shall be a minimum of 75. The minimum acceptable result for any single test shall be 70.
3. Coarse Aggregate: The testing laboratory shall perform the standard test on each coarse aggregate proposed for use.
   a. Coarse Aggregate Test Methods:

Test	ASTM Method	Requirement
Aggregates	C33	Conform
Resistance to abrasion of small size coarse aggregate by use of the Los Angeles machine	C131	Not more than 45%
Clay lumps and friable particles	C142	Not more than 5%
Soundness	C88	Not more than 10% by either method

   b. Inferior Material: Aggregate containing more than 10% of inferior materials, flat or elongated particles,

cracked or laminated rock, or rock which can readily be broken after immersion in water for one hour, will be rejected. When shaken or washed in water, the volume of silt settling in one hour shall not exceed three percent of the volume of the sample.

C. Concrete as Placed:

1. The following listed tests of concrete as placed will be performed by the Engineer. The laboratory shall file results of the tests, reporting conformance or nonconformance to these Specifications.

   a. Concrete Strength: During the progress of the work and for each different mix of concrete, a set of three standard 6" x 12" concrete cylinders shall be cast and tested for each 100 cubic yards or fraction thereof poured during each and every day concrete is poured. Sampling of the concrete for the purpose of casting test cylinders shall be in conformance with ASTM C172. One cylinder shall be tested at an age of 7 days, a second at an age of 28 days, and the third cylinder of the set shall be held as a spare. Making and curing of the cylinders shall be in accordance with ASTM C31. Testing of cylinders shall conform to ASTM C39. Costs will be paid by the City.

      1) Casting of test cylinders will be performed by the Engineer's representative, subject to review by the Engineer.

      2) The Contractor shall arrange and pay for transportation of test cylinders from job site to the laboratory. He shall cooperate to the fullest extent in casting and storing the cylinders at the project. An acceptable method of storage shall be in tightly constructed, firmly braced wooden boxes, located so as not to be subjected to vibrations. The box shall be constructed or equipped so as to keep the temperature immediately adjacent to the specimens between 60° and 80° F and to prevent loss of moisture. Other methods may be used, subject to favorable review by the Engineer.

   b. Slump: For every 50 cubic yards of concrete placed, a slump test will be made in accordance with ASTM C143. The slump shall not exceed 4" at point of delivery. Non-conformance to these limits subjects the concrete to possible rejection. The Engineer or his representative shall be the sole judge with respect to rejection. A slump test will be made on each sample of concrete taken for test cylinders. Slump tests will be taken by Engineer's representative.

   c. Additional Tests: In all cases that the test results of concrete cylinders or concrete materials submitted for use fail to meet the appropriate requirements specified, the Contractor shall provide and pay for additional

tests on new specimens except as specifically excluded below. If, in the opinion of the Engineer, results of tests on concrete cylinders indicate the possibility of sub-standard concrete in the structure, he may require cored samples taken from the concrete. The coring and testing shall conform to ASTM C42. All costs for these additional tests shall be paid by the Contractor if the tests indicate defective concrete; otherwise the Owner will pay the costs. If, in the opinion of the Engineer, the results of the core tests indicate that concrete has been placed which does not meet this specification, the defective concrete shall be removed and replaced, at the Contractor's expense.

1.05 ADVANCE DESIGN OF CONCRETE MIXES

A. General:

1. The Contractor, at his own expense, shall employ an independent commercial testing laboratory favorably reviewed by the Engineer to design all concrete mixes. The mixes shall be designed and trial batched far enough ahead of concrete pours to allow completion of trial batch test cylinders; and to submit the test results and the mix design to the Engineer for review.
2. The Contractor is solely responsible for selection of laboratory, submittal of materials to laboratory in time for all tests, and overall timing of all aspects of testing program, including submittals.
3. The mix shall be so designed that the 28 day strength of any test cylinder shall not be less than 3500 psi. The minimum amount of cement per cubic yard of concrete shall be 517 pounds.
4. Concrete shall consist of a mixture of portland cement, natural pozzolan, fine aggregate, coarse aggregate, water, air entraining agent and a water reducing agent. The amount of pozzolan shall be 15 percent by weight of the cement. The air entraining agent shall produce a total five percent entrained air in the mix, plus or minus one percent.
5. Cement, pozzolan, aggregates and water shall be proportioned by weight.
6. No chlorides shall be used in any concrete mix.
7. In proportioning aggregates and water, compensation shall be made for the weight of moisture in the aggregates (which shall be determined periodically).

1.06 MATERIAL STORAGE

A. Cement and Pozzolan: Should any cement and/or pozzolan be stored on the project site, immediately upon receipt of the shipment, it shall be stored in a dry, weathertight, properly ventilated structure, with adequate provisions for prevention of moisture absorption and overheating of the cement.

B. Aggregates: Should any aggregates be stored on the project site, they shall be stored in piles which afford good drainage and which are so protected so as to prevent the inclusion of foreign material. The various sizes or gradations of aggregates shall be stockpiled separately.

C. Lumber: All lumber, including plywood for forms, shall be stored so as to prevent direct contact with the ground. The stored lumber shall be protected from the elements by a suitable covering, such as polyethylene film or waterproof building paper, suitably held in place.

1.07 SUBMITTAL OF SHOP DRAWINGS, SAMPLES AND DESCRIPTIVE DETAILS

A. General: The Contractor shall submit to the Engineer for review the following, even though items proposed to be furnished conform to the exact description stated in this Section, or as shown on the Drawings.

1. A notarized statement that the cement conforms to ASTM C150. If such a statement is not possible, the cement shall be tested as noted subsequently in this Specification under "Material Tests."
2. A notarized statement that the pozzolan for project has been tested just prior to shipping, and conforms to ASTM C618, Type N.
3. Manufacturer's descriptive details or samples of the following, when item is specified in this Section:
   a. Admixtures.
   b. Joint materials, including sealants and waterstops.
   c. Curing materials and curing program.
   d. Non-shrink non-metallic grout.
   e. Epoxy compounds or grouts, including epoxy adhesive compound.
   f. Form ties.
   g. Form coatings.
   h. Forms, if fabricated off construction site.
4. Construction joint layout.
5. Program and method of concrete placement.
6. Results of tests for conformance to ASTM C330 if the use of rhyolite aggregates is requested.

1.08 (NOT USED)

1.09 READY-MIX CONCRETE

A. Should the Contractor elect to use ready-mix concrete for the project, the concrete shall be supplied by a ready-mix plant which is certified by the National Ready-Mix Concrete Association. The Contractor shall submit verification of this certification to the Engineer.

B. If the concrete supplier is not certified by the National Ready-

Mix Concrete Association, he may qualify for supplying concrete by conforming to the following requirements:

1. Ready-mixed concrete may be produced by stationary mixers or truck mixers. Agitation of the concrete subsequent to mixing may be done by truck mixers or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place, a metal plate or plates on which is plainly marked, for the various uses for which the equipment is designed, the capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades. Stationary mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. Truck mixers or agitators transporting central-mixed, shrink-mixed, or transit-mixed concrete shall be equipped with a non-resettable counter for recording the number of revolutions of the drum, blades or paddles.
2. The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.
3. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.
4. Slump tests may be made of individual samples taken at approximately the 1/4 and 3/4 points of the load and if the slumps differ by more than 2-inches, the mixer or agitator shall not be used until the condition is corrected. If the slump test is not satisfactorily met by mixers when operated during the minimum specified mixing time and loaded to capacity, or by agitators when loaded to capacity, the equipment may still be used when operation with a longer mixing time or with a smaller load will produce concrete that will meet the slump tests.
5. Ready-mixed concrete shall be mixed and delivered by means of one of the following combinations of operations:
   a. Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitator speed (known as central-mixed concrete).
   b. Mixed partially in a stationary mixer and the mixing completed in a truck mixer (known as shrink-mixed concrete).
   c. Mixed completely in a truck mixer (known as transit-mixed concrete).
6. The mixing may be performed under the surveillance of a representative of the Engineer, either at the plant site or at the jobsite.
7. Mixers and agitators shall be operated within the limits of capacity and speed of rotation designated by the manufac-

turer of the equipment.

8. When a stationary mixer is used for partial mixing of the concrete (shrink-mixing), the mixing time in the stationary mixer may be reduced to the minimum required to intermingle the ingredients (about 30 seconds).
9. When a truck mixer is used either for complete mixing or to finish the partial mixing done in a stationary mixer, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.
10. When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.
11. When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours after the introduction of the cement to the mix. In hot weather or under conditions contributing to quick stiffening of the concrete, a delivery time of less than 1-1/2 hours may be required. When a truck mixer is used for the com plete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been intermixed with the aggregates. Concrete transported in a truck mixer or agitator shall not have been subjected to more than 250 revolutions of the drum or blades at the time it is placed in the work. Intermittent agitation of the concrete will be permitted in order to stay below the maximum of 250 revolutions provided that the time limit of 1-1/2 hours after the introduction of the cement to the mix is not exceeded.
12. The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to ensure continuous delivery at the rate required. The rate of delivery of concrete shall be such as to provide for the proper placing of the concrete. The methods of delivering and handling the concrete shall be such as will facilitate placing with a minimum of rehandling and without damage to the structure or the concrete.

PART 2 - PRODUCTS

2.01 GENERAL

All materials shall be furnished by an established and experienced manufacturer or supplier. All materials shall be new, shall be of first-class ingredients and shall be guaranteed to perform the service required.

2.02 CONCRETE MATERIALS

A. Portland cement, unless noted otherwise in this Section, shall be Type II and shall conform to ASTM C150; it shall meet the requirements of low alkali cement in conformance with Table 1A of ASTM C150. Only one brand of cement shall be used for concrete placed on the project, unless a change in brand is favorably reviewed in writing by the Engineer.

B. Concrete Aggregates (General):
   1. Concrete aggregates shall be free from deleterious coatings, clay balls, roots, bark, sticks, rags and other extraneous materials, and shall be thoroughly and uniformly washed before use.
   2. Unless noted otherwise in this Section, or unless the Contractor's request for use of smaller aggregate has been favorably reviewed by the Engineer, concrete aggregate shall be 1-1/2-inch maximum size for all concrete on the project, except for thin sections, such as slabs or walls 10 inches thick or less, or for sections which require special placement due to shape, form or density of reinforcing, in which case maximum size shall be 3/4-inch nominal.

C. Coarse Aggregate:
   1. General: Coarse aggregate shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or combinations thereof. At the Contractor's option, local lightweight aggregates (specifically rhyolite) conforming to ASTM C330, "Lightweight Aggregates for Structural Concrete," may be substituted for the concrete aggregates specified in these Specifications. In addition to conforming to ASTM C330, the requirement for the possibility of reactivity to alkali in the cement (ASTM C289) and the specified drying shrinkage tests shall apply if this aggregate is optioned. Results of laboratory tests shall be submitted to the Engineer for favorable review prior to design of mix.
   2. Gradation:
      a. Coarse aggregate for Portland cement concrete shall be in accordance with the applicable requirements of ASTM C33, and shall be composed of and properly graded from aggregate segregated into the following two primary size groups which shall be identified by the maximum nominal size in each:

Sieve Sizes	Percentage by Weight Passing Primary Aggregate Nominal Sizes 1-1/2" x 3/4"	3/4" x No. 4
2"	100	-
1-1/2"	90-100	-
1"	20-55	100
3/4"	0-15	90-100
3/8"	0-5	20-55
No. 4	-	0-15
No. 8	-	0-5

b. The gradation of the primary aggregate nominal sizes as furnished for the work shall be of such uniformity that: Of the material of the 1-1/2-inch nominal size, the maximum variation from a favorably reviewed gradation of the percentage of material passing the 1-inch sieve shall be ±15. Such variation is the maximum allowable and will be reduced by the amount necessary to meet the grading requirements set forth in the preceding table.

c. Except in the case of 3/4-inch x No. 4 aggregate, coarse aggregate shall be furnished from both of the primary size groups listed in the foregoing table. Aggregate of each size group shall be handled separately and combined with the other size when the aggregates are proportioned for each batch of concrete.

D. Fine Aggregate:

1. General: Fine aggregate shall be natural sand or a combination of natural and manufactured sand, consisting of material of siliceous, granitic or igneous origin, and shall be hard and durable. It shall be free from oil and injurious amount of clay, shale, mica or other objectionable materials.

2. Gradation:

a. The dry sand or fine mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will conform to the following grading requirements:

Sieve Size	Percentage by Weight Passing
3/8"	100
No. 4	95-100
No. 8	65-95
No. 16	45-80
No. 30	25-55
No. 50	10-35
No. 100	2-10
No. 200	0-5

b. In addition to the required grading analysis set forth hereinbefore, the distribution of the fine aggregate sizes shall be such that the difference between the total percentage passing the No. 16 sieve and the total percentage passing the No. 30 sieve shall be between 10 and 35 percent; and the difference between the percentage passing the No. 30 and No. 50 sieves shall be between 10 and 30 percent.

c. The gradation of the fine aggregate furnished for the work shall be of such uniformity that the material passing the Nos. 16, 30 and 50 sieves will not vary from a favorably reviewed gradation by more than the following:

Max. variation of percentage of material passing the No. 16 sieve ±8
Max. variation of percentage of material passing the No. 30 sieve ±7
Max. variation of percentage of material passing the No. 50 sieve ±4

d. The variations shown immediately hereinbefore are the maximum allowable and shall be reduced by the amount necessary to meet the grading requirements set forth in the preceding table.

Max. variation of percentage of material passing the No. 16 sieve ±8
Max. variation of percentage of material passing the No. 30 sieve ±7
Max. variation of percentage of material passing the No. 50 sieve ±4

d. The variations shown immediately hereinbefore are the maximum allowable and shall be reduced by the amount necessary to meet the grading requirements set forth in the preceding table.

E. Combined Aggregates: Concrete aggregates, for all normal concrete, shall conform to the following requirements: Fine aggregate and coarse aggregate shall be well graded from fine to coarse. Combined aggregate shall be uniformly graded between the screen sizes specified and shall fall within the limits specified below:

Sieve Size	Combined Aggregate 1-1/2" Max.	Combined Aggregate 3/4" Max.
2"	100	-
1-1/2"	90-100	-
1"	50-86	100
3/4"	45-75	55-100
3/8"	38-55	45-75
No. 4	30-45	35-60
No. 8	23-38	27-45
No. 16	17-33	20-35
No. 30	10-22	12-25
No. 50	4-10	5-15
No. 100	1-3	1-5
No. 200	0-2	0-2

2.03 WATER

A. The water for curing, for washing aggregates, for mixing and for patching grout and finishing shall be free from oil and shall not contain more than 1000 parts per million of chlorides as Cl, nor more than 1300 parts per million of sulfates as SO_4. In no case shall the water contain an amount of impurities that will cause a change in the setting time of the portland cement of more than 25 percent, nor a reduction in the compressive strength of mortar at 14 days of more than 5 percent when compared to the results obtained with distilled water.

B. In addition to the above requirements, water for curing concrete shall not contain any impurities in a sufficient amount to cause discoloration of the concrete or produce etching of the surface.

C. The Engineer may require tests of the water should there be a question as to the quality. Costs of such tests would be borne by the Owner.

2.04 ADMIXTURES

A. Air entraining agent shall conform to ASTM C260.

B. Water reducing admixture shall conform to ASTM C494, Type A, or for special conditions, Type F when favorably reviewed by the Engineer.

C. No other admixtures, other than natural pozzolan Type N, air entrainment agent and water reducing admixture, shall be used. Air entraining and water reducing admixtures shall be added to concrete mix ingredients in liquid form by means of a special dispensing unit, approved by the manufacturer of the admixture as suitable for accurately dispensing the admixture. The dispensing unit shall be equipped with suitable devices that indicate proper operation of the unit to the batch plant operator. An alarm or indicator shall be installed which will immediately inform the batch plant operator if the dispensing unit malfunctions. Equipment shall be designed so that its accuracy can be checked conveniently. Admixtures shall be dispensed uniformly into the mixing water as it is added to the concrete batch. The strength of the concrete containing the admixture (used in the amount recommended by the manufacturer for the mixes to be used on this project) shall, at the age of 48 hours and longer, be not less than that of similar concrete without the admixture. Data on admixtures shall be submitted to the Engineer for favorable review prior to use of the admixture in the concrete mix.

D. No admixture containing any chloride ions is acceptable.

2.05 DRY PACK GROUT

Shall be very stiff mix grout, consisting of one part portland cement to two parts sand (by weight) and water. The mixture shall be wetted only sufficiently to moisten the materials to the point where they will ball when squeezed by hand.

2.06 (NOT USED)

2.07 (NOT USED)

2.08 EPOXY ADHESIVE COMPOUND

Epoxy adhesive compound shall be equal to Sikadur epoxy adhesives as manufactured by the Sika Chemical Corporation; or Concresive compounds manufactured by the Adhesive Engineering Company, 1411 Industrial Rd., San Carlos, CA 94070. Compounds shall be suitable for the specific use. These products are represented by W. C. Hodges, Palo Alto, CA.

2.09 EXPANSION JOINT MATERIAL

Expansion joint material shall be a closed cell, non-extruding material, prefabricated and semi-rigid. It shall be capable of providing resistance to weathering and ozone, have good cementing properties, and shall conform to the following requirements. The Contractor shall submit sample for favorable review.

Density	5 Min.-20 Max. lbs. per cu. ft.
Force needed to compress to 50% of thickness	45 ± 10 psi
Force needed to compress to 75% of thickness	20 ± 10 psi max.
Recovery after 3 compressions to 50%; load released after each application and tested one hour after third application	90% min.
Water Adsorption (lbs. of water absorbed per sq. ft. of cut surface after 48 hours immersion under a 10 ft. head)	0.1 max. lbs./ sq. ft.
Applicable temperature range and recommended extreme exposures	-40° to 110°F max. continuous exposures. Higher temperature intermittent exposures.

Acceptable products are Rodofoam PVC joint filler type 327/Semi-rigid as manufactured by W. R. Grace; Premolded Joint Filler, Rubatex R-8409-S or R-8407-S, as manufactured by Rubatex Corp.; or equal.

2.10 SEALANT

Sealant used for joints when shown on the Drawings shall be Vulkem #116, a 1-part self-priming urethane sealant manufactured

by Mameco; or Sikaflex 1a, a 1-component polyurethane-base, non-sag elastomeric sealant, manufactured by Sika Chemical Corporation; or equal. If the second named product is used, one coat of Sikaflex Primer shall also be used. Application of primer and/or sealants shall be in strict accordance with manufacturer's recommendations.

2.11 CURING MATERIALS

A. Concrete may be cured by fog spray, or by one of the following methods after discontinuance of the fog spray.

B. Liquid membrane curing compound, conforming to ASTM C309, Type 1-D, Class B. No curing compound shall be used until favorably reviewed by the Engineer. Curing compound shall be delivered to the project site in unopened containers. The Contractor shall furnish data to the Engineer from the supplier or manufacturer, stating that the compound will comply with the requirements noted above, and will not be incompatible with paint or cement mortar finishes.

C. Sheet materials for curing concrete may be waterproof paper, plastic sheeting or white burlap-polyethylene sheet. Plastic sheeting shall be polyethylene sheeting, fungus-resistant, minimum 4-mil thick, clear and free of defects, having ASTM E96 PERM rating of not more than 0.5, ASTM D882 tensile strength rating of 1200 pounds maximum and elongation of 250 percent. The waterproof paper shall be reinforced in both directions. All shall conform to ASTM C171. Submit samples to Engineer for review.

D. Wet blankets shall be made of clean cotton mats (burlap is unacceptable). The material shall be free from any substance which will have a deleterious effect on the concrete. Mats shall have a thickness sufficient to retain moisture between programmed applications of water.

2.12 FORMS

A. Forms for exposed concrete surfaces shall be faced with clean, smooth plywood. Exposed concrete surfaces include beams, columns, slabs, interior and exterior walls, and surfaces of tank, chamber and tunnel walls except those in contact with earth.

B. Unlined steel forms may be used where concrete work will not be exposed to view. Unlined steel forms may be used for concrete exposed to view if the forms are new, custom-made, and fabricated for this project. Steel forms shall be capable of incorporating reinforcement, inserts, pipe fittings, box-outs, and other details shown on the Contract Drawings without modification to these details.

C. Exposed corners shall be chamfered 3/4-inch, unless otherwise noted on the Contract Drawings.

2.13 FORM COATING COMPOUNDS

Form coating compounds shall not stain or impart any material or residue to the concrete surface detrimental or incompatible with any specified paint system to be applied later. The Contractor shall furnish a letter to the Engineer from the compound manufacturer stating that the material proposed meets this requirement. No form coating shall be used without first receiving favorable review by the Engineer.

2.14 CHEMICAL HARDENER FOR CONCRETE

A polymerized solution of natural chlorinated rubber and epoxy resins containing no wax, oil or silicone materials, containing 18% solids, meeting ASTM C309 type 1. P-C/PROCO CRETE by P-C Western Chemicals, Inc.; Preston CRC 800 by Preston-Pacific; or equal.

2.15 NON-SHRINK GROUT

Non-shrink non-metallic grout shall be premixed, consisting of properly proportioned amounts of non-metallic, dimensionally stable material to which water is added. Submit to the Engineer for review, brand name and product information pertaining to grout proposed for use.

2.16 NON-STAINING CURING PAPER

Two layers of kraft paper laminated with latex adhesive and reinforced with glass fiber. Non-staining. St. Regis Paper Co. Seekure; Conrad Sovig; or equal.

2.17 (NOT USED)

2.18 (NOT USED)

PART 3 - EXECUTION

3.01 PROPORTIONING CONCRETE MATERIALS

A. Concrete shall be proportioned by weight as specified in this Section.

B. No concrete shall be placed prior to favorable review by the Engineer of submittals for reinforcing steel and other materials specified in this Section and of the mix proposed. Unfavorable results of actual pours may necessitate a redesign of mixes.

3.02 BATCHING AND MIXING CONCRETE MATERIALS

A. The mixing and transporting equipment shall be of a favorably reviewed type, or ready mix equipment conforming to ASTM C94 and shall have been certified by the National Ready-Mix Concrete Association. Conform to Paragraph 1.09 of this Section. It shall be capable of combining aggregates, cement, pozzolan, and water, within the specified time, into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The materials of one batch shall be completely discharged before the mixer is recharged.

B. No cement having a temperature exceeding 160°F shall be used in any batch.

C. Mixing may be performed at the site, subject to favorable review of mixing equipment and methods by the Engineer, or may be ready or transit mixed.

D. Ready or Transit Mixed Concrete and Mortar:
   1. Shall be completely mixed when delivered to the project site.
   2. No additional mixing water shall be incorporated into the concrete or mortar during hauling. Water may be added after delivery only when ordered by the Engineer or his representative. Should water be added, the mixing drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharge is commenced.
   3. Each load of ready-mixed concrete or mortar delivered at the job site shall be accompanied by a ticket showing mix design number, volume of concrete or mortar, the weight of cement in pounds and the total weight of all ingredients in pounds. The ticket shall also show the time of day at which the materials were batched and the reading of the revolution counter at the time the truck mixer was charged.
   4. The retempering of any concrete or mortar which has partially hardened; that is, mixing with or without additional cement, aggregate or water; will not be permitted, and such partially hardened concrete or mortar shall not be used in the work.
   5. Concrete shall be deposited in the forms within the time specified in Paragraph 1.09 of this Section.

E. Batching in Adverse Weather:
   1. Cold Weather: When the atmospheric temperature is below 40°F, or is likely to fall below 40°F during the 24-hour period after placing, concrete and mortar materials shall be heated by appropriate means before mixing, so that the temperature of the concrete when deposited shall be between 65° and 80°F. Mixing water shall not be heated over 165°F. Lumps of frozen material and ice shall be removed from the aggregates before they are placed in the mixer.

2. Hot Weather: In hot weather, when temperatures are above 90°F, extra care shall be taken to reduce the temperature of the concrete mix by using iced mixing water, and protecting aggregates and cement from direct rays of the sun. Temperature of the concrete when placed shall not exceed 80°F.
3. Should the provisions noted in 1. and 2. above not be possible or practicable, the concrete pour shall be postponed until favorable weather conditions prevail.

3.03 FORMS

A. General: Forms shall be constructed to conform to the shape, form, line and grade indicated on the Drawings. They shall be made of wood and maintained so as to ensure completed work within the allowable limits specified, and shall be mortar tight.

B. All concrete shall be formed unless specified or favorably reviewed otherwise by the Engineer.

C. Adequacy of the form, bracing, and shoring shall be the sole responsibility of the Contractor. The design shall meet the requirements of ACI 347.

All forms shall be properly braced, shored, tied and supported to ensure stability against pressure from any source, without failure of any component part, and to maintain the desired position and shape during and after placing concrete. If, in the opinion of the Engineer, forms provide inadequate support, all concrete placed shall be removed and replaced at the Contractor's expense.

D. All exposed outside corners, including the top edges of all walls, machinery bases and curbs, shall be chamfered 3/4 inch or as shown on the Drawings. All chamfer strips shall be mill run, surfaced all sides. Chamfer all equipment bases (as shown on details), at all vertical corners and all around top of base. The top edges of sidewalks, walkways and where directed shall be rounded rather than chamfered.

E. Before placing the forms, the contact surfaces of forms shall be coated with non-staining mineral oil or non-staining form coating compound or form release compound. Mineral oil shall not be used on forms for surfaces which are to be painted, dash-coated, plastered or bonded to other concrete. All excess coating shall be removed by wiping clean with cloths. Reused forms shall have the contact surfaces cleaned thoroughly; those which have been coated shall be given an additional application of the coating. It is the intent of these specifications, that wherever exposed unpainted concrete surfaces are constructed, that surfaces shall be uniform in appearance and color.

F. Form Ties:
   1. The number and strength of form ties shall be sufficient to prevent spreading of forms while placing concrete.
   2. Submit manufacturer's descriptive details of form ties for favorable review by the Engineer.
   3. Form ties shall be commercially manufactured steel rods capable of withstanding applied pressures. Wire ties will not be used.
   4. Form ties shall be adjustable in length or of proper fixed length, and the type used shall have no metal closer than 1-1/2 inch to the finished concrete surface. Ties shall not leave holes larger than 1-inch diameter at the surface. use a plastic cone spacer at each end of the form tie to allow a full 1-1/2 inch breakback. Ties shall be provided with 1-inch diameter waterstop washers bonded to rods at the wall centerline or with other favorably reviewed water seal devices.
   5. Remove the removable portion of form ties immediately after stripping the forms. Avoid spalling the exposed concrete surfaces.

3.04 ALLOWABLE VARIATIONS FOR FORMS

A. Except as noted, tolerances for formed surfaces shall meet the requirements of ACI 301.

B. Variations in Size:
   1. Footings:
      a. Variation in length and width from dimensions shown on Drawings -- ±1/2 inch.
      b. Reduction in thickness from dimensions shown on Drawings or specified -- five percent.
   2. Variation in thickness of slabs and walls shown on Drawings, or specified.
      a. For thickness of 6" or less -- 0".
      b. For thickness of more than 6" -- ±1/4".

C. Allowable Tolerances (Location, Lines and Grades):
   1. Horizontal misplacement or eccentricity of footings: Two percent of footing width but not more than 1 inch.
   2. Variation of horizontal dimensions at all floor levels from specified position in plan.
      a. Overall structure dimensions ... ±1/4 inch per 100-foot length. Lesser lengths in proportion.
   3. Variation of vertical dimensions from specified position in plan.
      a. Overall structural dimensions ... ±1/4".
   4. Variation from level or from slopes specified for floors, ceilings, and conspicuous lines.
      a. For overall length of line or surface:
         10-ft. or less .....±1/8 inch
         Up to 20-ft. .....±1/4 inch

b. For any two successive intermediate points on the line or surface separated by:
10-ft. .....1/8 inch
20-ft. or more .....1/4 inch

5. Variation in location from specified position in plan of:
a. Sleeves, pits, floor and wall openings .... ±1/4".

3.05 REMOVAL OF FORMS

A. General: Forms shall be removed without damage to the concrete in a manner to ensure complete safety of the structure. Forms shall not be removed until the concrete has hardened sufficiently to permit their removal with safety, and the members have attained sufficient strength to safely support the imposed loads.

B. Removal Time: The minimum time before removal of forms from walls shall be forty-eight (48) hours and from sides of beams shall be twenty-four (24) hours after placing of concrete. Forms for a surface which will be part of a construction joint (such as vertical surfaces of all slabs, beams, or walls which will be poured in segments) shall not be removed until a minimum of forty-eight (48) hours has elapsed since the pour was completed. In cold weather (40°F or lower), the minimum time for form removal may be increased by the Engineer, if in his opinion a longer time is needed to insure the proper cure of the formed section. Slab forms and shores for framed slabs; suspended slabs; elevated walkways; and elevated beams and girders, and similar types of framing shall not be removed until at least 21 full days after the last pour of concrete, or until the average compressive strength of at least three test cylinders, cast at the time of the concrete pour, is 90 percent of the design concrete strength f_c'. The cylinders shall be field cured in a manner similar to the cure used for the poured structure. Additional cylinders beyond those required in Paragraph 1.04 C. shall be prepared by the Contractor and shall be tested by an independent commercial testing laboratory, all at the Contractor's expense.

C. Variation: The Contractor shall set and maintain concrete forms to ensure that, after removal of the forms and prior to patching and finishing, no portion of the concrete work will exceed any of the tolerances noted herein. Variations in floor levels are to be measured before removal of supporting shores. The Contractor shall be responsible for variations due to deflections resulting from concrete quality or curing other than that which has been specified. The tolerances specified shall not be exceeded by any portion of any concrete surface; the specified variation for one element of the structure will not be applicable when it will permit another element of the structure to exceed its allowable variation.

3.06 PLACING CONCRETE AND GROUT

A. General:

1. Before beginning placement of concrete, hardened concrete and foreign materials shall be removed from the inner surface of the mixing and conveying equipment. All debris shall be removed from the space to be occupied by the concrete. Reinforcement shall be thoroughly secured in position and both forms and reinforcement shall have been favorably reviewed by the Engineer.
2. Water shall be removed from the space to be occupied by the concrete before concrete is deposited, except as specifically exempted herein. Any flow of water into an excavation shall be diverted through proper side drainage to a sump, or be removed by other methods which will avoid washing the freshly deposited concrete. If necessary in the opinion of the Engineer, water vent pipes and drains shall be filled by grouting or other means after the concrete has thoroughly hardened.
3. Concrete shall be handled from the mixer at the site or, in the case of ready-mixed concrete, from the transporting vehicle at the site to the place of final deposit as rapidly as practicable by methods which shall prevent the separation or loss of ingredients. In no case shall concrete which has reached initial set be placed anywhere on the project. If pumping of concrete is used, the concrete mixes shall be especially designed for that purpose by an independent testing laboratory; and the pump mixes shall have been favorably reviewed by the Engineer. Under no circumstances shall concrete that has partially hardened be deposited in the work. Concrete shall be deposited in the forms as nearly as practicable in its final position to avoid rehandling. It shall be so deposited as to maintain, until the completion of the pour, a plastic surface approximately horizontal.
4. No concrete shall be placed until all sleeves, castings, pipes, conduits, bolts, anchors, fixtures, forms for openings and any other items required by this Section and the Drawings are accurately and securely placed within or on the forms.
5. Concrete, regardless of the type of transporting media, shall have the quality required when deposited in the forms. It shall be deposited in layers of from 12 inches to 20 inches in depth. The Contractor is cautioned to avoid too rapid a pour which might cause form failures. Repairs to such damage shall be at the Contractor's expense. Chuting will be permitted only where the concrete is deposited into a hopper before it is placed in the forms. The method of depositing concrete shall be such as to avoid displacing the reinforcement and segregating the aggregate. Maximum height of free fall for concrete during placement shall be not more than 6 feet.
6. Concrete shall be deposited continuously or in layers of

such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located at points as provided for in the Drawings or favorably reviewed by the Engineer.

7. The Contractor shall use every means to secure a dense, impervious, homogeneous concrete, free from voids or pockets. The Contractor shall be responsible for providing fully filled out, smooth, clean and properly aligned surfaces, free from objectionable air pockets. Honeycomb and large air pockets will not be acceptable. If such should occur, the Contractor, at his expense, shall repair the structure to the complete satisfaction of the Engineer, and shall modify his placing method or mix design, at his expense, to prevent recurrence of deficient concrete. Extensive honeycomb or air pockets may be cause for rejection of the work.

B. Vibration:

1. All concrete, with the exception of concrete slabs 4 inches or less in depth, shall be compacted with high frequency, internal mechanical vibrating equipment, and when deemed necessary by the Engineer shall be supplemented by hand spading and tamping. Concrete slabs 4 inches or less in depth shall be consolidated by hand tampers, spreading and settling with a heavy leveling straightedge.
2. Vibrators shall be designed to operate with vibratory element submerged in the concrete, and shall have a frequency of not less than 6000 impulses per minute when submerged. The vibrating equipment shall be at all times adequate in number of units and power of each unit to consolidate the concrete properly. Vibrators shall not be used to transport the concrete horizontally in the forms. The Contractor is advised that for this project this requirement will be strictly enforced. Vibration shall be discontinued when the concrete has been compacted thoroughly and ceases to decrease in volume.
3. Vibration shall be by direct action in the concrete and not against forms or reinforcements. The concrete shall be thoroughly worked around the reinforcement, and around embedded fixtures and into the corners of the forms. Vibration shall penetrate deeply into previously poured layers as new layers are poured, provided the running vibrator penetrates by its own weight. Final layer shall be revibrated. To secure even and dense surfaces, free from aggregate pockets, honeycomb, or air pockets, vibration shall be supplemented when deemed necessary by the Engineer by forking or spading by hand or hammering the forms lightly opposite the freshly deposited concrete.
4. The Contractor shall furnish a sufficient number of vibrators to complete the compaction as specified without caus-

ing delay in the depositing of concrete. He shall have at least one spare unit for each structure when concrete is being placed. There shall be at least one vibrator for each 25 cubic yards per hour of concrete placement.

C. Construction Joints:
   1. Because of the requirement for quality concrete, the Contractor is informed herein that the requirements of this Section will be strictly adhered to. No deviation will be permitted if, in the sole judgment of the Engineer, such deviation would possibly result in lessening the quality of the concrete work.
   2. Construction joints shall be placed at the locations shown on the Drawings, or as located on the favorably reviewed drawing submitted by the Contractor. Vertical construction joints shall be spaced not more than 40 feet apart, unless wall is supported intermediately by perpendicular walls.
   3. All construction joints shall have keyways and shall be constructed as shown on the Drawings. All reinforcing shall run through the joint unless otherwise noted.
   4. Before depositing new concrete on or against concrete which has hardened, the surfaces of concrete, horizontal, vertical, and inclined shall be sandblasted with coarse silica sand sufficiently to clean and roughen the entire surface of the joint exposing clean coarse aggregate solidly embedded in mortar matrix. For joints which are shown on architectural drawings as having a continuous reveal or recess, the wood form used to create the reveal or recess shall be left in place or shall be re-inserted before sandblasting. It shall remain in place to prevent concrete of succeeding pour from filling the reveal or recess, and shall be removed only when the wall form for the concrete pour above the joint is removed. The sandblasted joint shall be drenched with clean water. Horizontal joints shall be covered with a minimum thickness of 2 inches and a maximum of 6 inches of the modified concrete mix, consisting of the designated concrete mix with one-half of the coarse aggregate removed. Special care shall be used in vibrating adjacent to vertical construction joints to ensure thorough consolidation of the concrete against the hardened portion of the joint. Additional hand tamping may be required by the Engineer.

D. Embedded Items:
   1. The Contractor shall be responsible for placement of all equipment, bolts, anchors, sleeves, inserts, structural steel members and angles and similar items which require embedment in the concrete.
   2. All ferrous metal sleeves, inserts, anchors, and other embedded ferrous items shall be hot-dipped galvanized wherever shown or called for. Anchor bolts for equipment shall be set to templates, shall be plumbed carefully and checked for location and elevation with an instrument, and shall be

held in position rigidly by double nutting to the template to prevent displacement while concrete is being poured.

3. Reinforcement bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items, but not so as to impair design strengths of the member. If bars are moved more than two bar diameters, the resulting arrangement of bars shall be submitted to the Engineer for review.
4. Installation of all embedded items and reinforcing shall be accomplished under the observation of the Engineer, or his representative.

E. Precast Items:
1. Any precast concrete items may be cast on or off the site, at the Contractor's option.
2. Pours for precast items shall be governed by all applicable portions of this Section, including, but not limited to, materials, forms, placement, finish and curing.
3. Particular care shall be taken when handling and placing the precast items. None shall be lifted or moved until a strength of 90 percent of the design f_c' has been attained. The average compressive strength of three test cylinders shall be used for this determination.

3.07 PATCHING NEW CONCRETE

A. Immediately after carefully removing forms, all concrete surfaces will be inspected by the Engineer. Any defective work such as concrete out of line, level or plumb; cracks; poor joints; rock pockets; honeycomb; voids; spalls and exposed reinforcing; together with tie bolt holes, shall be patched at once before the concrete is thoroughly dry.

B. Minor areas to be patched shall be cleaned thoroughly. Curing compound shall not be applied to these areas prior to patching. Minor honeycombed or otherwise defective areas shall be cut out to solid concrete but to a depth of not less than 1 inch. The edges of the cut shall be slightly more than perpendicular to the surface of the concrete, so as to form a key.

C. Major defects of large areas involving voids or rock pockets extending through the section may be cause for rejection of the work. If, in the opinion of the Engineer, repairs can be made without adversely affecting the structural integrity of the work, the section shall be cut out and shall be either dry packed, or
1. Reformed and repoured to match the adjacent concrete. The reinforcing shall not be cut in the repair, and keyways shall be cut into the adjacent sound concrete to securely fasten the patch to the original work. All surfaces shall be coated with epoxy adhesive compound immediately prior to patching. The concrete patch shall be placed before the

epoxy adhesive compound has set. The epoxy adhesive compound shall be mixed and used in accordance with the manufacturer's recommendations.

2. The patch shall have a 28-day compressive strength of 3500 psi. The patch shall be cured in accordance with Paragraph 3.08 of this Section.

D. Material for patching all form tie holes and minor defective areas shall be cement mortar, as specified. The amount of water used in mixing the patch material shall be as little as consistent with the requirements of handling and placing. The patching material shall be thoroughly compacted into place and screeded off to leave the patch flush with the surrounding surface. Keep the surface damp for at least 48 hours.

E. Any visible leaks at joints or cracks which do not heal autogeniously within a period of 7 days shall be repaired by a method favorably reviewed by the Engineer.

3.08 CURING AND PROTECTION

A. Concrete shall be protected adequately from injurious actions by sun, rain, flowing water, frost and mechanical injury, and shall not be allowed to dry out from the time it is placed until the expiration of the minimum curing periods specified hereinafter. After the initial moist cure, curing shall be accomplished by moist curing, impervious-sheeting curing, or by application of liquid membrane-formed compound, in accordance with the provisions noted hereafter. Favorable review of the Engineer shall be obtained prior to the use of any alternative to the moist cure specified herein for slabs.

B. Unless otherwise directed, all concrete slab finish shall be given a uniform moist cure spray treatment for at least 36 hours, immediately following final troweling, using clean water and special fog spray nozzles of type and number required to keep entire surface moist. During hot or dry weather, the length of curing time and number of nozzles shall be increased as necessary to prevent shrinkage cracking. During cold weather, fog spraying shall be reduced as necessary and the slabs protected to prevent damage by frost. All traffic shall be kept off the floor surfaces for the first 36 hours of curing.

C. If fog curing is not continued after 36 hours, the slab surface shall be further cured by one of the following methods:

1. Waterproof curing paper shall be placed smoothly upon the moist concrete surface with all joints and edges lapped a minimum of 4 inches and continuously sealed with tape and kept in place for at least 14 days. No paper that will leave an impression on the finish shall be used. Torn or scuffed sheets shall be repaired or replaced during the entire 14-day curing period, and resealed.

2. Polyethylene plastic sheeting shall be installed and maintained in the same manner as for curing paper for at least 14 days.
3. Liquid membrane curing compound, if favorably reviewed by the Engineer.

D. Only if waterproof curing paper or polyethylene plastic sheeting is used for curing slab finish as in C.1. or C.2. above, light foot traffic will be allowed on slabs upon installation of the plastic sheeting or paper. Use of these surfaces for storage of other building materials shall be deferred until there is no danger of damage to the finished slab surface.

E. Only after 14 days curing may materials be placed on these slab areas. They shall be placed on wood sleepers or plywood in order to protect finished surfaces.

F. All concrete surfaces other than slabs may be cured by some method of moist curing favorably reviewed by the Engineer. They shall be kept continuously and thoroughly wet for not less than 14 days. Moist curing shall be continued for a longer time where necessary to attain specified strength. The Contractor shall provide sufficient hose or pipe to extend to all areas where water is required.

G. As an alternate method for moist curing all concrete surfaces other than slabs, the Contractor shall cure such surfaces by spraying with liquid membrane-forming compound immediately after stripping the forms.
1. Liquid membrane-forming compound curing shall be accomplished by applying a clear compound containing a fugitive dye, free of paraffin or petroleum, over the concrete surface to restrict evaporation of the mixing water. All joint openings shall be sealed at the top by inserting moistened paper or fiber rope or covering with strip of waterproof material prior to application of the curing compound, in a manner to prevent the curing compound from entering the joint. Ten days following the placing of the liquid membrane-formed compound shall be considered as the end of the curing period and the basis for determining when joint sealing material will be placed in joints.
2. The compound shall be applied immediately after the forms have been stripped. Curing compound shall be agitated thoroughly by mechanical means during use and shall be applied uniformly in a two coat continuous operation by appropriate power-spraying equipment. The total coverage for the two coats shall be between 150 and 200 square feet per gallon of undiluted compound. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply two coats if required by the Engineer. An additional coat of the compound shall be applied

immediately to areas where the film is defective. Specified covering, other than liquid curing compound, shall be kept readily available for use to protect the freshly placed concrete in the event conditions occur which prevent correct application of the compound at the proper time. Concrete surfaces that are subject to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed (when slab reaches a moist condition and there is no standing water) with two coats of curing compound by the foregoing method and coverage, at the Contractor's expense.

3. Removal of curing compound inadvertently sprayed on reinforcing steel or construction joint areas shall be by sandblasting. If the cones of tie holes are sprayed with curing compound, such tie holes shall be lightly reamed prior to patching tie holes.
4. Liquid membrane curing shall not be used on surfaces to be painted, surfaces which are to receive a bituminous membrane, or surfaces which are to receive a special finish, such as vinyl asbestos tile, ceramic tile, carpeting, or a treatment of any kind which would be incompatible with the liquid membrane cured surface. See the "Finish Schedule" on the Drawings.

H. Cold Weather Requirements: Adequate equipment shall be provided for heating the placed concrete during freezing or near freezing weather. The following operations shall be employed:
1. Whenever the temperature of the surrounding air is below 40°F, or when the possibility exists that the temperature will fall below 40°F within the 24-hour period subsequent to the pouring of concrete, all freshly poured concrete shall be maintained at a temperature of not less than 70°F for 3 days or 50°F for 5 days. The housing, covering, or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heating is discontinued. No manure, salt, calcium chloride, or other chemicals shall be used on the concrete to prevent freezing.

I. The Contractor shall submit his complete proposed method and program of curing for review by the Engineer.

3.09 (NOT USED)

3.10 (NOT USED)

3.11 (NOT USED)

3.12 CLEAN-UP

Upon completion of all work performed under this Section, all excess materials, storage facilities and temporary facilities, used exclusively for the work under this Section, shall be

removed from the site. Areas which were used or occupied during concrete construction operations shall be smoothed and cleaned of debris, and left in first-class condition.

END OF SECTION

SECTION 15050

PIPING

TABLE OF CONTENTS

SECTION 15050
PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

Work Included in this Section: The Contractor shall furnish and install all piping, and accessories as shown on the Drawings, described in the Specifications and as required to complete the pipe.

1.02 QUALITY ASSURANCE

All materials and equipment furnished under this Section shall be of a manufacturer who has been regularly engaged in the design and manufacture of the materials and equipment. Demonstrate to the satisfaction of the Engineer that the quality is equal to the materials and equipment made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.

1.03 SUBMITTALS

Shop Drawings:

1. Verify by excavation, inspection and measurement all installation conditions for shop fabricated pipe before preparation of Shop Drawings. Submit field measurements and photos with Shop Drawings where exposed conditions are significantly different than indicated on the Drawings.
2. Submit data to show that the following items conform to the Specification requirements:
   a. Pipe, fittings, and accessories.
3. Submit certified test reports as required herein and by the referenced standard specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pipe sizes are nominal inside diameter unless otherwise noted.

B. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.

C. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping shall be based on inspection and leakage tests as specified hereinafter.

2.02 GENERAL MATERIAL REQUIREMENTS

Gaskets: Unless specifically specified otherwise, all gaskets shall be chloroprene.

2.03 PIPING MATERIALS

A. Low Level Outlet Works:
   1. Pipe: Reinforced concrete pipe, ASTM 76, Class V, C-Wall design.
   2. Manufacture: Pipe shall be centrifugally spun or vertical cast only. Forms for steam cured pipe shall not be removed until 6 hours after the completion of concrete placement, and forms for water cured pipe shall not be removed until 12 hours after the completion of concrete placement.
   3. Cement: Type II.
   4. Joints: Single gasketed bell and spigot, all concrete, with bell cast integral with the pipe. Beveled joints up to 2-1/2 degrees may be used, ASTM A361.
   5. Factory Testing:
      a. Hydrostatic tests performed in accordance with ASTM C361 shall be witnessed by the Engineer prior to the delivery of this pipe type to the job site. Test pressures shall be 25 psi. Hydrostatic test on pipe and hydrostatic test on rubber gasket joints shall be made with two pieces of pipe selected at random by the Engineer.
      b. Concrete tests in accordance with ASTM C361.
      c. Rubber gasket compound tests in accordance with ASTM C361.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. General Handling and Placing:
   1. All piping shall be placed or erected to accurate line and grade and shall be backfilled, supported, hung, or braced against movement as specified or shown on the Drawings, or as required for proper installation. All dirt and foreign matter shall be removed from the pipe interior prior to installation and all joints shall be thoroughly cleaned before joining.
   2. Pipes 10-inch and larger penetrating new concrete walls shall be cast into the wall without blockout.

B. General Buried Piping Installation:
   1. Trenching, bedding, and backfill for buried piping shall be as shown on the Drawings and as specified in Section 02201, EXCAVATION.
   2. Where Pipe grade elevations are shown on the Drawings, install the pipe with straight grades between the indicated

elevations.

3. Each pipe shall have a firm, uniform bearing for its full length in the trench except at field joints. No pipe shall be laid in water or when trench conditions or weather are unsuitable for such work.

C. Installation Specifics:

1. Low Level Outlet Works:

a. Unless specifically otherwise shown, each length of pipe shall be laid on a firm bed and shall have a true bearing for its entire length between bell holes. Holes of only sufficient size to accommodate the bell shall be excavated at each joint location. Adjustment to line and grade shall be made by scraping away, filling in, and tamping the backfill material to provide true grade to fit the barrel of the pipe. No wedging or blocking up of the pipe shall be permitted.

b. Both bell and spigot shall be clean before the joint is made and care shall be taken that nothing but the joint material and lubricant enters the joint. Pipe spigot, bell, and gasket shall be lubricated in accordance with the manufacturer's recommendations. Gasket shall be properly placed into the groove on the spigot before joining. Pipe shall be jointed together to provide the proper space betwen abutting ends of pipe. Joints may be pulled to compensate for slight grade and alignment changes. In no case shall the joint pull exceed 1/2 inch or 1/2 the manufacturer's recommended value, whichever is smaller.

c. After a joint is assembled, a thin metal feeler gauge shall be inserted between bell and spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If gasket is not in proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked.

d. After making the joint, the pipe shall be rigidly secured in place by backfilling to the top of the pipe on each side of the pipe at the center section, but not as to fill the bell hole nor interfere with the next jointing operation, using Select Backfill Material compacted in such a manner as not to disturb the pipe.

e. When pipe laying is not in progress, the forward end of the pipe shall be kept effectively closed with a temporary plug.

3.02 FIELD TESTING

A. General: Perform leakage tests on all pipe installed in this project. Furnish all equipment, material, personnel and supplies to perform the tests and shall make all taps and other necessary temporary connections. The test pressure, allowable

leakage and test medium shall be as specified and as shown in the following Schedule. Test pressure shall be measured at the highest point on the line unless specifically noted otherwise. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Engineer.

B. Buried Piping: The leakage test for buried piping shall be made after all pipe is installed and backfilled. However, the Contractor may conduct preliminary tests prior to backfill. If the Contractor elects to conduct preliminary tests, provide any necessary temporary thrust restraint.

C. Testing Apparatus: Provide pipe taps, nozzles and connections as necessary in piping to permit testing including valves to isolate the new system, addition of test media, and draining lines and disposal of water, as is necessary. These openings shall be plugged in a manner favorably reviewed by the Engineer after use. Provide all required temporary bulkheads.

D. Correction of Defects: If leakage exceeds the allowable, the installation shall be repaired or replaced and leakage tests shall be repeated as necessary until conformance to the leakage test requirements specified herein have been fulfilled. All visible leaks shall be repaired even if the pipeline passes the allowable leakage test.

E. Reports: The Contractor shall keep records of each piping test, including:
1. Description and identification of piping tested.
2. Test pressure.
3. Date of test.
4. Witnessing by Contractor and Engineer.
5. Test evaluation.
6. Remarks, to include such items as:
   a. Leaks (type, location).
   b. Repairs made on leaks.

Test reports shall be submitted to the Engineer.

F. Testing Specifics:
1. Low level Outlet Works:
   a. Duration: Four hours.
   b. Pressure: 22 psi.
   c. Medium: Potable water.
   d. Presoaking: Fill pipeline at least four hours before beginning test.
   e. Allowable Leakage:

$$\frac{17 \text{ gallons}}{\text{inch diameter-mile}}$$

APPENDIX I

HARDING LAWSON ASSOCIATES

GEOTECHNICAL REPORT, OCTOBER 1988

Harding Lawson Associates

November 9, 1988

0843,149.05

Kennedy/Jenks/Chilton
160 Hubbard Way, Suite 2
Reno, Nevada 89502

Attention: Mr. Phil Logan

Gentlemen:

SUPPLEMENTAL RECOMMENDATIONS
GEOTECHNICAL INVESTIGATION
PROPOSED DANT BOULEVARD DETENTION DAM
RENO, NEVADA

At your request, this letter provides supplemental recommendations to our previously submitted report entitled "Geotechnical Investigation Proposed Dant Boulevard Detention Dam," dated October 27, 1988.

Spillway wing wall design may assume a maximum foundation bearing pressure of 2,500 pounds per square foot (psf) for footings founded on compacted embankment soils or undisturbed, natural dense soils. This assumes a minimum footing width of 18 inches and a minimum effective embedment depth of 12 inches. Lateral design can assume a lateral passive pressure of 300 psf per foot and a friction factor of 0.4 on the base of footings, to be utilized with dead loads only.

You requested we provide our opinion with regard to the permeability of the compacted embankment materials. For the soil types encountered in the borrow area, we estimate the permeability in the embankment will range from 10^{-4} centimeters per second (cps) to 10^{-6} cps. In our opinion, these permeabilities will retard the formation of a line of seepage through the embankment given the expected short time frame of water impoundment (i.e., on the order of one day).

We trust this provides you with the information you require at this time. Please call if you should have any questions.

Very truly yours,

HARDING LAWSON ASSOCIATES

Scott S. Smith
Civil Engineer - 6853 (NV)

SSS/et

A Report Prepared for

Kennedy/Jenks/Chilton
160 Hubbard Way, #2
Reno, Nevada 89502

GEOTECHNICAL INVESTIGATION
PROPOSED DANT BOULEVARD DETENTION DAM
RENO, NEVADA

HLA Job No. 0843,149.05

by

Mary E. Wells
Staff Engineer

Scott S. Smith
Civil Engineer - 6853 (NV)

Harding Lawson Associates
940 Matley Lane
Reno, Nevada 89502
(702) 329-6123

October 27, 1988

TABLE OF CONTENTS

I. INTRODUCTION

This report presents the results of our soil investigation at the site of the proposed Dant Boulevard Detention Dam. The embankment will serve a dual purpose. It will extend the existing Dant Boulevard to the south into the Lakeridge Development and serve as a flood and debris detention structure. It will be an approximately 50 feet high and 500 feet long earthfill structure. The borrow for the embankment will come from an area immediately east and southeast. The location of the embankment and borrow areas are shown on Plate 1.

The outlet pipe will be a 42-inch diameter reinforced concrete pipe (RCP). It will be constructed as a positive projection pipe and bedded in Type II base material.

The emergency spillway will be constructed over the embankment. It will pass under the road as a double box culvert. The box culvert will discharge into a lined concrete U-channel spillway. Spillway walls will be backfilled and will vary in height from 4 feet near the road to 15 feet at the concrete stilling basin.

The scope of our services included:

- Excavation, logging, and sampling seven (7) test pits within the proposed embankment area.
- Excavation, logging, and sampling six (6) test pits within the proposed borrow area.
- Surface geologic mapping within the embankment area.
- Laboratory classification testing of potential borrow soils.

- Analysis of field and laboratory data.
- Preparation of a written report including:

  1. Summary logs of test pits.
  2. Geology map of embankment area.
  3. Summary of laboratory test results.
  4. Conclusions and recommendations with regard to:

     - Site Preparation
     - Embankment Construction and Stability
     - Outlet Works
     - Emergency Spillway

II. FIELD AND LABORATORY INVESTIGATION

A total of seven test pits (Pits 1 through 7) were excavated within the embankment area, at locations approximately shown on Plate 2. Six additional test pits (Pits 8 through 13) were excavated within the proposed borrow area, at locations shown on Plate 1. The test pits were excavated to depths varying from 8 to 12 feet below existing grade. The subsurface materials exposed in the pits were logged by our engineering geologist who also mapped the surface geology in the embankment area. Selected bulk (disturbed) samples of the subsurface materials were obtained and returned to our laboratory for testing.

The geologic map is shown on Plate 3. Summary logs of the subsurface materials encountered in the test pits are presented on Plates 4 through 10. The soils were classified in accordance with the ASTM D2487-85 Soil Classification System described on Plate 11.

Representative samples of the soils were tested for plastic limit, liquid limit, and grain size. The results of these tests are summarized on Plates 12 through 15 and on the test pit logs.

III. SURFACE AND SUBSURFACE CONDITIONS

A. Embankment Area

The slopes forming the abutments on the north and south side are both approximately 30 feet high. The right abutment is sloped at approximately 2:1 (horizontal:vertical). The left abutment slope varies but has an average slope of approximately 3:1. The drainage area in the center is approximately 150 feet wide. The area is covered with sparse vegetation consisting of sagebrush and grass. Isolated large brush is located along the current drainage courses.

Our engineering geologist mapped the surface exposures at the site of the embankment. As shown on the geologic map, the site is mainly underlain by alluvial fan soils of the Peavine Mountain. These soils were encountered at the surface in Test Pits 1 through 4. The soils encountered were generally very dense, dry to moist, brown, well-graded gravel with sand, overlying a stiff to hard, moist, brown sandy silt containing gravel. A thin veneer of loose to medium dense, silty sand and soft, sandy silt capped the subsurface soils at Test Pits 1 and 2, respectively.

Artificial fill soils were encountered to a depth of approximately 2-1/2 feet in Test Pit 5 and to the full depth in Test Pits 6 and 7. The fill soils are generally loose and soft and not suitable to support the proposed embankment in their current state. The fill was

most likely placed as part of the housing and street construction north of the embankment area.

B. Borrow Area

The borrow area slopes gently to the northeast at approximately 10 percent. It is covered with sparse sagebrush and grass.

The subsurface materials encountered in the test pits consisted mainly of a very dense, dry, well-graded gravel with sand, silt and cobbles. Cemented layers of this formation were encountered below a depth of approximately 2 feet in Test Pits 8, 9, 10, and 11. Refusal was encountered at approximately 8 feet in Test Pits 8, 12, and 13. An approximately 2-foot thick upper layer of a very stiff, dry, sandy lean clay with gravel was encountered in Test Pits 8 and 12. An approximately 2-foot thick upper layer of dense, dry, clayey sand with gravel was encountered in Test Pit 13.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Site Preparation

The existing fill soils located on the left abutment are not suitable to support the proposed embankment. These soils should be removed to expose native, natural, dense soils. The removal of fill should extend horizontally beyond the embankment a distance equal to the depth of fill at the toe of the embankment.

The area upon which embankment or structures are to be placed should be cleared, grubbed, and stripped to remove brush, roots, organic soils, and any existing improvements. It is estimated that the stripping depth required will vary between 3 to 6 inches. Areas to receive fill should then be scarified to a depth of 6 inches, conditioned to a moisture content near optimum, and compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557-78. If the scarification turns up a significant amount of boulders, the subgrade can be prepared by proof rolling to a non-yielding surface. Abutment areas steeper than 5:1 (horizontal:vertical) should be benched into competent natural soils a minimum horizontal distance of 5 feet before embankment is placed.

B. Embankment Construction

The soils encountered in the test pits within the proposed borrow area are suitable as embankment fill. The fill soils encountered in the left abutment area may be reused as embankment fill. The sandy clay and clayey sand soils encountered in the borrow area should not be allowed within 2 feet of the proposed Dant Boulevard roadbed. The borrow area should be stripped of all vegetation before excavation commences. We estimate this excavation depth may vary from 3 to 6 inches.

The embankment fill should be placed in approximately horizontal lifts with a maximum loose thickness of 8 inches. Rocks greater than 8 inches in least dimension should either be screened before placement or raked and disposed of over embankment slopes. No deleterious material should be allowed in the fill. The fill should be compacted to a minimum of 90 percent relative compaction near optimum moisture content as determined by the ASTM D1557-78 method.

C. Outlet Pipe and Spillway

The natural soils at the proposed embankment location will provide adequate support for the RCP outlet pipe. We recommend cut-off collars be constructed around the outlet pipe. The collars should penetrate a minimum of 12 inches into the native soils.

The concrete spillway can be founded on either the compacted embankment soils or native, stiff or dense soil. We recommended the spillway walls be backfilled with a well graded soil meeting the following specification:

Maximum Size	Less than 1 inch
Liquid Limit	Less than 40
Plastic Limit	Less than 10
Passing No. 200 Sieve	Less than 40% Greater than 15%

If backfilled with this material, the cantilevered walls can be designed for an equivalent fluid density of 35 pounds per cubic foot, if the backfill surface is level and adequate drainage is provided so that hydrostatic pressures are not developed.

V. EMBANKMENT DESIGN

It is proposed to construct the embankment with upstream and downstream slopes of 3:1. This is a very conservative slope with respect to slope stability. As an example, if it is conservatively assumed the compacted embankment materials have shear strength parameters consisting of an internal friction angle of 32 degrees and an apparent cohesion of 100 pounds per square foot, published charts predict a factor of safety of approximately 2.0. This factor of safety assumes a line of seepage is not formed within the embankment. We believe however that this assumption is valid since the embankment will impound water for a period of 1 or 2 days, at the most. This is not sufficient time for significant seepage to develop within the embankment because of the well graded nature of the proposed embankment materials. For this same reason, we do not see the need to incorporate internal seepage controls within the embankment structure.

A twelve inch thick layer of rip-rap will be placed on the upstream and downstream slopes. Given the small size of the rip-rap and the proposed 3:1 slopes, it is our opinion the rip-rap can be placed directly on the embankment face after the face has been proof rolled.

VI. CONSTRUCTION AND TESTING

We should review the project plans and specifications for conformance with the intent of our recommendations. Site preparation and grading should be performed under our observation and testing to permit us to check that soil conditions are consistent with our findings. We should evaluate variations of soil conditions which require special consideration or modification of our recommendations.

PLATES

ORIGINAL

FILE IN TRIPLICATE

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES

Application No..... Filed.....

APPLICANT MUST NOT FILL IN ABOVE BLANKS

APPLICATION FOR APPROVAL OF THE PLANS AND SPECIFICATIONS FOR THE CONSTRUCTION, RECONSTRUCTION OR ALTERATION OF A DAM

This Application Involves in No Way the Right to Appropriate Water

To secure the right to appropriate water, application should be made to the State Engineer on forms which will be furnished upon request.

I, Phillip J. Logan (Name of applicant) of 160 Hubbard Way, Suite 2 (Address) Reno, Nevada 89502, hereby make application for the approval of the plans and specifications for the Construction (Construction, reconstruction, alteration) of Dant Boulevard Detention (Name of dam) dam.

The owner of the proposed dam is City of Reno (Name of owner)

of P.O. Box 1900, Reno, Nevada 89510 (Address) State of Nevada

If the owner is a corporation, give name and address of president and secretary—

n/a

The applicant is acting for the owner in the legal capacity of Agent (Agent, Lessee, Trustee, etc.)

Location of Dam

1. The source of water to be stored is unknown (Name of stream or underground) which is a tributary of unnamed drainage (Stream),

and the proposed dam to be located within the SE ¼, NE ¼, Sec. 27

Twp. 19, R. 19 E., M.D.B. & M. in Washoe County, Nevada.

Description and Dimensions of Dam

(If for an alteration, the data given below is for the altered dam)

2. Type of dam earth (Concrete arch or gravity, earth, rockfill, etc.) 3. Length of crest 500 ft.

4. Height stream bed to spillway crest 32 ft. 5. Height foundation to spillway crest 33 ft.

6. Freeboard 10 ft. (Spillway crest to top) 7. Thickness at top 59 ft. 8. Thickness at bottom 300 ft.

9. Slope upstream* 3h:1v 10. Slope downstream* 3h:1v 11. Upstream facing* rip-rap (Concrete or rock paving, etc.)

*This information to be supplied for earth or rockfill dams.

12. Amount of material in dam 80,000 (Approximate) cu. yds. 13. Estimated cost $ 830,000.

14. Spillway data Reinforced concrete, 24 feet wide, 1400 cfs at max pool (Type, capacity, etc.)

15. Outlet data 36" diameter RCP with submerged inlet, 110 cfs at max pool (Type, capacity, etc.)

16. Elevation of crest of dam 4710 (Approximate elevation to be given if true elevation not available) above MSL (NVGD) datum

17. Area of reservoir at spillway level 25 acres. 18. Capacity of reservoir 80 @ max pool ac. ft.

$100 filing fee must accompany this application

General Information

19. State the **purpose** of the dam Storm Water Detention
Diversion only; storage only; storage and diversion; debris storage, etc.

20. State the **use** that is to be made of water n/a
Municipal, domestic, irrigation, power, mining and milling, recreation, or stockwatering

21. Engineers Kennedy/Jenks/Chilton
Name and address of Engineers preparing plans
160 Hubbard Way, Suite 2
Reno, Nevada 89502

22. If the proposed dam is to be built under Federal supervision, state what department has jurisdiction
n/a

23. The maps, plans and specifications accompanying this application are a part thereof.

[SIGNED] Phillip J. Rogers
Applicant

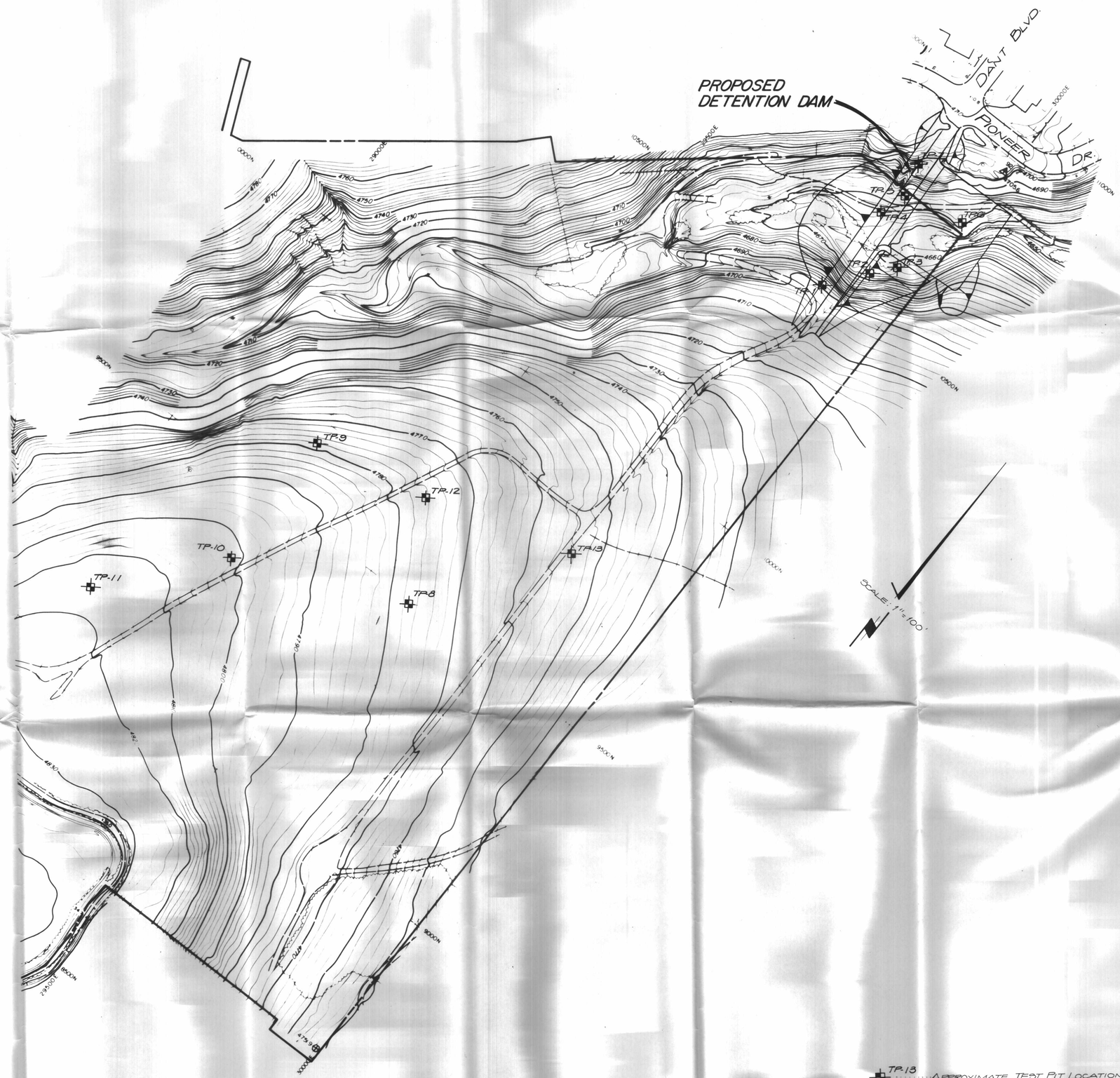
this 17 day of Nov., 19 88

APPROVAL OF APPLICATION NO. ....., INCLUDING THE PLANS AND SPECIFICATIONS

THIS IS TO CERTIFY That Application No. ....., including the plans and specifications for the .....dam has been examined and the same is hereby .....approved, subject to the following conditions:

Witness my hand and seal this .....day of .....19.....

.....
State Engineer



TP-13 ..... APPROXIMATE TEST PIT LOCATION.

TEST PITS 8 THROUGH 13 IN PROPOSED BORROW AREA.

JOB NO. 0843.149.03
DESIGNED BY MEW
DRAWN BY MEW
CHECKED BY SS
DATE 10-03-88
APPROVED BY
DATE

R.E. No.

NO.	DATE	REVISIONS	BY

SITE PLAN
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

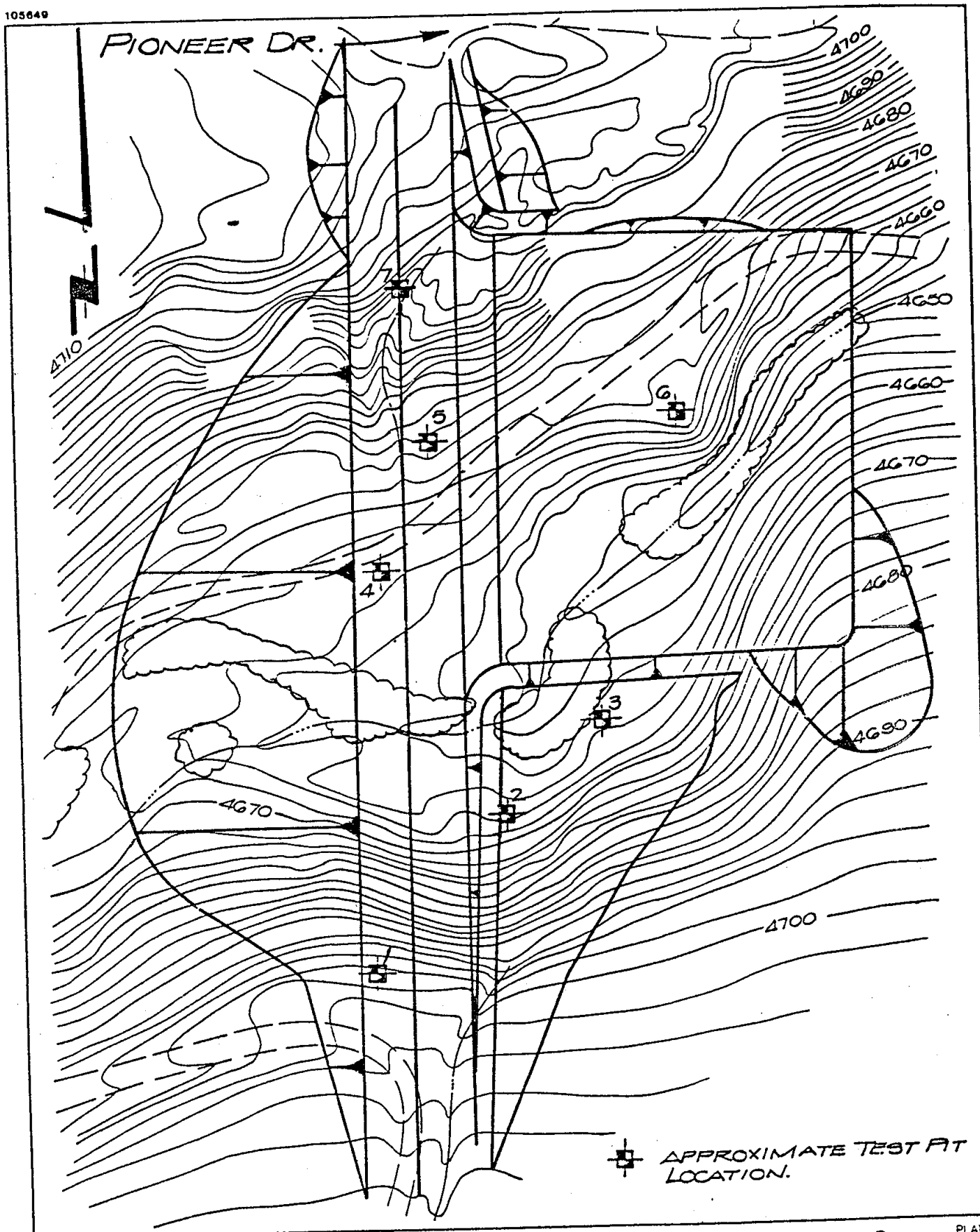
Harding Lawson Associates
Engineers, Geologists & Geophysicists
940 MATLEY LANE
RENO, NEVADA 89502
702 / 324-6723

NEVADA
CALIFORNIA
TEXAS
COLORADO
ALASKA
HAWAII

PLATE
1

NOV 17 1988

105649



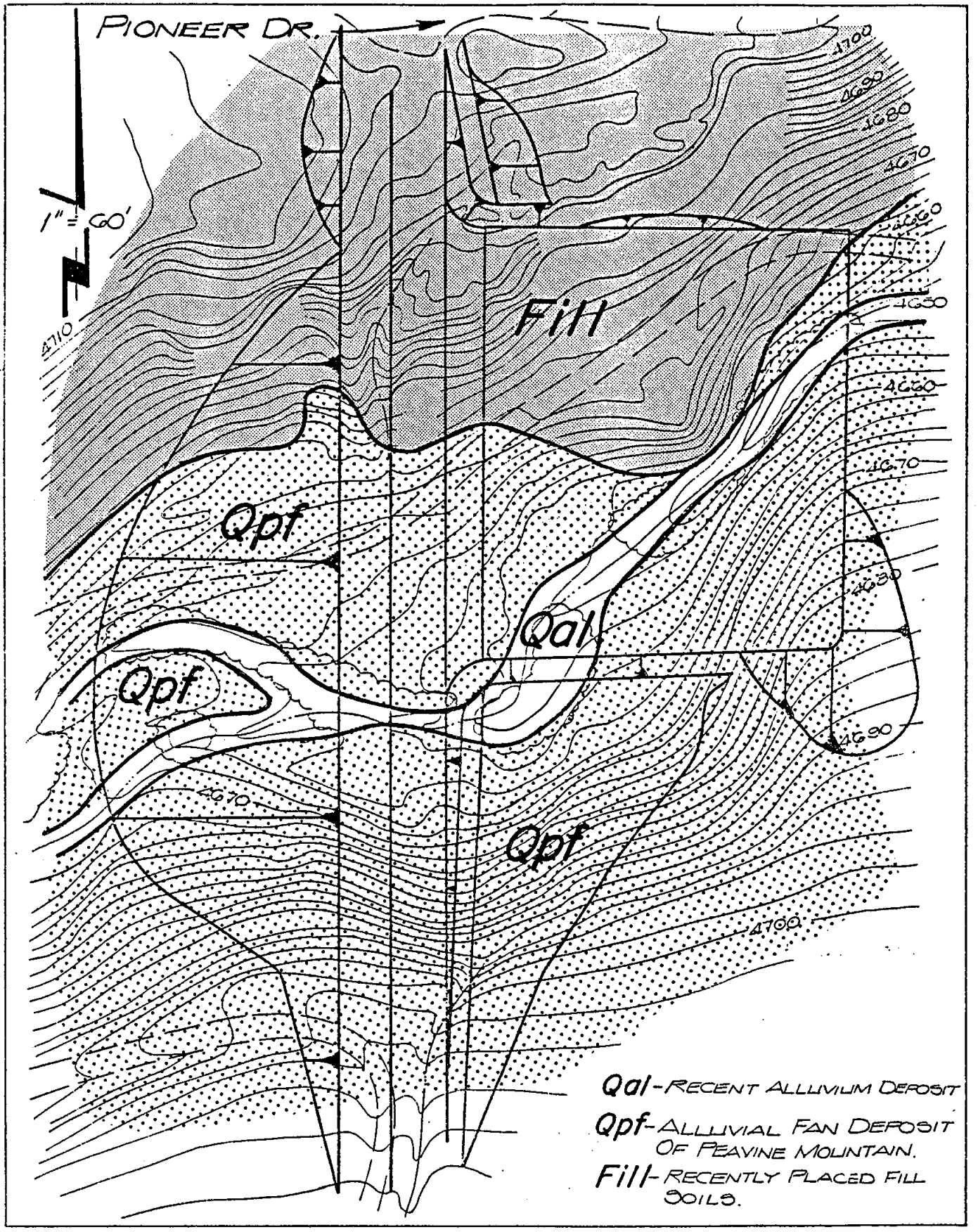
Harding Lawson Associates
Engineers and Geoscientists

APPROXIMATE TEST PIT LOCATIONS
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	00843.149.05	SBS	10-3-88		

105649



Harding Lawson Associates
Engineers and Geoscientists

GEOLOGIC MAP
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	00843,149.05	SBJ	10-3-88		

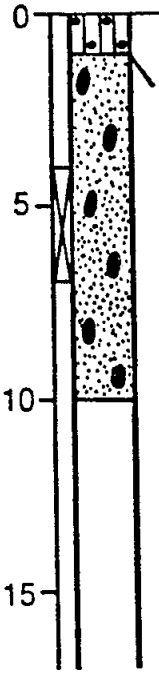
Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

LOG OF TEST PIT 1

Equipment Ford Backhoe

Elevation ± 4699 Ft.[1] Date 9/14/88

Depth (ft) | Sample



0 — DARK RED BROWN SILTY SAND (SM)
Loose to medium dense, dry
BROWN WELL GRADED GRAVEL WITH SAND (GW)
Very dense, dry

5

10 — Test pit terminated at 10.0 feet

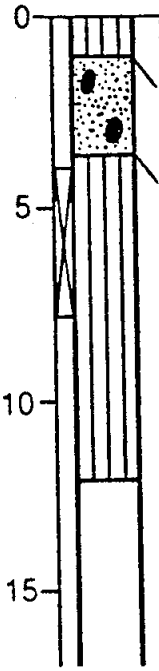
15

LOG OF TEST PIT 2

Equipment Ford Backhoe

Elevation ± 4666 Ft. Date 9/14/88

Depth (ft) | Sample



0 — DARK BROWN SANDY SILT (ML)
Soft, moist
RED BROWN WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)
Dense to very dense, moist
BROWN SANDY SILT WITH GRAVEL (ML)
Very stiff to hard, moist, some plasticity

5

10 — Test pit terminated at 12.0 feet

15

[1] Elevations interpolated from site topographic map, Plate 1.

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOGS OF TEST PITS 1 AND 2
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05	SSG	10/4/88		

Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

LOG OF TEST PIT 3

Equipment Ford Backhoe

Elevation ± 4663 Ft. Date 9/14/88

Depth (ft)	Sample	
0		BROWN WELL GRADED GRAVEL WITH SAND (GW) Cobbles to 12", very dense, dry
5		GRAY BROWN SANDY SILT (ML) Very stiff, moist
10		Test pit terminated at 10.0 feet
15		

LOG OF TEST PIT 4

Equipment Ford Backhoe

Elevation ± 4667 Ft. Date 9/14/88

Depth (ft)	Sample	
0		DARK BROWN WELL GRADED GRAVEL WITH SAND (GW) Cobbles to 12", dense to very dense, slightly moist
5		RED BROWN SANDY SILT (ML) Stiff to very stiff, moist
10		Test pit terminated at 10.0 feet
15		

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOGS OF TEST PITS 3 AND 4
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 5

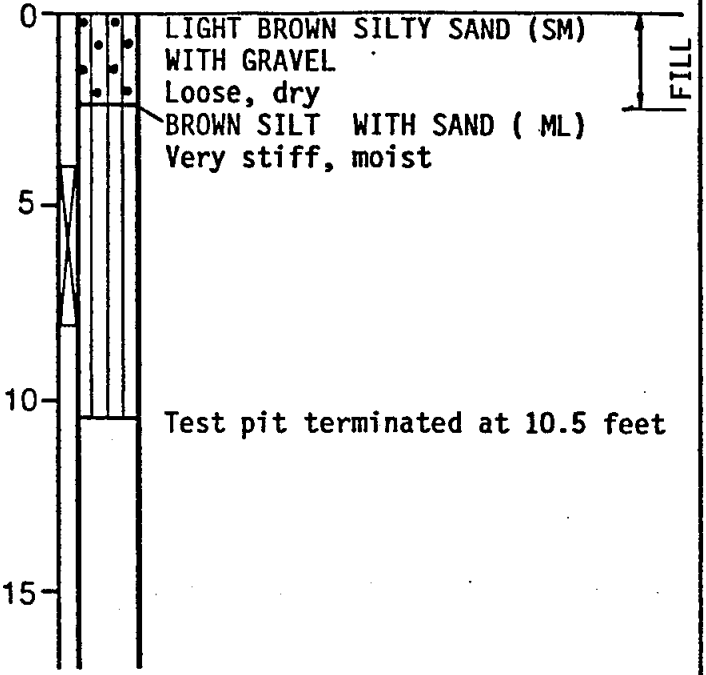
DRAWN MAE | JOB NUMBER 0843,149.05 | APPROVED SSS | DATE 10/4/88 | REVISED | DATE

Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

LOG OF TEST PIT 5

Equipment Ford Backhoe

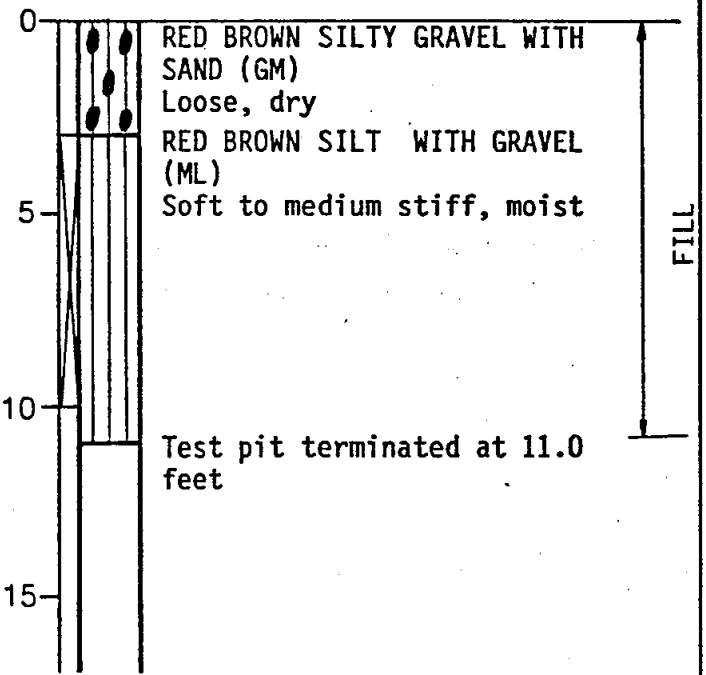
Elevation ± 4675 Ft. Date 9/14/88



LOG OF TEST PIT 6

Equipment Ford Backhoe

Elevation ± 4671 Ft. Date 9/14/88



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Engineers, Geologists
& Geophysicists

LOGS OF TEST PITS 5 AND 6
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05		10/4/88		

Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

% Passing No. 200
Sieve = 26.4
LL=36, PI=6

LOG OF TEST PIT 7
Equipment Ford Backhoe
Elevation ± 4694 Ft. Date 9/14/88

Depth (ft)	Sample	
0		BROWN SILTY SAND (SM) Trace gravel, loose to medium dense, dry
5		FILL
10		Test pit terminated at 10.0 feet
15		

LOG OF TEST PIT 8
Equipment Ford Backhoe
Elevation ± 4777 Ft. Date 9/15/88

Depth (ft)	Sample	
0		DARK BROWN SANDY LEAN CLAY WITH GRAVEL (CL) Very stiff to hard, dry, roots to 2.0 feet
5		RED BROWN WELL GRADED GRAVEL WITH SAND (GW) Cobbles, very dense, dry, cemented from 2.0 to 4.0 feet Refusal Test pit terminated at 8.0 feet
10		
15		

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOGS OF TEST PITS 7 AND 8
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05	SSJ	10/4/88		

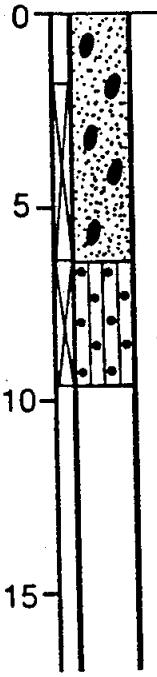
Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

% Passing No. 200 Sieve = 11.7
LL=38, PI=14

LOG OF TEST PIT 9

Equipment: Ford Backhoe
Elevation: ± 4778 Ft. Date: 9/15/88

Depth (ft) | Sample



BROWN WELL GRADED GRAVEL WITH SAND AND SILT (GW)
Very dense, dry

Cemented from 3.5 to 5.0 feet

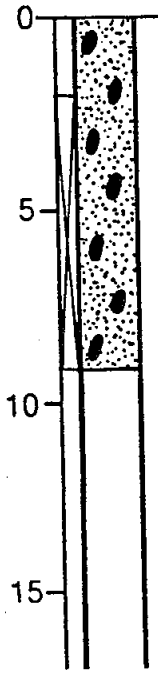
BROWN WELL-GRADED SAND WITH SILT GRAVEL (SW-SM)
Dense to very dense, moist

Test pit terminated at 9.5 feet

LOG OF TEST PIT 10

Equipment: Ford Backhoe
Elevation: ± 4802 Ft. Date: 9/15/88

Depth (ft) | Sample



BROWN WELL GRADED GRAVEL WITH SAND AND SILT (GW)
Cobbles, dense to very dense, dry
Cemented from 2.5 to 4.5 feet

Test pit terminated at 9.0 feet

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOGS OF TEST PITS 9 AND 10
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

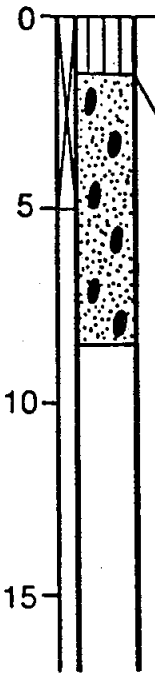
PLATE 8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05	SS	10/4/88		

Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

% Passing No. 200
Sieve = 7.6
Non-Plastic

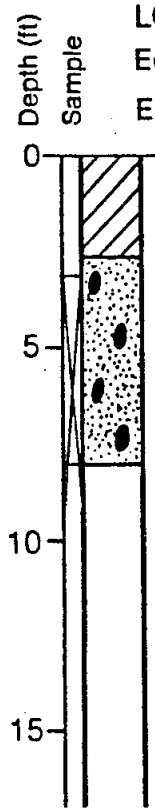
LOG OF TEST PIT 11
Equipment Ford Backhoe
Elevation ± 4815 Ft. Date 9/15/88



DARK BROWN SILTY GRAVEL WITH SAND (GM)
Loose to medium dense, dry
RED BROWN WELL GRADED GRAVEL WITH SILT AND SAND (GW)
Very dense, dry
Cemented from 2.0 to 7.0 feet

Test pit terminated at 8.1 feet

LOG OF TEST PIT 12
Equipment Ford Backhoe
Elevation ± 4776 Ft. Date 9/15/88



DARK BROWN SANDY CLAY WITH GRAVEL (CL)
Stiff to very stiff, dry
BROWN WELL GRADED GRAVEL WITH SILT, SAND, AND COBBLES (GW-GM)
Very dense, dry

Refusal
Test pit terminated at 8.0 feet

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOGS OF TEST PITS 11 AND 12
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 9

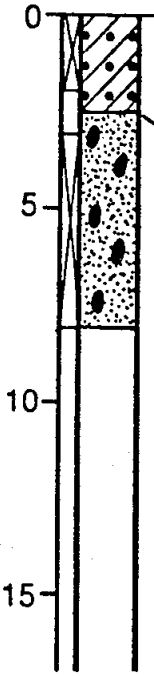
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05	SSS	10/4/88		

Laboratory Tests | Blows/foot | Moisture Content (%) | Dry Density (pcf)

LL=38, PI=19
% Passing No. 200
Sieve = 36.6

LOG OF TEST PIT 13
Equipment Ford Backhoe
Elevation ± 4754 Ft. Date 9/15/88

Depth (ft) | Sample

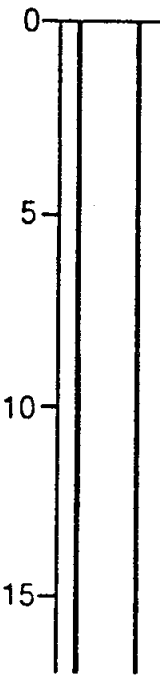


BROWN CLAYEY SAND WITH GRAVEL (SC)
Dense to very dense, dry
Cemented from 2.0 to 5.0 feet
RED BROWN WELL GRADED GRAVEL WITH SAND AND SILT (GW)
Cobbles, very dense, dry

Refusal
Test pit terminated at 8.0 feet

LOG OF TEST PIT _____
Equipment _____
Elevation _____ Date _____

Depth (ft) | Sample



Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOG OF TEST PIT 13
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MAE	0843,149.05		10/4/88		

MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP		POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC		CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP		POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL		ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION - ASTM D2487-85

Perm	—	Permeability
Consol	—	Consolidation
LL	—	Liquid Limit (%)
PI	—	Plastic Index (%)
G_s	—	Specific Gravity
MA	—	Particle Size Analysis
■	—	"Undisturbed" Sample
☒	—	Bulk or Classification Sample

	Shear Strength (psf)	Confining Pressure		
TxUU (FM) or (S)	3200	(2600)	—	Unconsolidated Undrained Triaxial Shear (field moisture or saturated)
TxCU (P)	3200	(2600)	—	Consolidated Undrained Triaxial Shear (with or without pore pressure measurement)
TxCD	3200	(2600)	—	Consolidated Drained Triaxial Shear
SSCU (P)	3200	(2600)	—	Simple Shear Consolidated Undrained (with or without pore pressure measurement)
SSCD	3200	(2600)	—	Simple Shear Consolidated Drained
DSCD	2700	(2000)	—	Consolidated Drained Direct Shear
UC	470		—	Unconfined Compression
LVS	700		—	Laboratory Vane Shear

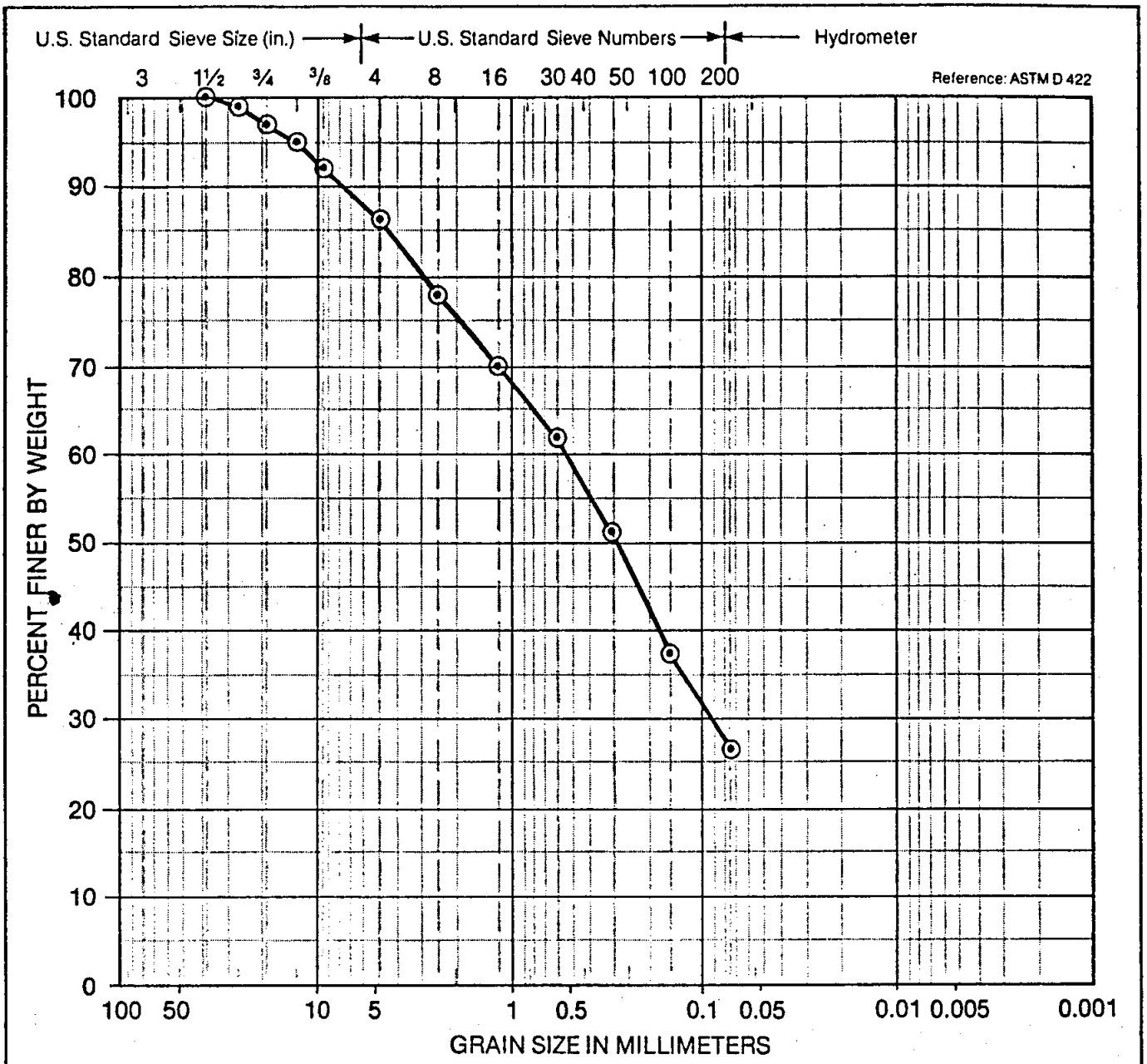
KEY TO TEST DATA

Harding Lawson Associates
Engineers and Geoscientists

SOIL CLASSIFICATION AND KEY TO TEST DATA
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE 11

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	0843,149.05		10/4/88		



COBBLES	GRAVEL: COARSE	GRAVEL: FINE	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SILT OR CLAY

Symbol	Sample Source	Classification
⊙	Trench 7 @ 2' to 8'	BROWN SILTY SAND (SM)

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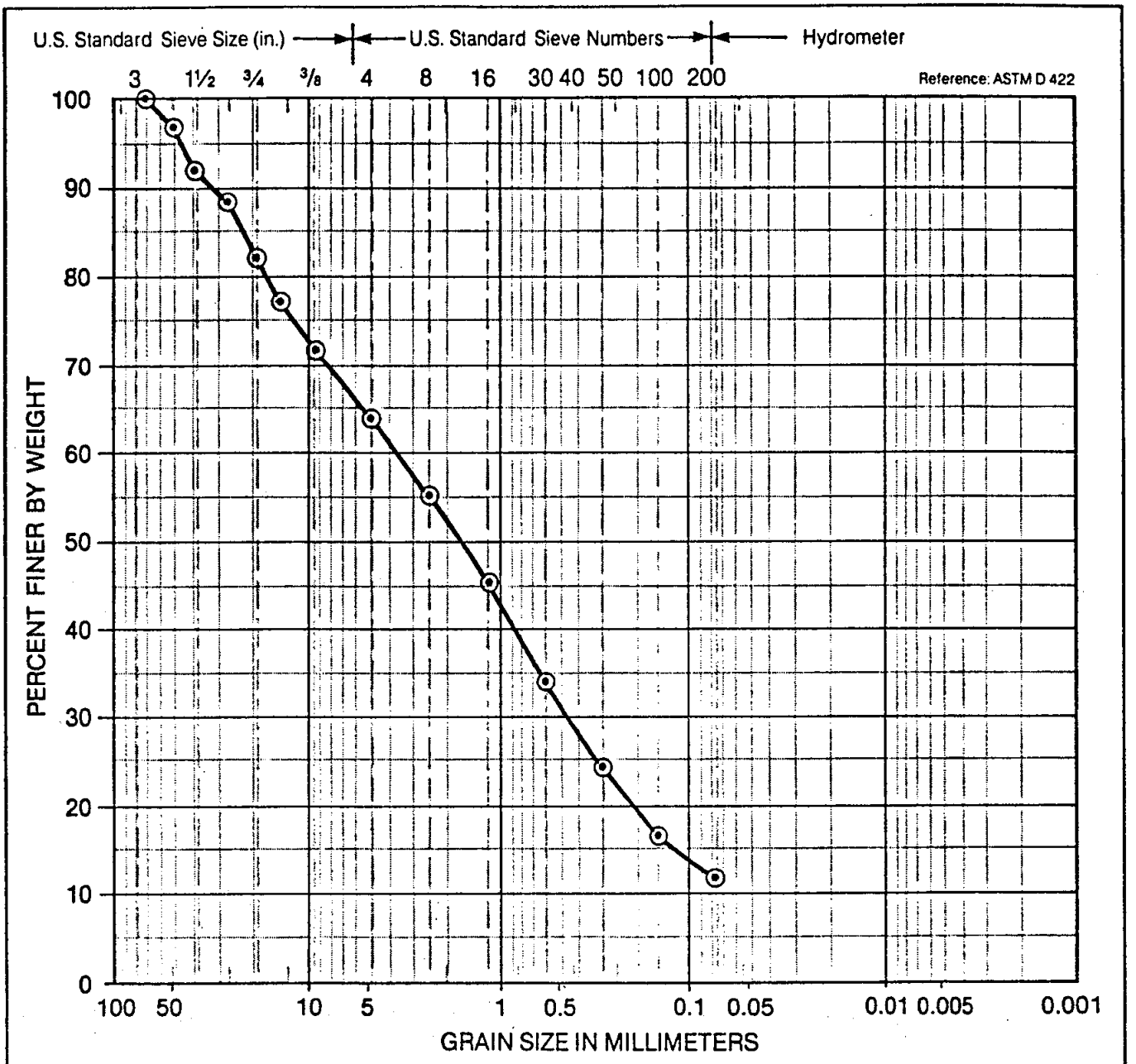
Engineers, Geologists
& Geophysicists

Particle Size Analysis
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
12

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	0843,149.05		10/4/88		



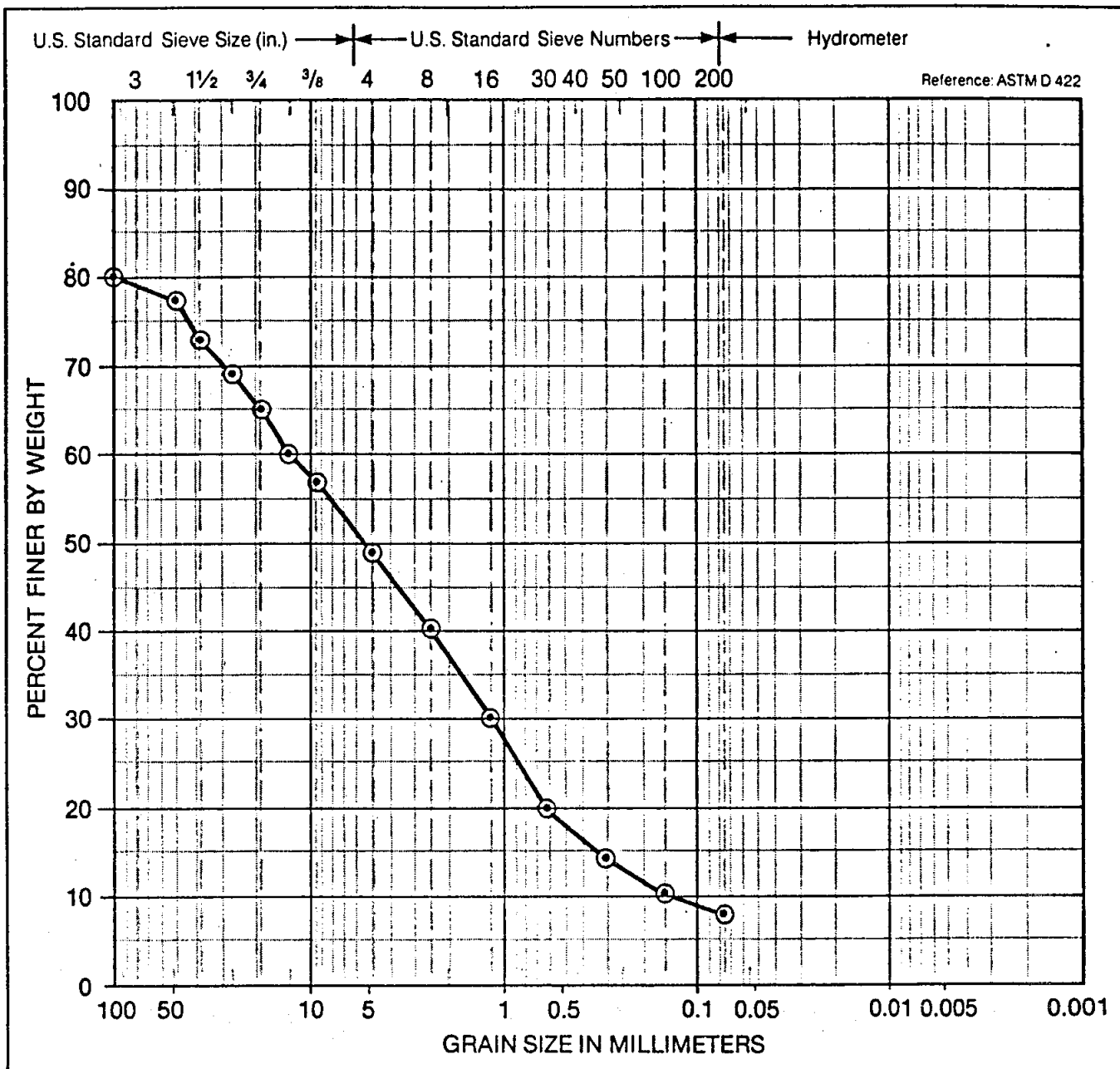
Symbol	Sample Source	Classification
◉	Trench 9 @ 6-1/2′ to 9-1/2′	BROWN WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Particle Size Analysis
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
13

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	0843,149.05		10/4/88		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

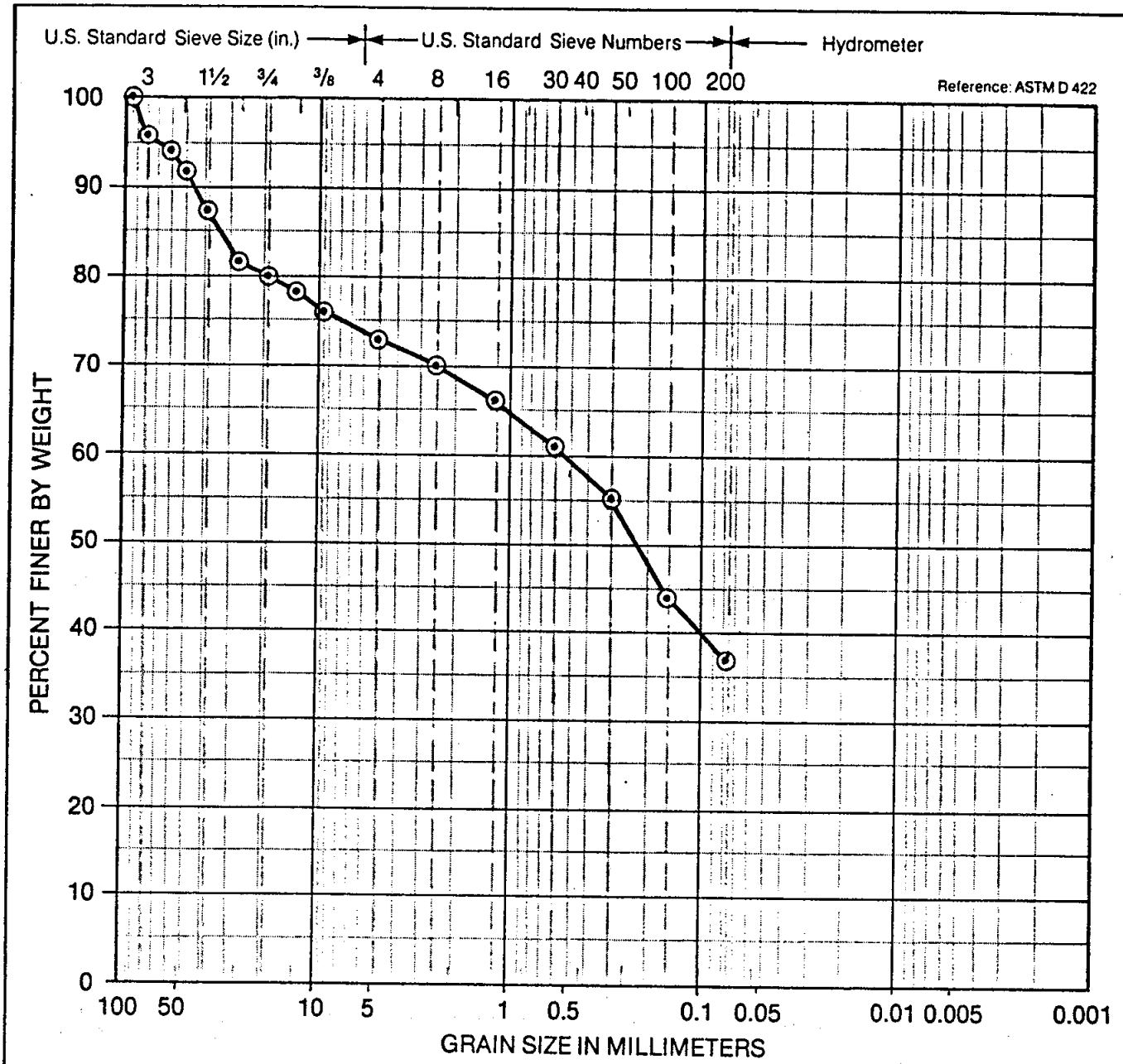
Symbol	Sample Source	Classification
⊙	Trench 12 @ 3' to 8'	BROWN WELL GRADED GRAVEL WITH SILT, SAND AND COBBLES (GW-GM)

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Particle Size Analysis
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
14

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	0843,149.05		10/4/88		



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT OR CLAY
	GRAVEL		SAND			

Symbol	Sample Source	Classification
⊙	Trench 13 @ 0′ to 2′	BROWN CLAYEY SAND WITH GRAVEL (SC)

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Particle Size Analysis
DANT BOULEVARD DETENTION DAM
RENO, NEVADA

PLATE
15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	0843,149.05		10/4/88		

DISTRIBUTION

4 Copies:	Kennedy/Jenks/Chilton, A.I.A. 160 Hubbard Way, #2 Reno, Nevada 89502
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1 Copy:	Novato

SSS/et

QUALITY CONTROL REVIEWER

Albert A. Joseph
Civil Engineer - 5146 (NV)

APPENDIX II

PROJECT CORRESPONDENCE

RICHARD H. BRYAN
Governor

STATE OF NEVADA

ROLAND D. WESTERGARD, P.E.
Director

PETER G. MORROS, P.E.
State Engineer

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF WATER RESOURCES
Capitol Complex
201 S. Fall Street
Carson City, Nevada 89710
(702) 885-4380

September 2, 1988

Phil Logan
Kennedy/Jenks/Chilton
160 Hubbard Way #2
Reno, Nevada 89502

Re: Dant Street Detention Dam

Dear Mr. Logan:

I have reviewed your preliminary plans, concept and letter of August 31, 1988, for a flood detention dam at Dant Street and have the following comments:

1. I like the spillway design flow criteria and I can live with the 1/2 PMF with no free board provided all of the hydrology input is well on the conservation side, i.e., time of concentration, curve number, percent impervious area, etc.

2. Even though the 100 year storm will be detained and evacuated over a 24 hour period there may be instances where a small amount of water will be stored over longer periods of time. Depending on what the foundation exploration shows and the embankment soils classification, sound engineering principles should be used to determine if any internal drainage is required.

3. Spillway velocities should be determined to evaluate whether some energy dissipation is required in the spillway chute as well as at the toe of the dam, keeping in mind this will only be needed one percent of the time.

As the design progresses further, I will be more than happy to discuss any questions you may encounter.

Sincerely,

R. Michael Turnipseed, P.E.

R. Michael Turnipseed, P.E.
Chief, Surface Water and
Adjudication Section

RMT/bk

Kennedy/Jenks/Chilton

Consulting Engineers

160 Hubbard Way, No. 2
Reno, Nevada 89502
702-827-7900

31 August 1988

Mr. Mike Turnipseed P.E.
Division of Water Resources
Carson City, NV 89701

Subject: City of Reno - Plumas/Moana Storm Drain
Dant Street Detention Dam
K/J/C Job No. 877041.00

Dear Mr. Turnipseed:

Kennedy/Jenks/Chilton has been engaged by the City of Reno to study and design a storm sewer system in the Moana Lane/Plumas Street and Lakeside Drive area. Currently, runoff travels overland and collects at the corner of Moana Lane and Lakeside Drive and causes flooding of that intersection as well as adjacent private and commercial properties.

Our initial task was to collect this runoff and convey it to the Virginia Lake facility. However, the magnitude of the 100 year runoff flows made underground conveyance to Virginia Lake economically infeasible. The City of Reno subsequently directed Kennedy/Jenks/Chilton to explore upstream storm water detention dam sites to reduce the peak flows that have to be carried through the project site.

To that end, we have defined a detention site on the major drainage basin and channel that provides significant flood attenuation for the project. The site (see location map) is located in the defined channel that parallels Skyline Boulevard to the east. Specifically, the site is adjacent to the intersection of Dant Street and Pioneer Drive in Reno, Nevada.

Enclosed are preliminary plans of the proposed detention dam which consists of:

1. 40 scale plan view of the dam.
2. 40 scale horizontal vs. 10 scale vertical centerline profile of the dam.
3. Typical dam cross-section.
4. Cross section of the dam at the spillway.

We would like to request that the State review these preliminary plans and the following listed design assumptions/parameters and offer any comments and or suggestions that you think important for this structure. Also, we would appreciate a listing of specific design requirements that would be imposed on this dam because of its location and height.

Our design assumptions/parameters are:

1. Spillway capacity for 1/2 PMF flows (Preliminary PMF flows approximate 5500 cfs, 6 hour PMP of 12.9 inches).
2. 1/2 PMF flows will be taken over the top of the dam (approximately 2750 cfs).
3. No freeboard allowance required in spillway for 1/2 PMF flows.
4. Minimum low-level outlet storm pipe size to be 24 inches (not shown on plans).
5. Detention basin to be completely drained within 24 hours after the 100 year peak.
6. Minimum of 3 feet of freeboard above 100 year flood storage elevation. (Preliminary 100 year elevation 4696.6 and 40 acre-feet).
7. Homogenous embankment with upstream face erosion protection.
8. Geotechnical studies to include proposed embankment material physical characteristics (Unified Soil classification, gradation, Atterberg limits, compaction characteristics and triaxial tests) at least 3 foundation borings (abutments and bottom) and a stability analyses of the embankment.
9. Spillway erosion protection with Gabion mats.
10. This structure will be classified as high risk.

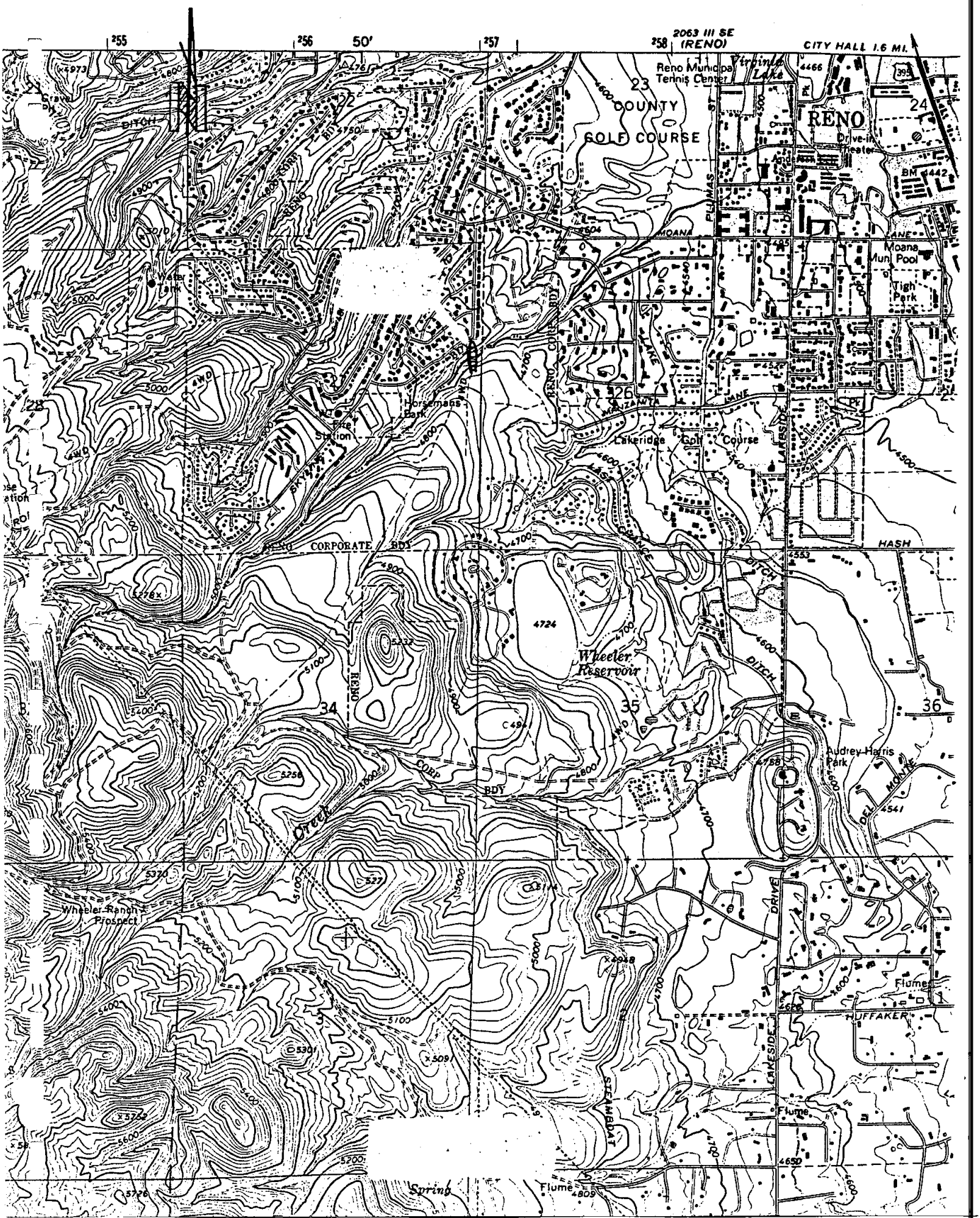
It would be a great help if you could respond to this request as soon as your schedule allows. The City of Reno hopes to be able to negotiate a cost sharing construction package with a private developer who will be working on the adjacent land. I will be free to meet with you in Carson City to discuss this project and to answer any questions you may have.

Sincerely,

KENNEDY/JENKS/CHILTON

Phillip J. Logan P.E.
Civil Engineer

Encl.
cc: Steve Varela - City of Reno w/Encl.
Robert Gottsacker - City of Reno w/Encl.


255
256
50'
257
258
2063 III SE
(RENO)
CITY HALL 1.6 MI.
Reno Municipal
Tennis Center
Virginia
Lake
COUNTY
GOLF COURSE
RENO
Drive-in
Theater
PLUMAS ST
MOANA LANE
Moana
Pool
Park
Water
Tank
Horsemans
Park
Fire
Station
RENO CORPORATE BDY
RENO CORP BDY
LAKE
LAKESIDE
Lakeridge Golf Course
HASH DITCH
Wheeler
Reservoir
4724
Audrey Harris
Park
MONTE
DRIVE
Wheeler Ranch
Prospect
Creek
Spring
Flume
HUFFAKER
STEAMBOAT
CANESIDE
23
24
25
26
34
35
36

APPENDIX III

HYDROLOGY

1

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1


```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  1         ID       DANT BLVD DETENTION DAM
  2         ID       FUTURE LAND USE CONDITIONS WITH DETENTION BASIN AT DANT ROAD ADDED
  3         ID       DRAINAGE AREA TRIBUTARY TO DAN BASIN ONLY - USING SCS METHODOLOGY
  4         ID       100-YEAR,24-HOUR STORM, SCS EMERGENCY SPILLWAY DISTRIBUTION
  5         ID       FILE 100Y.INP      JANET CARSON      NOVEMBER 1, 1988
            *DIAGRAM
  6         IT      5       0       0     289
  7         IO      5       0
  8         IN     15       0       0
            *   ********************************************************************************

  9         KK   PLUM1
 10         KM       PLUM1 SUBBASIN IS HIGHEST, WESTERNMOST, DUE SOUTH OF MT ROSE SUBSTN.
 11         BA    0.35
 12         PB    2.7
 13         PC    0.00    .002    .005    .008    .011    .014    .017    .020    .023    .026
 14         PC    .029    .032    .035    .038    .041    .044    .048    .052    .056    .060
 15         PC    .064    .068    .072    .076    .080    .085    .090    .095    .100    .105
 16         PC    .110    .115    .120    .126    .133    .140    .147    .155    .163    .172
 17         PC    .181    .191    .203    .218    .236    .257    .283    .387    .663    .707
 18         PC    .735    .758    .776    .791    .804    .815    .825    .834    .842    .849
 19         PC    .856    .863    .869    .875    .881    .887    .893    .898    .903    .908
 20         PC    .913    .918    .922    .926    .930    .934    .938    .942    .946    .950
 21         PC    .953    .956    .959    .962    .965    .968    .971    .974    .977    .980
 22         PC    .983    .986    .989    .992    .995    .998   1.00
 23         LS      0      85
 24         UD    0.31
            *   ********************************************************************************

 25         KK   PLUM2
 26         KM       PLUM2 SUBBASIN PARALLELS PLUM1 TO THE EAST, EQUALLY HIGH IN WATERSHED
 27         BA    0.20
 28         LS      0      85
 29         UD    0.27
            *   ********************************************************************************

 30         KK    COMB
```

```
33          KK   ROUTE
34          KM        ROUTE PLUM1 & PLUM2 COMBINED FLOWS THROUGH PLUM3 USING KINEMATIC WAVE
35          RK    2200   0.064    0.04           TRAP     10.      2.
            *  ***************************************************************************
36          KK   PLUM3
37          KM        PLUM3 SUBBASIN IS ON MAINSTEM BETWEEN TRANSMISSION LINE & MCCARRAN BLVD
38          BA    0.26
39          LS       0      85
40          UD    0.31
            *  ***************************************************************************
1                                        HEC-1 INPUT                                    PAGE  2
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

41          KK    COMB
42          KM        COMBINE PLUM3 LOCAL INFLOW WITH ROUTED FLOW FROM ABOVE AT MCCARRAN
43          HC       2
            *  ***************************************************************************
44          KK   ROUTE
45          KM        ROUTE ALL FLOWS FROM SUBBASINS 1,2,3 FROM MCCARRAN TO DANT BLVD.
46          RK    5600   0.050    0.04           TRAP     10.      2.
            *  ***************************************************************************
47          KK   PLUM4
48          KM        PLUM4 IS SUBBASIN BETWEEN MCCARRAN AND DANT BLVD.
49          BA    0.40
50          LS       0      85
51          UD    0.49
            *  ***************************************************************************
52          KK    COMB
53          KM        COMBINE RUNOFF FROM PLUM4 WITH ROUTED FLOW FROM ABOVE AT DANT BLVD.
54          HC       2
            *  ***************************************************************************
55          KK   DETEN
            *       ROUTE ALL COMBINED FLOWS THROUGH DETENTION BASIN WITH 24" OUTLET
            *       NOTE: SV IS RESERVOIR STORAGE DATA; SE IS CORRESPONDING ELEVATIONS;
            *             SS DESCRIBES SPILLWAY CHARACTERISTICS; SL IS LOW-LEVEL OUTLET.
56          RS       1    STOR       0
57          SV     0.0     .04      .28      .77     1.57     2.66      4.0      5.6     7.58     10.1
58          SV    13.2    17.1     21.7     32.9     39.5     46.8     54.9     73.1     83.4     94.6
59          SE    4668    4670     4672     4674     4676     4678     4680     4682     4684     4686
60          SE    4688    4690     4692     4696     4698     4700     4702     4706     4708     4710
61          SS    4700    23.3      3.1      1.5
62          SL    4667    2.43      0.9      0.5
63          KD       1       2
64          ZZ
1
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE NO.

(V) ROUTING (---->) DIVERSION OR PUMP FLOW

(.) CONNECTOR (<----) RETURN OF DIVERTED OR PUMPED FLOW

```
 9      PLUM1
          .
          .
25        .      PLUM2
          .        .
```

```
                V
                V
    33      ROUTE
                .
                .
    36          .       PLUM3
                .         .
                .         .
    41      COMB.............
                V
                V
    44      ROUTE
                .
                .
    47          .       PLUM4
                .         .
                .         .
    52      COMB.............
                V
                V
    55      DETEN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1                                                    ****
                          FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
                 U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                                     ****



                              DANT BLVD DETENTION DAM
                              FUTURE LAND USE CONDITIONS WITH DETENTION BASIN AT DANT ROAD ADDED
                              DRAINAGE AREA TRIBUTARY TO DAN BASIN ONLY - USING SCS METHODOLOGY
                              100-YEAR,24-HOUR STORM, SCS EMERGENCY SPILLWAY DISTRIBUTION
                              FILE 100Y.INP      JANET CARSON      NOVEMBER 1, 1988

   7 IO         OUTPUT CONTROL VARIABLES
                     IPRNT         5  PRINT CONTROL
                     IPLOT         0  PLOT CONTROL
                     QSCAL        0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                      NMIN         5  MINUTES IN COMPUTATION INTERVAL
                     IDATE     1    0  STARTING DATE
                     ITIME       0000  STARTING TIME
                        NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     2    0  ENDING DATE
                     NDTIME          ENDING TIME

                  COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.00 HOURS

          ENGLISH UNITS

 WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***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****

63 KO OUTPUT CONTROL VARIABLES

IPRNT	1	PRINT CONTROL
IPLOT	2	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

56 RS STORAGE ROUTING

NSTPS	1	NUMBER OF SUBREACHES
ITYP	STOR	TYPE OF INITIAL CONDITION
RSVRIC	.00	INITIAL CONDITION
X	.00	WORKING R AND D COEFFICIENT

57 SV STORAGE	.0	.0	.3	.8	1.6	2.7	4.0	5.6	7.6	10.1
	13.2	17.1	21.7	32.9	39.5	46.8	54.9	73.1	83.4	94.6
59 SE ELEVATION	4668.00	4670.00	4672.00	4674.00	4676.00	4678.00	4680.00	4682.00	4684.00	4686.00
	4688.00	4690.00	4692.00	4696.00	4698.00	4700.00	4702.00	4706.00	4708.00	4710.00

62 SL LOW-LEVEL OUTLET

ELEVL	4667.00	ELEVATION AT CENTER OF OUTLET
CAREA	2.43	CROSS-SECTIONAL AREA
COQL	.90	COEFFICIENT
EXPL	.50	EXPONENT OF HEAD

61 SS SPILLWAY

CREL	4700.00	SPILLWAY CREST ELEVATION
SPWID	23.30	SPILLWAY WIDTH
COQW	3.10	WEIR COEFFICIENT
EXPW	1.50	EXPONENT OF HEAD

***

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	.00	19.31	21.48	24.20	27.71	32.41	39.03	49.05	65.98	100.76
ELEVATION	4668.00	4668.21	4668.50	4668.90	4669.50	4670.41	4671.95	4674.82	4681.15	4700.00
OUTFLOW	103.50	120.67	165.78	252.35	393.91	603.95	896.01	1283.44	1780.01	2399.13
ELEVATION	4700.11	4700.41	4700.92	4701.62	4702.52	4703.62	4704.92	4706.41	4708.11	4710.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.00	.01	.02	.03	.04	.09	.27	.28	.77
OUTFLOW	17.54	19.31	21.48	24.20	27.71	30.38	32.41	39.03	39.22	46.41
ELEVATION	4668.00	4668.21	4668.50	4668.90	4669.50	4670.00	4670.41	4671.95	4672.00	4674.00
STORAGE	1.10	1.57	2.66	4.00	4.92	5.60	7.58	10.10	13.20	17.10
OUTFLOW	49.05	52.62	58.17	63.24	65.98	67.93	72.32	76.45	80.38	84.12
ELEVATION	4674.82	4676.00	4678.00	4680.00	4681.15	4682.00	4684.00	4686.00	4688.00	4690.00
STORAGE	21.70	32.90	39.50	46.80	47.24	48.48	50.52	53.37	54.90	57.28
OUTFLOW	87.70	94.45	97.66	100.76	103.50	120.67	165.78	252.35	308.06	393.91
ELEVATION	4692.00	4696.00	4698.00	4700.00	4700.11	4700.41	4700.92	4701.62	4702.00	4702.52
STORAGE	62.28	68.18	73.10	75.23	83.40	84.00	94.60			
OUTFLOW	603.95	896.01	1171.10	1283.44	1746.69	1780.01	2399.13			
ELEVATION	4703.62	4704.92	4706.00	4706.41	4708.00	4708.11	4710.00			

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 18. TO 28.
THE ROUTED HYDROGRAPH PEAKS

HYDROGRAPH AT STATION DETEN

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	18.	.0	4668.0	1		98	7.	.0	4668.0	1		195	94.	32.1	4695.7
1		2		7.	.0	4668.0	1		99	7.	.0	4668.0	1		196	94.	31.7	4695.6
1		3		7.	.0	4668.0	1		100	7.	.0	4668.0	1		197	93.	31.3	4695.4
1		4		7.	.0	4668.0	1		101	7.	.0	4668.0	1		198	93.	30.9	4695.3
1		5		7.	.0	4668.0	1		102	7.	.0	4668.0	1		199	93.	30.6	4695.2
1		6		7.	.0	4668.0	1		103	7.	.0	4668.0	1		200	93.	30.2	4695.0
1		7		7.	.0	4668.0	1		104	7.	.0	4668.0	1		201	93.	29.8	4694.9
1		8		7.	.0	4668.0	1		105	7.	.0	4668.0	1		202	92.	29.5	4694.8
1		9		7.	.0	4668.0	1		106	7.	.0	4668.0	1		203	92.	29.1	4694.6
1		10		7.	.0	4668.0	1		107	7.	.0	4668.0	1		204	92.	28.7	4694.5
1		11		7.	.0	4668.0	1		108	7.	.0	4668.0	1		205	92.	28.4	4694.4
1		12		7.	.0	4668.0	1		109	7.	.0	4668.0	1		206	91.	28.0	4694.3
1		13		7.	.0	4668.0	1		110	7.	.0	4668.0	1		207	91.	27.6	4694.1
1		14		7.	.0	4668.0	1		111	7.	.0	4668.0	1		208	91.	27.2	4694.0
1		15		7.	.0	4668.0	1		112	7.	.0	4668.0	1		209	91.	26.8	4693.8
1		16		7.	.0	4668.0	1		113	7.	.0	4668.0	1		210	91.	26.5	4693.7
1		17		7.	.0	4668.0	1		114	7.	.0	4668.0	1		211	90.	26.1	4693.6
1		18		7.	.0	4668.0	1		115	7.	.0	4668.0	1		212	90.	25.7	4693.4
1		19		7.	.0	4668.0	1		116	7.	.0	4668.0	1		213	90.	25.3	4693.3
1		20		7.	.0	4668.0	1		117	7.	.0	4668.0	1		214	90.	24.9	4693.1
1		21		7.	.0	4668.0	1		118	7.	.0	4668.0	1		215	89.	24.5	4693.0
1		22		7.	.0	4668.0	1		119	7.	.0	4668.0	1		216	89.	24.1	4692.9
1		23		7.	.0	4668.0	1		120	7.	.0	4668.0	1		217	89.	23.8	4692.7
1		24		7.	.0	4668.0	1		121	7.	.0	4668.0	1		218	89.	23.4	4692.6
1		25		7.	.0	4668.0	1		122	7.	.0	4668.0	1		219	88.	23.0	4692.5
1		26		7.	.0	4668.0	1		123	7.	.0	4668.0	1		220	88.	22.6	4692.3
1		27		7.	.0	4668.0	1		124	7.	.0	4668.0	1		221	88.	22.2	4692.2
1		28		7.	.0	4668.0	1		125	7.	.0	4668.0	1		222	88.	21.8	4692.0
1		29		7.	.0	4668.0	1		126	8.	.0	4668.0	1		223	87.	21.4	4691.9
1		30		7.	.0	4668.0	1		127	9.	.0	4668.0	1		224	87.	21.0	4691.7
1		31		7.	.0	4668.0	1		128	10.	.0	4668.0	1		225	87.	20.6	4691.5
1		32		7.	.0	4668.0	1		129	11.	.0	4668.0	1		226	87.	20.2	4691.3
1		33		7.	.0	4668.0	1		130	12.	.0	4668.0	1		227	86.	19.8	4691.2
1		34		7.	.0	4668.0	1		131	14.	.0	4668.0	1		228	86.	19.4	4691.0
1		35		7.	.0	4668.0	1		132	15.	.0	4668.0	1		229	86.	19.0	4690.8
1		36		7.	.0	4668.0	1		133	17.	.0	4668.0	1		230	85.	18.6	4690.6
1		37		7.	.0	4668.0	1		134	20.	.0	4668.3	1		231	85.	18.2	4690.5
1		38		7.	.0	4668.0	1		135	22.	.0	4668.6	1		232	85.	17.8	4690.3
1		39		7.	.0	4668.0	1		136	25.	.0	4669.1	1		233	84.	17.4	4690.1
1		40		7.	.0	4668.0	1		137	28.	.0	4669.6	1		234	84.	17.0	4689.9
1		41		7.	.0	4668.0	1		138	31.	.0	4670.1	1		235	84.	16.6	4689.7
1		42		7.	.0	4668.0	1		139	32.	.1	4670.3	1		236	83.	16.2	4689.5
1		43		7.	.0	4668.0	1		140	34.	.1	4670.8	1		237	83.	15.8	4689.3
1		44		7.	.0	4668.0	1		141	37.	.2	4671.5	1		238	83.	15.4	4689.1
1		45		7.	.0	4668.0	1		142	41.	.4	4672.4	1		239	82.	15.0	4688.9
1		46		7.	.0	4668.0	1		143	45.	.7	4673.5	1		240	82.	14.7	4688.8
1		47		7.	.0	4668.0	1		144	50.	1.3	4675.2	1		241	81.	14.3	4688.6
1		48		7.	.0	4668.0	1		145	57.	2.5	4677.7	1		242	81.	13.9	4688.4
1		49		7.	.0	4668.0	1		146	65.	4.7	4680.8	1		243	81.	13.5	4688.2
1		50		7.	.0	4668.0	1		147	73.	8.1	4684.4	1		244	80.	13.2	4688.0
1		51		7.	.0	4668.0	1		148	79.	12.3	4687.4	1		245	80.	12.8	4687.7
1		52		7.	.0	4668.0	1		149	84.	16.9	4689.9	1		246	79.	12.4	4687.5
1		53		7.	.0	4668.0	1		150	87.	21.1	4691.8	1		247	79.	12.0	4687.2
1		54		7.	.0	4668.0	1		151	90.	24.9	4693.1	1		248	78.	11.6	4687.0
1		55		7.	.0	4668.0	1		152	91.	27.8	4694.2	1		249	78.	11.2	4686.7

1	59	7.	.0	4668.0	*	1	156	96.	35.3	4696.7	*	1	253	76.	9.7	4685.7
1	60	7.	.0	4668.0	*	1	157	96.	36.3	4697.0	*	1	254	75.	9.3	4685.4
1	61	7.	.0	4668.0	*	1	158	96.	37.1	4697.3	*	1	255	75.	8.9	4685.1
1	62	7.	.0	4668.0	*	1	159	97.	37.7	4697.5	*	1	256	74.	8.6	4684.8
1	63	7.	.0	4668.0	*	1	160	97.	38.2	4697.6	*	1	257	73.	8.2	4684.5
1	64	7.	.0	4668.0	*	1	161	97.	38.7	4697.7	*	1	258	73.	7.8	4684.2
1	65	7.	.0	4668.0	*	1	162	97.	39.0	4697.8	*	1	259	72.	7.5	4683.9
1	66	7.	.0	4668.0	*	1	163	98.	39.2	4697.9	*	1	260	71.	7.1	4683.5
1	67	7.	.0	4668.0	*	1	164	98.	39.3	4698.0	*	1	261	71.	6.8	4683.2
1	68	7.	.0	4668.0	*	1	165	98.	39.4	4698.0	*	1	262	70.	6.4	4682.8
1	69	7.	.0	4668.0	*	1	166	98.	39.5	4698.0	*	1	263	69.	6.1	4682.5
1	70	7.	.0	4668.0	*	1	167	98.	39.5	4698.0	*	1	264	68.	5.8	4682.2
1	71	7.	.0	4668.0	*	1	168	98.	39.5	4698.0	*	1	265	67.	5.4	4681.8
1	72	7.	.0	4668.0	*	1	169	98.	39.4	4698.0	*	1	266	67.	5.1	4681.4
1	73	7.	.0	4668.0	*	1	170	98.	39.3	4697.9	*	1	267	66.	4.8	4681.0
1	74	7.	.0	4668.0	*	1	171	97.	39.2	4697.9	*	1	268	65.	4.5	4680.6
1	75	7.	.0	4668.0	*	1	172	97.	39.0	4697.9	*	1	269	64.	4.2	4680.2
1	76	7.	.0	4668.0	*	1	173	97.	38.8	4697.8	*	1	270	63.	3.9	4679.8
1	77	7.	.0	4668.0	*	1	174	97.	38.6	4697.7	*	1	271	62.	3.6	4679.4
1	78	7.	.0	4668.0	*	1	175	97.	38.4	4697.7	*	1	272	61.	3.3	4679.0
1	79	7.	.0	4668.0	*	1	176	97.	38.2	4697.6	*	1	273	60.	3.1	4678.6
1	80	7.	.0	4668.0	*	1	177	97.	38.0	4697.5	*	1	274	59.	2.8	4678.2
1	81	7.	.0	4668.0	*	1	178	97.	37.7	4697.5	*	1	275	57.	2.5	4677.8
1	82	7.	.0	4668.0	*	1	179	97.	37.4	4697.4	*	1	276	56.	2.3	4677.3
1	83	7.	.0	4668.0	*	1	180	97.	37.2	4697.3	*	1	277	55.	2.0	4676.9
1	84	7.	.0	4668.0	*	1	181	96.	36.9	4697.2	*	1	278	54.	1.8	4676.4
1	85	7.	.0	4668.0	*	1	182	96.	36.5	4697.1	*	1	279	53.	1.6	4676.0
1	86	7.	.0	4668.0	*	1	183	96.	36.2	4697.0	*	1	280	51.	1.4	4675.5
1	87	7.	.0	4668.0	*	1	184	96.	35.9	4696.9	*	1	281	49.	1.2	4675.0
1	88	7.	.0	4668.0	*	1	185	96.	35.6	4696.8	*	1	282	48.	1.0	4674.5
1	89	7.	.0	4668.0	*	1	186	96.	35.2	4696.7	*	1	283	46.	.8	4674.0
1	90	7.	.0	4668.0	*	1	187	95.	34.9	4696.6	*	1	284	44.	.6	4673.3
1	91	7.	.0	4668.0	*	1	188	95.	34.6	4696.5	*	1	285	42.	.5	4672.7
1	92	7.	.0	4668.0	*	1	189	95.	34.2	4696.4	*	1	286	40.	.3	4672.1
1	93	7.	.0	4668.0	*	1	190	95.	33.9	4696.3	*	1	287	36.	.2	4671.3
1	94	7.	.0	4668.0	*	1	191	95.	33.5	4696.2	*	1	288	33.	.1	4670.5
1	95	7.	.0	4668.0	*	1	192	95.	33.2	4696.1	*	2	289	28.	.0	4669.5
1	96	7.	.0	4668.0	*	1	193	94.	32.8	4696.0	*					
1	97	7.	.0	4668.0	*	1	194	94.	32.4	4695.8	*					
					*						*					

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 98.	13.83		94.	46.	46.	46.
		(INCHES)	.723	1.412	1.412	1.412
		(AC-FT)	47.	91.	91.	91.

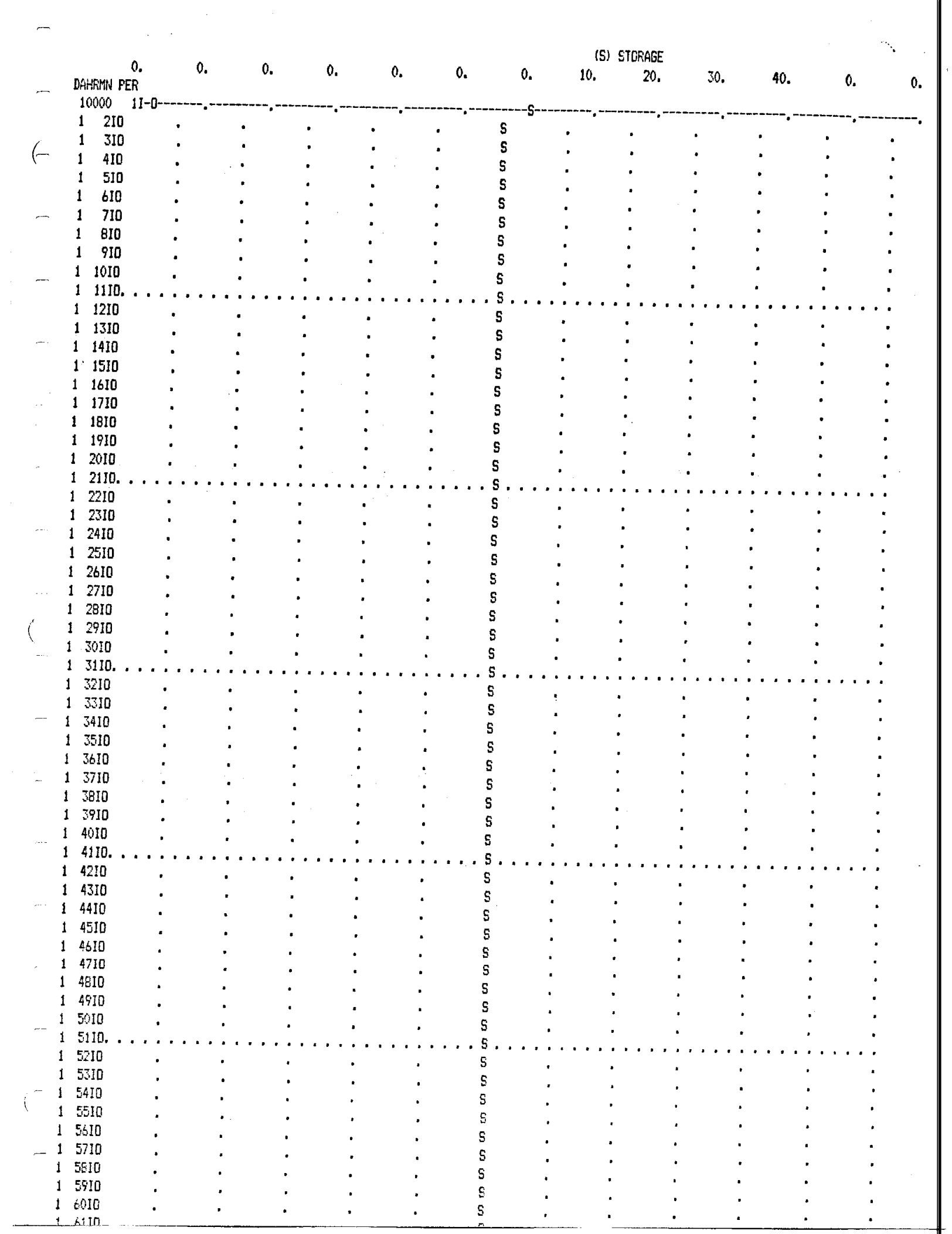
PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.00-HR
+ (AC-FT)	(HR)				
39.	13.83	33.	11.	11.	11.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.00-HR
(FEET)	(HR)				
4698.00	13.83	4695.79	4679.02	4679.02	4679.02

CUMULATIVE AREA = 1.21 SQ MI

1

STATION DETEN


(S) STORAGE
0. 0. 0. 0. 0. 0. 0. 10. 20. 30. 40. 0. 0.
DAHRMN PER
10000 II-O S
1 210 S
1 310 S
1 410 S
1 510 S
1 610 S
1 710 S
1 810 S
1 910 S
1 1010 S
1 1110. S
1 1210 S
1 1310 S
1 1410 S
1 1510 S
1 1610 S
1 1710 S
1 1810 S
1 1910 S
1 2010 S
1 2110. S
1 2210 S
1 2310 S
1 2410 S
1 2510 S
1 2610 S
1 2710 S
1 2810 S
1 2910 S
1 3010 S
1 3110. S
1 3210 S
1 3310 S
1 3410 S
1 3510 S
1 3610 S
1 3710 S
1 3810 S
1 3910 S
1 4010 S
1 4110. S
1 4210 S
1 4310 S
1 4410 S
1 4510 S
1 4610 S
1 4710 S
1 4810 S
1 4910 S
1 5010 S
1 5110. S
1 5210 S
1 5310 S
1 5410 S
1 5510 S
1 5610 S
1 5710 S
1 5810 S
1 5910 S
1 6010 S

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1 6410 . . . . . S . . . . . .
1 6510 . . . . . S . . . . . .
1 6610 . . . . . S . . . . . .
1 6710 . . . . . S . . . . . .
1 6810 . . . . . S . . . . . .
1 6910 . . . . . S . . . . . .
1 7010 . . . . . S . . . . . .
1 7110. . . . . S . . . . . .
1 7210 . . . . . S . . . . . .
1 7310 . . . . . S . . . . . .
1 7410 . . . . . S . . . . . .
1 7510 . . . . . S . . . . . .
1 7610 . . . . . S . . . . . .
1 7710 . . . . . S . . . . . .
1 7810 . . . . . S . . . . . .
1 7910 . . . . . S . . . . . .
1 8010 . . . . . S . . . . . .
1 8110. . . . . S . . . . . .
1 8210 . . . . . S . . . . . .
1 8310 . . . . . S . . . . . .
1 8410 . . . . . S . . . . . .
1 8510 . . . . . S . . . . . .
1 8610 . . . . . S . . . . . .
1 8710 . . . . . S . . . . . .
1 8810 . . . . . S . . . . . .
1 8910 . . . . . S . . . . . .
1 9010 . . . . . S . . . . . .
1 9110. . . . . S . . . . . .
1 9210 . . . . . S . . . . . .
1 9310 . . . . . S . . . . . .
1 9410 . . . . . S . . . . . .
1 9510 . . . . . S . . . . . .
1 9610 . . . . . S . . . . . .
1 9710 . . . . . S . . . . . .
1 9810 . . . . . S . . . . . .
1 9910 . . . . . S . . . . . .
1 10010 . . . . . S . . . . . .
1 10110. . . . . S . . . . . .
1 10210 . . . . . S . . . . . .
1 10310 . . . . . S . . . . . .
1 10410 . . . . . S . . . . . .
1 10510 . . . . . S . . . . . .
1 10610 . . . . . S . . . . . .
1 10710 . . . . . S . . . . . .
1 10810 . . . . . S . . . . . .
1 10910 . . . . . S . . . . . .
1 11010 . . . . . S . . . . . .
1 11110. . . . . S . . . . . .
1 11210 . . . . . S . . . . . .
1 11310 . . . . . S . . . . . .
1 11410 . . . . . S . . . . . .
1 11510 . . . . . S . . . . . .
1 11610 . . . . . S . . . . . .
1 11710 . . . . . S . . . . . .
1 11810 . . . . . S . . . . . .
1 11910 . . . . . S . . . . . .
1 12010 . . . . . S . . . . . .
1 12110. . . . . S . . . . . .
1 12210 . . . . . S . . . . . .
1 123.I . . . . . S . . . . . .
1 124.I . . . . . S . . . . . .
1 125.I . . . . . S . . . . . .
1 126.I . . . . . S . . . . . .
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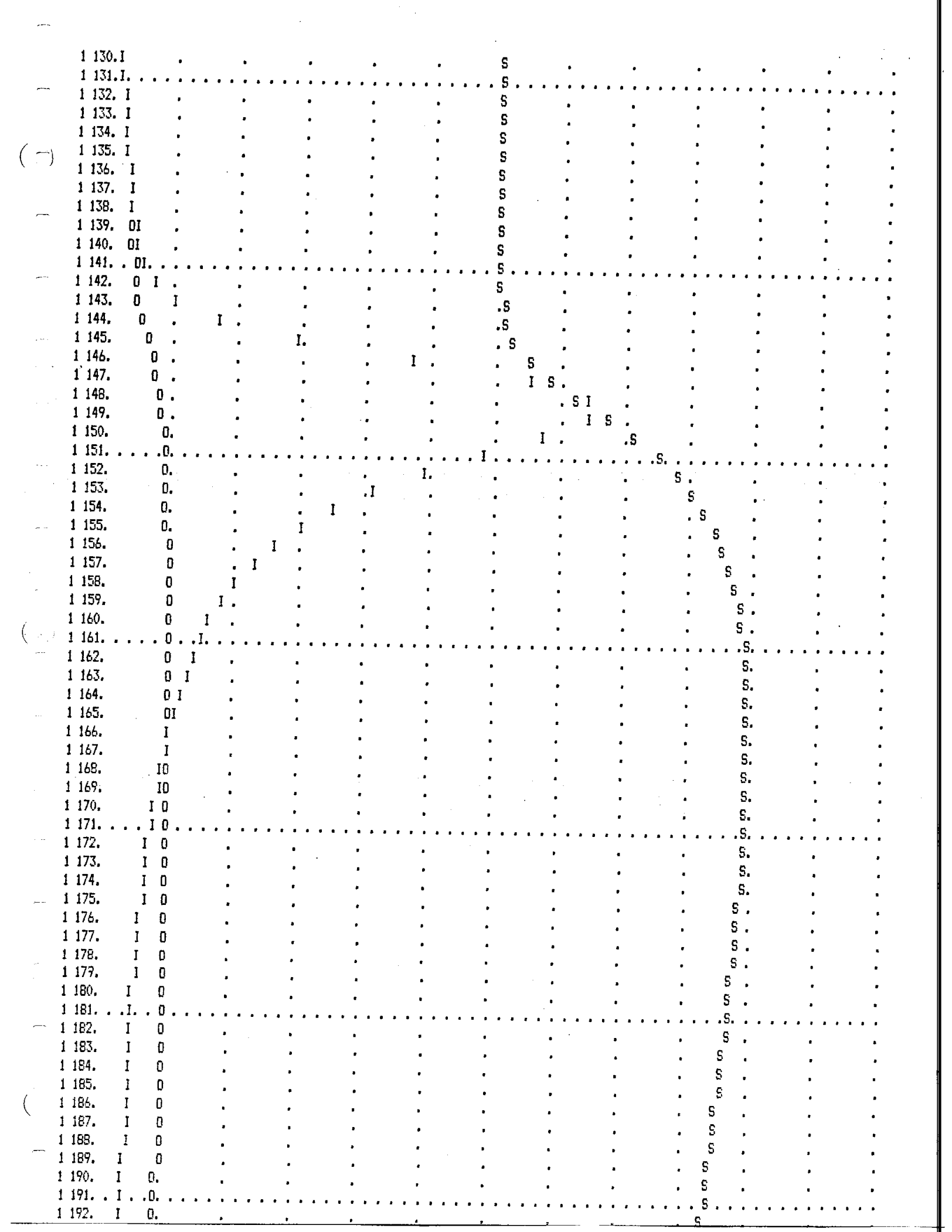

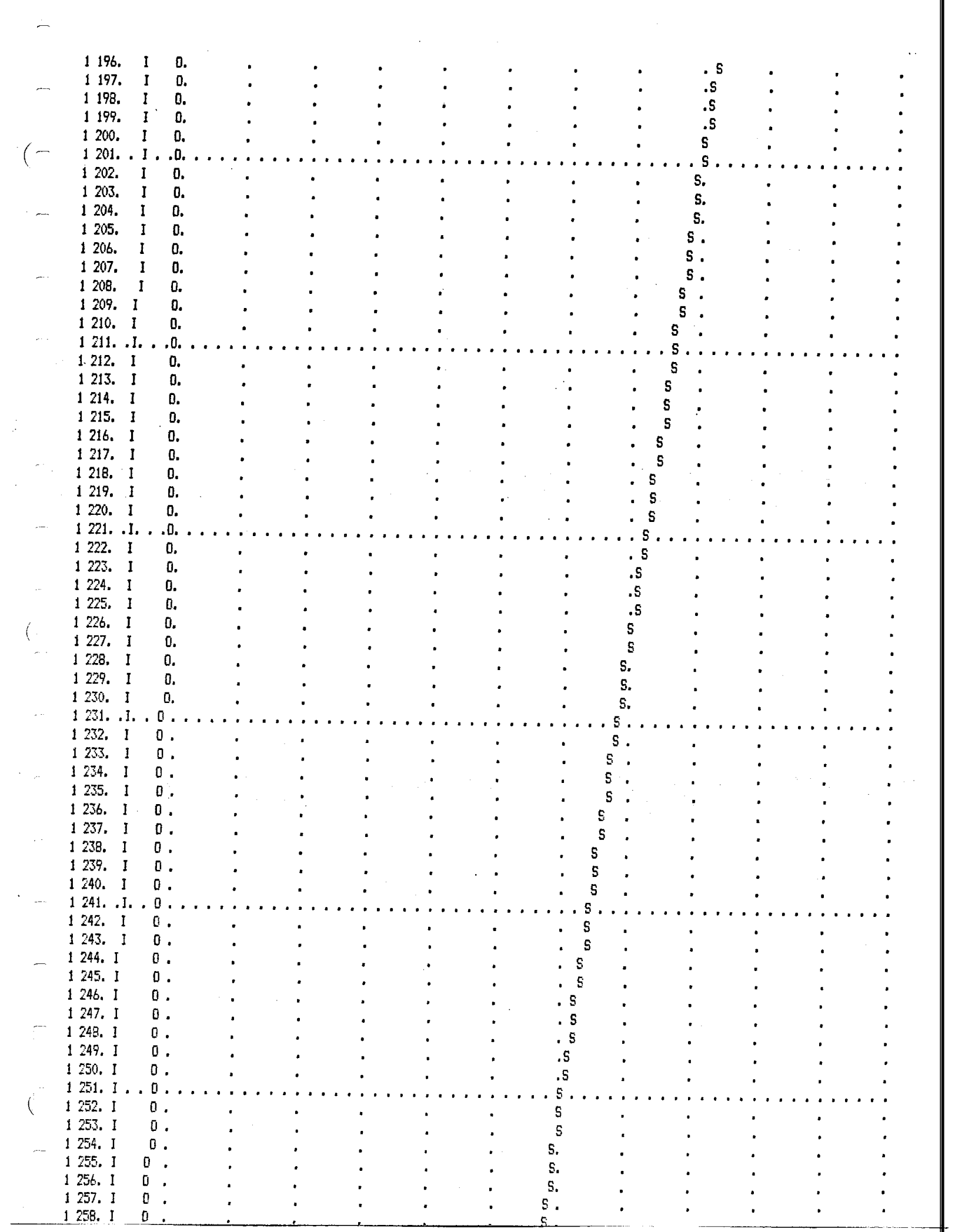
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1 197. I 0.
1 198. I 0.
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1 201. I 0.
1 202. I 0.
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1 204. I 0.
1 205. I 0.
1 206. I 0.
1 207. I 0.
1 208. I 0.
1 209. I 0.
1 210. I 0.
1 211. I 0.
1 212. I 0.
1 213. I 0.
1 214. I 0.
1 215. I 0.
1 216. I 0.
1 217. I 0.
1 218. I 0.
1 219. I 0.
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1 222. I 0.
1 223. I 0.
1 224. I 0.
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1 226. I 0.
1 227. I 0.
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1 239. I 0.
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1 243. I 0.
1 244. I 0.
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1 249. I 0.
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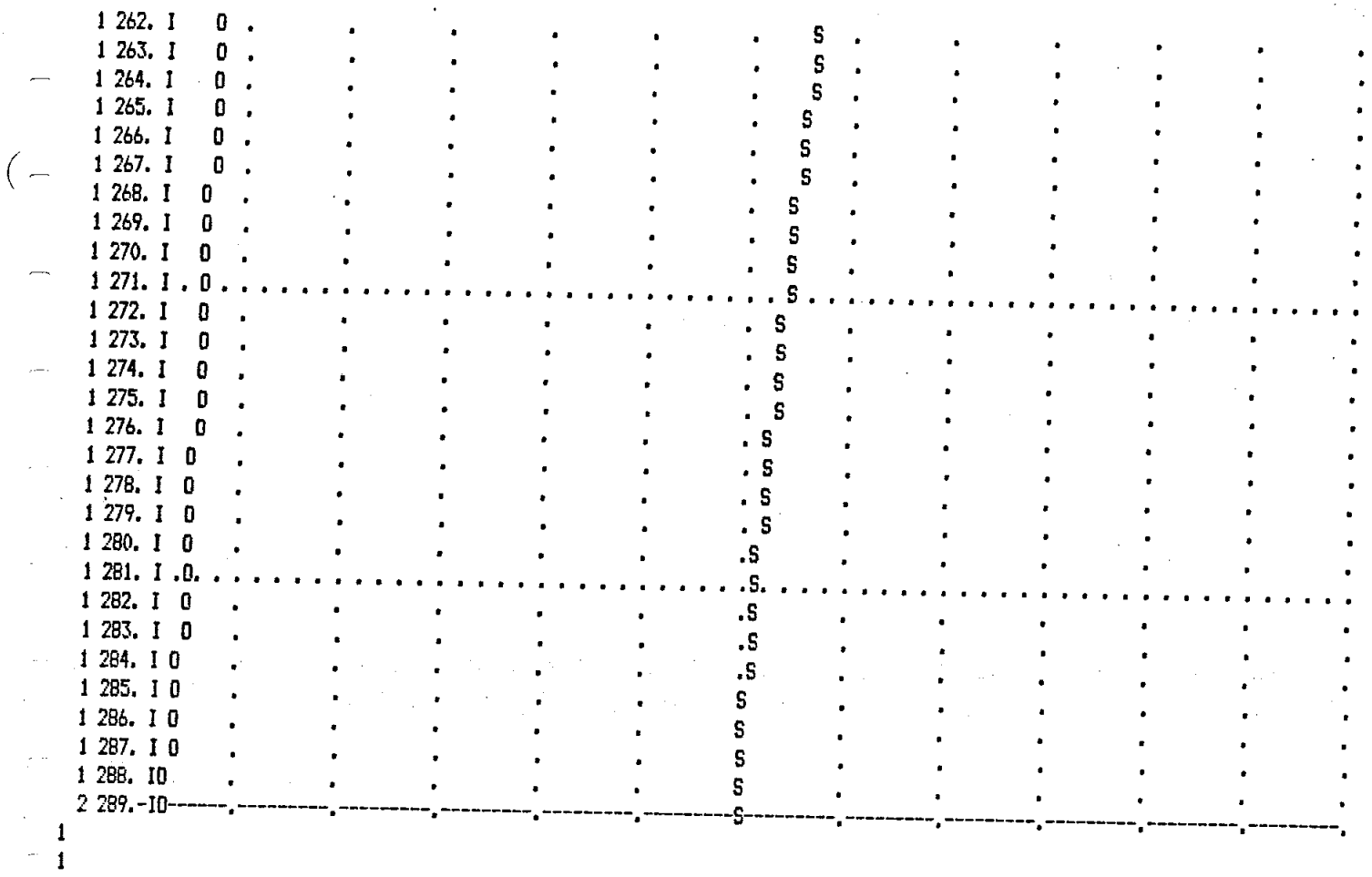
1 258. I 0.



RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	PLUM1	240.	12.17	41.	13.	13.	.35		
HYDROGRAPH AT	PLUM2	150.	12.17	23.	7.	7.	.20		
2 COMBINED AT	COMB	389.	12.17	64.	20.	20.	.55		
ROUTED TO	ROUTE	381.	12.25	64.	20.	20.	.55		
HYDROGRAPH AT	PLUM3	178.	12.17	30.	9.	9.	.26		
2 COMBINED AT	COMB	557.	12.25	95.	29.	29.	.81		
ROUTED TO	ROUTE	551.	12.25	95.	29.	29.	.81		
HYDROGRAPH AT	PLUM4	210.	12.42	47.	14.	14.	.40		
2 COMBINED AT									

+	DETEN	98.	13.83	94.	46.	46.	1.21	
+							4698.00	13.83

*** NORMAL END OF HEC-1 ***

1

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3


```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  1         ID       DANT BLVD DETENTION DAM
  2         ID       FUTURE LAND USE CONDITIONS WITH DETENTION BASIN AT DANT ROAD ADDED
  3         ID       DRAINAGE AREA TRIBUTARY TO DAN BASIN ONLY - USING SCS METHODOLOGY
  4         ID       HALF PMP 6-HR STORM, SCS EMERGENCY SPILLWAY DISTRIBUTION
  5         ID       FILE HALF.INP      JANET CARSON     NOVEMBER 1, 1988
            *DIAGRAM
  6         IT      5       0       0     145
  7         IO      5       0
  8         IN      7       0       0
            *   ********************************************************************************

  9         KK   PLUM1
 10         KM        PLUM1 SUBBASIN IS HIGHEST, WESTERNMOST, DUE SOUTH OF MT ROSE SUBSTN.
 11         BA    0.35
 12         PB     5.8
 13         PC    0.00    .008   .0162   .0246   .0333   .0425   .0524   .0630   .0743   .0863
 14         PC   .0990   .1124   .1265   .1420   .1595   .1800   .2060   .2550   .3430   .4370
 15         PC   .5300   .6030   .6330   .6600   .6840   .7050   .7240   .7420   .7590   .7750
 16         PC   .7900   .8043   .8180   .8312   .8439   .8561   .8678   .8790   .8898   .9002
 17         PC   .9103   .9201   .9297   .9391   .9483   .9573   .9661   .9747   .9832   .9916
 18         PC   1.000
 19         LS       0      85
 20         UD    0.31
            *   ********************************************************************************

 21         KK   PLUM2
 22         KM        PLUM2 SUBBASIN PARALLELS PLUM1 TO THE EAST, EQUALLY HIGH IN WATERSHED
 23         BA    0.20
 24         LS       0      85
 25         UD    0.27
            *   ********************************************************************************

 26         KK    COMB
 27         KM        COMBINE FLOWS FROM PLUM1 & PLUM2 SUBBASINS
 28         HC       2
            *   ********************************************************************************
```

```
                29          KK   ROUTE
                30          KM        ROUTE PLUM1 & PLUM2 COMBINED FLOWS THROUGH PLUM3 USING KINEMATIC WAVE
                31          RK    2200   0.064    0.04           TRAP     10.      2.
                            *  ************************************************************************

                32          KK   PLUM3
                33          KM        PLUM3 SUBBASIN IS ON MAINSTEM BETWEEN TRANSMISSION LINE & MCCARRAN BLVD
                34          BA    0.26
                35          LS       0      85
                36          UD    0.31
                            *    ************************************************************************

                37          KK    COMB
                38          KM        COMBINE PLUM3 LOCAL INFLOW WITH ROUTED FLOW FROM ABOVE AT MCCARRAN
                39          HC       2
                            *  ************************************************************************
1                                                    HEC-1 INPUT                                          PAGE  2

            LINE            ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10


                40          KK   ROUTE
                41          KM        ROUTE ALL FLOWS FROM SUBBASINS 1,2,3 FROM MCCARRAN TO DANT BLVD.
                42          RK    5600   0.050    0.04           TRAP     10.      2.
                            *  ************************************************************************

                43          KK   PLUM4
                44          KM        PLUM4 IS SUBBASIN BETWEEN MCCARRAN AND DANT BLVD.
                45          BA    0.40
                46          LS       0      85
                47          UD    0.49
                            *  ************************************************************************

                48          KK    COMB
                49          KM        COMBINE RUNOFF FROM PLUM4 WITH ROUTED FLOW FROM ABOVE AT DANT BLVD.
                50          HC       2
                            *  ************************************************************************

                51          KK   DETEN
                            *       ROUTE ALL COMBINED FLOWS THROUGH DETENTION BASIN WITH 24" OUTLET
                            *       NOTE: SV IS RESERVOIR STORAGE DATA; SE IS CORRESPONDING ELEVATIONS;
                            *             SS DESCRIBES SPILLWAY CHARACTERISTICS; SL IS LOW-LEVEL OUTLET.
                52          RS       1   STOR       0
                53          SV     0.0     .04     .28     .77    1.57    2.66     4.0     5.6    7.58    10.1
                54          SV    13.2    17.1    21.7    32.9    39.5    46.8    54.9    73.1    83.4    94.6
                55          SE    4668    4670    4672    4674    4676    4678    4680    4682    4684    4686
                56          SE    4688    4690    4692    4696    4698    4700    4702    4706    4708    4710
                57          SS    4700    23.3     3.1     1.5
                58          SL    4667    2.43     0.9     0.5
                59          KO       1       2
                60          ZZ
1

                SCHEMATIC DIAGRAM OF STREAM NETWORK

 INPUT
  LINE      (V) ROUTING          (---->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<----) RETURN OF DIVERTED OR PUMPED FLOW

     9      PLUM1
              .
              .
    21        .       PLUM2
              .         .
              .         .
```

```
          V
 29      ROUTE
           .
           .
 32        .      PLUM3
           .          .
           .          .
 37      COMB............
          V
          V
 40      ROUTE
           .
           .
 43        .      PLUM4
           .          .
           .          .
 48      COMB............
          V
          V
 51      DETEN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1
                                              ****
                          FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
             U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                              ****



                        DANT BLVD DETENTION DAM
                        FUTURE LAND USE CONDITIONS WITH DETENTION BASIN AT DANT ROAD ADDED
                        DRAINAGE AREA TRIBUTARY TO DAN BASIN ONLY - USING SCS METHODOLOGY
                        HALF PMP 6-HR STORM, SCS EMERGENCY SPILLWAY DISTRIBUTION
                        FILE HALF.INP     JANET CARSON     NOVEMBER 1, 1988

  7 IO       OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT       HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     1    0  STARTING DATE
                  ITIME       1200  STARTING TIME
                     NQ        145  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     1    0  ENDING DATE
                 NDTIME         ENDING TIME

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   12.00 HOURS

        ENGLISH UNITS

 WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
 51 KK    *    DETEN   *
```

59 KO OUTPUT CONTROL VARIABLES

IPRNT	1	PRINT CONTROL
IPLOT	2	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

52 RS STORAGE ROUTING

NSTPS	1	NUMBER OF SUBREACHES
ITYP	STOR	TYPE OF INITIAL CONDITION
RSVRIC	.00	INITIAL CONDITION
X	.00	WORKING R AND D COEFFICIENT

53 SV STORAGE	.0	.0	.3	.8	1.6	2.7	4.0	5.6	7.6	10.1
	13.2	17.1	21.7	32.9	39.5	46.8	54.9	73.1	83.4	94.6
55 SE ELEVATION	4668.00	4670.00	4672.00	4674.00	4676.00	4678.00	4680.00	4682.00	4684.00	4686.00
	4688.00	4690.00	4692.00	4696.00	4698.00	4700.00	4702.00	4706.00	4708.00	4710.00

58 SL LOW-LEVEL OUTLET

ELEVL	4667.00	ELEVATION AT CENTER OF OUTLET
CAREA	2.43	CROSS-SECTIONAL AREA
COQL	.90	COEFFICIENT
EXPL	.50	EXPONENT OF HEAD

57 SS SPILLWAY

CREL	4700.00	SPILLWAY CREST ELEVATION
SPWID	23.30	SPILLWAY WIDTH
COQW	3.10	WEIR COEFFICIENT
EXPW	1.50	EXPONENT OF HEAD

***

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	.00	19.31	21.48	24.20	27.71	32.41	39.03	49.05	65.98	100.76
ELEVATION	4668.00	4668.21	4668.50	4668.90	4669.50	4670.41	4671.95	4674.82	4681.15	4700.00
OUTFLOW	103.50	120.67	165.78	252.35	393.91	603.95	896.01	1283.44	1780.01	2399.13
ELEVATION	4700.11	4700.41	4700.92	4701.62	4702.52	4703.62	4704.92	4706.41	4708.11	4710.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.00	.01	.02	.03	.04	.09	.27	.28	.77
OUTFLOW	17.54	19.31	21.48	24.20	27.71	30.38	32.41	39.03	39.22	46.41
ELEVATION	4668.00	4668.21	4668.50	4668.90	4669.50	4670.00	4670.41	4671.95	4672.00	4674.00
STORAGE	1.10	1.57	2.66	4.00	4.92	5.60	7.58	10.10	13.20	17.10
OUTFLOW	49.05	52.62	58.17	63.24	65.98	67.93	72.32	76.45	80.38	84.12
ELEVATION	4674.82	4676.00	4678.00	4680.00	4681.15	4682.00	4684.00	4686.00	4688.00	4690.00
STORAGE	21.70	32.90	39.50	46.80	47.24	48.48	50.52	53.37	54.90	57.28
OUTFLOW	87.70	94.45	97.66	100.76	103.50	120.67	165.78	252.35	308.06	393.91
ELEVATION	4692.00	4696.00	4698.00	4700.00	4700.11	4700.41	4700.92	4701.62	4702.00	4702.52
STORAGE	62.28	68.18	73.10	75.23	83.40	84.00	94.60			
OUTFLOW	603.95	896.01	1171.10	1283.44	1746.69	1780.01	2399.13			
ELEVATION	4703.62	4704.92	4706.00	4706.41	4708.00	4708.11	4710.00			

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 18. TO 28.
THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

HYDROGRAPH AT STATION DETEN

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		1200	1	18.	.0	4668.0	1		50	630.	62.8	4703.7	1		99	97.	38.8	4697.8		
1		2		7.	.0	4668.0	1		51	600.	62.2	4703.6	1		100	97.	38.1	4697.6		
1		3		7.	.0	4668.0	1		52	577.	61.6	4703.5	1		101	97.	37.5	4697.4		
1		4		7.	.0	4668.0	1		53	555.	61.1	4703.4	1		102	96.	36.8	4697.2		
1		5		7.	.0	4668.0	1		54	535.	60.6	4703.3	1		103	96.	36.1	4697.0		
1		6		7.	.0	4668.0	1		55	516.	60.2	4703.2	1		104	96.	35.5	4696.8		
1		7		7.	.0	4668.0	1		56	498.	59.8	4703.1	1		105	95.	34.8	4696.6		
1		8		7.	.0	4668.0	1		57	482.	59.4	4703.0	1		106	95.	34.2	4696.4		
1		9		7.	.0	4668.0	1		58	466.	59.0	4702.9	1		107	95.	33.5	4696.2		
1		10		7.	.0	4668.0	1		59	452.	58.7	4702.8	1		108	94.	32.9	4696.0		
1		11		7.	.0	4668.0	1		60	439.	58.3	4702.8	1		109	94.	32.2	4695.8		
1		12		7.	.0	4668.0	1		61	426.	58.0	4702.7	1		110	94.	31.6	4695.5		
1		13		7.	.0	4668.0	1		62	415.	57.8	4702.6	1		111	93.	30.9	4695.3		
1		14		7.	.0	4668.0	1		63	404.	57.5	4702.6	1		112	93.	30.3	4695.1		
1		15		7.	.0	4668.0	1		64	394.	57.3	4702.5	1		113	92.	29.7	4694.8		
1		16		7.	.0	4668.0	1		65	386.	57.1	4702.5	1		114	92.	29.0	4694.6		
1		17		7.	.0	4668.0	1		66	378.	56.9	4702.4	1		115	92.	28.4	4694.4		
1		18		16.	.0	4668.0	1		67	371.	56.7	4702.4	1		116	91.	27.8	4694.2		
1		19		30.	.0	4669.8	1		68	365.	56.5	4702.3	1		117	91.	27.1	4693.9		
1		20		35.	.2	4670.9	1		69	358.	56.3	4702.3	1		118	91.	26.5	4693.7		
1		21		41.	.4	4672.5	1		70	352.	56.1	4702.3	1		119	90.	25.9	4693.5		
1		22		47.	.8	4674.1	1		71	346.	56.0	4702.2	1		120	90.	25.3	4693.3		
1		23		51.	1.4	4675.5	1		72	340.	55.8	4702.2	1		121	89.	24.7	4693.1		
1		24		56.	2.2	4677.2	1		73	334.	55.6	4702.2	1		122	89.	24.0	4692.8		
1		25		61.	3.3	4679.0	1		74	326.	55.4	4702.1	1		123	89.	23.4	4692.6		
1		26		66.	5.0	4681.2	1		75	313.	55.0	4702.0	1		124	88.	22.8	4692.4		
1		27		72.	7.5	4683.9	1		76	294.	54.5	4701.9	1		125	88.	22.2	4692.2		
1		28		78.	11.3	4686.8	1		77	271.	53.9	4701.7	1		126	88.	21.6	4692.0		
1		29		84.	17.3	4690.1	1		78	245.	53.1	4701.6	1		127	87.	21.0	4691.7		
1		30		90.	25.6	4693.4	1		79	220.	52.3	4701.4	1		128	87.	20.4	4691.4		
1		31		96.	36.3	4697.0	1		80	195.	51.5	4701.2	1		129	86.	19.8	4691.2		
1		32		125.	48.7	4700.5	1		81	170.	50.7	4701.0	1		130	86.	19.2	4690.9		
1		33		526.	60.4	4703.2	1		82	152.	49.9	4700.8	1		131	85.	18.6	4690.7		
1		34		952.	69.2	4705.1	1		83	136.	49.2	4700.6	1		132	85.	18.0	4690.4		
1		35		1250.	74.6	4706.3	1		84	121.	48.5	4700.4	1		133	84.	17.5	4690.2		
1		36		1398.	77.3	4706.8	1		85	112.	47.9	4700.3	1		134	84.	16.9	4689.9		
1		37		1438.	77.9	4706.9	1		86	104.	47.2	4700.1	1		135	83.	16.3	4689.6		
1		38		1407.	77.4	4706.8	1		87	101.	46.6	4700.0	1		136	83.	15.7	4689.3		
1		39		1337.	76.2	4706.6	1		88	100.	46.0	4699.8	1		137	82.	15.2	4689.0		
1		40		1250.	74.6	4706.3	1		89	100.	45.4	4699.6	1		138	82.	14.6	4688.7		
1		41		1161.	72.9	4706.0	1		90	100.	44.7	4699.4	1		139	81.	14.0	4688.4		
1		42		1070.	71.3	4705.6	1		91	100.	44.1	4699.3	1		140	81.	13.5	4688.1		
1		43		985.	69.8	4705.3	1		92	99.	43.4	4699.1	1		141	80.	12.9	4687.8		
1		44		910.	68.4	4705.0	1		93	99.	42.8	4698.9	1		142	79.	12.4	4687.5		
1		45		849.	67.2	4704.7	1		94	99.	42.1	4698.7	1		143	79.	11.8	4687.1		
1		46		795.	66.1	4704.5	1		95	98.	41.4	4698.5	1		144	78.	11.3	4686.8		
1		47		746.	65.1	4704.3	1		96	98.	40.8	4698.4	1		145	77.	10.8	4686.4		
1		48		702.	64.3	4704.1	1		97	98.	40.1	4698.2								
1		49		664.	63.5	4703.9	1		98	98.	39.5	4698.0								

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	12.00-HR
(CFS)	(HR)				
		(CFS)			
1438.	3.00	452.	258.	258.	258.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	12.00-HR
+ (AC-FT)	(HR)				
78.	3.00	56.	35.	35.	35.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	12.00-HR
+ (FEET)	(HR)				
4706.94	3.00	4702.05	4693.14	4693.14	4693.14

CUMULATIVE AREA = 1.21 SQ MI

1

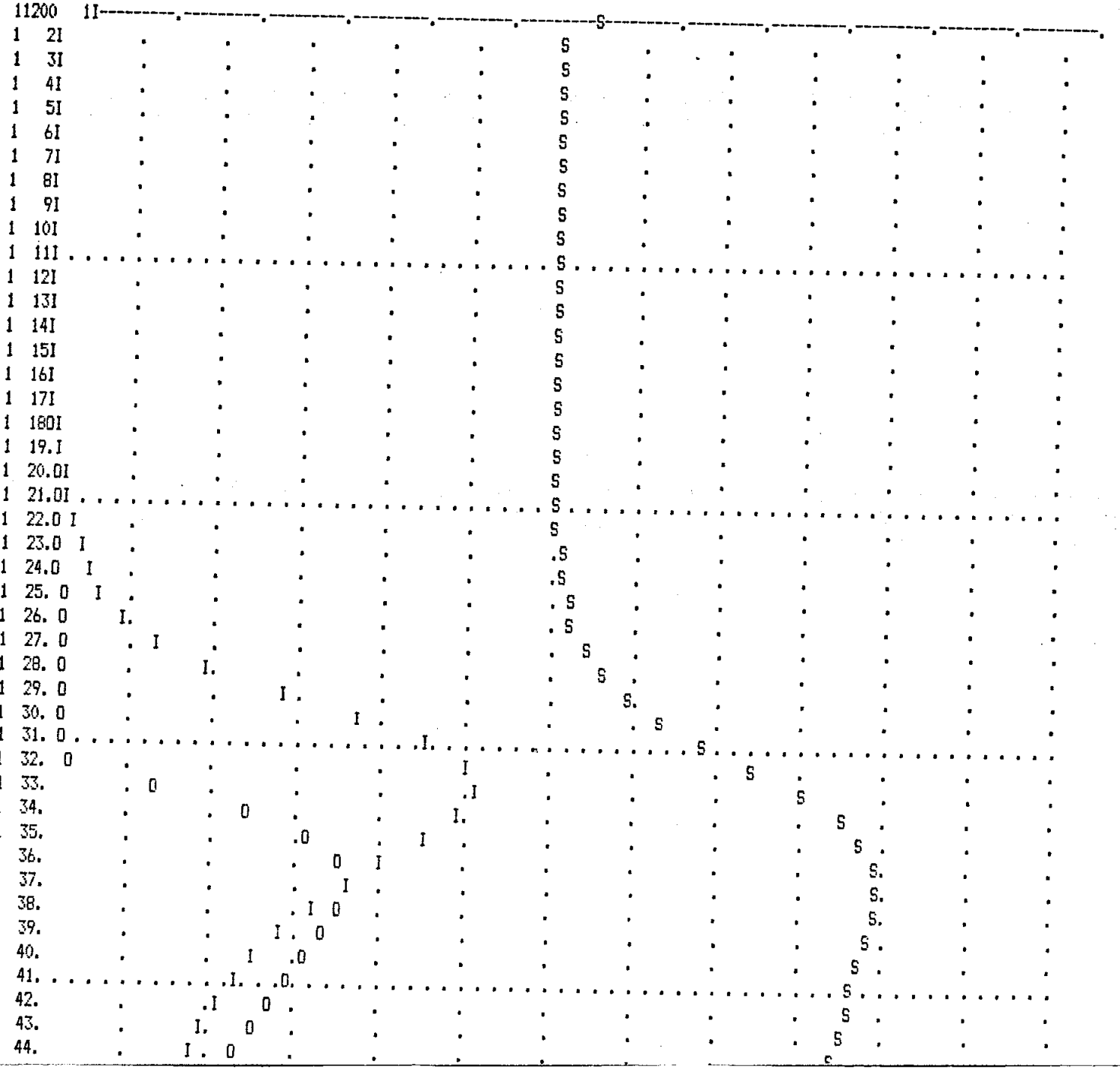
STATION DETEN

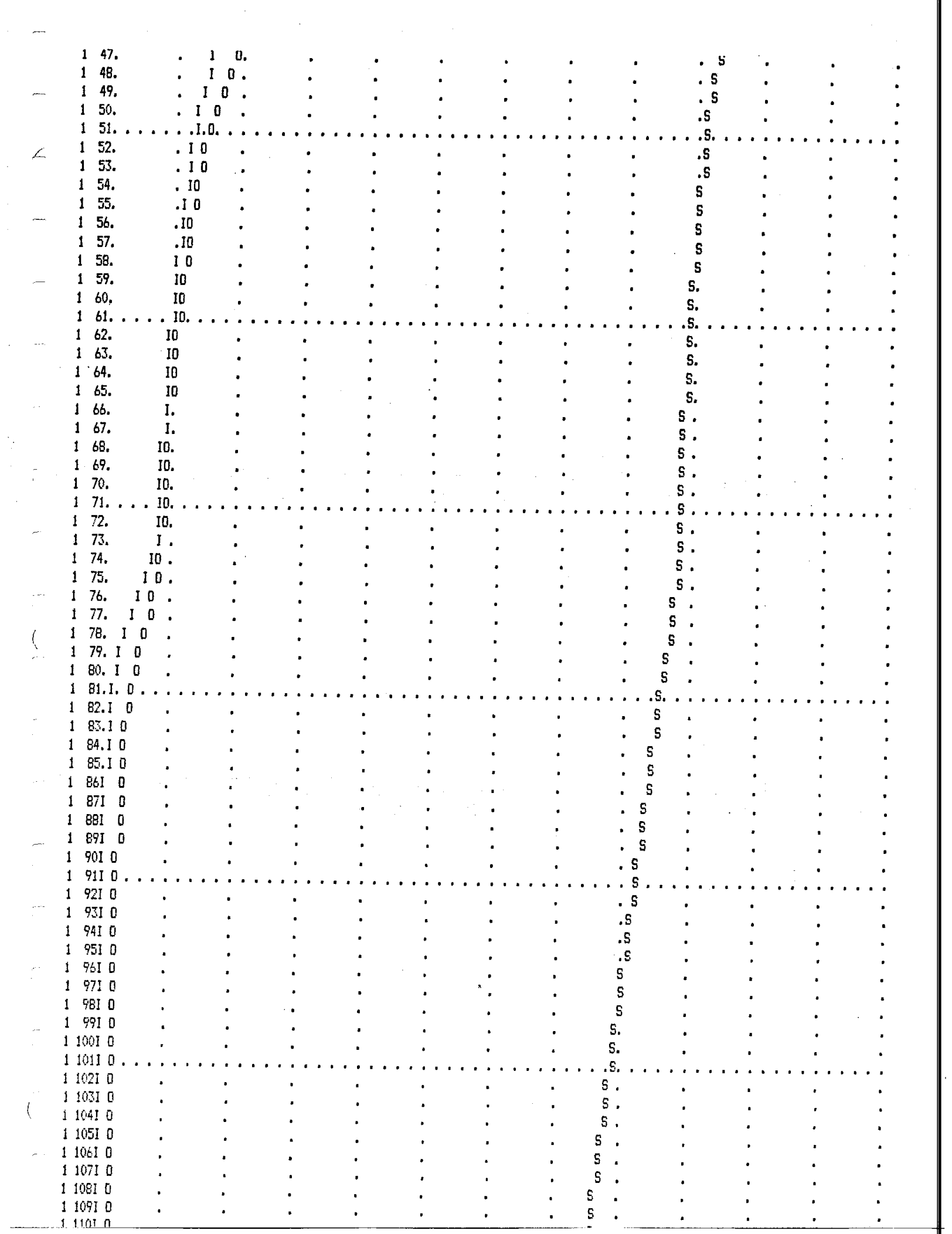
(I) INFLOW, (O) OUTFLOW

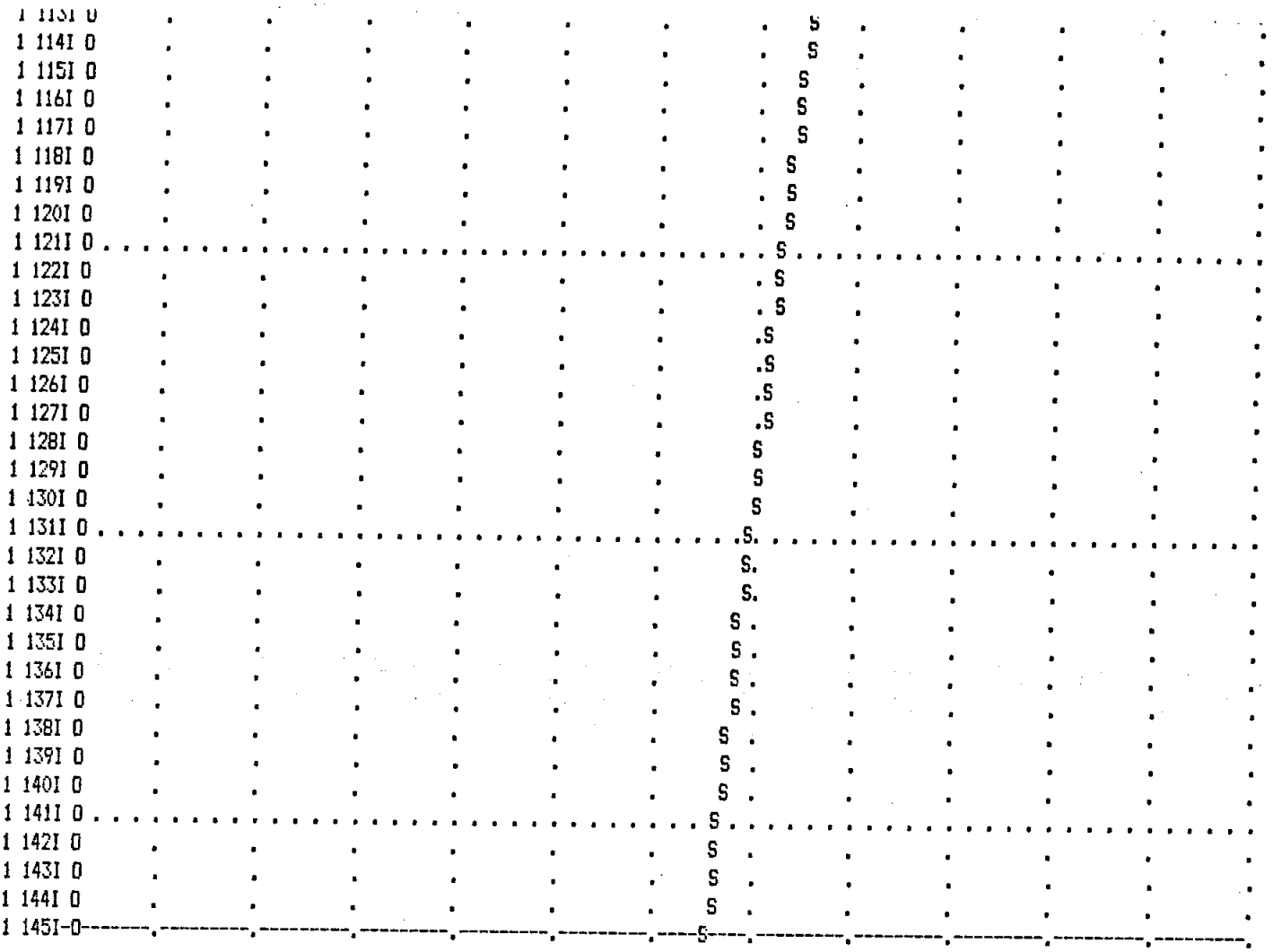
0. 400. 800. 1200. 1600. 2000. 2400. 0. 0. 0. 0. 0. 0.

(S) STORAGE

0. 0. 0. 0. 0. 0. 0. 20. 40. 60. 80. 0. 0.







1
1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	PLUM1	645.	2.58	155.	77.	77.	.35		
HYDROGRAPH AT	PLUM2	383.	2.50	88.	44.	44.	.20		
2 COMBINED AT	COMB	1026.	2.58	243.	122.	122.	.55		
ROUTED TO	ROUTE	1020.	2.58	244.	122.	122.	.55		
HYDROGRAPH AT	PLUM3	479.	2.58	115.	58.	58.	.26		
2 COMBINED AT	COMB	1499.	2.58	359.	179.	179.	.81		
ROUTED TO	ROUTE	1470.	2.58	358.	179.	179.	.81		

	2 COMBINED AT								
+		COMB	2053.	2.67	535.	268.	268.	1.21	
	ROUTED TO								
+		DETEN	1438.	3.00	452.	258.	258.	1.21	
+									4706.94 3.00

*** NORMAL END OF HEC-1 ***

DRAFT

PLUMAS/MOANA
STORM DRAIN PROJECT
DRAFT PRELIMINARY
HYDROLOGIC ANALYSIS

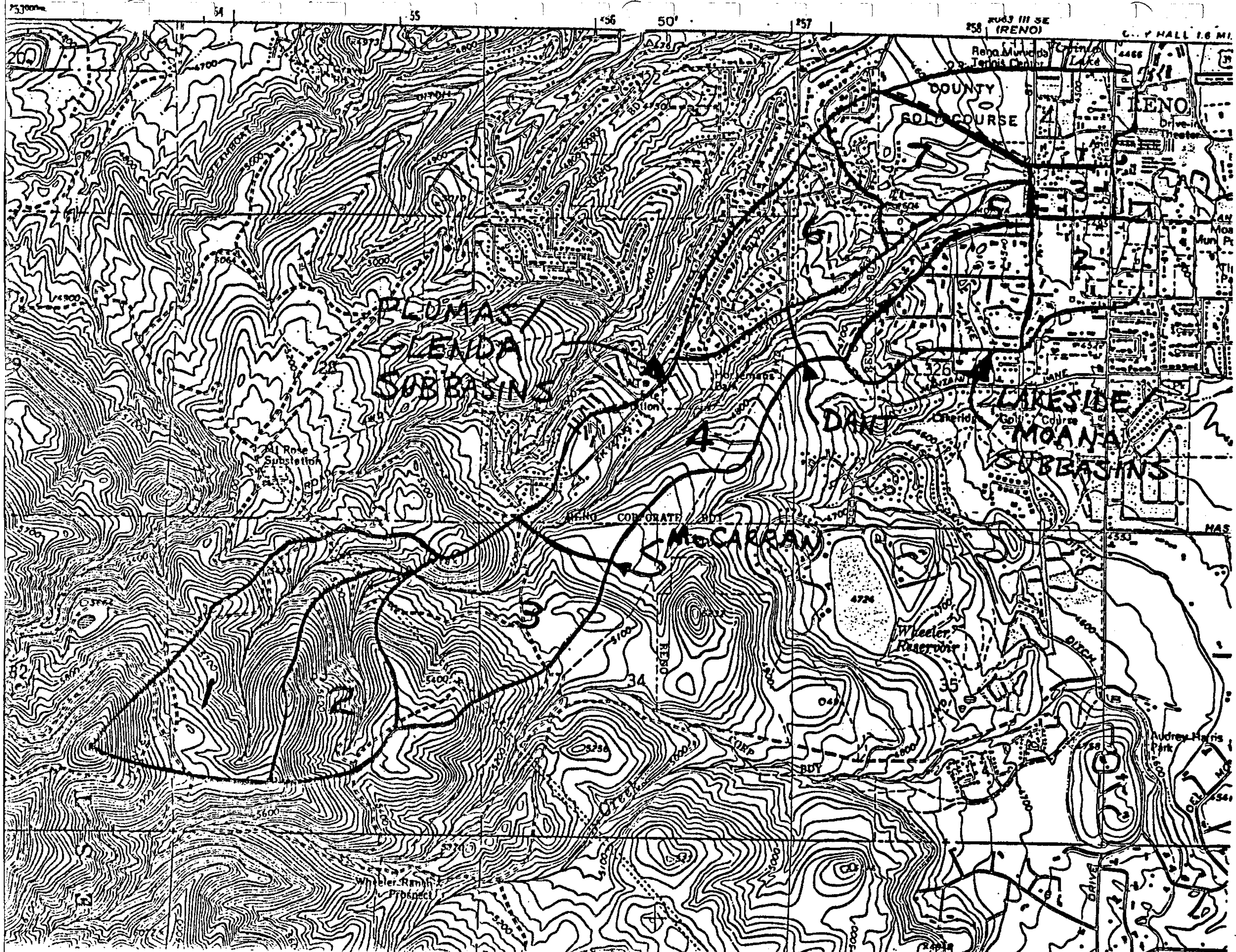
FOR

CITY OF RENO

RENO, NEVADA

September 1988

KENNEDY/JENKS/CHILTON
877041.00


PLUMAS / GLENDA SUBBASINS
LAKESIDE / MOANA SUBBASINS
McCARRAN
DAM
COUNTY GOLF COURSE
RENO
Wheeler Reservoir
Audrey Harris Park
Wheeler Ranch Prospect
Reno Municipal Tennis Center
Virginia Lake
RENO CORPORATE BDY
1
2
3
4
5
6
7

SUMMARY OF PEAK FLOWS BASED ON SCS METHODOLOGY
(FLOW IN CFS)

lood vent	Moana & Lakeside		At Dant Crossing		Flow At Plumas & Glenda				Flow Into Virigina Lake			
					No Dant		With Dant		No Dant		With Dant	
	6 Hr	24 Hr	6 Hr	24 Hr	6 Hr	24 Hr	6 Hr	24 Hr	6 Hr	24 Hr	6 Hr	24 Hr
5 Yr	34	56	151	261	198	347	105	154	252	430	158	238
0 Yr	46	73	207	339	275	452	131	186	346	555	201	293
5 Yr	73	107	337	503	446	667	186	255	554	816	294	409
0 Yr	95	135	446	630	590	855	228	309	726	1037	367	498
0 Yr	111	153	527	716	697	972	260	345	853	1175	422	558

DESIGN STORM PRECIPITATION AMOUNTS FROM NOAA ATLAS 2 FOR PLUMAS/MOANA WATERSHED

Return Period In Years	Precipitation Amount In Inches 6 Hour Storm	24 Hours Storm
2 Yr	0.8	1.2
5 Yr	1.0	1.6
10 Yr	1.25	1.8
25 Yr	1.4	2.2
50 Yr	1.6	2.5
100 Yr	1.8	2.7

PLUMAS/MOANA HYDROLOGY
SUMMARY OF RUNOFF PARAMETERS FOR SCS METHOD

Sub-basin Number	Curve Number	Time Of Concentration (Hours)	Lag Time (Hours) (=0.6Tc)	Travel Time Thru Down-Stream Reach	Accum.Time Of Concen. (Hours)	Accum.Lag Time (Hours)
Plumas						
1	85	0.51	0.31	-	0.51	0.31
2	85	0.44	0.27	-	0.51	0.31
3	85	0.51	0.31	0.05	0.56	0.34
4	85	0.92	0.55	0.15	0.92	0.55
5	86	0.92	0.55	0.12	1.04	0.62
6	84	0.89	0.53	-	0.89	0.53
7	85	0.92	0.55	0.08	0.97	0.58
Lakeside						
1	84	0.92	0.55	-	0.92	0.55
2	88	0.97	0.58	0.08	1.00	0.60
3	96	0.59	0.35	0.02	1.06*	0.64
4	95	0.66	0.40	0.02	1.08	0.65
5	95	0.59	0.35	0.02	1.10	0.66

* Combined With Plumas Subbasin 5

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS MCANA HYDROLOGY By SRD Date 8-11-88

Location PLUMAS WATERSHED SUBBASIN 1 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND			
1. Surface description (table 3-1)			BRUSH			
2. Manning's roughness coeff., n (table 3-1)			0.20			
3. Flow length, L (total L ≤ 300 ft)	ft		300			
4. Two-yr 24-hr rainfall, P_2	in		1.2			
5. Land slope, s	ft/ft		0.20			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	0.32	+		=
Shallow concentrated flow		Segment ID	COLLECTIN			
7. Surface description (paved or unpaved)			UNPAVED			
8. Flow length, L	ft		2200			
9. Watercourse slope, s	ft/ft		0.20			
10. Average velocity, V (figure 3-1)	ft/s		7.2			
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.08	+		=
Channel flow		Segment ID	MAIN			
12. Cross sectional flow area, a (1:10 SCS d=3)		ft^2	48			
13. Wetted perimeter, p_w		ft	23.4			
14. Hydraulic radius, $r = \frac{a}{p_w}$	Compute r	ft	2.05			
15. Channel slope, s		ft/ft	0.10			
16. Manning's roughness coeff., n			0.05			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	15			
18. Flow length, L		ft	6000			
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.11	+		= 0.51
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr				

$L_{AG} = 0.6\ T_c$

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MIANA HYDROLOGY By SRD Date 8-11-88

Location PLUMAS WATERSHED SUBBASIN 2 Checked _____ Date _____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND	
1. Surface description (table 3-1)			BRUSH	
2. Manning's roughness coeff., n (table 3-1)			0.20	
3. Flow length, L (total L ≤ 300 ft)	ft		300	
4. Two-yr 24-hr rainfall, P_2	in		1.2	
5. Land slope, s	ft/ft		0.20	
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t hr		.32	+ ____ = ____

Shallow concentrated flow		Segment ID	COLLECTOR	
7. Surface description (paved or unpaved)			1200	
8. Flow length, L	ft		0.20	
9. Watercourse slope, s	ft/ft		0.20	
10. Average velocity, V (figure 3-1)	ft/s		7.2	
11. $T_t = \frac{L}{3600\ V}$	Compute T_t hr		0.05	+ ____ = ____

Channel flow		Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = \frac{a}{P_w}$	Compute r ft			
15. Channel slope, s	ft/ft		0.16	
16. Manning's roughness coeff., n			0.05	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V ft/s		15	
18. Flow length, L	ft		4000	
19. $T_t = \frac{L}{3600\ V}$	Compute T_t hr		0.07	+ ____ = 0.44

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr ____

LAG = 0.6 TC

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MANA HYDROLOGY By SRD Date 8-11-86

Location PLUMAS WATERSHED SUBBASIN 3 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND		
1. Surface description (table 3-1)			BRUSH		
2. Manning's roughness coeff., n (table 3-1)			0.20		
3. Flow length, L (total L ≤ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.2		
5. Land slope, s	ft/ft		0.15		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$	Compute T_t	hr	0.36	+	=
Shallow concentrated flow		Segment ID	COLLECTOR		
7. Surface description (paved or unpaved)			UNPAVED		
8. Flow length, L	ft		2200		
9. Watercourse slope, s	ft/ft		0.15		
10. Average velocity, V (figure 3-1)	ft/s		6.2		
11. $T_t = \frac{L}{3600\, V}$	Compute T_t	hr	0.10	+	=
Channel flow		Segment ID	MAIN		
12. Cross sectional flow area, a	ft^2		48		
13. Wetted perimeter, p_w	ft		23.4		
14. Hydraulic radius, $r = \frac{a}{p_w}$	Compute r	ft	2.05		
15. Channel slope, s	ft/ft		0.064		
16. Manning's roughness coeff., n			0.05		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$	Compute V	ft/s	12		
18. Flow length, L	ft		2200		
19. $T_t = \frac{L}{3600\, V}$	Compute T_t	hr	0.05	+	= 0.51
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr			

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MANA HYDROLOGY By SRD Date 8-11-08

Location PLUMAS WATERSHED SUBBASIN 4 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND		
1. Surface description (table 3-1)			LAWN		
2. Manning's roughness coeff., n (table 3-1)			0.24 ~~0.20~~		
3. Flow length, L (total L ≤ 300 ft)	ft		200		
4. Two-yr 24-hr rainfall, P_2	in		1.2		
5. Land slope, s	ft/ft		0.02		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr		~~0.58~~ 0.47	+	=
Shallow concentrated flow		Segment ID	COLLECTOR		
7. Surface description (paved or unpaved)			UNPAVED		
8. Flow length, L	ft		1500		
9. Watercourse slope, s	ft/ft		0.08		
10. Average velocity, V (figure 3-1)	ft/s		4.6		
11. $T_t = \frac{L}{3600\, V}$ Compute T_t	hr		0.09	+	=
Channel flow		Segment ID	MAIN		
12. Cross sectional flow area, a 4:10' 5:2:1 d= 4'	ft^2		56		
13. Wetted perimeter, P_w	ft		27.9		
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r	ft		2.01		
15. Channel slope, s	ft/ft		0.05		
16. Manning's roughness coeff., n			0.05		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft/s		10.6		
18. Flow length, L	ft		5600		
19. $T_t = \frac{L}{3600\, V}$ Compute T_t	hr		0.15	+	= ~~0.85~~ 0.72
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MANA HYDROLOGY By SRD Date 8-11-88

Location PLUMAS WATERSHED SUBBASIN 5 Checked _____ Date _____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND			
1. Surface description (table 3-1)			LAWN			
2. Manning's roughness coeff., n (table 3-1)			~~0.20~~ 0.24			
3. Flow length, L (total L ≤ 300 ft)	ft		200			
4. Two-yr 24-hr rainfall, P_2	in		1.2			
5. Land slope, s	ft/ft		~~0.05~~ 0.11			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	0.44 0.68	+		=
Shallow concentrated flow		Segment ID	COLLECTOR			
7. Surface description (paved or unpaved)			UNPAVED			
8. Flow length, L	ft		1500			
9. Watercourse slope, s	ft/ft		0.05			
10. Average velocity, V (figure 3-1)	ft/s		3.6			
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.12	+		=
Channel flow		Segment ID				
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, p_w	ft					
14. Hydraulic radius, $r = \frac{a}{p_w}$	Compute r	ft	2.0			
15. Channel slope, s	ft/ft		0.03			
16. Manning's roughness coeff., n			0.04			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	10.2			
18. Flow length, L	ft		4450			
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.12	+		= 0.65 (0.92)
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr				

$T_c = 0.6\ T_t$

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MUANA HYDROLOGY By SRD Date 8-11-88

Location PLUMAS WATERSHED SUBBASIN 6 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND		
1. Surface description (table 3-1)			LAWN		
2. Manning's roughness coeff., n (table 3-1)			~~0.20~~ 0.24		
3. Flow length, L (total L ≤ 300 ft)	ft		200		
4. Two-yr 24-hr rainfall, P_2	in		1.2		
5. Land slope, s	ft/ft		0.02		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	~~0.58~~ 0.68	+	-
Shallow concentrated flow		Segment ID	COLLECTOR		
7. Surface description (paved or unpaved)			UNPAVED		
8. Flow length, L	ft		1200		
9. Watercourse slope, s	ft/ft		0.05		
10. Average velocity, V (figure 3-1)	ft/s		3.6		
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.09	+	-
Channel flow		Segment ID	MAIN		
12. Cross sectional flow area, a	ft^2		28		
13. Wetted perimeter, P_w	ft		18.9		
14. Hydraulic radius, $r = \frac{a}{P_w}$	Compute r	ft	1.48		
15. Channel slope, s	ft/ft		0.03		
16. Manning's roughness coeff., n			0.04		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	8.4		
18. Flow length, L	ft		3500		
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.12	+	- ~~0.79~~ 0.99
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr			

1 AC = 0.6 Tc

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MANNA HYDROLOGY By SRD Date 8-11-88

Location PLUMAS WATERSHED SUBBASIN 7 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND		
1. Surface description (table 3-1)			LAWN		
2. Manning's roughness coeff., n (table 3-1)			~~0.15~~ 0.24		
3. Flow length, L (total L ≤ 300 ft)	ft		200		
4. Two-yr 24-hr rainfall, P_2	in		1.2		
5. Land slope, s	ft/ft		~~0.03~~ 0.02		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	hr	Compute T_t	~~0.50~~ 0.18	+	=
Shallow concentrated flow		Segment ID	COLLECTOR		
7. Surface description (paved or unpaved)			UNPAVED		
8. Flow length, L	ft		1850		
9. Watercourse slope, s	ft/ft		0.04		
10. Average velocity, V (figure 3-1)	ft/s		3.2		
11. $T_t = \frac{L}{3600\ V}$	hr	Compute T_t	0.16	+	=
Channel flow		Segment ID	MAIN		
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$	ft	Compute r	1.48		
15. Channel slope, s	ft/ft		0.02		
16. Manning's roughness coeff., n			0.04		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	ft/s	Compute V	6.8		
18. Flow length, L	ft		1900		
19. $T_t = \frac{L}{3600\ V}$	hr	Compute T_t	0.08	+	= ~~0.77~~ 0.92
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				

LAG = 0.6 Tc

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MOANA HYDROLOGY By SRD Date 8-11-88

Location MOANA/LAKESIDE SUBBASIN 1 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND			
1. Surface description (table 3-1)			LAWN			
2. Manning's roughness coeff., n (table 3-1)			~~0.170~~ 0.24			
3. Flow length, L (total L ≤ 300 ft)	ft		200			
4. Two-yr 24-hr rainfall, P_2	in		1.2			
5. Land slope, s	ft/ft		~~0.07~~ 0.07			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	~~0.79~~	+		= 0.69
Shallow concentrated flow		Segment ID	COLLECTOR			
7. Surface description (paved or unpaved)			UNPAVED			
8. Flow length, L	ft		1500			
9. Watercourse slope, s	ft/ft		0.035			
10. Average velocity, V (figure 3-1)	ft/s		3.0			
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.14	+		=
Channel flow		Segment ID	MAIN			
12. Cross sectional flow area, a	ft^2		30			
13. Wetted perimeter, P_w	ft		17.4			
14. Hydraulic radius, $r = \frac{a}{P_w}$	Compute r	ft	1.72			
15. Channel slope, s	ft/ft		0.032			
16. Manning's roughness coeff., n			0.04			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	9.6			
18. Flow length, L	ft		3500			
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.10	+		= ~~1.1~~ 1.03
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr				

16 12.9 1.24

0.92

$T_c = 2.1\ T_t$

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MORNA HYDROLOGY By SRO Date 8-11-88

Location MORNA/LAKESIDE SUBBASIN 2 Checked ____ Date ____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

$(0.0)^{.4} < 0.16$

$(0.05)^{.4} < 0.21$

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND		
1. Surface description (table 3-1)			LAWN		
2. Manning's roughness coeff., n (table 3-1)			0.24		
3. Flow length, L (total L ≤ 300 ft)	ft		200		
4. Two-yr 24-hr rainfall, P_2	in		1.2		
5. Land slope, s	ft/ft		2%		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$	Compute T_t	hr	0.24	+	= 0.68
Shallow concentrated flow		Segment ID	COLLECTOR		
7. Surface description (paved or unpaved)			UNPAVED		
8. Flow length, L	ft		1200		
9. Watercourse slope, s	ft/ft		0.01		
10. Average velocity, V (figure 3-1)	ft/s		1.6		
11. $T_t = \frac{L}{3600\,V}$	Compute T_t	hr	0.21	+	=
Channel flow		Segment ID			
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, P_w	ft				
14. Hydraulic radius, $r = \frac{a}{P_w}$	Compute r	ft	1.72		
15. Channel slope, s	ft/ft		0.015		
16. Manning's roughness coeff., n			0.04		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$	Compute V	ft/s	6.6		
18. Flow length, L		ft	2000		
19. $T_t = \frac{L}{3600\,V}$	Compute T_t	hr	0.08	+	= 0.08
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr			0.97

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MOANA HYDROLOGY By SRD Date _____

Location GLENDA & LAKESIDE 3 Checked ____ Date _____

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND					
1. Surface description (table 3-1)			LAWN					
2. Manning's roughness coeff., n (table 3-1) ..			0.24					
3. Flow length, L (total L ≤ 300 ft)	ft		100					
4. Two-yr 24-hr rainfall, P_2	in		1.2					
5. Land slope, s	ft/ft		0.01					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	0.51	+		=		
Shallow concentrated flow		Segment ID	COLLECT					
7. Surface description (paved or unpaved)			PAVED					
8. Flow length, L	ft		400					
9. Watercourse slope, s	ft/ft		0.01					
10. Average velocity, V (figure 3-1)	ft/s		2.0					
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.06	+		=		
Channel flow		Segment ID	CHANNEL					
12. Cross sectional flow area, a	ft^2		25					
13. Wetted perimeter, P_w	ft		15					
14. Hydraulic radius, $r = \frac{a}{P_w}$	Compute r	ft	1.67					
15. Channel slope, s	ft/ft		0015					
16. Manning's roughness coeff., n			0.015					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	17					
18. Flow length, L	ft		1300					
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.02	+		=	059	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr						

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MOANA HYDROLOGY By SRO Date _____

Location LAKESIDE & BRINKBY 4 Checked ____ Date _____

Circle one: Present Developed

Circle one: T_c T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND			
1. Surface description (table 3-1)			LAWN			
2. Manning's roughness coeff., n (table 3-1) ..			0.24			
3. Flow length, L (total L ≤ 300 ft)	ft		100			
4. Two-yr 24-hr rainfall, P_2	in		1.2			
5. Land slope, s	ft/ft		0.01			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.51	+		=
Shallow concentrated flow		Segment ID	COLLECT			
7. Surface description (paved or unpaved)			PAVED			
8. Flow length, L	ft		1200			
9. Watercourse slope, s	ft/ft		0.015			
10. Average velocity, V (figure 3-1)	ft/s		2.5			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.13	+		=
Channel flow		Segment ID	CHANNEL			
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, p_w	ft					
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft					
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		15			
18. Flow length, L	ft		1100			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.02	+		= 0.66
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr					

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project PLUMAS/MUNA HYDROLOGY By SRD Date 8.25.08

Location VIRGINIA LAKE (AREA = 15.1 AC) Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	OVERLAND					
1. Surface description (table 3-1)			LAWN					
2. Manning's roughness coeff., n (table 3-1) ..			0.24					
3. Flow length, L (total L ≤ 300 ft)	ft		100					
4. Two-yr 24-hr rainfall, P_2	in		1.2					
5. Land slope, s	ft/ft		0.01					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t	hr	0.51	+		=		
Shallow concentrated flow		Segment ID	COLLECTOR					
7. Surface description (paved or unpaved)			PAVED					
8. Flow length, L	ft		400					
9. Watercourse slope, s	ft/ft		0.01					
10. Average velocity, V (figure 3-1)	ft/s		2.0					
11. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.06	+		=		
Channel flow		Segment ID	CHANNEL					
12. Cross sectional flow area, a	ft^2							
13. Wetted perimeter, p_w	ft							
14. Hydraulic radius, $r = \frac{a}{p_w}$	Compute r	ft						
15. Channel slope, s	ft/ft							
16. Manning's roughness coeff., n								
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft/s	10					
18. Flow length, L	ft		800					
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr	0.02	+		=	0.59	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		hr						

PC

RAINFALL TABLE 2

STANDARD SCS 24-HOUR, TYPE II DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

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      TABLE NO.          TIME INCREMENT
5 RAINFL 2                   0.2500
8                  0.0        0.0020     0.0050     0.0080     0.0110
8                  0.0140     0.0170     0.0200     0.0230     0.0260
8                  0.0290     0.0320     0.0350     0.0380     0.0410
8                  0.0440     0.0480     0.0520     0.0560     0.0600
8                  0.0640     0.0680     0.0720     0.0760     0.0800
8                  0.0850     0.0900     0.0950     0.1000     0.1050
8                  0.1100     0.1150     0.1200     0.1260     0.1330
8                  0.1400     0.1470     0.1550     0.1630     0.1720
8                  0.1810     0.1910     0.2030     0.2180     0.2360
8                  0.2570     0.2830     0.3870     0.6630     0.7070
8                  0.7350     0.7580     0.7760     0.7910     0.8040
8                  0.8150     0.8250     0.8340     0.8420     0.8490
8                  0.8560     0.8630     0.8690     0.8750     0.8810
8                  0.8870     0.8930     0.8980     0.9030     0.9080
8                  0.9130     0.9180     0.9220     0.9260     0.9300
8                  0.9340     0.9380     0.9420     0.9460     0.9500
8                  0.9530     0.9560     0.9590     0.9620     0.9650
8                  0.9680     0.9710     0.9740     0.9770     0.9800
8                  0.9830     0.9860     0.9890     0.9920     0.9950
8                  0.9980     1.0000     1.0000     1.0000     1.0000
9 ENDTBL
```

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0. The format for this table is Form #271, Page F-7.