Toyota Technical Center, U.S.A., Inc.
Arizona Proving Grounds

Drainage Design Report

September 1991

Prepared for:

Toyota Technical Center, U.S.A., Inc.
2901 North Central Avenue, Suite 900
Phoenix, Arizona 85012

Taisei-Bechtel Joint Venture
2700 North Central Avenue, Suite 1110
Phoenix, Arizona 80567

Prepared by:

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APPENDIX

Stanley Franzoy Corey Engineering Company
Hydrology Report

Robert Wood, Consulting Engineer
East Diversion Channel Design Report

Sergent, Hauskins & Beckwith Engineers
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1.0 INTRODUCTION

1.1 General

The Toyota Arizona Proving Ground is intended to facilitate design, research, development, and testing of various types of Toyota vehicles. The Proving Ground will consist of a wide variety of roads, tracks, and driving surfaces which simulate actual driving conditions, plus research and support buildings, and access, service, and perimeter security roads. The most significant feature of this project is the 10-mile long oval high speed test track.

This report presents the results of a hydrology analysis done by Stanley Franzoy Corey Engineering Company, East Diversion Channel hydraulic design and analysis done by Robert Wood, Consulting Engineer in cooperation with Sverdrup Corporation, and the hydraulic drainage design for the construction design of the Toyota Arizona Proving Ground. The concept of the drainage plan is to manage storm water runoff to avoid adverse downstream impacts.

1.2 Purpose of Study

The purpose of this study is: (1) to evaluate the existing hydrologic conditions for the water shed tributary to the proposed Toyota Arizona Proving Ground, (2) to evaluate the existing drainage conditions within the Proving Ground, and (3) to develop a drainage concept that satisfies on-site requirements while avoiding redirection or redistribution of storm runoff off-site, and maintains or reduces peak flows from the property.

1.3 Study Area

The Toyota Arizona Proving Ground site is located in the northwestern part of Maricopa County (see Figure 1, Location Map). It is located approximately 45 miles northwest of Phoenix and approximately 16 miles south of Wickenburg. The site occupies 10,936.8 acres on the Hassayampa Plain entirely within Township 5 North, Range 5 West of the Gila and Salt River Base and Meridian, Maricopa County, Arizona. It includes Sections 16 through 22, portions of Section 23, and Sections 25 through 35.

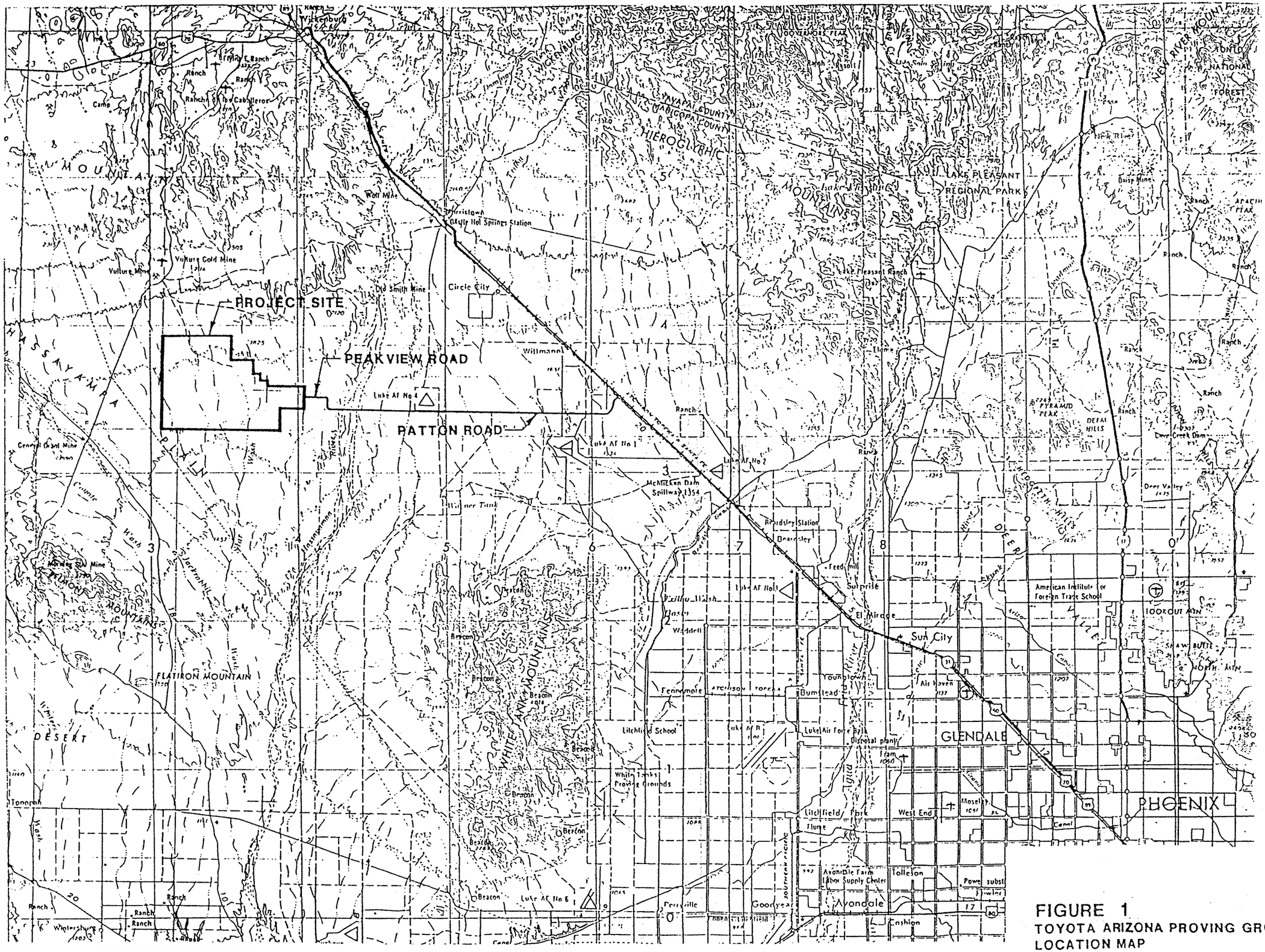

FIGURE 1
TOYOTA ARIZONA PROVING GROUND
LOCATION MAP

Sverdrup CORPORATION

1.3.1 Drainage Area Characteristics

The proposed Toyota Arizona Proving Ground is located on range land on the alluvial Hassayampa Plain. Storm runoff typically flows from north to south. With average elevations of 1837 feet on the north property line to 1620 feet on the south property line, the ground slopes approximately 1.0 percent across the property.

There are three major zones that affect project drainage: the Vulture Mountains, the entrenched alluvial fan transition zone, and the Hassayampa Plain. The three zones differ significantly in relief and hydrologic soil-cover complex characteristics.

North of the drainage area is the Vulture Mountains. The mountains are a combination of rugged rock outcrop and steep, hilly terrain with large, stable washes combined with canyons. The alluvial fan transition zone is characterized by convex contour lines, evidence of ancient channel avulsions from earlier periods of active fan formation and several remaining stream branchings, counter balanced by channel entrenchment, indicating a less active fan. The lower alluvial Hassayampa Plain is characterized by shallower relief, straight or slightly concave contours, and a greater tendency for sheet flow.

The Vulture Mountains, with their rocky outcrops and generally steep slopes (5-10% and greater), are composed primarily of Type D soils. They exhibit high runoff potential and short times of concentration. Vegetative cover is typically 40%.

The alluvial fan transition zone lies immediately below the Vulture Mountains and above the Hassayampa Plain. Slopes here are less steep (2-3%) and the soil types vary greatly, but are generally in the B/C range. Vegetative cover is typically in the 40% to 50% range.

The Hassayampa Plain, upon which the project site is located, has contours which are linear to slightly concave and slopes which are on the order of 1%. Soil types vary between A and B with some type C and D soils. Vegetative cover varies down to 30%. The project site is characterized by numerous small, shallow washes along with wider yet shallow washes coming from the upland areas. The low relief and linear contours indicate that overflow of channels and a tendency for sheet flow is likely for the larger runoff events.

The climate has very hot summers and moderate winters. Average daily temperatures in January are 60-65°F while the minimum is 25-30°F. July's temperatures range from an average daily of 100-120°F to lows of 80°F. Precipitation occurs mostly during the winter months and summer monsoon season.

1.3.2 Existing and Future Development

The existing development on the project site has been limited to stock water ponds and stock corrals. Unmaintained graded and ungraded roads meander through the project site, generally following the ground contours. Roads in the north-south direction, have typically become storm runoff channels, often resulting in extensive erosion.

The proposed project site improvements are aligned parallel to the contours of the land for the most part, thus creating a barrier to storm runoff. Culverts are designed to convey cross-drainage, but significant volumes of storm water will be detained upstream of the culverts during a storm. The High Speed Oval Track and Cornering Course (See Figure 2) will be constructed at elevations set to assure that upstream detention volumes are less than 50 acre-feet (so as not to require regulation by the Arizona Department of Water Resources, Safety of Dams Section). In most cases, the peak runoff leaving the site will be less than at present due to storm water storage behind the road embankments. Phase I and future site improvements have been modeled in the HEC 1 hydrology program to size the culverts taking advantage of upstream detention and to incorporate needed retention facilities in Phase I construction (See Section 6.2 of the Hydrology Report).

A closed storm drain system, outletting into a graded earthen channel, is used in the cut section of the High Speed Oval Track. The below-grade underpasses and Steep Grades Course have wet well storage with pumps to discharge storm water into nearby washes.

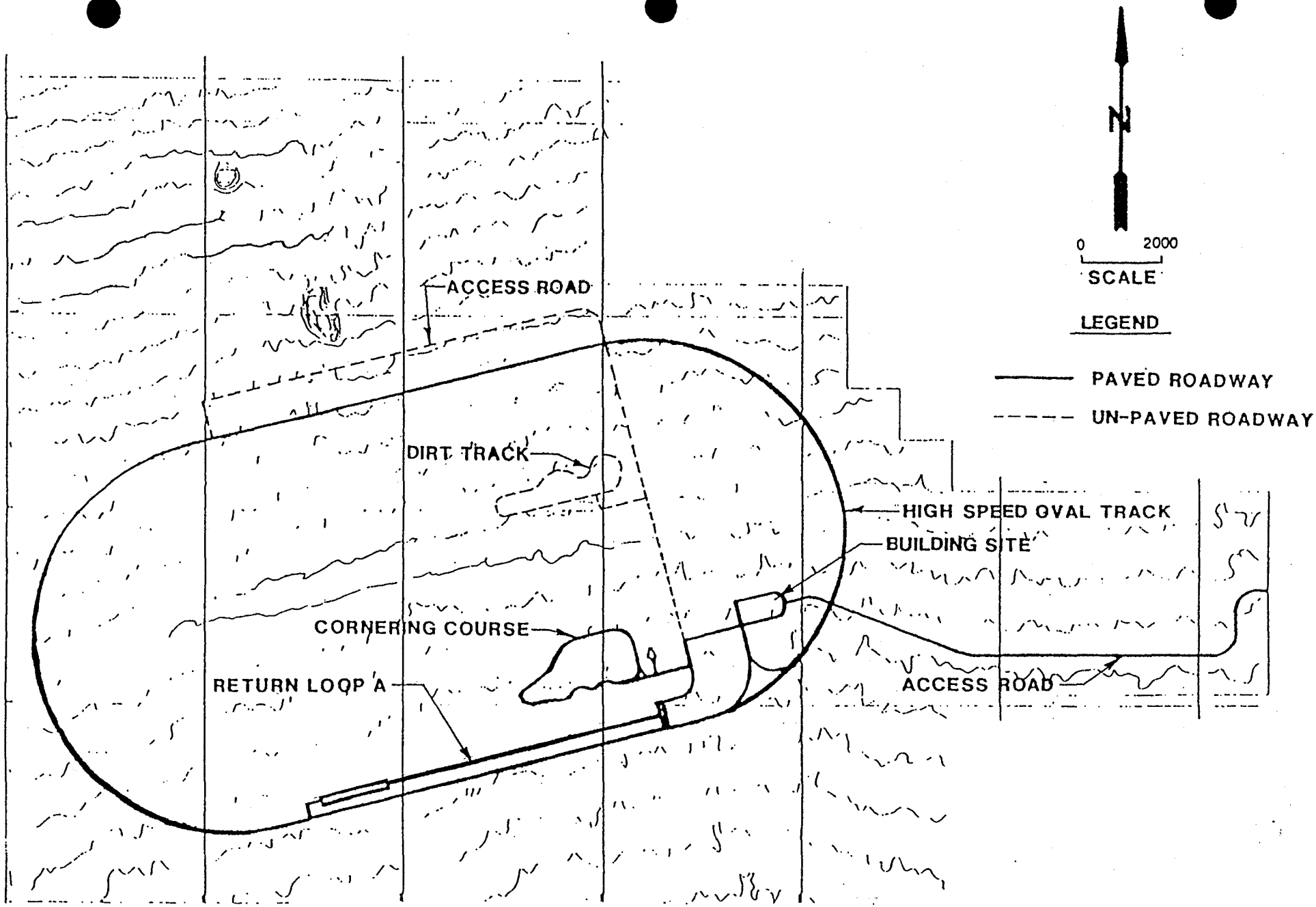

FIGURE 2
TOYOTA ARIZONA PROVING GROUND
PROJECT FEATURES PHASE 1

Sverdrup
CORPORATION

1.3 Previous Studies

The Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program has previously performed a drainage study on the lower portion of the project site. Specific sections are 31-35 and the south three-quarters of Section 25-30. All other portions of the site are beyond the limits of the Flood Insurance Rate Map, effective April 15, 1988. Shown on Community Panel Numbers 04013C1075D and 04013C1100D of Maricopa County, Arizona, the entire mapped portion of the site is in "Zone B". Zone B is defined as "areas between limits of the 100-year flood and 500-year flood or certain areas subject to 100-year flooding with average depths less than one (1) foot or where contributing drainage area is less than one (1) square mile, or areas protected by levees from the base flood."

The "Jackrabbit Wash Floodplain Delineation Study" was completed for the Flood Control District of Maricopa County to update flood insurance rate mapping in the area. The study included the Star Wash and Daggs Wash drainage basins which include the project site. The HEC 1 model developed for the Jackrabbit Wash study was adopted as base data in completing the hydrology report for this project.

2.0 PROCEDURES AND METHODOLOGIES

2.1 Precipitation Criteria

The design storms specified by the Flood Control District of Maricopa County are either a 2-hour or a 6-hour distribution. The 2-hour storm will be used for retention design purposes. The 6-hour storm will be used for all hydrologic analyses for areas up to 100 square miles. Design of cross culverts will use the 100-year, 6-hour storm. On site retention facilities have been based on the 100-year, 2-hour rainfall event and will follow the drainage regulations for the unincorporated areas of the Flood Control District. Detention basins will be designed for slope stability at the entrance and outlets to cross culverts.

2.2 Hydrologic Analysis

See Stanley Franzoy Corey Engineering Company report in the appendix of this report.

2.3 Drainage Design Concept

Criteria used to establish the drainage design concept for this facility are:

1. No diversion of flows to downstream property owners.

2. No increase in either the peak discharge rate or the runoff volume from the 100-year, 6-hour storm.

3. Culverts and channels to be designed based upon the 100-year, 6-hour storm. Retention basins to be designed based upon the 100-year, 2-hour storm. Riprap erosion protection to be designed based upon the 10-year, 6-hour storm.

4. Utilize the natural storage at culvert inlets to reduce culvert sizing. Where embankment heights are six feet or greater detention volume must be less than 50 acre feet so as not to require regulation by the Arizona Department of Water Resources, Safety of Dams Section.

After drainage basins and concentration points along the High Speed Oval Track, Loop Road A, and the Cornering Course were identified, the ponding areas above each concentration point were determined at two foot elevation increments. The storage volume was then computed for the various

elevations and a stage-storage curve was developed. From the curve, a maximum elevation for each track was selected which would limit the storage behind each concentration point to below 50 acre feet.

Culverts were then sized based upon the peak and volume of the storm flow for the 100-year 6-hour design storm. The design flow was then routed through the culverts to check the maximum pooling elevation behind the track.

Several culverts were depressed below the elevation of the existing wash using drop inlets to collect the storm water. Many of the depressed culverts require short reaches of soil cement channels downstream of the culverts to return the flow back to the original channel.

The High Speed Oval Track passes through a cut section in the northeast corner. A soil cement channel is designed to redirect storm runoff away from the cut. Storm water falling directly in the cut section is picked up by a closed drainage system and conveyed to a drainage wash (See Storm Drain Design in Section 2.7).

Per design criteria, several of the paved service and access roads are designed to fit the existing terrain. Where storm water crosses the roads in dip sections the roads may be closed for a short time during storms. The continuous cross slope of the paved roads will reduce the amount of silt and sand deposited by storm flows, and thus minimize the maintenance required after a storm.

The Dirt Track test area has been designed to fit the existing terrain to minimize earthwork. A perimeter security road follows the existing ground and has no drainage facilities.

The steep grade course will be constructed below grade. Storm water collection within the excavation is collected and pumped to a nearby wash. Cut slopes will be treated to mitigate erosion. The underpass structures on the Oval Track also requires storm water collection and pumping (See Pump Station Design Section 2.6).

The building site location is located to avoid major washes. Drainage design within the building area is not part of this report effort. However, the overall site hydrology, including the building area, has been addressed in the hydrology report prepared by Stanley Franzoy Corey Engineering Company (See Appendix).

2.4 Culvert Hydraulic Design

Reinforced concrete box culverts are based on the ADOT Structures Section Standard Drawings, 1988, and Reinforced Concrete Box Culvert Manual, March 1981. Construction plans include culvert plans, culvert profiles, and summary sheets which specify box sizes and applicable standards and typical details. Figure 3 shows the location of all the culverts designed for Phase I construction (See the pocket holder at the end of this report).

Cross culverts are used at concentration points identified by site hydrology. Cross culvert sizes, alignments, lengths, and grades are based on the design outflow rate of the basin (concentration point) taking into account the longitudinal grade, materials, and the available water storage behind the road embankment. Inlet/outlet structures are designed to minimize erosion.

The method used for hydraulic design of the box and pipe culverts is as outlined in the Hydraulic Design Series No. 5 "Hydraulic Design of Highway Culverts" published by the Federal Highway Administration. For the preliminary design of culverts, a spreadsheet computer program was developed that utilizes the S.C.S. Storage Indication Method to determine the initial size of the culvert given the peak inflow rates and the amount of storage available. Stage volume data was determined from 1" = 100' scale mapping with 2' contours. Volumes were computed using the Conic Method. Computer modeling using HEC 1 determined the storage and routing of the various culvert and detention basin sizes. Results from the HEC 1 runs were used to finalize culvert designs. Tables showing the results of HEC 1 modeling of the project site are contained in Section 3.0, Results and Recommendations. Design computations for the culverts can be found in Section 5.1. See construction drawings for additional information and details.

Protection against scour downstream from culverts will vary from dumped riprap plunge basins to soil cement channel lining with downstream dumped riprap. The riprap plunge basins were designed to provide erosion protection for the ten year storm for the box culverts and the one hundred year storm for the pipe culverts. The soil cement lined channels are designed to contain the one hundred year storm allowing adequate freeboard to contain the hydraulic jump downstream of the box culvert. A soil cement cutoff wall at the end of the channel was designed to protect the channel from the one hundred year storm. In addition, dumped riprap has been added to reduce erosion at the end of the channel for the ten year storm. Design of the channel is based upon Manning's Equation for open channel flow. Plunge basin design was based upon Hydraulic Engineering Circular No. 14, "Hydraulic Design of Energy Dissipators for Culverts and Channels", published by the Federal Highway Administration, and "Practical Guidance For Estimating and Controlling Erosion at Culvert

Outlets", Published by U.S. Army Engineer Waterways Experiment Station. See construction drawings for details.

With an increase in water surface elevation upstream of the culverts, dikes have been designed to restrict lateral movement of water. The top of dike elevation was set above the maximum pool elevation for the 100-year, 6-hour design storm. Diversion channels will be constructed upstream end of the dikes to provide an emergency spillway or by-pass channel for the storm flows greater than the anticipated design storm. Storm water will move laterally through the by-pass channel in a controlled release into an adjacent detention basin. The elevation of the by-pass channel will be set typically 0.5 feet below the 100-year, 6-hour storm maximum pool elevation. This will allow the by-pass to become operational just prior to the maximum pool elevation being reached. Lateral movement of the storm flows above the 100-year, 6-hour storm, will provide an additional level of safety for the test facility as well as downstream property owners. See construction drawings for details.

2.5 Low Flow Crossing Design

Low flow crossings have been designed at five locations along access roads between the building area and the east end of Loop Road A. Low flows are allowed to cross under the access roads through corrugated metal arch pipes, while higher flows pass over the roadway through dip crossings. Protection for the access roads is provided by lining approximately 100 feet of the roadway prism with soil cement. The edges are toed down 3' below the culvert invert on each side of the roadway. Dumped riprap provides erosion protection downstream of the culverts. See construction drawings for details.

2.6 Pump Station Design

Four pump stations are provided to remove storm water from the three underpasses and the Steep Grades Facility. The pump stations were designed to incorporate uniform size pumps and similar wetwell sizes for ease of maintenance, replacement parts, and economy.

The pump stations were designed to convey water from a 2-year, 2-hour storm with two pumps in operation. Two submersible pumps are placed in a wetwell located adjacent to the low point of each site. The wetwell is constructed from 8 ft. diameter precast concrete pipe with a cast-in-place concrete base and cover. The cover has two steel access hatches and a base for a portable hoist for pump maintenance. Pumps are lowered into the wetwell using steel guide bars running from the cover to the base.

Pumps are 30 H.P. Flygt submersible wastewater pumps capable of discharging 1200 to 1600 GPM against 53 to 32 feet of discharge head, respectively. The pumps are designed for dual operation at peak flow, with no redundancy included in the event of pump failure. The pumps are controlled by mercury float switches set to activate at predetermined water levels. Pump controls alternate pump starts to ensure even wear. Monthly "Exercise" cycles of twenty seconds, are incorporated in the controls to maintain proper operating conditions during dry periods and to remove water from small storms. A flush valve was included to agitate water prior to pump operation to help disperse solids from the basin.

The pumps discharge water through a ductile iron pipe system including a check valve immediately after the pump and a gate valve located outside of the wetwell for each discharge pipe. The two discharge pipes combine into one ductile iron outfall pipe to convey water to an outfall location. Water is discharged into a riprap plunge basin and through a graded ditch to an existing wash. A flap valve placed on the end of the discharge pipe prevents rodents and debris from entering the discharge pipe.

Although the pump stations have been sized for an estimated 2-year, 2 hour storm, the impacts of the 10 and 50 year storm events were investigated. The available storage in the pump wetwell, storm drain piping, and collection system contain the water produced by a 10 year storm. However, minor ponding will occur during the 50 year storm that will close the undercrossings for as much as 15 minutes.

The drainage collection system is designed for the 10 year storm. The Steep Grades Facility includes three catch basins with slotted drains, connected to the wetwell by storm drains constructed of high density, polyethylene pipe. The slotted drains are sized to intercept all of the storm water produced by the design storm, using a 67% efficiency factor to account for clogging.

The catch basins each have a two-foot deep sump for the collection of sediment and debris. Routine cleaning of the sumps will reduce the amount of sand and grit carried into the pump station.

Design storm flows were estimated using the Rational Method and site information provided in the "Hydrologic Design Manual", Maricopa County, Arizona. Catch basins and slotted drains were sized in accordance with Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", published by the Federal Highway Administration. Design computations for the pump stations and collection systems can be found in Section 5.1. See construction drawings for additional information and details.

2.7 Storm Drain Design

The High Speed Oval Track passes through a cut section in the northeast corner. Storm water falling directly on the cut section is picked up in a closed drainage system and conveyed to a drainage wash.

Catch basins and storm drain pipe are sized for flows estimated for the 50-year, two-hour storm. Gutters and catch basins are specified per ADOT standards, type "B" gutter sections. High density, polyethylene pipe is specified for the storm drains. The pipe is economical, easy to install, and has a low friction coefficient.

Storm water intercepted by the oval track and marginal strip are collected in a gutter located at the intersection of the lower shoulder and the cut slope. The gutter conveys water to catch basins spaced at the maximum spacing suggested by ADOT for the pipe size specified. Catch basins are sized using a 50 % grate efficiency factor to allow for clogging from debris. Slotted drains are required at the end of the system to collect 100% of the storm water with no by-pass flows. The slotted drains are sized using an efficiency factor of 67% for clogging from debris.

Design storm flows were estimated using the Rational Method and site information provided in the "Hydrologic Design Manual", Maricopa County, Arizona. Catch basins and slotted drains were sized in accordance with Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", published by the Federal Highway Administration. All design information is summarized in tables similar to ADOT's standard calculation sheets and is included in the design computations in Section 5.1. See construction drawings for details.

2.8 Retention Basin Design

Retention basins are used along most of the north tangent section of the High Speed Oval Track, and between Loop Road A and the south tangent section of the High Speed Oval Track to collect runoff from the impervious area of the track. In addition an 8.3 acre area located within the Cornering Course on the west end has been diked off to retain storm water. These retention areas are necessary to reduce the peak volume of runoff.

Retention basins along the north tangent section were sized for the 100-year, two-hour storm flows. Drainage ditches along the downstream side of the roadway will collect and convey storm water to the basins. Four basin sizes were used contain the runoff. Selection of the size of basin was based upon containing the runoff volume with a maximum water depth of two feet (See computations in Section 5.4). Design storm flows were estimated using the Rational Method and site information provided in the

"Hydrologic Design Manual", Maricopa County, Arizona. Retention basin volumes were calculated using the Conic Method.

Retention basins along the south tangent section and the Cornering Course are provided by natural storage upstream of roadway embankments that contain the 100-year, two-hour storm flows.

Percolation tests have been conducted in the three areas mentioned above. The results of the tests can be found in the Appendix of this report.

2.9 Inspection and Maintenance Requirements

All drainage systems must be periodically inspected to maintain their ability to perform as intended. Guidelines for inspection and maintenance are as follows.

1. Culverts and channels should be inspected after every flow event. Accumulated debris at the entrance to culverts should be removed and hauled away. Inspection of channel bottoms downstream of culverts and documentation of any significant build-up of sediment or lowering of channel bottoms will help to identify any trends that may require corrective action.

2. Soil cement channels should be inspected for cracks in the lining and monitoring them for needed repairs. If the cracks enlarge or settlement has occurred, then corrective work is warranted. Slope paving on culverts 12 and 13 require additional monitoring. Should this bank-lining fail, large headcuts could propagate upstream and large amounts of sediment could be deposited in the downstream channels.

3. Earth dikes should be inspected for any signs of erosion. If a significant amount of erosion has occurred then corrective action should be taken.

4. Removal of deposits of sediment from the bottom of soil cement lined channels should be performed only with rubber tired vehicles.

3.1 Summary of Results

Table 5 of the Hydrology Report prepared by Stanley Franzoy Corey has been reproduced here as Table 1 of this report. Minor variations between the final design and the results of the computer modeling have been listed below. In addition, information on three culverts (Culvert Numbers 26, 32, and 33) which were not modeled have also been listed below.

Culvert Number 26 at Node 67 L-2 is sized as a single 24" diameter RCP. Peak culvert outflow is 31 cfs, with a maximum pooling elevation 1643.70.

The inlet invert elevation for Culvert Number 28 at Node 70 Q-2 has been lowered to 1635.5. The box size has been increased to a two barrel 10' x 6' RCBC. The resulting maximum pool elevation has been lowered to 1644.20, with no change in the peak outflow rate.

Culvert Number 32 at Node 70 M-1 is sized as a single 24" diameter RCP. Peak culvert outflow is 23 cfs, with a maximum pooling elevation 1650.50.

Culvert Number 33 at Node 70 M-2 is sized as a single barrel 6' x 4' RCBC. Peak culvert outflow is 240 cfs, with a maximum pooling elevation 1656.34.

The size of Culvert Number 39 was changed to a double barrel 10' x 5' RCBC from a three barrel 10' x 4' RCBC. The resulting maximum pool elevation has increased to 1666.05 with no change in the peak outflow rate.

Culvert Number 41, located 700' east of Culvert Number 40 has been eliminated. The flow has been combined at Culvert Number 40. Culvert Number 40 is now sized as a single barrel 10' x 4' RCBC. Peak culvert outflow is now 399 cfs, and the maximum pooling elevation is 1670.60.

Seven low flow crossings were added between the east end of Loop Road A and the building area. Culverts at these crossings are designed to pass low flows through 49" x 33" CMP Arch pipes with the excess from greater flows passing over the roadway at dip crossings. These culverts are numbered 41 through 47 and have not been modeled by the HEC 1 computer program.

3.2 Conclusions

The drainage structures modeled in the Hydrology Report using the HEC 1 computer program have been successfully designed, and will provide the peak discharges as modeled and reported in the hydrology report.

Table 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
Stanley Franzoy Cory Engineering Company - 07/11/91
Page 15

Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
1	70E	5-10 X 5 RCBC	1734.0	1737.0	4.36	100 YR-6 HR	2990	284	1741.83	15.9	2683	281
						50 YR-6 HR	2509	234	1740.95	10.5	2334	231
						10 YR-6 HR	1053	88	1737.68	0.4	1020	85
						100 YR-2 HR	3791	302	1743.13	30.4	3033	300
2	70C	1-24 IN. RCP	1732.0	1731.9	0.19	100 YR-6 HR	459	12	1740.00	8.7	41	12
						50 YR-6 HR	397	10	1739.67	7.7	40	10
						10 YR-6 HR	201	5	1738.33	3.5	36	5
						100 YR-2 HR	421	11	1740.00	8.7	41	11
3	69	3-10 X 4 RCBC	1732.0	1732.4	3.81	100 YR-6 HR	2296	199	1742.47	27.9	1706	199
						50 YR-6 HR	1841	157	1740.83	12.8	1510	158
						10 YR-6 HR	517	39	1735.23	0.1	517	39
						100 YR-2 HR	3162	231	1744.06	49.6	1895	232
4	67E	1-10 X 4 RCBC	1733.5	1734.2	0.58	100 YR-6 HR	915	38	1742.40	10.5	506	38
						50 YR-6 HR	779	32	1741.84	7.3	483	32
						10 YR-6 HR	387	15	1739.18	1.0	346	16
						100 YR-2 HR	863	34	1742.23	9.3	499	34
5	67F	1-36 IN. RCP	1736.5	1738.3	0.06	100 YR-6 HR	179	4	1742.25	2.1	68	4
						50 YR-6 HR	157	3	1742.13	1.8	67	3
						10 YR-6 HR	82	2	1740.58	0.4	50	2
						100 YR-2 HR	190	4	1742.13	1.8	67	4
6	67A	5-10 X 4 RCBC	1730.5	1733.6	7.56	100 YR-6 HR	3177	492	1741.20	14.4	2891	491
						50 YR-6 HR	2588	403	1739.26	5.4	2502	402
						10 YR-6 HR	1076	167	1734.24	0.0	1041	161
						100 YR-2 HR	3833	538	1742.91	28.5	3210	538

Table 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
Stanley Franzoy Cory Engineering Company - 07/11/91

Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
7	67B	1-10 X 4 RCBC	1733.0	1735.0	3.99	100 YR-6 HR	2133	192	1741.51	15.5	1697	193
	&					50 YR-6 HR	1651	149	1739.96	3.9	1452	149
8	67C	2-10 X 5 RCBC	1732.5	1734.3		10 YR-6 HR	359	37	1734.89	0.0	306	31
						100 YR-2 HR	2982	233	1743.19	39.5	1928	232
9	67D	2-10 X 4 RCBC	1734.5	1737.9	0.40	100 YR-6 HR	589	28	1739.43	0.0	590	28
						50 YR-6 HR	504	23	1738.83	0.0	505	23
						10 YR-6 HR	262	12	1737.16	0.0	262	12
						100 YR-2 HR	536	24	1739.01	0.0	532	24
10	60C	1-24 IN. RCP	1734.5	1734.3	0.11	100 YR-6 HR	243	7	1742.00	4.6	40	7
						50 YR-6 HR	207	6	1741.67	3.9	39	6
						10 YR-6 HR	98	3	1740.25	1.1	34	3
						100 YR-2 HR	215	6	1741.67	3.9	39	6
11	60B	1-24 IN. RCP	1731.0	1733.2	0.12	100 YR-6 HR	289	7	1739.50	5.2	43	7
						50 YR-6 HR	249	6	1739.25	4.6	42	6
						10 YR-6 HR	120	3	1738.00	1.4	38	3
						100 YR-2 HR	273	7	1739.25	4.6	42	7
12	60A	5-10 X 4 RCBC	1717.5	1726.7	9.33	100 YR-6 HR	2619	468	1726.34	0.0	2517	449
						50 YR-6 HR	2107	373	1724.08	0.0	1996	352
						10 YR-6 HR	655	113	1719.96	0.0	587	101
						100 YR-2 HR	3277	568	1730.05	3.6	3234	567
13	60F	1-10 X 4 RCBC	1698.5	1704.8	0.14	100 YR-6 HR	292	9	1703.39	0.0	292	9
						50 YR-6 HR	248	7	1702.77	0.0	248	7
						10 YR-6 HR	121	3	1701.01	0.0	121	3
						100 YR-2 HR	270	8	1701.07	0.0	270	8

Table 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
Stanley Franzoy Cory Engineering Company - 07/11/91

Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
14	60G	1-10 X 4 RCBC	1661.0	1661.3	0.30	100 YR-6 HR	446	21	1664.99	7.8	229	21
						50 YR-6 HR	387	18	1664.65	6.3	204	18
						10 YR-6 HR	203	9	1663.59	2.9	126	9
						100 YR-2 HR	402	18	1664.76	6.8	212	18
15	60E	1-24 IN. RCP	1652.5	1652.0	0.13	100 YR-6 HR	291	9	1656.00	6.4	23	8
						50 YR-6 HR	249	7	1655.83	5.9	22	7
						10 YR-6 HR	121	4	1654.67	2.8	14	3
						100 YR-2 HR	260	7	1655.83	5.9	22	7
16	60D	5-10 X 4 RCBC & 1-10 X 4 RCBC	1739.5 1739.0	1737.9	10.98	100 YR-6 HR	2277	482	1744.97	16.8	2034	469
						50 YR-6 HR	1792	373	1744.19	8.2	1704	362
						10 YR-6 HR	512	101	1741.32	0.1	488	95
						100 YR-2 HR	2961	634	1746.24	34.1	2466	627
17	60J-I	1-6 X 4 RCBC	1643.0	1645.5	0.16	100 YR-6 HR	460	11	1649.63	4.0	241	12
						50 YR-6 HR	396	10	1649.17	3.0	227	10
						10 YR-6 HR	193	4	1648.02	0.3	181	4
						100 YR-2 HR	446	10	1649.27	3.2	230	10
18	60J-2	1-10 X 4 RCBC	1639.0	1643.5	0.16	100 YR-6 HR	241	12	1643.16	0.00	241	12
						50 YR-6 HR	227	10	1642.96	0.00	227	10
						10 YR-6 HR	181	4	1642.35	0.00	181	4
						100 YR-2 HR	230	10	1643.00	0.00	230	10
19	67H-1	7-10 X 4 RCBC	1643.0	1644.8	12.78	100 YR-6 HR	2960	639	1649.93	10.8	2915	639
						50 YR-6 HR	2445	502	1648.64	4.9	2416	502
						10 YR-6 HR	891	151	1645.61	0.1	892	151
						100 YR-2 HR	4251	802	1652.62	39.8	3744	802

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Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
20	67H-2	8-10 X 4 RCBC	1639.0	1641.7	12.78	100 YR-6 HR	2915	639	1644.92	0.0	2915	639
						50 YR-6 HR	2416	502	1644.02	0.0	2416	502
						10 YR-6 HR	892	151	1642.38	0.0	892	151
						100 YR-2 HR	3744	802	1646.96	0.0	3744	802
21	67I-1	1-10 X 4 RCBC	1640.0	1640.0	0.74	100 YR-6 HR	1124	49	1648.75	17.2	500	49
						50 YR-6 HR	963	41	1648.10	11.1	474	41
						10 YR-6 HR	475	19	1645.51	1.7	336	19
						100 YR-2 HR	1173	46	1648.78	17.4	501	46
22	67I-2	1-10 X 4 RCBC	1636.5	1636.8	0.74	100 YR-6 HR	500	49	1644.75	0.0	500	49
						50 YR-6 HR	474	41	1644.10	0.0	474	41
						10 YR-6 HR	336	19	1641.51	0.0	336	19
						100 YR-2 HR	501	46	1644.78	0.0	501	46
23	67J-1	1-10 X 4 RCBC	1641.5	1641.6	0.98	100 YR-6 HR	504	56	1646.69	16.3	313	55
						50 YR-6 HR	424	46	1646.31	11.9	287	46
						10 YR-6 HR	261	24	1644.53	2.9	157	19
						100 YR-2 HR	565	54	1646.70	16.4	314	54
24	67J-2	1-10 X 4 RCBC	1638.0	1638.0	0.98	100 YR-6 HR	313	55	1643.19	0.0	313	55
						50 YR-6 HR	287	46	1642.81	0.0	287	46
						10 YR-6 HR	157	19	1641.03	0.0	157	19
						100 YR-2 HR	314	54	1643.20	0.0	314	54
25	67L-1	1-24 IN. RCP	1642.0	1642.0	0.07	100 YR-6 HR	204	6	1647.20	3.8	31	6
						50 YR-6 HR	179	5	1647.00	3.3	30	5
26	67L-2	NOT MODELED				10 YR-6 HR	98	3	1646.25	1.4	27	3
						100 YR-2 HR	192	5	1647.20	3.8	31	5

Table 1
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Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume *Stores	CFS	AC-FT
27	70Q-1	2-10 X 5 RCBC	1638.0	1638.2	4.48	100 YR-6 HR	1373	222	1647.84	4.9	1284	223
						50 YR-6 HR	1200	174	1646.47	1.7	1147	174
						10 YR-6 HR	381	41	1641.49	0.0	379	41
						100 YR-2 HR	1545	267	1648.99	14.2	1399	268
28	70Q-2	2-10 X 5 RCBC	1636.5	1638.2	4.48	100 YR-6 HR	1284	223	1646.34	0.0	1284	223
						50 YR-6 HR	1147	174	1644.35	0.0	1147	174
						10 YR-6 HR	379	41	1639.99	0.0	379	41
						100 YR-2 HR	1399	268	1647.45	0.0	1399	268
29	70P-1	5-10 X 6 RCBC	1641.5	1643.5	5.00	100 YR-6 HR	2256	293	1647.73	6.8	2228	293
						50 YR-6 HR	1997	239	1647.18	5.0	1981	239
						10 YR-6 HR	841	84	1644.69	0.4	842	84
						100 YR-2 HR	2469	322	1648.15	9.1	2418	322
30	70P-2	4-10 X 6 RCBC	1637.0	1639.0	5.00	100 YR-6 HR	2228	293	1644.46	0.0	2228	293
						50 YR-6 HR	1981	239	1643.74	0.0	1981	239
						10 YR-6 HR	842	84	1640.65	0.0	842	84
						100 YR-2 HR	2418	322	1645.06	0.0	2418	322
31	70O	2-10 X 4 RCBC	1637.0	1639.0	1.07	100 YR-6 HR	1131	72	1644.98	3.2	938	72
						50 YR-6 HR	937	59	1643.96	1.0	836	59
32	70M-1	NOT MODELED				10 YR-6 HR	394	24	1640.55	0.1	392	24
33	70M-2	NOT MODELED				100 YR-2 HR	1247	71	1646.03	5.6	1022	72
34	76J	1-10 X 4 RCBC	1646.5	1646.5	0.59	100 YR-6 HR	984	42	1657.88	9.1	605	43
						50 YR-6 HR	839	35	1657.08	6.1	573	36
						10 YR-6 HR	440	18	1653.52	0.4	421	18
						100 YR-2 HR	946	38	1657.70	8.5	598	38

Table 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
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Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
35	70A	3-10 X 5 RCBC	1663.5	1663.5	4.36	100 YR-6 HR	1681	222	1671.12	12.3	1582	218
						50 YR-6 HR	1470	174	1670.33	7.7	1388	171
						10 YR-6 HR	457	43	1666.33	0.2	430	41
						100 YR-2 HR	1882	262	1672.07	18.1	1749	260
36	70F	5-10 X 6 RCBC	1663.5	1665.2	4.91	100 YR-6 HR	2631	296	1670.40	6.1	2528	290
						50 YR-6 HR	2258	242	1669.64	3.2	2187	237
						10 YR-6 HR	919	86	1666.83	0.1	889	84
						100 YR-2 HR	2958	319	1671.15	10.5	2858	317
37	70B	3-10 X 5 RCBC	1654.0	1654.0	4.43	100 YR-6 HR	1577	221	1660.85	32.4	1379	220
						50 YR-6 HR	1377	173	1660.03	21.1	1206	173
						10 YR-6 HR	416	41	1656.71	2.0	390	41
						100 YR-2 HR	1745	264	1661.59	42.7	1551	264
38	70G	4-10 X 5 RCBC	1652.5	1652.5	4.95	100 YR-6 HR	2522	291	1660.75	28.5	2259	291
						50 YR-6 HR	2177	238	1659.76	19.2	2000	238
						10 YR-6 HR	869	84	1656.25	2.4	851	84
						100 YR-2 HR	2840	319	1661.84	39.6	2472	319
39	76E	3-10 X 4 RCBC	1660.0	1660.0	0.40	100 YR-6 HR	817	29	1664.60	0.0	817	29
						50 YR-6 HR	706	24	1664.08	0.0	706	24
						10 YR-6 HR	371	13	1662.55	0.0	371	13
						100 YR-2 HR	770	25	1664.38	0.0	770	25
40	76F	1-6 X 4 RCBC	1664.0	1664.0	0.10	100 YR-6 HR	262	7	1671.33	0.0	262	7
						50 YR-6 HR	229	6	1670.23	0.0	229	6
						10 YR-6 HR	123	3	1667.67	0.0	123	3
						100 YR-2 HR	260	6	1671.27	0.0	260	6

Table 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
Stanley Franzoy Cory Engineering Company - 07/11/91
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Cul. No.	Node	Culvert Size	Culvert Inlet Invert Elev.	Existing Channel Invert Elev.	Drainage Area (sq.mi.)	Precip.	Culvert Inflow		Inlet Storage		Culvert Outflow	
							CFS	AC-FT	Max. Pool Elev.	Max. Volume Stores	CFS	AC-FT
41	76G	1-6 X 4 RCBC	1667.0	1667.0	0.04	100 YR-6 HR	127	4	1670.76	0.0	127	4
						50 YR-6 HR	113	3	1670.44	0.0	113	3
						10 YR-6 HR	67	2	1669.38	0.0	67	2
						100 YR-2 HR	136	3	1670.96	0.0	136	3

Note: See Hydrology Report for node locations.

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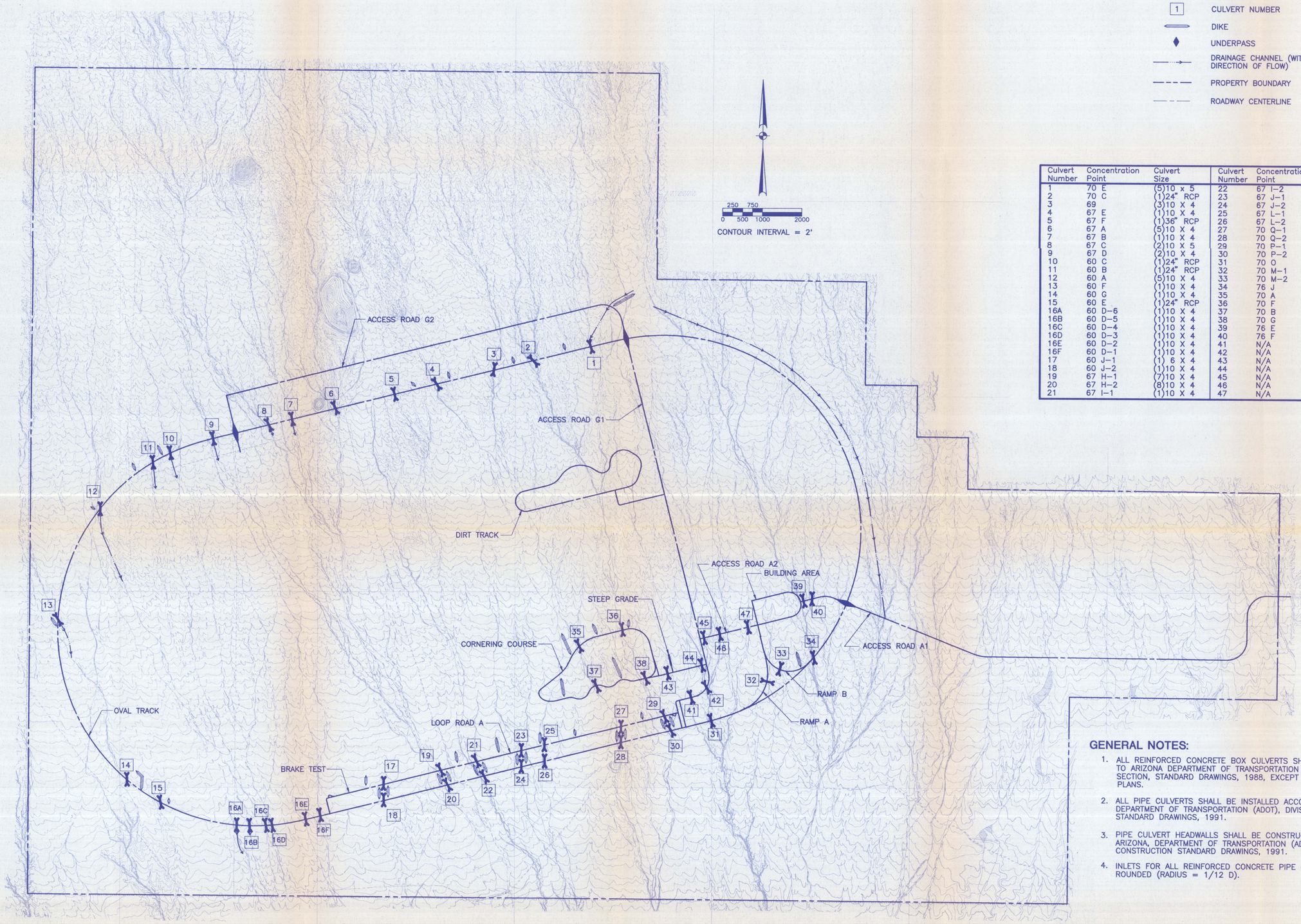
DRAINAGE LOCATION PLAN



LEGEND

- CULVERT
- 1 CULVERT NUMBER
- DIKE
- UNDERPASS
- DRAINAGE CHANNEL (WITH DIRECTION OF FLOW)
- PROPERTY BOUNDARY
- ROADWAY CENTERLINE

Culvert Number	Concentration Point	Culvert Size	Culvert Number	Concentration Point	Culvert Size
1	70 E	(5)10 x 5	22	67 I–2	(1)10 X 4
2	70 C	(1)24" RCP	23	67 J–1	(1)10 X 4
3	69	(3)10 X 4	24	67 J–2	(1)10 X 4
4	67 E	(1)10 X 4	25	67 L–1	(1)24" RCP
5	67 F	(1)36" RCP	26	67 L–2	(1)24" RCP
6	67 A	(5)10 X 4	27	70 Q–1	(2)10 X 5
7	67 B	(1)10 X 4	28	70 Q–2	(2)10 X 6
8	67 C	(2)10 X 5	29	70 P–1	(5)10 X 6
9	67 D	(2)10 X 4	30	70 P–2	(4)10 X 6
10	60 C	(1)24" RCP	31	70 O	(2)10 X 4
11	60 B	(1)24" RCP	32	70 M–1	(1)24" RCP
12	60 A	(5)10 X 4	33	70 M–2	(1) 6 X 4
13	60 F	(1)10 X 4	34	76 J	(1)10 X 4
14	60 G	(1)10 X 4	35	70 A	(3)10 X 5
15	60 E	(1)24" RCP	36	70 F	(5)10 X 6
16A	60 D–6	(1)10 X 4	37	70 B	(3)10 X 5
16B	60 D–5	(1)10 X 4	38	70 G	(4)10 X 5
16C	60 D–4	(1)10 X 4	39	76 E	(2)10 X 5
16D	60 D–3	(1)10 X 4	40	76 F	(1)10 X 4
16E	60 D–2	(1)10 X 4	41	N/A	(1)49 X 33 CMP ARCH
16F	60 D–1	(1)10 X 4	42	N/A	(2)49 X 33 CMP ARCH
17	60 J–1	(1) 6 X 4	43	N/A	(2)49 X 33 CMP ARCH
18	60 J–2	(1)10 X 4	44	N/A	(2)49 X 33 CMP ARCH
19	67 H–1	(7)10 X 4	45	N/A	(1)49 X 33 CMP ARCH
20	67 H–2	(8)10 X 4	46	N/A	(2)49 X 33 CMP ARCH
21	67 I–1	(1)10 X 4	47	N/A	(2)49 X 33 CMP ARCH

GENERAL NOTES:

1. ALL REINFORCED CONCRETE BOX CULVERTS SHALL BE CONSTRUCTED ACCORDING TO ARIZONA DEPARTMENT OF TRANSPORTATION (ADOT), HIGHWAYS DIVISION, STRUCTURES SECTION, STANDARD DRAWINGS, 1988, EXCEPT WHERE MODIFIED BY THE CONSTRUCTION PLANS.
2. ALL PIPE CULVERTS SHALL BE INSTALLED ACCORDING TO STATE OF ARIZONA, DEPARTMENT OF TRANSPORTATION (ADOT), DIVISION OF HIGHWAYS, CONSTRUCTION STANDARD DRAWINGS, 1991.
3. PIPE CULVERT HEADWALLS SHALL BE CONSTRUCTED ACCORDING TO STATE OF ARIZONA, DEPARTMENT OF TRANSPORTATION (ADOT), DIVISION OF HIGHWAYS, CONSTRUCTION STANDARD DRAWINGS, 1991.
4. INLETS FOR ALL REINFORCED CONCRETE PIPE CULVERTS SHALL BE BEVELED OR ROUNDED (RADIUS = 1/12 D).

ENGINEER: Sverdrup CORPORATION
432 N. 44TH STREET • PHOENIX, ARIZONA 85008
PH: (602) 231-8999

MANAGER: TAISEI • BECHTEL Joint Venture

OWNER: TOYOTA TECHNICAL CENTER, U.S.A., INC.

NO.	DATE	REVISION	BY	CH.

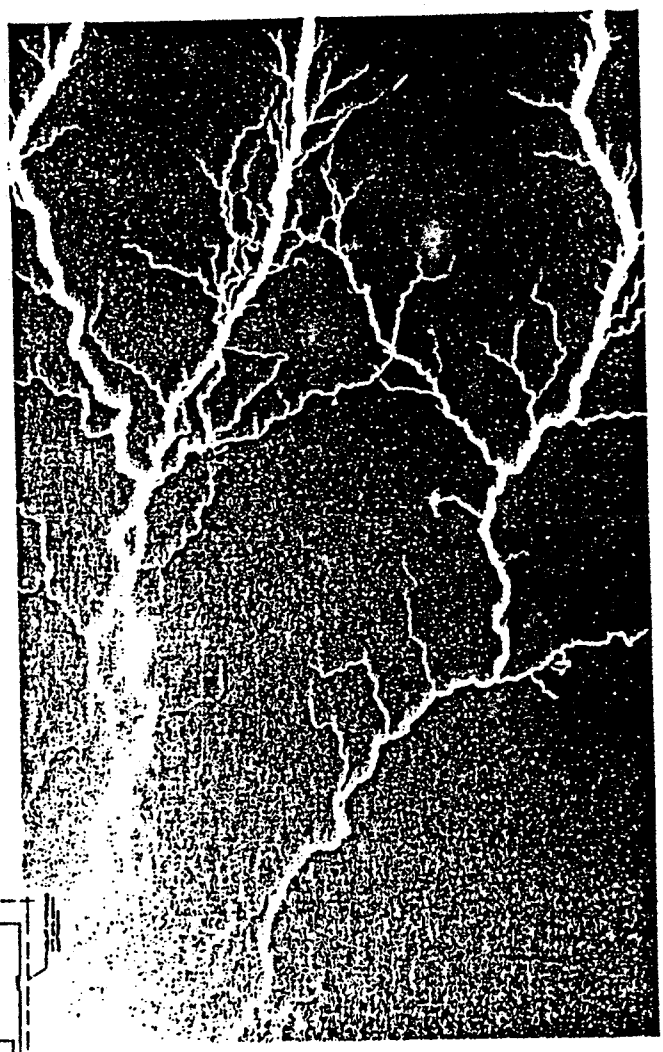
DRAWING TITLE: LOCATION PLAN FOR SITE DRAINAGE

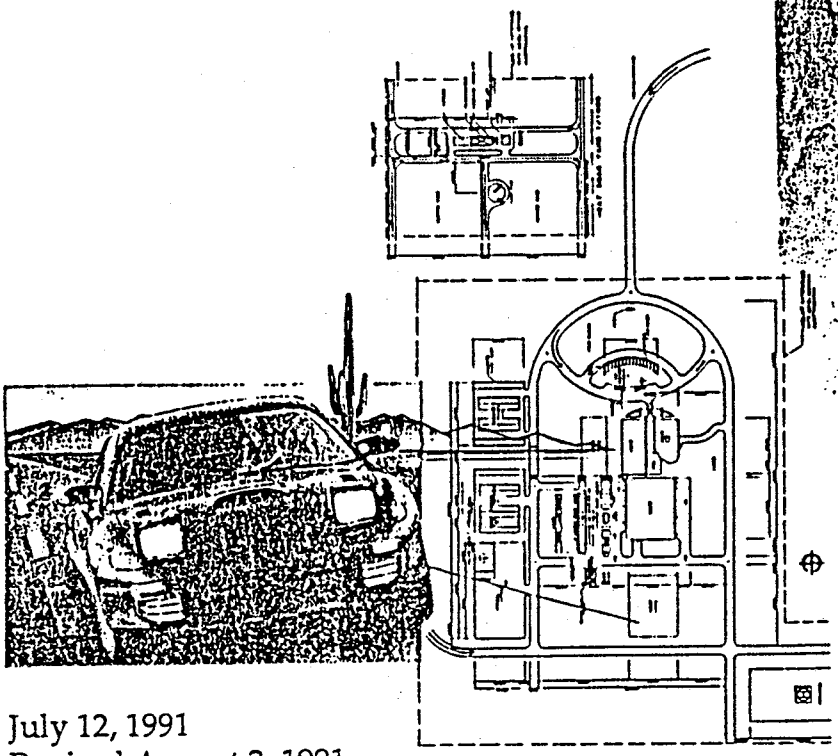
DESIGNED: BDO
DRN: SLS CHKD: RJT
SCALE: 1" = 1000', N/A
DATE: 9-9-91
JOB NO: 40477
ACAD FILE: DR-RPT

FIGURE 3

TAISEI/BECHTEL
JOINT VENTURE
TOYOTA ARIZONA
PROVING GROUNDS

PROJECT HYDROLOGY REPORT





Registered Professional Engineer (Civil)
CERTIFICATE NO. 15372
RUSSELL L. MIRACLE
Date Signed 7/11/91
ARIZONA, U.S.A.

July 12, 1991
Revised August 2, 1991

In Association with

Sverdrup
CORPORATION

TOYOTA ARIZONA PROVING GROUNDS
PROJECT HYDROLOGY REPORT

AUGUST 1991

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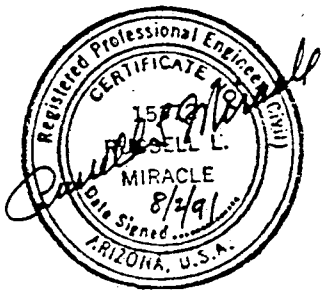

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TOYOTA ARIZONA PROVING GROUND
HYDROLOGY REPORT

1. INTRODUCTION

The Toyota Technical Center, USA, Inc. is proposing to construct a vehicle test facility to be located approximately 15 miles south-southwest of Wickenburg, Arizona. The purpose of the facility is to field test vehicles under a variety of road conditions. The facility will include a paved 10-mile oval track; approximately 35 miles of associated paved and unpaved tracks for testing acceleration, braking, handling, and other vehicle performance and durability characteristics; an aircraft landing strip; office and maintenance buildings; and access roads to the site. The facility will be developed in phases with the initial phase consisting of the paved 10-mile oval track, a paved cornering course, various access roads and return loops, a site access road, and a building site. The phase 1 project features, and phase 1 with future project features are shown on figures 1 and 2 respectively.

1.1 Authority and Purpose

This study was authorized by and completed for the Toyota Technical Center, USA, Inc. as part of the overall final design process for completion of the proposed facility. Project features are designed with sizes and grades established based upon the flood flows and volumes documented herein. Minor adjustments to structure sizes and grades may be necessary prior to and during construction to meet site conditions.

The purpose of this study is to determine existing hydrologic conditions within the project area and to analyze the impact of proposed drainage structures upon downstream lands. This study considered the effect of only the drainage structures to be constructed as phase 1 of the total project. However, the study does consider the additional runoff from impervious areas resulting from the total project (phase 1 and future).

The proposed project lies within the jurisdiction of Maricopa County. The Flood Control District of Maricopa County (FCDMC) has responsibilities for review and approval of the project drainage features. The FCDMC requires that new developments are designed consistent with their drainage regulations and hydrologic procedures as documented in the 'Hydrologic Design Manual for Maricopa County, Arizona' (Hydrologic Design Manual) and the 'Drainage Regulations for the Unincorporated Areas of Maricopa County'. The FCDMC also requires that new developments do not result in diversion of flows to downstream properties, and do not result in increases of either the peak discharge nor the runoff volume from the 100-year, 6-hour storm.

1.2 Project Setting

The project site occupies approximately 11,000 acres (about 17 square miles). The site is located within sections 16 through 22, 25 through 35, and a portion of section 23, Township 5 North, Range 5 West. Figure 3 shows the general location of the project lands.

The major topographic features in the area are the Vulture Mountains to the north and the Hassayampa River to the east. The project lands lie within the Star Wash and Daggs Wash watersheds which originate in the Vulture Mountains. The Star Wash is tributary to Jackrabbit Wash which flows southerly joining the Hassayampa River about 16 miles to the south of the project. Daggs Wash, crosses the eastern property boundary flowing southerly to join the Hassayampa River about 6 miles north of the Jackrabbit Wash - Hassayampa River confluence. Ground slopes within the project site slope toward the south-southeast at about a one percent slope (53 ft per mile). The site terrain is generally uniform with topographic contours nearly parallel.

Drainage patterns in the area are typical of the Sonoran Desert bahada formations with the general land form gently undulating and laced with small incised washes. The washes are

generally not capable of conveying the 100-year frequency floods and are capable of conveying only the smaller frequently occurring flows. Runoff from larger storms exceed the wash capacities and the excess flows spread and cross the ground surface as sheet flows.The excess flows tend to spill from one wash to the next making delineation of drainage area boundaries difficult. The steep land slopes result in the washes flowing at high velocities with high sediment transport capabilities. The wash bank and bed materials are easily eroded. Headcutting is evident within the project area in both the washes as well as the desert floor.

2. PREVIOUS STUDIES

Two hydrologic studies, which include the project lands, have been recently completed. The 'Toyota Arizona Preliminary Drainage Analysis', March 1990, was completed as part of the planning and preliminary design phase of this project. The study was completed to establish the overall design philosophy and conceptual designs of project drainage features. The Corps of Engineers HEC1 computer program was used to compute flood hydrographs originating above the project site. The design storm for the purposes of the study was based upon a precipitation event with a 50-year recurrence frequency, and a 2-hour duration. The study was completed prior to adoption of the Hydrologic Design Manual by the FCDMC. The FCDMC now requires that all new developments be analyzed using the hydrologic methodologies as presented in the Hydrologic Design Manual.

The 'Jackrabbit Wash Floodplain Delineation Study' was completed for the FCDMC to update flood insurance rate mapping in the area. The study included the Star Wash and Daggs Wash drainage basins which include the project site. The Star Wash and Daggs Wash were designated in the study as basins 10 and 12 respectively. Basin 10 was subdivided into subbasins 10a through 10ab and basin 12 was subdivided into subbasins 12a through 12e. The Star Wash and Daggs Wash drainage basins and subbasins are shown on figure 4 along

with the Toyota project site boundary. The basin and subbasin boundaries and basin parameters used in the study were determined based upon US Geological Survey 7-1/2 minute quadrangle topographic mapping, with 10 or 20 foot contour intervals at a scale of 1 foot equals 2,000 feet. The methodologies contained in the Hydrologic Design Manual were used and the HEC1 computer program was used. The HEC1 model developed for the Jackrabbit Wash study was adopted as base data in completing this study.

3. DRAINAGE BASIN PARAMETERS

3.1 Basin Boundaries and Areas

The drainage basin boundaries established in the Jackrabbit Wash study were used and modified to meet the purposes of this study. The drainage basin boundaries were established in the Jackrabbit Wash study utilizing US Geological Survey 7 1/2 minute quadrangle mapping with 10 and 20 foot contour intervals and a scale of one inch equals 2,000 feet. Detailed topographic mapping with two foot contour intervals at a scale of one foot equals 1,000 feet was developed from photogrammetrically generated topographic data for the project lands. The basin and subbasin boundaries from the Jackrabbit Wash study were transferred to the detailed mapping. The increased accuracy of the detailed mapping allowed for more accurate delineation of the subbasin boundaries and resulted in modifications to the boundaries within the project site. The subbasin boundaries as delineated on the two foot contour mapping were then transferred back to the 7-1/2 minute quadrangle mapping.

The centerline alignment of the Toyota Arizona Proving Ground project features were then transferred to both maps and concentration points identified at intersections of the project features with existing washes. The areas contributing to each of the new concentration points were delineated on the detailed maps and transferred to the 7 1/2 quadrangles (see figure 5).

The new subareas were named according to the subbasin in which they were located. For example subbasin 10U was divided into subareas 10U1 through 10U20. Using the detailed mapping resulted in more accurate basin boundary locations and computing the basin parameters on the 7 1/2 minute quadrangles resulted in accuracy consistent with the data used in the Jackrabbit Wash model. Hydraulic parameters for the basins (e.g. elevations at the rim, centroid, and outfall;flow lengths from the rim and centroid to the outfall) were determined from the quadrangle maps.

3.2 Soils

The model parameters affecting the rainfall-runoff and routing infiltration losses were determined from the soil classification data as presented in the USDA Soil Conservation Services (SCS) publication 'Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona', April 1986 and criteria published in the FCDMC's 'Hydrologic Design Manual'. The SCS soils maps show the areas of different soils labeled as numeric map symbols. The numeric map symbols indicate the soils name for which various properties have been determined. Loss rate parameters for these soils have been included in Appendix A of the FCDMC Hydrologic Design Manual. These parameters were used in completing the Jackrabbit Wash study and were used in modifications incorporated in this study.

4. HEC1 MODEL

Consistent with the Jackrabbit Wash study and in accordance with the FCDMC requirements, the US Army Corps of Engineers HEC1 computer program was used to complete the study. The general approach to the model was to utilize the methodologies and parameters used in the Jackrabbit Wash study.

4.1 Existing Conditions

The existing Jackrabbit Wash model was based upon the methodologies adopted by the FCDMC in the Hydrologic Design Manual. The purpose of that study was to document existing flooding conditions within the Jackrabbit Wash watershed. The Star Wash and Daggs Wash basins are tributary to the Jackrabbit Wash and were modeled as part of the study. The Jackrabbit Wash study contained several concentration points in the vicinity of the Toyota Proving Grounds property at which flood hydrographs were computed.

The existing model was modified to incorporate the additional subareas and concentration points required to complete project designs and to analyze property boundary conditions. The modified model was then compared to the original model to verify that the results were compatible and reasonable. A comparison of the basin areas, peak discharges, and volumes is presented in table 1. As discussed in section 3.1, the revised drainage area boundaries resulted in changes in peak flows and volumes. The most significant changes were the boundary between subbasins $10K_2$ and 10N. This is reflected in table 1 at Node 63. The revised drainage areas were checked by totaling drainage areas at nodes downstream of the project. The combined drainage areas at node nos. 83, 80, 77, 71, 68, and 61 total 111.33 square miles in the Jackrabbit Wash model and total 111.31 in the revised model. Considering the scale of the base mapping used in the study (1 inch = 2,000 ft), this is considered as a very accurate correlation between the two models. The data shown in table 1 is for the once-in-100 year recurring precipitation with a 6-hour storm duration. Data are shown for concentration points common to both models located within the vicinity of the Toyota property. Considering the revisions made to the drainage areas and added hydrograph channel routings, the modified model is considered reasonable and consistent with the Jackrabbit Wash model. Therefore, the modified model was used as representing base conditions from which the impact of the project was measured.

4.2 Model Methodologies and Parameters

The HEC1 model was developed to incorporate most of the commonly accepted methodologies for analysis of precipitation areal and temporal distribution, rainfall-runoff computation, unit hydrograph computation, and hydrograph channel and storage routing. The FCDMC has established specific methodologies for use on project analysis for which they have administrative review responsibilities. Detailed descriptions of the FCDMC methodologies are documented in the FCDMC Hydrologic Design Manual. Additionally the FCDMC developed the computer program titled Maricopa County Unit Hydrograph Procedure 2 (MCUHP2) to compute input data for the HEC1 program using FCDMC methodologies. The MCUHP2 program was used in developing HEC1 data cards for the Jackrabbit Wash model and was also used in this study to make modifications to the Jackrabbit Wash model.

Precipitation data for the 100-, 50-, and 10-year recurrence intervals were developed using the FCDMC procedures for both the 6- and 2-hour durations. The Green and Ampt equation option in HEC1 was used to compute rainfall infiltration. The regional S graph methodology was used to generate unit hydrographs for the basins. Routing of hydrographs through channels and ponding areas were simulated using the storage routing options in HEC1 along with the channel loss option to simulate infiltration losses.

Input data to the MCUHP2 program for the revised subareas were determined from the topographic and soils mapping as described above. Table 2 shows the hydrologic basin parameters used in developing the HEC1 models. The data used in the Jackrabbit Wash model are presented as subbasins with the subbasin names shown in the first column. The data for the subareas which replaced the subbasins in the revised model are listed following the assigned subarea names listed in the second column.

The data developed as input for the channel routing of hydrographs is summarized in table 3. The first column indicated the subbasin in which the routing occurs and the second column indicates the concentration points between which the routing occurs.

4.3 Precipitation

The total point storm precipitation depths were derived from depth-duration-frequency data developed by the US Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Office of Hydrology. This point source total precipitation was adjusted to determine the average total precipitation which could be expected over areas of varying sizes. These precipitation depth-area adjustments were made according to FCDMC procedures. The time distribution of the precipitation over the specified storm duration was also specified according to FCDMC procedures. The precipitation total depths for both the 6- and 2-hour storm durations are shown in table 4. Depths for the 100-, 50-, and 10-year recurrence intervals are shown for varying basin areas.

5. PROPOSED DRAINAGE SYSTEM

To assess the impact of the proposed proving ground facilities upon existing flooding conditions, the HEC1 model of existing conditions described above was modified to incorporate the proposed project drainage features. The modeled flow conditions at concentration points where flows exit the property were compared for existing conditions and future conditions with the proving grounds. The proposed drainage structure details are documented in the project drainage report.

5.1 Concept

The proposed drainage system is designed to prevent floodwater from a 100-year, 6-hour storm from over topping the test track roadway surface. Culverts were utilized where possible to convey water under the roadway. The culverts were located at existing significant washes. The roadway embankments will intercept sheet flows and redirect the flows into the culverts. The northeast portion of the track is in an excavated section and it was necessary to provide an interceptor channel to divert runoff toward the southeast around the eastern end of the track. The drainage structures are designed to maintain or improve flow conditions exiting the property.

5.2 Culverts

Culverts are located at nodes shown in table 5, and are sized to convey flows resulting from the 100-year, 6-hour storm without overtopping the roadway surface. Hydraulic procedures developed by the Federal Highway Administration were utilized in completing the hydraulic designs. The reservoir routing routine of the HEC1 computer program was utilized to verify required sizes and grades of the culvert and to compute maximum pool conditions at the culvert inlets. Inlet flow conditions in the culverts were used in the reservoir routing analysis. Stage volume data was determined from 1 inch = 100 feet scale mapping with two foot contours. Infiltration losses from the ponded water at the culvert inlets were also modeled. Culvert sizes and grades were established to minimize the roadway embankments and to prevent the volume of water ponded at the culvert inlets from exceeding 50 acre-feet. Results of the analysis for the 100-, 50-, and 10-year, 6 hour events as well as the 100-year, 2-hour event are summarized in table 5.

5.3 Channelization

At the northeast corner of the oval track, the roadway is in an excavated section and culvert under crossings are not practical. A diversion channel will intercept flood flows and divert the flows around the east end of the track. These flows are returned to their existing water course at the channel outlet.

5.4 Detention/Retention

The Flood Control District of Maricopa County requires that retention areas retain runoff from a 100-year, 2-hour event with outlet piping of 24 inches in diameter or less. These areas are not to receive runoff from areas outside the retention area. The Arizona Department of Water Resources considers impoundments storing greater than 50 acre-feet water as reservoirs. Therefore, at culvert locations where the natural storage upstream of the roadway embankment was available to retain the runoff from the 100-year, 2-hour event, the site was designed to function as a retention basin. The available storage was limited to less than 50 acre-feet. These areas are shown on figure 5. At locations where the volume of runoff exiting the Toyota property exceeded the existing conditions, retention basins designed and located to collect runoff from the roadway surface were included. These basins will include drainage channels along the downstream side of the roadway which drain to retention basins sized to store runoff from the roadway surface resulting from the 100-year, 2-hour event. These basins were included along portions of the north straight-a-way of the oval track where flood water intercepted by the roadway is directed toward nodes (culvert sites) 67A, 67B, 67C, 67D,67E, 67F, 69, 70C, and 70E.

6. RESULTS

6.1 Jackrabbit Wash vs. Revised Model

The Jackrabbit Wash HEC1 model was modified as described above to include concentration points at intersections of project roadways with significant existing washes. Flows at concentration points common to both models, in the vicinity of the Toyota property, were compared to verify consistency of the two models. The results of the comparison are shown in table 1. The differences in discharges and volumes are attributed to modifications to the drainage areas and added routing reaches. The comparison indicates that the modified model is compatible with the original Jackrabbit Wash model and is suitable for use as baseline existing hydrology.

6.2 Property Boundary Conditions

Comparison of the flow conditions along the southern Toyota property boundary is shown in table 6. The 100-year, 6-hour flows are compared for existing conditions and conditions with the project at significant wash locations. The project will not adversely affect existing flow conditions as flows are passed through the project site without diversion of flows between drainage basins. Peak runoff flow rates are significantly reduced where intercepted by project drainage structures. Runoff volumes are maintained or reduced for both the phase 1 and future features except for the area above node 67N where flows are increased by only 2 acre-feet. With an existing runoff volume of 639 acre-feet for the 100-year, 6-hour event, the added volume represents an increase of only 0.3 percent. This is not considered significant and is considered within the accuracy of the modeling procedures. The one acre-foot increase at node 88F is also not considered significant and is considered as within the accuracy of the modeling procedure.

Note that HEC1 does not balance volumes during routing procedures, and a small change in volume may result only due to the mathematical procedures applied, e.g. in table 5, culverts 7 and 8, the outflow exceeds the inflow by 1 acre-foot for the 100-year, 6-hour event. Therefore, a slight change in volume is considered within the accuracy limits of the model.

7. CONCLUSIONS

The revised HEC1 model of existing conditions compares favorably with the Jackrabbit Wash model and is acceptable as documentation of existing hydrologic conditions within the vicinity of the Toyota property.

The proposed development, as documented herein with the drainage structures located and sized to protect the facility, will result in lower peak discharges exiting the property where intercepted by the culvert drainage structures. Also, the runoff volumes will be reduced or maintained as computed within the accuracy of the HEC1 model.

TABLE 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
COMPARISON WITH JACKRABBIT WASH FIS DATA
7/11/91

	JACKRABBIT WASH FIS			TOYOTA EXISTING CONDITIONS		
	100 YR - 6 HR			100 YR - 6 HR		
NODE	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)
58	20.29	2059	585	20.29	2059	585
59	36.99	3429	894	36.99	3429	894
61	51.00	3984	1041	51.19	4097	1039
63	5.44	2328	233	12.74	3126	637
68	15.08	2504	723	15.51	2964	703
69	3.81	2296	199	3.81	2296	199
70	3.92	3046	267	3.92	3046	267
71	11.99	3826	508	11.75	4039	509
76	16.77	5658	929	16.42	5722	917
77	19.89	5220	1008	20.04	5124	958
79	8.04	3906	614	8.04	3906	614
80	11.74	3344	696	10.99	3475	686
83	1.63	1226	104	1.83	679	113
87	4.79	1449	152	4.79	1449	152
88	13.31	2748	618	13.33	2748	619
89	18.6	2221	753	18.52	2177	698

NOTE: Toyota data reflect's subbasin boundary modifications based upon 2 foot contour, 1 in. = 1,000 ft. mapping.

SOURCE: SFC ENGINEERING COMPANY

TABLE 2
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROLOGIC INPUT PARAMETERS TO MCUHP2
7/11/91

SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS -N-	LAG (HOURS)	LAG (MIN)	S GRAPH
	10J1	1539	2.40	0.35	0.34	4.4	0.61	0	4.73	2.84	2060	1735	68.7	0.03	0.72	43	VALLEY
	10J2	74	0.12	0.35	0.34	4.4	0.61	0	0.95	0.47	1800	1740	63.2	0.03	0.20	12	VALLEY
	10J3	73	0.11	0.35	0.34	4.4	0.61	0	1.1	0.55	1810	1745	59.1	0.03	0.23	14	VALLEY
	10J4	815	1.27	0.35	0.34	4.4	0.61	0	1.9	0.95	1745	1640	55.3	0.03	0.35	21	VALLEY
	10J4A	67	0.10	0.35	0.34	4.4	0.61	0	0.83	0.34	1690	1650	48.2	0.03	0.18	11	VALLEY
	10J4B	37	0.06	0.35	0.34	4.4	0.61	0	0.57	0.23	1675	1645	52.6	0.03	0.13	8	VALLEY
	10J5	85	0.13	0.35	0.34	4.4	0.61	0	1.2	0.5	1715	1658	47.5	0.03	0.24	14	VALLEY
	10J6	90	0.14	0.35	0.34	4.4	0.61	0	1.2	0.63	1775	1705	58.3	0.03	0.25	15	VALLEY
	10J7	100	0.16	0.35	0.34	4.4	0.61	0	1.23	0.6	1725	1660	52.8	0.03	0.25	15	VALLEY
	10J8	181	0.28	0.35	0.34	4.4	0.61	0	1.4	0.6	1700	1630	50.0	0.03	0.27	16	VALLEY
	10J9	96	0.15	0.35	0.34	4.4	0.61	0	0.36	0.18	1640	1625	41.7	0.03	0.10	6	VALLEY
	10J10	1497	2.34	0.35	0.34	4.4	0.61	0	2.9	1.5	1670	1549	41.7	0.03	0.52	31	VALLEY
10 K1		563	0.88	0.16	0.35	5.5	0.43	0	2.54	1.36	2343	2043	118.1	0.04	0.52	31	PHX. MTN
10 K2		2918	4.56	0.35	0.35	4.9	0.42	0	6.21	3.26	2043	1655	62.5	0.03	0.86	52	VALLEY
	10K21	891	1.39	0.35	0.35	4.9	0.42	0	4.1	2.1	2020	1740	68.3	0.04	0.81	49	VALLEY
	10K22	789	1.23	0.35	0.35	4.9	0.42	0	5	2.8	2120	1745	75.0	0.04	0.96	58	VALLEY
	10K23	1206	1.88	0.35	0.35	4.9	0.42	0	4.2	2.3	2043	1745	71.0	0.04	0.84	51	VALLEY
	10K24	259	0.40	0.35	0.35	4.9	0.42	0	2.16	1	1880	1740	64.8	0.04	0.49	29	VALLEY
	10K25	508	0.79	0.35	0.35	4.9	0.42	0	1.7	1.1	1745	1655	52.9	0.04	0.48	29	VALLEY
10 L		4058	6.34	0.35	0.35	3.9	0.69	0	6.93	3.22	1720	1452	38.7	0.03	0.98	59	VALLEY
	10L1	120	0.19	0.35	0.35	3.9	0.69	0	0.85	0.28	1685	1645	47.1	0.03	0.17	10	VALLEY
	10L2	131	0.20	0.35	0.35	3.9	0.69	0	0.49	0.2	1645	1620	51.0	0.03	0.12	7	VALLEY
	10L3	2988	4.67	0.35	0.35	3.9	0.69	0	4.7	2.68	1620	1452	35.7	0.03	0.80	48	VALLEY
10 M		3949	6.17	0.21	0.32	7	0.17	0	6.06	3.33	2915	2015	148.5	0.043	1.05	63	PHX. MTN
10 N		2220	3.47	0.35	0.36	4.6	0.47	0	8.41	3.3	2100	1560	64.2	0.03	0.96	58	VALLEY
	10N1	373	0.58	0.35	0.36	4.6	0.47	0	2.4	1.08	1890	1750	58.3	0.03	0.40	24	VALLEY
	10N2	37	0.06	0.35	0.36	4.6	0.47	0	0.5	0.23	1780	1745	70.0	0.03	0.12	7	VALLEY
	10N3	14	0.02	0.35	0.36	4.6	0.47	0	0.3	0.13	1658	1645	43.3	0.03	0.09	5	VALLEY
	10N4	17	0.03	0.35	0.36	4.6	0.47	0	0.43	0.2	1663	1645	41.9	0.03	0.12	7	VALLEY
	10N5	449	0.70	0.35	0.36	4.6	0.47	0	1.93	0.94	1745	1640	54.4	0.03	0.35	21	VALLEY
	10N6	168	0.26	0.35	0.36	4.6	0.47	0	1.93	1	1742	1640	52.8	0.03	0.36	22	VALLEY
	10N7	52	0.08	0.35	0.36	4.6	0.47	0	1.14	0.6	1700	1640	52.6	0.03	0.24	15	VALLEY
	10N8	44	0.07	0.35	0.36	4.6	0.47	0	0.66	0.27	1675	1640	53.0	0.03	0.15	9	VALLEY
	10N9	192	0.30	0.35	0.36	4.6	0.47	0	0.66	0.3	1640	1610	45.5	0.03	0.16	9	VALLEY
	10N10	336	0.53	0.35	0.36	4.6	0.47	0	1.51	0.85	1630	1560	46.4	0.03	0.32	19	VALLEY
	10N11	88	0.14	0.35	0.36	4.6	0.47	0	0.61	0.3	1645	1615	49.2	0.03	0.15	9	VALLEY
10 R		2928	4.58	0.16	0.36	5.8	0.31	0	6	3.11	2301	2017	47.3	0.04	1.05	63	MOUNTAIN
10 S		2509	3.92	0.3	0.36	5.5	0.23	0	6.16	2.73	2320	1775	88.5	0.033	0.81	49	VALLEY
10 T		2438	3.81	0.34	0.35	5.4	0.36	0	6.06	3.52	2240	1740	82.5	0.031	0.84	51	VALLEY
10 U		2726	4.26	0.35	0.36	4.9	0.47	0	5.61	2.58	1860	1572	51.3	0.03	0.78	47	VALLEY

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SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS -N-	LAG (HOURS)	LAG (MIN)	S GRAPH
	10U1	350	0.55	0.35	0.36	4.9	0.47	0	2.27	0.85	1790	1665	55.1	0.03	0.36	22	VALLEY
	10U2	44	0.07	0.35	0.36	4.9	0.47	0	0.25	0.11	1665	1655	40.0	0.03	0.08	5	VALLEY
	10U3	121	0.19	0.35	0.36	4.9	0.47	0	1.17	0.42	1818	1740	66.7	0.03	0.21	12	VALLEY
	10U4	192	0.30	0.35	0.36	4.9	0.47	0	1.61	0.8	1842	1740	63.4	0.03	0.30	18	VALLEY
	10U5	90	0.14	0.35	0.36	4.9	0.47	0	0.76	0.28	1792	1748	57.9	0.03	0.15	9	VALLEY
	10U6	228	0.36	0.35	0.36	4.9	0.47	0	1.38	0.75	1740	1668	52.2	0.03	0.29	17	VALLEY
	10U7	23	0.04	0.35	0.36	4.9	0.47	0	0.25	0.23	1668	1655	52.0	0.03	0.10	6	VALLEY
	10U8	107	0.17	0.35	0.36	4.9	0.47	0	0.78	0.44	1742	1708	43.6	0.03	0.20	12	VALLEY
	10U9	135	0.21	0.35	0.36	4.9	0.47	0	0.85	0.47	1702	1658	51.8	0.03	0.20	12	VALLEY
	10U10	151	0.24	0.35	0.36	4.9	0.47	0	1.36	0.8	1744	1670	54.4	0.03	0.29	17	VALLEY
	10U11	115	0.18	0.35	0.36	4.9	0.47	0	1.42	0.66	1720	1665	38.7	0.03	0.29	18	VALLEY
	10U12	44	0.07	0.35	0.36	4.9	0.47	0	0.76	0.34	1702	1667	46.1	0.03	0.17	10	VALLEY
	10U13	150	0.23	0.35	0.36	4.9	0.47	0	1.14	0.57	1650	1600	43.9	0.03	0.25	15	VALLEY
	10U14	190	0.30	0.35	0.36	4.9	0.47	0	0.85	0.47	1640	1610	35.3	0.03	0.22	13	VALLEY
	10U15	48	0.08	0.35	0.36	4.9	0.47	0	0.47	0.23	1675	1650	53.2	0.03	0.12	7	VALLEY
	10U16	46	0.07	0.35	0.36	4.9	0.47	0	0.45	0.23	1667	1640	60.0	0.03	0.12	7	VALLEY
	10U17	30	0.05	0.35	0.36	4.9	0.47	0	0.45	0.27	1665	1640	55.6	0.03	0.13	8	VALLEY
	10U18	38	0.06	0.35	0.36	4.9	0.47	0	0.3	0.19	1655	1640	50.0	0.03	0.10	6	VALLEY
	10U19	43	0.07	0.35	0.36	4.9	0.47	0	0.28	0.15	1655	1640	53.6	0.03	0.08	5	VALLEY
	10U20	411	0.64	0.35	0.36	4.9	0.47	0	1.7	0.9	1650	1580	41.2	0.03	0.35	21	VALLEY
10 V		1997	3.12	0.35	0.35	4.9	0.46	0								48	
	10V1	223	0.35	0.35	0.35	4.9	0.46	0	1.9	0.76	1862	1741	63.7	0.03	0.31	19	VALLEY
	10V2	515	0.80	0.35	0.35	4.9	0.46	0	3.7	1.7	2003	1740	71.1	0.03	0.54	32	VALLEY
	10V3	299	0.47	0.35	0.35	4.9	0.46	0	2.3	0.76	1850	1720	56.5	0.03	0.34	21	VALLEY
	10V4	16	0.03	0.35	0.35	4.9	0.46	0	0.6	0.2	1738	1710	46.7	0.03	0.13	8	VALLEY
	10V5	192	0.30	0.35	0.35	4.9	0.46	0	1.4	0.76	1730	1660	50.0	0.03	0.29	18	VALLEY
	10V6	283	0.44	0.35	0.35	4.9	0.46	0	2.3	1.3	1800	1660	60.9	0.03	0.42	25	VALLEY
	10V7	30	0.05	0.35	0.35	4.9	0.46	0	0.3	0.2	1670	1650	66.7	0.03	0.09	6	VALLEY
	10V8	381	0.60	0.35	0.35	4.9	0.46	0	1.4	0.9	1770	1606	117.1	0.03	0.26	16	VALLEY
	10V9	268	0.42	0.35	0.35	4.9	0.46	0	1.4	0.8	1741	1670	50.7	0.03	0.30	18	VALLEY
	10V10	68	0.11	0.35	0.35	4.9	0.46	0	0.8	0.4	1720	1670	62.5	0.03	0.18	11	VALLEY
	10V11	24	0.04	0.35	0.35	4.9	0.46	0	0.4	0.1	1685	1672	32.5	0.03	0.09	5	VALLEY
	10V12	51	0.08	0.35	0.35	4.9	0.46	0	0.5	0.2	1606	1588	36.0	0.03	0.13	8	VALLEY
10 Y																	
	10Y1	199	0.31	0.35	0.36	4.7	0.49	0	1.86	0.8	1755	1660	51.1	0.03	0.33	20	MOUNTAIN
	10Y2	703	1.10	0.35	0.36	4.7	0.49	0	4.07	1.7	1890	1660	56.5	0.03	0.58	35	MOUNTAIN
	10Y3	300	0.47	0.35	0.36	4.7	0.49	0	1.25	0.7	1660	1610	40.0	0.03	0.28	17	MOUNTAIN
	10Y4	554	0.87	0.35	0.36	4.7	0.49	0	1.74	1.3	1610	1547	36.2	0.03	0.41	25	MOUNTAIN
	10Y5	131	0.20	0.35	0.36	4.7	0.49	0	1.17	0.5	1660	1615	38.5	0.03	0.24	15	MOUNTAIN
10 AA																	
	10AA1	228	0.36	0.35	0.36	6.3	0.29	0	1.67	0.8	1740	1665	44.9	0.03	0.33	20	MOUNTAIN
	10AA2	148	0.23	0.35	0.36	6.3	0.29	0	1.97	0.98	1755	1665	45.7	0.03	0.37	22	MOUNTAIN
	10AA3	262	0.41	0.35	0.36	6.3	0.29	0	2.37	1.1	1770	1665	44.3	0.03	0.42	25	MOUNTAIN
	10AA4	108	0.17	0.35	0.36	6.3	0.29	0	1.19	0.6	1665	1610	46.2	0.03	0.25	15	MOUNTAIN

TABLE 2
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROLOGIC INPUT PARAMETERS TO MCUHP2
7/11/91

SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS ~N~	LAG (HOURS)	LAG (MIN)	S GRAPH
	10AA5	246	0.38	0.35	0.36	6.3	0.29	0	1.25	0.75	1665	1610	44.0	0.03	0.29	17	MOUNTAIN
	10AA6	182	0.28	0.35	0.36	6.3	0.29	0	0.79	0.4	1610	1590	25.3	0.03	0.21	13	MOUNTAIN
12 D																	
	12D1	230	0.36	0.35	0.34	5.9	0.35	0	1.27	0.57	1715	1670	35.4	0.03	0.27	16	VALLEY
	12D2	23	0.04	0.35	0.34	5.9	0.35	0	0.55	0.28	1690	1670	36.4	0.03	0.15	9	VALLEY
	12D3	14	0.02	0.35	0.34	5.9	0.35	0	0.27	0.06	1690	1680	37.0	0.03	0.06	4	VALLEY
	12D4	14	0.02	0.35	0.34	5.9	0.35	0	0.15	0.07	1685	1680	33.3	0.03	0.05	3	VALLEY
	12D5	34	0.05	0.35	0.34	5.9	0.35	0	0.26	0.095	1670	1660	38.5	0.03	0.07	4	VALLEY
	12D6	21	0.03	0.35	0.34	5.9	0.35	0	0.28	0.15	1675	1665	35.7	0.03	0.09	5	VALLEY
	12D7	3000	4.69	0.35	0.34	5.9	0.35	0	5.68	2.3	1800	1570	40.5	0.03	0.79	47	VALLEY

SOURCE: SFC ENGINEERING COMPANY

TABLE 3
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROGRAPH ROUTING DATA
7/11/91

SUB BASIN	REACH	REACH LENGTH (MI)	REACH LENGTH (FT)	VEL	DELTA TIME	STEPS	START ELEV.	END ELEV.	SLOPE (FT/FT)
10J	60-60A	4.07	21500	5	5	14.3	2005	1725	0.0130
	60A-60D	1.72	9100	5	5	6.1	1725	1640	0.0093
	60B-60D	1.84	9700	5	5	6.5	1740	1640	0.0103
	60C-60D	1.86	9800	5	5	6.5	1745	1640	0.0107
	60F-60G	0.80	4200	5	5	2.8	1705	1660	0.0107
	60G-60H	0.63	3300	5	5	2.2	1660	1630	0.0091
	60E-60H	0.49	2600	5	5	1.7	1658	1630	0.0108
	60D-60I	0.38	2000	5	5	1.3	1640	1625	0.0075
	60I-61	2.03	10700	5	5	7.1	1625	1540	0.0079
	60H-61	2.22	11700	5	5	7.8	1630	1540	0.0077
	60J-60K	0.49	2600	5	5	1.7	1645	1620	0.0096
	60K-6082	4.79	25300	5	5	16.9	1620	1452	0.0066
10U	69-70A	2.27	11986	5	5	8.0	1740	1665	0.0063
	70A-70B	0.25	1320	5	5	0.9	1665	1655	0.0076
	70B-70Q	0.28	1478	5	5	1.0	1655	1640	0.0101
	70Q-71A	0.85	4488	5	5	3.0	1640	1610	0.0067
	71A-71	0.66	3485	5	5	2.3	1610	1572	0.0109
	70C-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70E-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70F-70G	0.25	1320	5	5	0.9	1668	1655	0.0098
	70G-70P	0.78	4118	5	5	2.7	1655	1640	0.0036
	70P-71AA	0.85	4488	5	5	3.0	1640	1610	0.0067
	70-70D	0.76	4013	5	5	2.7	1775	1748	0.0067
	70E-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70H-70J	0.85	4488	5	5	3.0	1708	1658	0.0111
	70J-70O	0.3	1584	5	5	1.1	1658	1640	0.0114
	70O-71B	1.14	6019	5	5	4.0	1640	1600	0.0066
	70L-70N	0.45	2376	5	5	1.6	1667	1640	0.0114
	70N-71B	1.14	6019	5	5	4.0	1640	1600	0.0066
	71B-71	0.66	3485	5	5	2.3	1600	1572	0.0080
	70K-70O	0.45	2376	5	5	1.6	1665	1640	0.0105
	70M-71B	1.14	6019	5	5	4.0	1650	1600	0.0083
10K	62-67c	4.22	22300	5	5	14.9	2040	1742	0.0134
	67c-63	1.63	8600	5	5	5.7	1742	1657	0.0099
	67-67a	4.03	21300	5	5	14.2	2020	1740	0.0131
	67a-63	1.56	8250	5	5	5.5	1740	1657	0.0101
	67b-63	1.59	8400	5	5	5.6	1742	1657	0.0101
	67d-63	1.70	9000	5	5	6.0	1740	1657	0.0092
	63-67g	0.30	1600	5	5	1.1	1657	1644	0.0081
10N	67g-67N	0.59	3100	5	5	2.1	1644	1615	0.0094
	67h-67N	0.57	3000	5	5	2.0	1644	1615	0.0097
	67f-67i	1.89	10000	5	5	6.7	1743	1640	0.0103
	67I-67M	0.66	3500	5	5	2.3	1640	1612	0.0080
	67E-67J	1.91	10100	5	5	6.7	1743	1640	0.0102
	67J-67M	0.63	3350	5	5	2.2	1640	1612	0.0084

TABLE 3
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROGRAPH ROUTING DATA
7/11/91

SUB BASIN	REACH	REACH LENGTH (MI)	REACH LENGTH (FT)	VEL	DELTA TIME	STEPS	START ELEV.	END ELEV.	SLOPE (FT/FT)
	67K-67M	0.63	3300	5	5	2.2	1640	1612	0.0085
	67L-67M	0.64	3400	5	5	2.3	1640	1612	0.0082
	67M-68	1.17	6200	5	5	4.1	1612	1560	0.0084
	62-63	0.39	2040	5	5	1.4	2040	1657	0.1877
	63-68	2.27	11986	5	5	8.0	1657	1560	0.0081
	67-68	8.22	43402	5	5	28.9	2020	1560	0.0106
	63-67G	0.30	1600	5	5	1.1	1657	1644	0.0081
	67H-67M	0.74	3900	5	5	2.6	1644	1612	0.0082
	67M-68	1.17	6200	5	5	4.1	1612	1560	0.0084
	62-63	5.85	30900	5	5	20.6	2400	1560	0.0272
	63-68	2.22	11700	5	5	7.8	1657	1560	0.0083
	67N-68	1.29	6800	5	5	4.5	1615	1560	0.0081
10V	76-76H	1.08	5700	5	5	3.8	1717	1660	0.0100
	76H-77A	1.44	7600	5	5	5.1	1660	1606	0.0071
	76A-76E	1.42	7500	5	5	5.0	1741	1670	0.0095
	76B-76E	1.31	6900	5	5	4.6	1740	1670	0.0101
	76C-76E	0.93	4900	5	5	3.3	1720	1670	0.0102
	76E-76J	0.28	1500	5	5	1.0	1670	1650	0.0133
	76D-76F	0.72	3800	5	5	2.5	1710	1670	0.0105
	76F-76J	0.27	1400	5	5	0.9	1670	1650	0.0143
	76G-76J	0.30	1600	5	5	1.1	1772	1650	0.0763
	76J-77A	1.23	6500	5	5	4.3	1650	1606	0.0068
	76I-77A	1.46	7700	5	5	5.1	1660	1606	0.0070
	77A-77	0.47	2500	5	5	1.7	1606	1588	0.0072
	76B-76C	0.57	3000	5	5	2.0	1740	1720	0.0067
	76C-76D	0.19	1000	5	5	0.7	1720	1710	0.0100
	76D-76H	0.89	4700	5	5	3.1	1710	1660	0.0106
	76A-76B	0.27	1400	5	5	0.9	1743	1740	0.0021
10Y	79-79B	1.99	10500	5	5	7.0	1755	1660	0.0090
	79B-79D	1.17	6200	5	5	4.1	1660	1615	0.0073
	79D-80	1.74	9200	5	5	6.1	1615	1547	0.0074
	79A-79C	1.25	6600	5	5	4.4	1660	1610	0.0076
	79C-80	1.74	9200	5	5	6.1	1610	1547	0.0068
10AA	83A-83D	1.17	6200	5	5	4.1	1665	1610	0.0089
	83B-83E	1.17	6200	5	5	4.1	1665	1610	0.0089
	83C-83E	1.23	6500	5	5	4.3	1665	1610	0.0085
	83D-83	0.76	4000	5	5	2.7	1610	1590	0.0050
	83E-83	0.80	4200	5	5	2.8	1610	1590	0.0048
12D	88A-88E	0.19	1000	5	5	0.7	1670	1660	0.0100
	88B-88E	0.25	1300	5	5	0.9	1670	1660	0.0077
	88C-88F	0.27	1400	5	5	0.9	1680	1665	0.0107
	88D-88	0.02	100	5	5	0.1	1680	1675	0.0500
	88E-89	2.35	12400	5	5	8.3	1660	1570	0.0073
	88F-89	2.75	14500	5	5	9.7	1665	1570	0.0066

TABLE 4
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
PRECIPITATION DEPTH-DURATION-FREQUENCY
7/11/91

BASIN AREA SQ. MI.	REDUCTION FACTOR	6 HOUR			2 HOUR
		100 YR	50 YR	10 YR	100 YR
0.01	0.0000	3.30	3.00	2.10	2.74
0.5	0.9933	3.28	2.98	2.09	2.72
2.8	0.9788	3.23	2.94	2.06	2.68
16	0.9212	3.04	2.76	1.93	2.52
90	0.8091	2.67	2.42	1.70	2.22
500	0.5700	1.88	1.71	1.20	1.56

SOURCE: SFC ENGINEERING COMPANY

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
1	70E	5-10 X 5 CBC	1734.0	1737.0	4.36	100 YR-6 HR	2990	284	1741.83	15.9	2683	281
						50 YR-6 HR	2509	234	1740.95	10.5	2334	231
						10 YR-6 HR	1053	88	1737.68	0.4	1020	85
						100 YR-2 HR	3791	302	1743.13	30.4	3033	300
2	70C	1-24 IN. RCP	1732.0	1731.9	0.19	100 YR-6 HR	459	12	1740.00	8.7	41	12
						50 YR-6 HR	397	10	1739.67	7.7	40	10
						10 YR-6 HR	201	5	1738.33	3.5	36	5
						100 YR-2 HR	421	11	1740.00	8.7	41	11
3	69	3-10 X 4 CBC	1732.0	1732.4	3.81	100 YR-6 HR	2296	199	1742.47	27.9	1706	199
						50 YR-6 HR	1841	157	1740.83	12.8	1510	158
						10 YR-6 HR	517	39	1735.23	0.1	517	39
						100 YR-2 HR	3162	231	1744.06	49.6	1895	232
4	67E	1-10 X 4 CBC	1733.5	1734.2	0.58	100 YR-6 HR	915	38	1742.40	10.5	506	38
						50 YR-6 HR	779	32	1741.84	7.3	483	32
						10 YR-6 HR	387	15	1739.18	1.0	346	16
						100 YR-2 HR	863	34	1742.23	9.3	499	34
5	67F	1-36 IN. RCP	1736.5	1738.3	0.06	100 YR-6 HR	179	4	1742.25	2.1	68	4
						50 YR-6 HR	157	3	1742.13	1.8	67	3
						10 YR-6 HR	82	2	1740.58	0.4	50	2
						100 YR-2 HR	190	4	1742.13	1.8	67	4
6	67A	5-10 X 4 CBC	1730.5	1733.6	7.56	100 YR-6 HR	3177	492	1741.20	14.4	2891	491
						50 YR-6 HR	2588	403	1739.26	5.4	2502	402
						10 YR-6 HR	1076	167	1734.24	0.0	1041	161
						100 YR-2 HR	3833	538	1742.91	28.5	3210	538
7	67B	1-10 X 4 CBC	1733.0	1735.0	3.99	100 YR-6 HR	2133	192	1741.51	15.5	1697	193
	&					50 YR-6 HR	1651	149	1739.96	3.9	1452	149
8	67C	2-10 X 5 CBC	1732.5	1734.3		10 YR-6 HR	359	37	1734.89	0.0	306	31
						100 YR-2 HR	2982	233	1743.19	39.5	1928	232
9	67D	2-10 X 4 CBC	1734.5	1737.9	0.40	100 YR-6 HR	589	28	1739.43	0.0	590	28
						50 YR-6 HR	504	23	1738.83	0.0	505	23
						10 YR-6 HR	262	12	1737.16	0.0	262	12
						100 YR-2 HR	536	24	1739.01	0.0	532	24

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
10	60C	1-24 IN. RCP	1734.5	1734.3	0.11	100 YR-6 HR	243	7	1742.00	4.6	40	7
						50 YR-6 HR	207	6	1741.67	3.9	39	6
						10 YR-6 HR	98	3	1740.25	1.1	34	3
						100 YR-2 HR	215	6	1741.67	3.9	39	6
11	60B	1-24 IN. RCP	1731.0	1733.2	0.12	100 YR-6 HR	289	7	1739.50	5.2	43	7
						50 YR-6 HR	249	6	1739.25	4.6	42	6
						10 YR-6 HR	120	3	1738.00	1.4	38	3
						100 YR-2 HR	273	7	1739.25	4.6	42	7
12	60A	5-10 X 4 CBC	1717.5	1726.7	9.33	100 YR-6 HR	2619	468	1726.34	0.0	2517	449
						50 YR-6 HR	2107	373	1724.08	0.0	1996	352
						10 YR-6 HR	655	113	1719.96	0.0	587	101
						100 YR-2 HR	3277	568	1730.05	3.6	3234	567
13	60F	1-10 X 4 CBC	1698.5	1704.8	0.14	100 YR-6 HR	292	9	1703.39	0.0	292	9
						50 YR-6 HR	248	7	1702.77	0.0	248	7
						10 YR-6 HR	121	3	1701.01	0.0	121	3
						100 YR-2 HR	270	8	1701.07	0.0	270	8
14	60G	1-10 X 4 CBC	1661.0	1661.3	0.30	100 YR-6 HR	446	21	1664.99	7.8	229	21
						50 YR-6 HR	387	18	1664.65	6.3	204	18
						10 YR-6 HR	203	9	1663.59	2.9	126	9
						100 YR-2 HR	402	18	1664.76	6.8	212	18
15	60E	1-24 IN. RCP	1652.5	1652.0	0.13	100 YR-6 HR	291	9	1656.00	6.4	23	8
						50 YR-6 HR	249	7	1655.83	5.9	22	7
						10 YR-6 HR	121	4	1654.67	2.8	14	3
						100 YR-2 HR	260	7	1655.83	5.9	22	7
16	60D	5-10 X 4 CBC	1739.5	1737.9	10.98	100 YR-6 HR	2277	482	1744.97	16.8	2034	469
		&				50 YR-6 HR	1792	373	1744.19	8.2	1704	362
		1-10 X 4 CBC	1739.0			10 YR-6 HR	512	101	1741.32	0.1	488	95
						100 YR-2 HR	2961	634	1746.24	34.1	2466	627
17	60J-1	1-6 X 4 CBC	1643.0	1645.5	0.16	100 YR-6 HR	460	11	1649.63	4.0	241	12
						50 YR-6 HR	396	10	1649.17	3.0	227	10
						10 YR-6 HR	193	4	1648.02	0.3	181	4
						100 YR-2 HR	446	10	1649.27	3.2	230	10

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
18	60J-2	1-10 X 4 CBC	1639.0	1643.5	0.16	100 YR-6 HR	241	12	1643.16	0.0	241	12
						50 YR-6 HR	227	10	1642.96	0.0	227	10
						10 YR-6 HR	181	4	1642.35	0.0	181	4
						100 YR-2 HR	230	10	1643.00	0.0	230	10
19	67H-1	7-10 X 4 CBC	1643.0	1644.8	12.78	100 YR-6 HR	2960	639	1649.93	10.8	2915	639
						50 YR-6 HR	2445	502	1648.64	4.9	2416	502
						10 YR-6 HR	891	151	1645.61	0.1	892	151
						100 YR-2 HR	4251	802	1652.62	39.8	3744	802
20	67H-2	8-10 X 4 CBC	1639.0	1641.7	12.78	100 YR-6 HR	2915	639	1644.92	0.0	2915	639
						50 YR-6 HR	2416	502	1644.02	0.0	2416	502
						10 YR-6 HR	892	151	1642.38	0.0	892	151
						100 YR-2 HR	3744	802	1646.96	0.0	3744	802
21	67I-1	1-10 X 4 CBC	1640.0	1640.0	0.74	100 YR-6 HR	1123	49	1648.75	17.2	500	49
						50 YR-6 HR	963	41	1648.10	11.1	474	41
						10 YR-6 HR	475	19	1645.51	1.7	336	19
						100 YR-2 HR	1173	46	1648.78	17.4	501	46
22	67I-2	1-10 X 4 CBC	1636.5	1636.8	0.74	100 YR-6 HR	500	49	1644.75	0.0	500	49
						50 YR-6 HR	474	41	1644.10	0.0	474	41
						10 YR-6 HR	336	19	1641.51	0.0	336	19
						100 YR-2 HR	501	46	1644.78	0.0	501	46
23	67J-1	1-10 X 4 CBC	1641.5	1641.6	0.98	100 YR-6 HR	504	56	1646.69	16.3	313	55
						50 YR-6 HR	424	46	1646.31	11.9	287	46
						10 YR-6 HR	261	24	1644.53	2.9	157	19
						100 YR-2 HR	565	54	1646.70	16.4	314	54
24	67J-2	1-10 X 4 CBC	1638.0	1638.0	0.98	100 YR-6 HR	313	55	1643.19	0.0	313	55
						50 YR-6 HR	287	46	1642.81	0.0	287	46
						10 YR-6 HR	157	19	1641.03	0.0	157	19
						100 YR-2 HR	314	54	1643.20	0.0	314	54
25	67L-1	1-24 IN. RCP	1642.0	1642.0	0.07	100 YR-6 HR	204	6	1647.20	3.8	31	6
						50 YR-6 HR	179	5	1647.00	3.3	30	5
26	67L-2	NOT MODELED				10 YR-6 HR	98	3	1646.25	1.4	27	3
						100 YR-2 HR	192	5	1647.20	3.8	31	5

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
27	70Q-1	2-10 X 5 CBNC	1638.0	1638.2	4.48	100 YR-6 HR	1373	222	1647.84	4.9	1284	223
						50 YR-6 HR	1200	174	1646.47	1.7	1147	174
						10 YR-6 HR	381	41	1641.49	0.0	379	41
						100 YR-2 HR	1545	267	1648.99	14.2	1399	268
28	70Q-2	2-10 X 5 CBC	1636.5	1638.2	4.48	100 YR-6 HR	1284	223	1646.34	0.0	1284	223
						50 YR-6 HR	1147	174	1644.35	0.0	1147	174
						10 YR-6 HR	379	41	1639.99	0.0	379	41
						100 YR-2 HR	1399	268	1647.45	0.0	1399	268
29	70P-1	5-10 X 6 CBC	1641.5	1643.5	5.00	100 YR-6 HR	2256	293	1647.73	6.8	2228	293
						50 YR-6 HR	1997	239	1647.18	5.0	81	239
						10 YR-6 HR	841	84	1644.69	0.4	42	84
						100 YR-2 HR	2469	322	1648.15	9.1	2418	322
30	70P-2	4-10 X 6 CBC	1637.0	1639.0	5.00	100 YR-6 HR	2228	293	1644.46	0.0	2228	293
						50 YR-6 HR	1981	239	1643.74	0.0	1981	239
						10 YR-6 HR	824	84	1640.65	0.0	842	84
						100 YR-2 HR	2418	322	1645.06	0.0	2418	322
31	70O	2-10 X 4 CBC	1637.0	1639.0	1.07	100 YR-6 HR	1131	72	1644.98	3.2	938	72
						50 YR-6 HR	937	59	1643.96	1.0	836	59
32	70M-1	NOT MODELED				10 YR-6 HR	394	24	1640.55	0.1	392	24
33	70M-2	NOT MODELED				100 YR-2 HR	1247	71	1646.03	5.6	1022	72
34	76J	1-10 X 4 CBC	1646.5	1646.5	0.59	100 YR-6 HR	984	42	1657.88	9.1	605	43
						50 YR-6 HR	839	35	1657.08	6.1	573	36
						10 YR-6 HR	440	18	1653.52	0.4	421	18
						100 YR-2 HR	946	38	1657.70	8.5	598	38
35	70A	3-10 X 5 CBC	1663.5	1663.5	4.36	100 YR-6 HR	1681	222	1671.12	1.2	1582	218
						50 YR-6 HR	1470	174	1670.33	7.7	1388	171
						10 YR-6 HR	457	43	1666.33	0.2	430	41
						100 YR-2 HR	1882	262	1672.07	18.1	1749	260
36	70F	5-10 X 6 CBC	1663.5	1665.2	4.91	100 YR-6 HR	2631	296	1670.40	6.1	2528	290
						50 YR-6 HR	2258	242	1669.64	3.2	2187	237
						10 YR-6 HR	919	86	1666.83	0.1	889	84
						100 YR-2 HR	2958	319	1671.15	10.5	2858	317

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
37	70B	3-10 X 5 CBC	1654.0	1654.0	4.43	100 YR-6 HR	1577	221	1660.85	32.4	1379	220
						50 YR-6 HR	1377	173	1660.03	21.1	1206	173
						10 YR-6 HR	416	41	1656.71	2.0	390	41
						100 YR-2 HR	1745	264	1661.59	42.7	1551	264
38	70G	4-10 X 5 CBC	1652.5	1652.5	4.95	100 YR-6 HR	2522	291	1660.75	28.5	2259	291
						50 YR-6 HR	2177	238	1659.76	19.2	2000	238
						10 YR-6 HR	869	84	1656.25	2.4	851	84
						100 YR-2 HR	2840	319	1661.84	39.6	2472	319
39	76E	3-10 X 4 CBC	1660.0	1660.0	0.40	100 YR-6 HR	817	29	1664.60	0.0	817	29
						50 YR-6 HR	706	24	1664.08	0.0	706	24
						10 YR-6 HR	371	13	1662.55	0.0	371	13
						100 YR-2 HR	770	25	1664.38	0.0	770	25
40	76F	1-6 X 4 CBC	1664.0	1664.0	0.10	100 YR-6 HR	262	7	1671.33	0.0	262	7
						50 YR-6 HR	229	6	1670.23	0.0	229	6
						10 YR-6 HR	123	3	1667.67	0.0	123	3
						100 YR-2 HR	260	6	1671.27	0.0	260	6
41	76G	1-6 X 4 CBC	1667.0	1667.0	0.04	100 YR-6 HR	127	4	1670.76	0.0	127	4
						50 YR-6 HR	113	3	1670.44	0.0	113	3
						10 YR-6 HR	67	2	1669.38	0.0	67	2
						100 YR-2 HR	136	3	1670.96	0.0	136	3

NOTE: SEE FIGURE 5 FOR NODE LOCATIONS

SOURCE: SFC ENGINEERING COMPANY

TABLE 6
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
EXISTING VS. PROPOSED FLOWS AT SOUTHERN PROPERTY BOUNDARY
7/11/91

	EXISTING CONDITIONS			WITH PROJECT			
	100 YR - 6 HR			100 YR - 6 HR			
NODE	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	CHANGE IN VOLUME (AC-FT)
60H	0.71	798	40	0.71	569	35	-5
60I	11.15	2151	472	11.13	2011	471	-1
60K	0.39	722	23	0.36	611	23	0
67N	12.93	3062	639	12.92	2894	641	2
67M	2.05	1260	104	2.02	817	104	0
71AA	9.81	4078	459	9.78	3216	457	-2
71B	1.3	1048	84	1.3	884	82	-2
77A	19.94	5378	995	19.94	5277	983	-12
79C	0.78	736	47	0.78	738	47	0
79D	9.34	3626	644	9.34	3626	644	0
83D	0.53	369	39	0.53	369	39	0
83E	1.02	586	69	1.02	587	69	0
88C	0.45	883	32	0.45	884	32	0
88F	0.05	139	3	0.05	140	4	1
TOTAL	70.45		3650	70.33		3631	-19

NOTE: SEE FIGURE 5 FOR NODE LOCATIONS

SOURCE: SFC ENGINEERING COMPANY

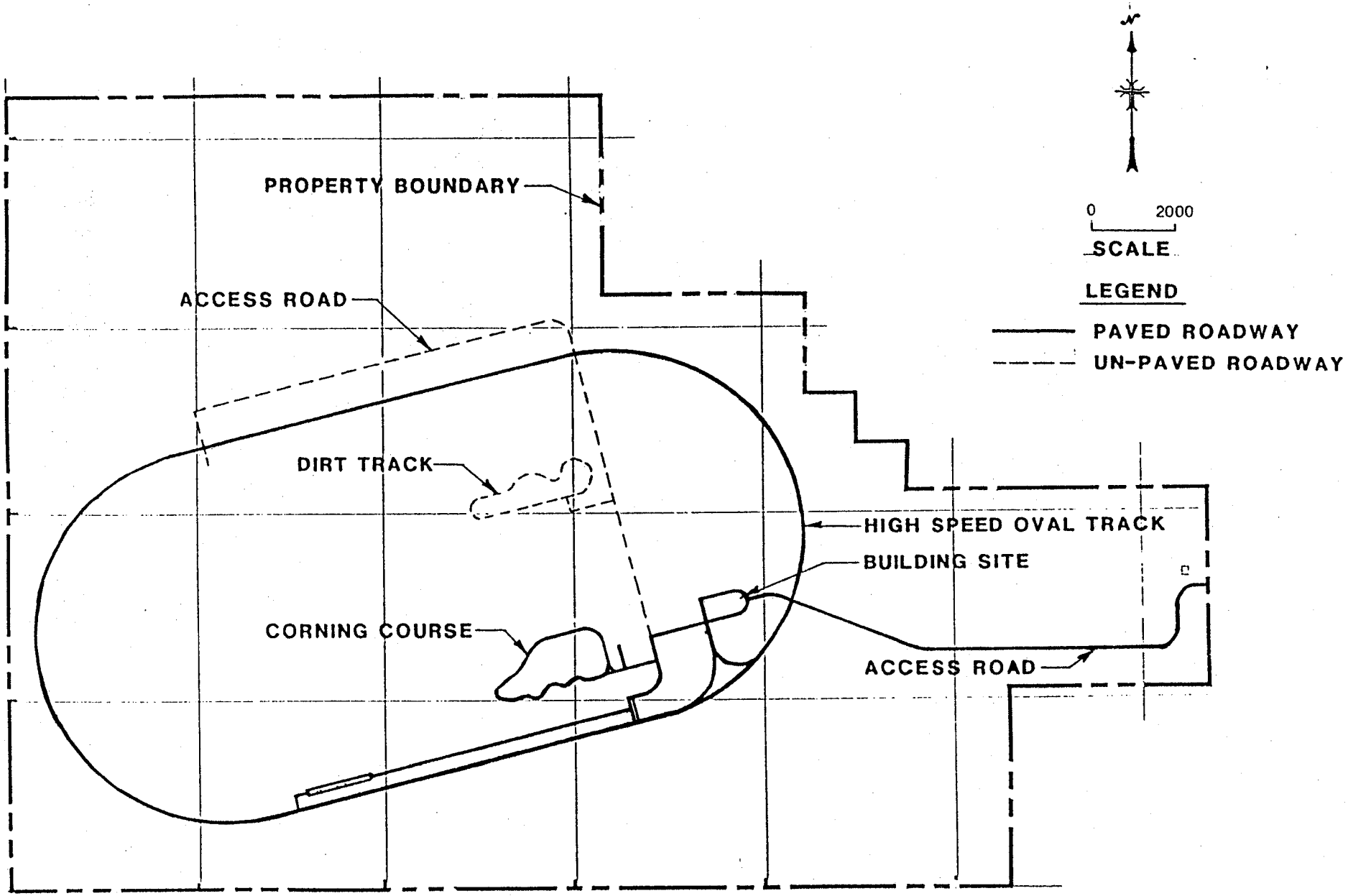


FIGURE 1
TOYOTA ARIZONA PROVING GROUND
PROJECT FEATURES PHASE 1

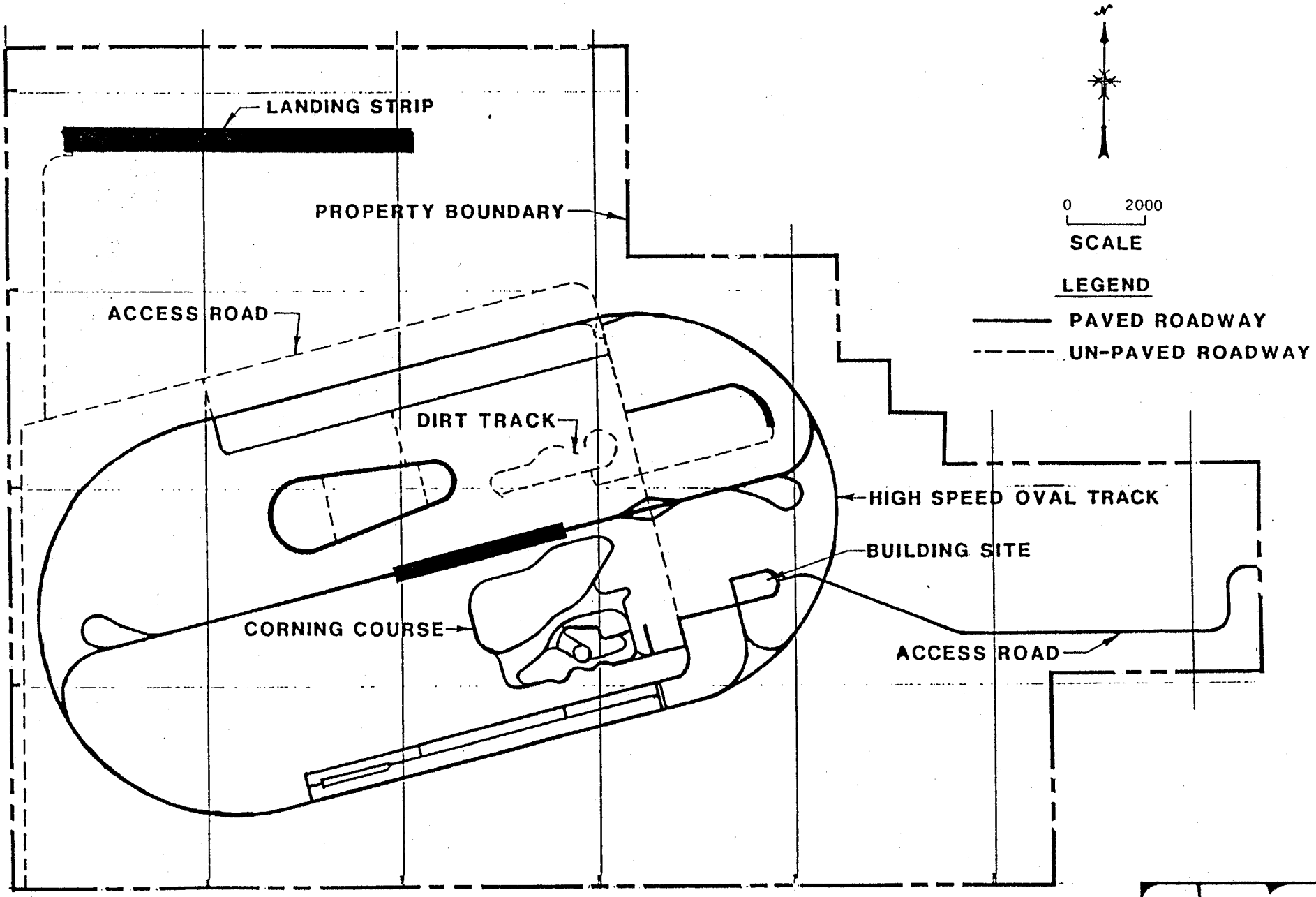


FIGURE 2
TOYOTA ARIZONA PROVING GROUND
PROJECT FEATURES PHASE 1 & FUTURE

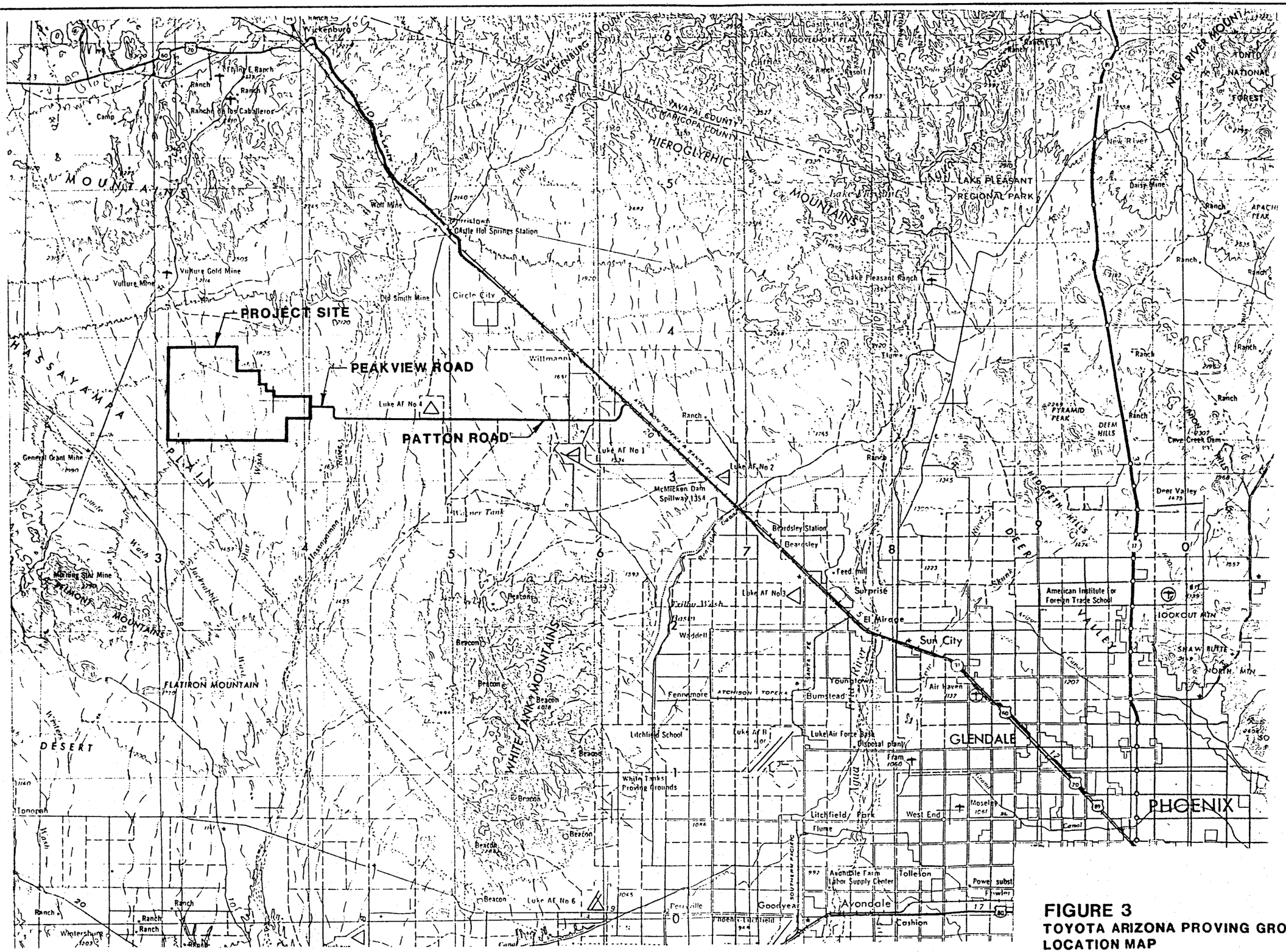
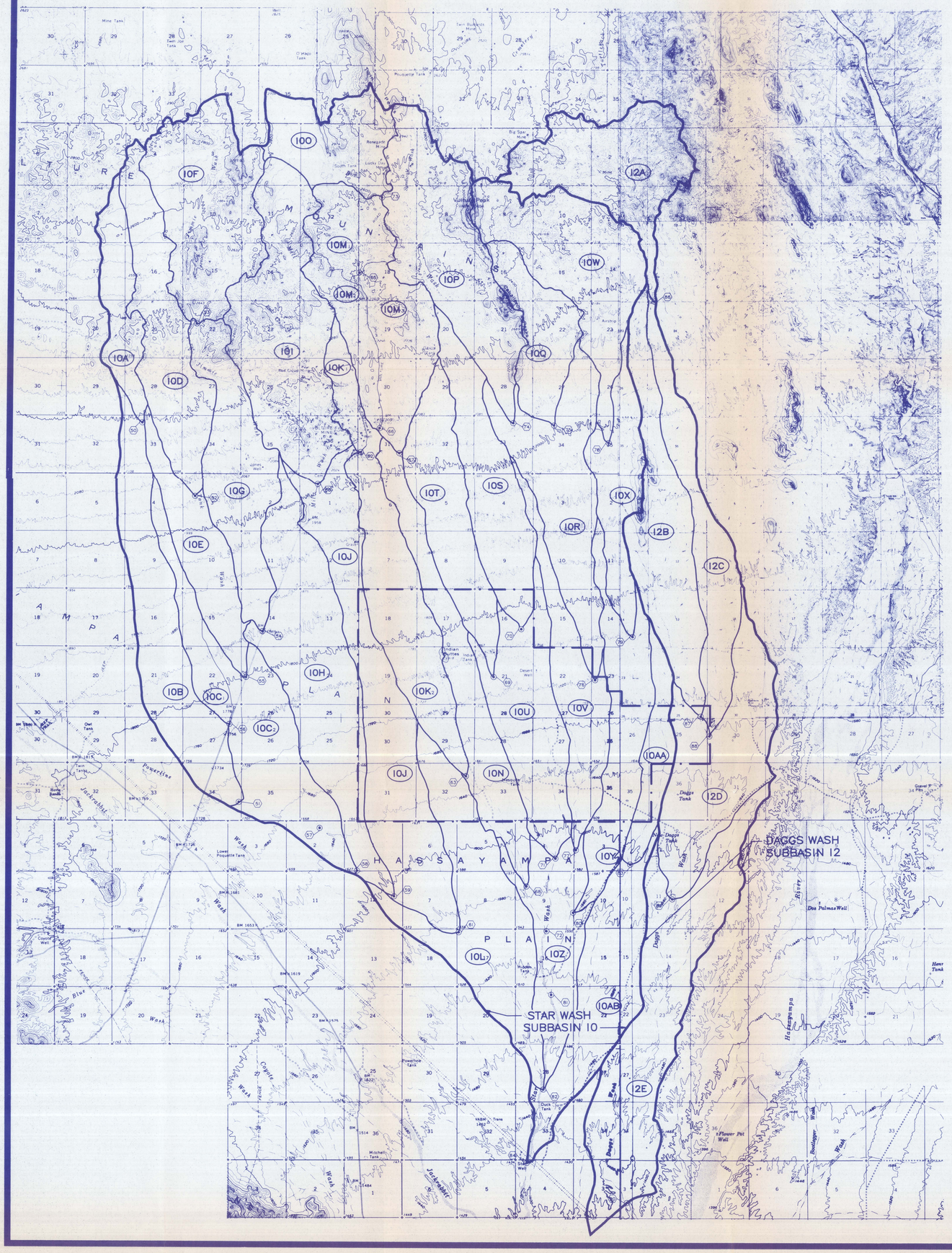


FIGURE 3
TOYOTA ARIZONA PROVING GROUND LOCATION MAP



N

SCALE:
0 1 MILE

LEGEND

- DRAINAGE BASIN BOUNDARY
- SUBBASIN BOUNDARY
- (7) CONCENTRATION POINT NUMBER
- (10U) SUBBASIN NAME
- TOYOTA ARIZONA PROVING GROUND PROPERTY BOUNDARY

NOTE: BASIN DELINEATIONS PER JACKRABBIT WASH FLOOD INSURANCE STUDY, FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, 1991.

FIGURE 4
TOYOTA ARIZONA PROVING GROUND STAR WASH AND DAGGS WASH DRAINAGE AREA BOUNDARIES

Sverdrup
CORPORATION
432 N. 44TH STREET, PHOENIX, ARIZONA 85008
PH. (602) 231-8999

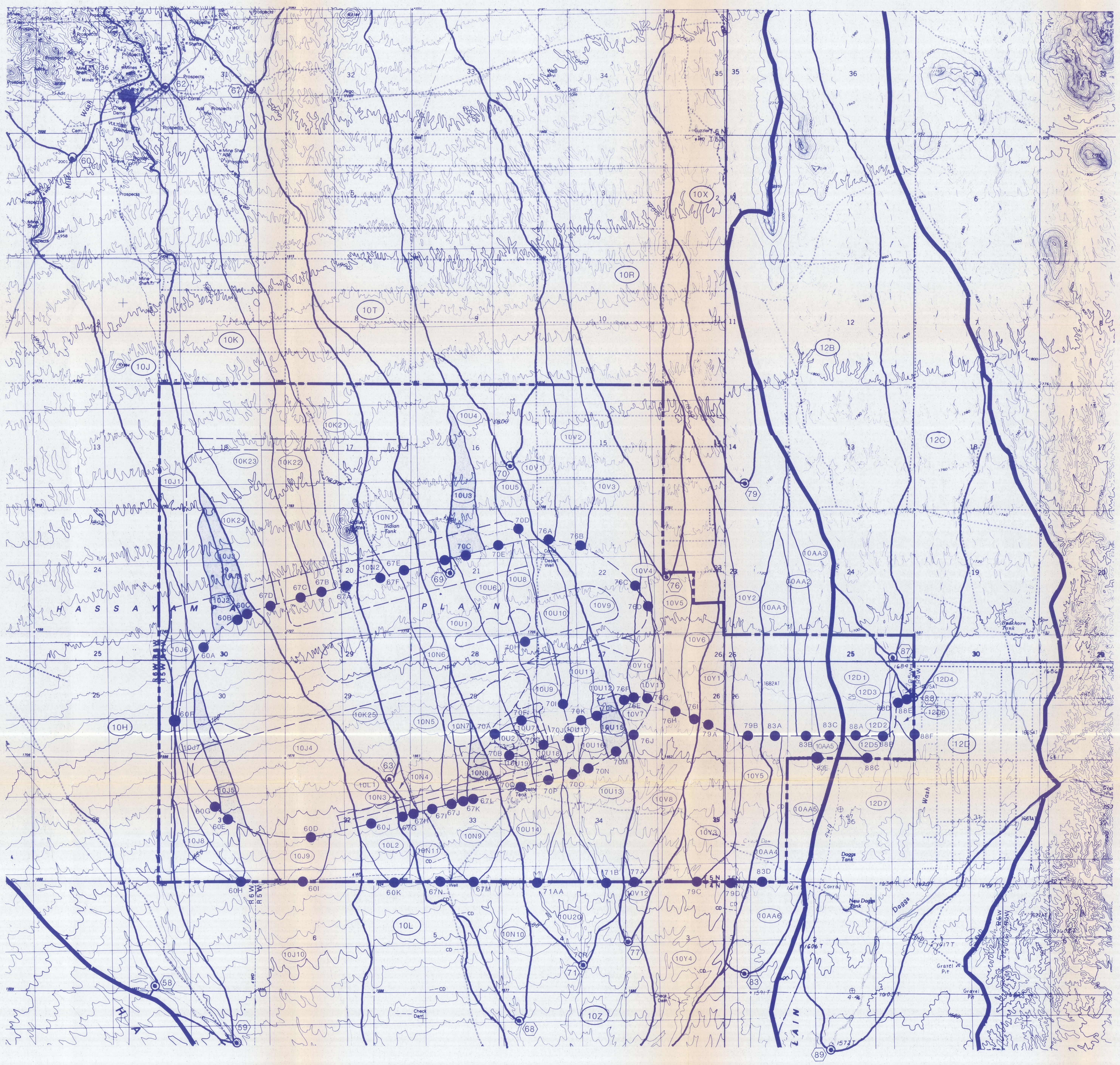
NO.	DATE	REVISION	BY	CH.

DRAWING TITLE:

DESIGNED:
DRN: CHKD:
SCALE:
H: V:
DATE:
JOB NO:
ACAD FILE:

DWG. NO.

SHEET
OF



N

SCALE: 1 INCH = 2000 FEET

0 2000

LEGEND

DRAINAGE BASIN BOUNDARY

SUBBASIN BOUNDARY

71 OR 67A CONCENTRATION POINT NUMBER

10U9 SUBBASIN OR SUBAREA NAME

TOYOTA ARIZONA PROVING GROUND PROPERTY BOUNDARY

SUBAREAS WITH STRUCTURES DESIGNED AS RETENTION BASINS

FIGURE 5

TOYOTA ARIZONA PROVING GROUND DRAINAGE SUBAREA BOUNDARIES AND CONCENTRATION POINTS

Sverdrup
CORPORATION
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NO.	DATE	REVISION	BY	CH.

DRAWING TITLE:

DESIGNED:
DRN: CHKD:
SCALE:
H: V:
DATE:
JOB NO:
ACAD FILE:

DWG. NO.

SHEET

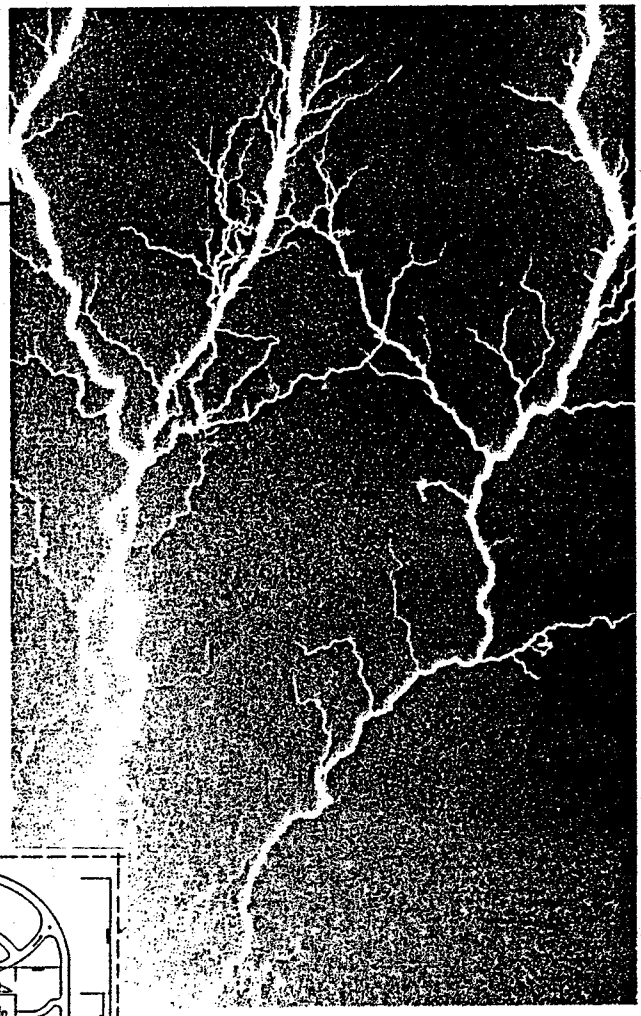
OF

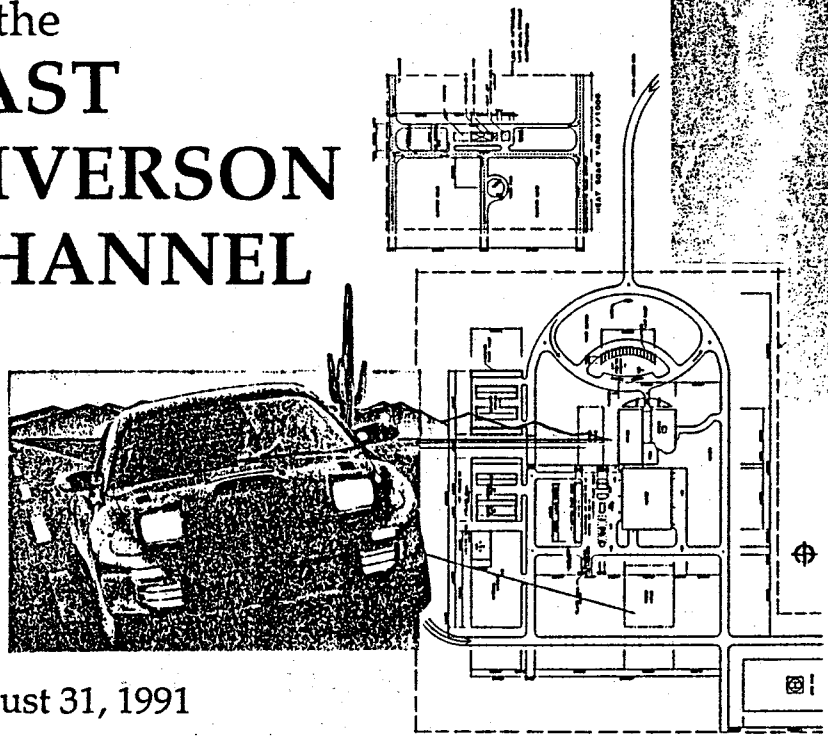
TAISEI/BECHTEL
JOINT VENTURE
TOYOTA ARIZONA
PROVING GROUNDS

HYDRAULIC & SEDIMENT TRANSPORT ANALYSIS

for the

EAST DIVERSON CHANNEL





August 31, 1991

In Association with

Sverdrup
CORPORATION

Registered Professional Engineer (Civil)
CERTIFICATE NO. 13088
FRED C. COREY
Date Signed 9/16/91
ARIZONA, U.S.A.

STANLEY
FRANZOY
COREY
ENGINEERING COMPANY

HYDRAULIC AND SEDIMENT TRANSPORT ANALYSIS FOR EAST DIVERSION CHANNEL

TOYOTA ARIZONA PROVING GROUNDS

SFC ENGINEERING COMPANY
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PHOENIX, ARIZONA 85044

August 31, 1991

PREFACE

This report was prepared by Robert L. Ward, P.E. in association with SFC Engineering Company and Sverdrup Corporation for the Taisei/Bechtel Joint Venture as part of the overall design of the Toyota Arizona Proving Grounds.

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ARIZONA, U.S.A.

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1 INTRODUCTION

The purpose of this report is to present the results of a hydraulic and sediment transport analysis that was performed to provide design recommendations for a drainage channel around the east end of the high-speed test track for the Toyota Arizona Proving Grounds Project. This project will be constructed by Taisei-Bechtel Joint Venture for the Toyota Technical Center, U.S.A., Inc.

Figure 1.1 shows the location of the proposed facility. This test facility is located approximately 15 miles south of Wickenburg, Arizona.

The natural drainage pattern through this area is predominantly north to south. The proposed drainage channel will intercept flows along the northeastern curve of the high-speed track and convey the flows to an existing natural watercourse just south of the proposed access road to the test facility.

The following sections of this report present a technical discussion of the engineering assumptions and methodologies used to develop the channel design recommendations. The channel design will be performed by the Sverdrup Corporation.

2 HYDROLOGY

All hydrologic modeling for this project was performed by Stanley-Franzoy-Corey Engineering Company (SFC). The Corps of Engineers HEC-1 computer program was used by SFC in performing this analysis. Details of the hydrologic modeling process are published in a separate report prepared by SFC.

Design discharges provided by SFC for the east diversion channel analysis are summarized in Table 2.1

For simplicity in the channel design, the peak discharge at Concentration Point 76C (1200 cfs) was also used at Concentration Points 76B and 76D.

Table 2.1
Peak Discharge Summary For East Diversion Channel
Toyota Arizona Proving Grounds

Concentration Point	Q_{100} (cfs)	Q_{10} (cfs)
76A	579	252
76B	1188	415
76C	1200	341
76D	1190	326
76H	5596	1595

3 HYDRAULICS

The hydraulic analysis for the east diversion channel was based on safely containing the entire 100-year flood at any point along the channel alignment.

Due to the braided, distributary drainage pattern through the site, it is impossible to accurately predict how much of the runoff from any of the HEC-1 sub-basins will actually enter the proposed channel at any given point along the channel alignment. In reality, the runoff from a 100-year event will probably be spread across a wide area, thus exhibiting characteristics of both overland and open channel flow.

It is quite possible that the reach of the diversion channel that parallels the natural drainage pattern (XSEC 418 to 478) may never receive 100 percent of the runoff from HEC-1 Concentration Point 76H, i.e., substantial portions of this flow will undoubtedly be carried by the small washs east of the proposed channel. However, to accommodate the worst-case scenario of a possible future shift in drainage pattern (either manmade or natural), the channel was designed to convey the entire 100-year peak discharge of 5596 cfs from XSEC 426 to the downstream end of the channel near XSEC 478.

The following subsections describe the assumptions that were used in the hydraulic analysis. The Corps of Engineers HEC-2 computer program was used to generate all water surface profiles for the channel design.

3.1 Channel Alignment

The proposed channel alignment, along with HEC-2 cross-section locations, is illustrated on Plate 1. The channel will initially intercept the southern flow of water near XSEC 374 and guide the water around the east side of the test track.

The proposed channel centerline is offset 250 feet from the high-speed test track centerline between XSEC 386 and XSEC 450. The remaining sections of the channel are aligned to tie into existing wash alignments. The channel improvements will terminate approximately 150 to 200 feet downstream of the access road near XSEC 478.

It is recommended that during final design, all channel curvature be based on high Froude Number (i.e., Fr≥0.86) flow criteria. Under such conditions, the minimum radius of curvature for the channel centerline should be computed with the following equation:

$$r_c = \frac{4V^2T}{gY_h} \quad \text{.....Eq. 3.1}$$

where r_c = radius of curvature for channel centerline (ft), not to be less than 4T

V = average flow velocity (fps)

T = channel topwidth at the water surface (ft)

Y_h = hydraulic depth of flow (ft)

Source: *City of Tucson Standards Manual For Drainage Design And Floodplain Management*, December 1989

Based on the sub-basin boundaries used for the SFC HEC-1 model, and a review of the site topography, the alignment shown on Plate 1 should insure that all intercepted floodwaters will be directed back to their natural drainage watercourse prior to leaving the property boundaries of the Toyota Arizona Proving Grounds facility.

3.2 Channel Profile

The proposed channel invert profile is illustrated on Figure 3.1. This Figure also shows the existing ground profile along the channel centerline.

The steepest slope that is possible between XSEC 374 and 478 is approximately 0.007659 ft/ft. An effort was made to utilize this slope as much as possible while still recognizing the economic consequences of not allowing cut sections to get excessively deep. Using this logic, the upstream end of the channel was

set at a slope of 0.004809 ft/ft between XSEC 374 and 414. Downstream of XSEC 414, the channel slope generally parallels the maximum allowable slope of 0.0076 (±) ft/ft.

In order to minimize deep channel cuts, and the associated high construction costs that would be required to provide bank protection within such cuts, four primary drop structures are proposed at XSECs 422, 425+25, 446, and 468+57. The drop heights vary from 2.0 to 3.0 feet.

Two additional grade control structures, located between XSECs 454 and 458 and XSECs 434 and 438, are also included as part of the channel design. Both of these structures, which will be buried so as to be flush with the proposed channel grade, are included as a safe-guard to prevent possible long-term undercutting of the channel bank-lining.

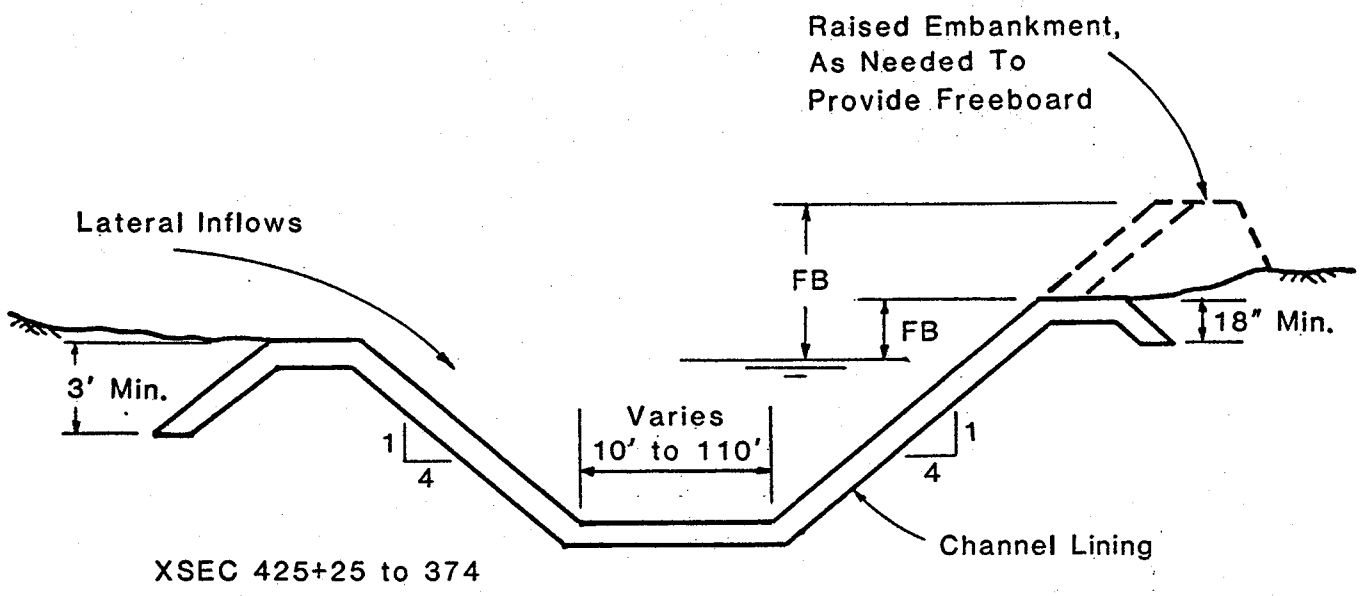
Each buried grade control structure should be designed as a drop structure, with the channel bank-lining extended to the bottom of a plunge pool. Section 4.3 presents a detailed discussion on the design of the plunge pools.

3.3 Channel Geometry

Channel cross-sections utilizing both 2:1 and 4:1 side-slopes were hydraulically analyzed for this project. Because of wildlife egress concerns, the Sverdrup Corporation elected to proceed with the channel design using a 4:1 side-slope.

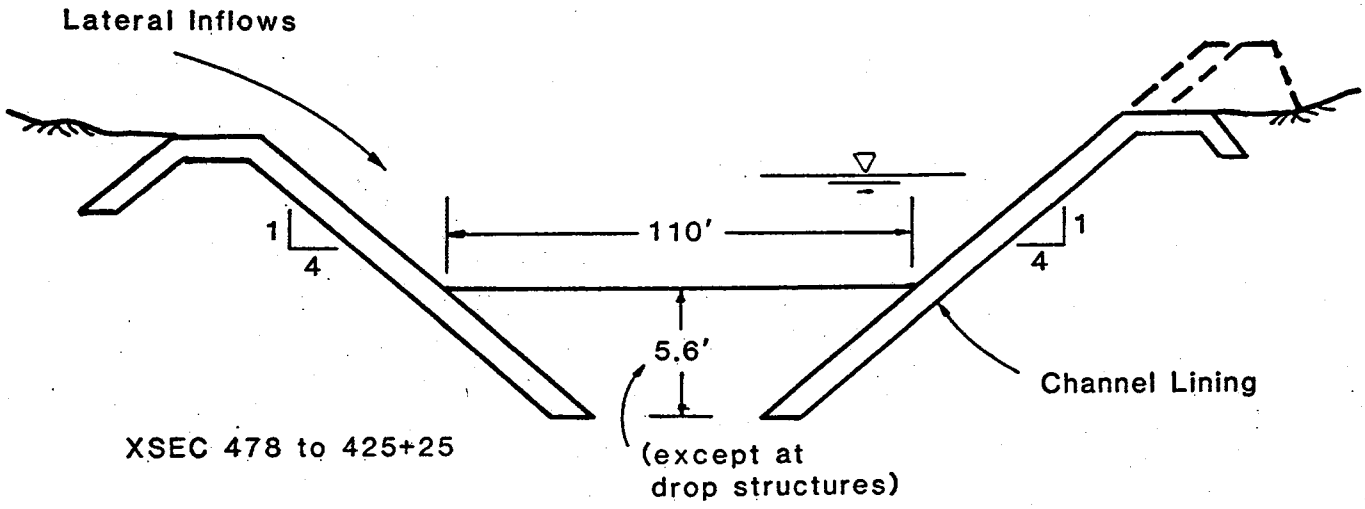
Figure 3.2 illustrates typical cross-sections that were used for the channel design. A fully lined channel, using a 10-foot bottomwidth, is proposed between XSEC 374 and 422. The 100-year discharge for this section varies from 579 cfs to 1200 cfs.

Between XSECs 422 and 425+25, the channel will transition to a 110 foot bottomwidth, while still retaining a fully lined cross-section. The 100-year discharge will increase from 1200 cfs to 5596 cfs through this transition. Full channel lining is used through this 325 foot transition as a more economical alternative to a high unit discharge energy dissipater below the drop at XSEC 422.



(Cross-Sections Oriented Looking Downstream)

NOT TO SCALE



Toyota Arizona Proving Grounds	
East Diversion Channel	
Typical Channel Cross-Sections	Figure 3.2

Downstream of the drop structure at XSEC 425+25, the channel will transition to a 110-foot bottomwidth with a natural earth bottom. Bank-lining will still be provided along the channel banks and will be extended 5.6 feet below grade to prevent undercutting by scour processes. A detailed discussion of the scour analysis is provided in Section 4.0 of this report.

Special attention should be given to the design of the bank-lining along the top of each bank. The north and east side of the diversion channel will be exposed to a constant occurrence of receiving substantial lateral inflows, as both sheetflow and flows from small washs are intercepted by the channel. In order to prevent such inflows from undercutting the top of the bank lining, and to also prevent the upstream propagation of headcuts resulting from bank erosion, it is very important that the north and east sides of the channel bank-lining be extended to the intersection with natural ground and that a cutoff wall be constructed along the top-of-bank. This cutoff wall should be extended a minimum of 3-feet below the top-of-bank, and should be designed with a sloping face that will cause lateral inflows to ride "up and over" the channel bank. A vertical cutoff wall should be avoided, since such a design could deflect water downward and under the bank-lining.

Although the westerly side of the channel bank (the bank adjacent to the high-speed test track) will only be exposed to receiving small amounts of local runoff that will accumulate between the test track and the channel, consideration should also be given to installing a cutoff wall along this bank as well. Due to the reduced magnitude of lateral inflows, the west cutoff wall could be less deep than the east wall. A cutoff wall depth of about 18 inches might be a reasonable dimension for the west side of the channel. An 18-inch minimum cutoff wall depth is in accordance with channel bank-lining criteria published in the City of Tucson Standards Manual For Drainage Design, December 1989. The typical cross-sections shown in Figure 3.2 illustrate this cutoff wall concept. Final design of this feature will be performed by the Sverdrup Corporation.

3.4 Channel Roughness

Multiple Manning's "n" values were used in the hydraulic analysis to reflect both the variation in channel cross-section and the potential for subcritical and supercritical flow. Average channel "n" values were computed for the different

cases using a channel perimeter-weighted procedure outlined in Open Channel Hydraulics, Chow, 1959. Specifically, the following equation was used to compute an equivalent roughness value for the channel cross-sections.

$$n = \frac{(P_1 n_1^2 + P_2 n_2^2 + \ldots + P_N n_N^2)^{1/2}}{P^{1/2}} \quad \text{.....Eq. 3.2}$$

where n = equivalent roughness value

P_N = sub-area perimeter

P = total wetted cross-section perimeter

The following base "n" values were used for the equivalent roughness calculations.

Table 3.1
Base "n" Values
Toyota Arizona Proving Grounds

	Flow Regime	
Channel Section	Subcritical	Supercritical
Soil-Cement Banks	0.023	0.016
Earth Bottom, With Small Brush & Weeds	0.045	0.025
Soil-Cement Bottom With Sand Deposits	0.035	0.016

Combining the assumptions in Table 3.1 with Equation 3.2 produced the following equivalent roughness values that were used in the HEC-2 models.

Table 3.2 Design "n" Values Toyota Arizona Proving Grounds		
	Flow Regime	
Channel XSEC	Subcritical	Supercritical
BW=10' z=4:1 Soil-Cement Banks & Bottom	0.023	0.016
BW=110" z=4:1 Soil-Cement Banks & Bottom	0.033	0.016
BW=110" z=4:1 Soil-Cement Banks & Earth Bottom	0.045	0.025

3.5 Water Surface Profiles

Both subcritical and supercritical profiles were developed for the proposed drainage channel. Channel capacity and freeboard dimensions were based on the subcritical profile for the 100-year event, while sediment transport and scour analyses were based on the supercritical profile for both the 100-year and 10-year events.

The channel alignment was divided into five reaches, each reach being separated by a drop structure. An independent HEC-2 model was developed for each reach. For the subcritical profiles, each model was run with a starting assumption of critical depth at each drop structure. The furthermost downstream reach (XSEC 506 to XSEC 468+57) was modeled with a starting condition based on the natural ground slope at XSEC 506.

Table 3.3 summarizes the pertinent data for each channel reach and the subcritical, 100-year water surface profile elevations.

Table 3.3

Toyota Arizona Proving Grounds

Summary Of Water Surface Elevations For East Diversion Channel

100-Year Event, Subcritical, All Flow Confined To Channel

XSEC	Q (cfs)	Channel Side-Slope	Channel Bottomwidth (ft)	Channel Invert Elevation (ft, MSL)	CWSEL (ft, MSL)	Centerline Distance To Downstream XSEC (ft)	Channel Centerline Location
478	5596	4:1	110	1658.30	1664.74	N/A	(see map)
474	5596	4:1	110	1662.52	1667.95	415	(see map)
470	5596	4:1	110	1665.70	1670.72	419	(see map)
468+57	5596	4:1	110	1666.79	1671.86	143	(see map)
468+57	5596	4:1	110	1668.80	1672.88	Drop	
466	5596	4:1	110	1670.80	1676.26	259	(see map)
462	5596	4:1	110	1673.80	1678.81	392	(see map)
458	5596	4:1	110	1676.70	1681.80	378	(see map)
454	5596	4:1	110	1679.80	1684.86	402	(see map)
450	5596	4:1	110	1683.00	1688.10	421	250' Offset
446	5596	4:1	110	1686.20	1691.29	421	250' Offset
446	5596	4:1	110	1689.20	1693.29	Drop	250' Offset
442	5596	4:1	110	1692.40	1697.99	421	250' Offset
438	5596	4:1	110	1695.60	1700.58	421	250' Offset
434	5596	4:1	110	1698.90	1703.97	421	250' Offset
430	5596	4:1	110	1702.10	1707.20	421	250' Offset
426	5596	4:1	110	1705.30	1710.38	421	250' Offset
425+25	5596	4:1	110	1706.03	1711.11	96	250' Offset
425+25	5596	4:1	110	1709.03	1713.12	Drop	250' Offset
422	1200	4:1	10	1711.50	1716.09	325	250' Offset
422	1200	4:1	10	1713.90	1718.41	Drop	250' Offset
418	1200	4:1	10	1717.10	1721.62	421	250' Offset
414	1200	4:1	10	1720.40	1724.91	421	250' Offset
410	1200	4:1	10	1722.40	1727.67	421	250' Offset
406	1200	4:1	10	1724.40	1729.32	421	250' Offset
402	1200	4:1	10	1726.50	1731.43	421	250' Offset
398	1200	4:1	10	1728.50	1733.51	421	250' Offset
394	1200	4:1	10	1730.50	1735.48	421	250' Offset
390	1200	4:1	10	1732.50	1737.49	421	250' Offset
386	1200	4:1	10	1734.60	1739.51	421	250' Offset
382	1200	4:1	10	1736.40	1741.43	380	(see map)
378	579	4:1	10	1738.40	1743.32	414	(see map)
374	579	4:1	10	1740.30	1743.83	397	(see map)
File: TOYS4.WK1					Total Length:	10,756	

It should be noted that consideration was given to the submergence effect that tailwater conditions will create at each of the drop structures. A supplemental analysis was performed to identify whether the tailwater submergence would invalidate the assumption of critical depth at each drop structure.

This analysis revealed that each drop was submerged to a depth less than critical depth. Accordingly, this fact alone lends credibility to the starting assumption of critical depth at each drop.

However, an additional analysis was also performed to further support this assumption. This additional analysis involved the computation of a friction slope over each drop. This slope was computed as the difference between the energy gradeline at the upstream and downstream side of each drop divided by an assumed transition length of 100 feet. These computed friction slopes were input to the HEC-2 models and the models were rerun with the slope-area option used for the starting condition. In all cases the computed friction slopes caused the models to assume critical depth at each drop structure location. Based on this supplemental analysis, an assumed starting condition of critical depth at each drop structure appears reasonable and justified.

Appendices A and B contain a complete set of HEC-2 input/output files for both subcritical and supercritical flow conditions, respectively.

3.6 Channel Freeboard

Channel freeboard is defined as the additional channel depth extending from the design water surface elevation to the top of the channel bank. Freeboard provides a safety factor for variations in the assumed hydrologic and hydraulic design assumptions, as well as for containment of wave action associated with flowing water.

For this specific project, additional freeboard should also be considered for the downslope (south/southwest) bank to provide a safe-guard against overtopping due to long-term aggradation between XSEC 422 and 374. Freeboard along the upslope (north/northeast) side of the channel is not required, since this side of the channel will be designed to receive lateral inflows.

It is recommended that a minimum freeboard dimension of 2.0 feet be added to the subcritical 100-year water surface elevations between XSEC 478 and the downstream side of the drop structure at XSEC 422. This dimension (2.0 ft) conforms to freeboard criteria published by the Flood Control District of Maricopa County (FCDMC) for supercritical channels. Depending on the degree of channel vegetation that may ultimately become established, the east diversion channel has the potential to flow supercritical.

Freeboard calculations based on 25 percent of the specific energy in this channel yield freeboard values of 1.5 to 1.7 feet (encompasses both subcritical and supercritical specific energy values). Accordingly, a dimension of 2.0 feet exceeds the specific energy criteria published by FCDMC.

The potential for long-term aggradation creates an additional hazard upstream of XSEC 422. Some of the channel sections in this reach will require a levee to contain the 100-year water surface elevation. Accordingly, FEMA freeboard criteria for levees should be used as an absolute minimum guideline. This minimum criteria should be supplemented with additional freeboard to account for the aggradation potential. Minimum FEMA criteria requires 3.0 feet of freeboard plus an additional 0.5 feet of freeboard at the upstream end of the levee, tapering to 0.0 additional feet at the downstream end of the levee.

It is recommended that a minimum of 1.0 additional foot of freeboard be added to the minimum FEMA criteria. There may be specific locations identified during final design where additional freeboard is required beyond these minimum recommendations. Additional freeboard should be based on the amount of hydraulic capacity remaining below the levee crest if the channel were to be filled with sediment. This approach acknowledges the potential for the overbank area to be an effective flow conveyance system should channel capacity be lost to sediment deposition.

It is recommended that the downslope bank-lining material (bank adjacent to the test track) be extended to the top of the freeboard dimension.

4 SEDIMENT TRANSPORT & SCOUR ANALYSIS

The arid landscapes of the southwest deserts are notorious sediment producers. The typically cohesionless soils of the desert, sparse vegetation, and high intensity rainfall cause large amounts of sediment to be moved through the washes, arroyos, and rivers of the southwest.

There is a continual, dynamic interaction between sediment particles and the transporting medium, water. As water moves sediment through a drainage system, there is a constant struggle to achieve a state of equilibrium, or balance, between sediment supply and sediment transport capacity. In seeking this balance, the drainage system is in a continual mode of change as both vertical and horizontal adjustments are made to the channel boundaries of the system's watercourses. Failure to anticipate, quantify and design for these adjustments can lead to serious damage and/or a poorly functioning flood control system.

A sediment transport analysis was conducted for this project in order to examine the potential for aggradation through the fully lined sections of channel, and to examine the scour potential for that section of channel with an earth bottom. The following sub-sections address the potential for both single-event bed scour and long-term bed-slope adjustments.

4.1 Scour Analysis

The design of a bank protection system must consider the potential for scour of the channel bed. Failure to do so could lead to the toe of the bank protection material being undercut by scour processes that will be induced by flowing water. Should this situation occur, the bank lining material may collapse into the scour hole, thus exposing the bank to erosive velocities and possible lateral movement.

Vertical incisement of the channel bed can occur in response to the following six processes:

$$\Delta Z_{TOT} = \Delta Z_{DEG} + \Delta Z_{LS} + \Delta Z_{GS} + \Delta Z_{BS} + \Delta Z_{I} + \Delta Z_{AD} \ldots\ldots\ldots \text{Eq. 4.1}$$

where ΔZ_{TOT} = total vertical adjustment in bed elevation

ΔZ_{DEG} = vertical change due to long-term degradation

ΔZ_{LS} = vertical change due to local scour

ΔZ_{GS} = vertical change due to general scour

ΔZ_{BS} = vertical change due to bend scour

ΔZ_{l} = vertical due to low-flow incisement

ΔZ_{AD} = vertical change due to antidune troughs

A brief discussion of each of these phenomena, and its applicability to this project, is presented in the following paragraphs.

1. Long-Term Degradation - This process occurs over a long period of time in response to an imbalance between the sediment transport capacity of the channel and the dominant sediment supply to the channel. When such imbalances occur, the channel will naturally adjust its slope to restore equilibrium between the transport capacity and incoming supply of sediment. If the transport capacity of the channel exceeds the sediment supply, the channel will flatten its slope (degrade). However, should the sediment supply exceed the transport capacity of the channel, the channel slope will increase (aggrade) in order to generate higher velocities that are capable of moving the sediment inflows.

   Long-term degradation is very difficult to quantify because of the many complex variables that drive this process. Accordingly, numerous assumptions have to be made on the basis of engineering judgement. An equilibrium slope analysis has been conducted in an effort to establish an approximate envelope of long-term aggradation/degradation for the proposed flood control channel. A detailed discussion that analysis, along with computational results, are presented in Section 4.2.

2. Local Scour - Local scour will occur in response to objects being placed in the path of flowing water. The most common form of local scour is that occurring at bridge piers and protruding bridge abutments or spur dikes. This process will not be applicable to the channel reaches discussed in this report due to the absence of bridge piers and spur dikes. However, a form of local scour will occur in the plunge pools below the proposed drop structures. Drop structure scour is discussed in Section 4.3.

3. General Scour - This scour process occurs in response to changes in channel geometry from one reach of a channel to the next. As a channel contracts and expands, its flow velocity (and thus sediment transport capacity) will change. General scour will occur when a channel contracts (in the downstream direction) and causes an increase in velocity through the contracted section. The increase in sediment transport capacity through the contracted reach will begin to remove more sediment from the bed of the contracted reach than is being delivered to the contraction by the wider, upstream reach. The result is a lowering (general scour) of the channel bed through the contracted reach. When the channel geometry expands in the downstream direction, the opposite effect can occur, i.e., sediment deposition will take place in the wider channel section.

General scour, and/or sediment deposition is usually quantified with a mobile-boundary sediment routing model. Such models are capable of predicting scour and deposition patterns as a function of bed-material size, channel geometry, and changes in discharge that occur during passage of a specific flood hydrograph.

Unless changes in channel geometry are extreme, typical values of general scour are usually in the 0.5 to 2.0 feet range.

Only one change in channel geometry occurs in the proposed drainage channel between XSEC 422 and 425+25. This change involves a channel expansion, but also an assumed increase in peak discharge through the expansion. Based on a simple comparison of the sediment transport rates between XSEC 422 and 425+25, substantial general scour would be predicted. However, in actuality, the large increase in channel discharge will undoubtedly be accompanied by large lateral sediment inflows which will supplement the sediment being delivered by the 10 foot wide upstream channel. These supplementary sediment inflows will tend to diminish the potential for general scour. The reader will recall from Section 3.3 of this report that the channel transition between XSECs 422 and 425+25 will have a lined bottom, thus eliminating any potential for scour.

The complexity of this problem (primarily due to uncertainty about specific inflow rates and locations of inflow) prohibits an accurate quantitative assessment of general scour. For design purposes, a 1.5 foot depth of general scour was assumed for all channel reaches downstream of XSEC 425+25.

4. Bend Scour - As the name implies, this process only occurs in the vicinity of channel curvature. The radii of curvature used for the proposed channel are not sufficiently short to induce measurable bend scour.

5. Low-Flow Incisement - Manmade channels with large width to depth ratios are very vulnerable to the formation of low-flow channels. When trapezoidal channels, designed to carry large events such as the 100-year flood, are exposed to smaller, more frequent flows (2 to 5 year floods), the wide channel bottomwidths may cause a shallow sheetflow condition to exist. Rather than transporting these smaller flows in this manner, the channel will develop a low-flow channel that provides a more efficient conveyance of these small discharges.

   Low-flow channels will meander across the bottom of the larger, parent channel, thus randomly coming into contact with the channel bank. Accordingly, it is important to acknowledge low-flow incisement when computing the total scour depth for bank-lining design. For the purpose of this study, 1-foot of low-flow incisement is included in the total scour depth for use in the bank-lining toedown dimension.

6. Antidune Troughs - Sand bed channels are prone to the development of transitory bedforms, such as dunes and antidunes. Such bedforms create troughs, or depressions, below the natural bed of the channel during the flow event. In order to account for the possibility of these troughs forming adjacent to the toe of the bank, it is prudent to include bedform troughs in the estimate of total scour. Based on laboratory flume studies, the maximum depth of these troughs (below the existing channel bed) is approximately equal to $0.0135V^2$ or one-half the depth of flow, whichever value is less. Obviously, this scour process will only be applicable to the earth-bottom section of channel downstream of XSEC 425+25.

Table 4.1 presents a summary of the scour processes and recommended scour depths that should be applied to the bank-lining downstream of XSEC 425+25. Scour depths are not applicable upstream of XSEC 425+25 because that section of channel will be fully lined with soil-cement or concrete. For ease of design and construction staking, a constant toedown depth of 5.6 feet is recommended, except in the vicinity of the drop structures. It should be noted that the total scour depths include a safety factor of 1.3.

4.2 Equilibrium Slope Analysis

Sediment transport analyses need to distinguish between short-term and long-term changes. Short- term changes are event-specific and occur to some extent during each flood hydrograph. Referring to the preceding section, examples of short-term changes would be local scour, general scour, bend scour, bedform troughs, and to some extent, low-flow incisement. With the exception of low-flow incisement, any visible signs of these processes may be difficult to detect after the flow has subsided.

As discussed in the preceding section, short-term scour processes can usually be quantified with empirical and/or theoretical relationships. With the aid of the computer, general scour is frequently evaluated with mobile boundary, sediment routing models.

Precise prediction of long-term channel impacts can be much more elusive than their short-term counterparts because of the time-span involved and the numerous variables that impact long-term changes. Since lateral erosion of the channel banks will be controlled by the application of soil-cement (or a similar bank stabilization product), this study will only investigate the potential for long-term vertical movement of the channel bed. This analysis will employ the concept of equilibrium slope to determine the long-term trend for aggradation or degradation of the channel bed.

Equilibrium slope is defined as the slope at which the sediment transport capacity of the channel is equal to the dominant, incoming sediment supply. When these two quantities are equal, the channel bed will neither aggrade nor degrade. However, if the incoming sediment supply is greater than the transport capacity of the channel, aggradation will occur, as the channel attempts to steepen its slope to generate a higher flow velocity (and resulting sediment transport rate).

Table 4.1
Toyota Arizona Proving Grounds
Scour Analysis For East Diversion Channel
Supercritical Flow, 100-Year Event

Channel Side-slope: 4
Channel "n": 0.025
Gradation Coefficient: 5.7
Bed-Material D50 (mm): 2.4
Superelevation Coefficient: 1.15

Note: Unit sediment transport rates computed with Equation 4.1

Channel Cross-Section	Discharge (cfs)	Channel Bottomwidth (ft)	Flow Depth (ft)	Channel Velocity (fps)	Energy Slope (ft/ft)	Channel Area (sf)	Channel Topwidth (ft)	Radius Of Curvature (ft)	Estimated Alpha	Hydraulic Depth (ft)	Unit Sediment Transport Rate (cfs/ft)	Total Sediment Transport Rate (cfs)	Allocated General Scour (ft)	Bend Scour (ft)	Allocated Low-Flow Incisement (ft)	Antidune Troughs (ft)	Scour Safety Factor	Total Scour Depth (ft)	Superelevation (ft)
425+25	5596	110	3.64	12.34	0.0076	453.4	139.12	5250	5	3.26	0.3638	40.01	1.50	0.00	1.00	1.82	1.3	5.62	0.14
426	5596	110	3.63	12.36	0.0076	452.0	139.04	5250	5	3.25	0.3666	40.33	1.50	0.00	1.00	1.82	1.3	5.61	0.14
430	5596	110	3.65	12.30	0.0075	454.8	139.20	5250	5	3.27	0.3584	39.42	1.50	0.00	1.00	1.83	1.3	5.62	0.14
434	5596	110	3.62	12.36	0.0077	450.6	138.96	5250	5	3.24	0.3669	40.36	1.50	0.00	1.00	1.81	1.3	5.60	0.14
438	5596	110	3.59	12.49	0.0079	446.5	138.72	5250	5	3.22	0.3848	42.33	1.50	0.00	1.00	1.80	1.3	5.58	0.15
442	5596	110	3.69	12.16	0.0073	460.4	139.52	5250	5	3.30	0.3400	37.40	1.50	0.00	1.00	1.85	1.3	5.65	0.14
446	5596	110	3.62	12.41	0.0078	450.6	138.96	5250	5	3.24	0.3734	41.07	1.50	0.00	1.00	1.81	1.3	5.60	0.15
446	5596	110	3.63	12.37	0.0077	452.0	139.04	5250	5	3.25	0.3679	40.47	1.50	0.00	1.00	1.82	1.3	5.61	0.14
450	5596	110	3.65	12.30	0.0075	454.8	139.20	5250	5	3.27	0.3584	39.42	1.50	0.00	1.00	1.83	1.3	5.62	0.14
454	5596	110	3.63	12.37	0.0077	452.0	139.04	0	0	3.25	0.3679	40.47	1.50	0.00	1.00	1.82	1.3	5.61	N/A
458	5596	110	3.62	12.40	0.0077	450.6	138.96	0	0	3.24	0.3721	40.93	1.50	0.00	1.00	1.81	1.3	5.60	N/A
462	5596	110	3.64	12.33	0.0076	453.4	139.12	0	0	3.26	0.3625	39.87	1.50	0.00	1.00	1.82	1.3	5.62	N/A
466	5596	110	3.63	12.37	0.0077	452.0	139.04	0	0	3.25	0.3679	40.47	1.50	0.00	1.00	1.82	1.3	5.61	N/A
468+57	5596	110	3.63	12.39	0.0077	452.0	139.04	0	0	3.25	0.3705	40.75	1.50	0.00	1.00	1.82	1.3	5.61	N/A
468+57	5596	110	3.64	12.35	0.0076	453.4	139.12	0	0	3.26	0.3650	40.15	1.50	0.00	1.00	1.82	1.3	5.62	N/A
470	5596	110	3.66	12.28	0.0075	456.2	139.28	0	0	3.28	0.3556	39.11	1.50	0.00	1.00	1.83	1.3	5.63	N/A
474	5596	110	3.63	12.38	0.0077	452.0	139.04	0	0	3.25	0.3692	40.61	1.50	0.00	1.00	1.82	1.3	5.61	N/A
478	5596	110	3.92	11.37	0.0059	492.7	141.36	0	0	3.49	0.2498	27.48	1.50	0.00	1.00	1.75	1.3	5.52	N/A
482	5596	305	6.02	8.51	0.0145	657.7	304.75	0	0	2.16	0.0628	19.16	1.50	0.00	1.00	0.98	1.3	4.52	N/A
486	5596	397	5.37	7.57	0.0139	739.1	396.59	0	0	1.86	0.0392	15.56	1.50	0.00	1.00	0.77	1.3	4.26	N/A

File: TYSC5.WK1

Conversely, if the sediment supply is less than the channel transport rate, the channel bed will degrade in order to flatten its slope, resulting in a lower flow velocity and lower sediment transport rate. Ideally, flood control channels should be designed on the basis of this equilibrium slope.

An equilibrium slope analysis was considered important to this study to determine whether the selected channel geometries, roughness values, and available ground slopes could combine to move the dominant sediment loads through the system, without causing any major long-term deposition or degradation Should deposition occur, the channel capacity might be jeopardized, while degradation could lead to undercutting of the bank lining.

The first step in an equilibrium slope analysis is to determine the sediment supply to the channel. For ephemeral channels, the 5- to 10-year event is considered the dominant discharge most responsible for affecting long-term changes to the channel. The 10-year event was selected for use in this study. Accordingly, the sediment inflows used in the equilibrium slope analysis are based on the 10-year discharge.

The sediment inflows computed for use in this analysis are based on a key assumption that the upstream washes are in a state of equilibrium. This is considered a reasonable assumption since the watershed is not presently developed to the extent that the natural supply of sediment is significantly disrupted.

A second basic assumption of the equilibrium slope analysis is that the sediment supply used to determine equilibrium conditions for a specific channel reach is equal to the total supply of all sediment being delivered to that reach. This assumes that all sources of sediment inflow to a reach are at an equilibrium condition. This assumption simplifies the calculation of sediment inflows because it allows the use of the existing watercourse slopes to compute the hydraulic parameters and sediment transport rates of all incoming washes.

The equilibrium slope analysis utilized the following equation (Zeller-Fullerton, 1983) to compute both the sediment inflows (i.e., sediment supply) and the sediment transport rate of the proposed channels.

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}} \quad \text{.....Eq 4.1}$$

where q_s = unit transport rate of bed-material load (cfs/ft)

n = Manning's "n" value

V = average channel velocity (fps)

G = gradation coefficient of bed-material

Y_h = hydraulic depth of flow (ft)

D_{50} = median diameter of bed-material particles (mm)

This equation is based on a regression analysis of hydraulic and sediment transport data for sand-bed channels in arid regions. The listed regression limits for D_{50} are 0.5 to 10.0 mm.

Bed-material data used for this study were taken from five sediment samples located in the general vicinity of the proposed channel. Each sample location was in a natural wash. Based on a review of the gradation curves for these five samples, a D_{50} of 2.4 mm, and gradation coefficient of 5.7, were selected for use in the equilibrium slope analysis. These values, which are typical of sand-bed channels, were used for both the sediment supply calculations and the sediment transport rates through the proposed flood control channel.

Due to the nature of the wide, braided, distributary drainage pattern that will be intercepted by the proposed channel, the quantification of the upstream sediment supply is very difficult. Based on a review of the 1"=400' topographic map of the project area, normal depth hydraulic calculations were performed for <u>eight</u> of the most prominent washs that will be intercepted by the proposed channel between XSEC 374 and XSEC 446. It was assumed that the majority of the bed-material sediments delivered to the new channel would come from these washs. Although there may be substantial overland flow intercepted by the channel, the fine sediments that would be carried by such low velocity flow would be considered wash load, and therefore, not influential on the long-term bed-slope of the proposed channel.

Using the normal depth hydraulic parameters for these eight washs, Equation 4.1 was used to compute the sediment transport rate of each wash for both 100 percent and 60 percent of the predicted 10-year peak discharge for the HEC-1 sub-basins within which each wash was located. Since some sub-basins contained more than one of the eight selected washs, judgement was used to distribute the total 10-year discharge among the multiple washs.

The 60 percent ratio was applied to the discharges to set a lower limit of sediment supply that acknowledges the potential for significant portions of runoff (40% assumed for this project) to be conveyed as non-bed-material transporting overland flow. The 100 percent ratio assumes all runoff is transported within the eight selected washs, thus establishing an assumed upper limit for sediment supply.

As one proceeds downstream along the channel alignment, the sediment supply increases as more washs are being intercepted. Table 4.2 summarizes the computed sediment supply rates that were computed for the eight washs. The sediment supply ranges from 0.56 cfs at the upstream end of the channel (XSEC 374) to a maximum value of 4.15 cfs at XSEC 446. The sediment supply rates are listed under the column titled "Target Q_s" in Table 4.2. The 10-year channel discharge, corresponding to the listed sediment supply values, is also listed in Table 4.2.

The purpose of Table 4.2 is to list the equilibrium slopes and associated hydraulic parameters that were used to compute the sediment transport capacity of the channel for the different discharges being conveyed by the channel. All hydraulic calculations in Table 4.2 are based on normal depth assumptions. The equilibrium slope for each set of channel geometry was adjusted until the computed sediment transport capacity of the channel was approximately equal to the sediment supply ("Target Q_s"). Both subcritical and supercritical "n" values were used in this analysis in order to examine a broad envelope of equilibrium slope scenarios.

Table 4.3 provides a more meaningful summary of the equilibrium slope analysis by cross-referencing discharge, sediment supply, channel bottomwidth, design slope, equilibrium slope envelope, and predicted long-term trend to specific channel cross-sections. The information in Table 4.3 is plotted on Figure 3.1 in order to provide a visual representation of the impact that the equilibrium slope envelopes might have on the channel profile.

Table 4.2
Toyota Arizona Proving Grounds
Summary of Sediment Supply Rates & Equilibrium Slope Calculations
East Diversion Channel
10-Year Event

File: TOYBQ.WK1

D50 Sediment Size (mm): 2.40
Sediment Gradation Coefficient: 5.70

10-Year Discharge (cfs)	Equilibrium Bed Slope (ft/ft)	Manning's Roughness	Horizontal Component of Side-slope	Flow Depth (ft)	Bottom Width (ft)	Velocity (fps)	Froude Number	Hydraulic Depth (ft)	Sediment Transport Capacity (cfs)	Target Qs (cfs)
252	0.0066	0.016	4.00	1.74	10.0	8.57	1.36	1.23	0.55	0.56
252	0.0102	0.016	4.00	1.55	10.0	10.02	1.67	1.12	1.11	1.10
252	0.0120	0.030	4.00	2.05	10.0	6.75	1.00	1.41	0.57	0.56
252	0.0180	0.030	4.00	1.85	10.0	7.82	1.21	1.30	1.10	1.10
341	0.0090	0.016	4.00	1.87	10.0	10.42	1.60	1.31	1.25	1.27
341	0.0137	0.016	4.00	1.68	10.0	12.13	1.95	1.20	2.48	2.47
341	0.0160	0.030	4.00	2.22	10.0	8.14	1.17	1.51	1.26	1.27
341	0.0243	0.030	4.00	2.00	10.0	9.47	1.42	1.38	2.48	2.47
341	0.0112	0.016	4.00	1.77	10.0	11.28	1.78	1.25	1.79	1.78
341	0.0165	0.016	4.00	1.60	10.0	12.96	2.13	1.15	3.34	3.36
341	0.0198	0.030	4.00	2.10	10.0	8.80	1.29	1.44	1.78	1.78
341	0.0292	0.030	4.00	1.91	10.0	10.13	1.55	1.33	3.35	3.36
1,595	0.0034	0.023	4.00	2.21	110.0	6.07	0.75	2.06	2.22	2.23
1,595	0.0052	0.023	4.00	1.95	110.0	6.95	0.91	1.83	4.11	4.15
1,595	0.0054	0.041	4.00	2.71	110.0	4.87	0.54	2.49	2.25	2.23
1,595	0.0082	0.041	4.00	2.40	110.0	5.57	0.66	2.22	4.14	4.15

Table 4.3
Toyota Arizona Proving Grounds
Summary of Equilibrium Slope Analysis
East Diversion Channel
10-Year Event

HEC-2 XSEC	Q10 (cfs)	Sediment Supply (cfs)	Channel BW (ft)	Slope (ft/ft) Design	Slope (ft/ft) Equilibrium	Predicted Long-Term Trend
374	252	0.56 to 1.10	10	0.004809	.0066 to .0180	Aggradation
378	252	0.56 to 1.10	10	0.004809	.0066 to .0180	Aggradation
382	341	1.27 to 2.47	10	0.004809	.0090 to .0243	Aggradation
386	341	1.27 to 2.47	10	0.004809	.0090 to .0243	Aggradation
390	341	1.27 to 2.47	10	0.004809	.0090 to .0243	Aggradation
394	341	1.27 to 2.47	10	0.004809	.0090 to .0243	Aggradation
398	341	1.78 to 3.36	10	0.004809	.0112 to .0292	Aggradation
402	341	1.78 to 3.36	10	0.004809	.0112 to .0292	Aggradation
406	341	1.78 to 3.36	10	0.004809	.0112 to .0292	Aggradation
410	341	1.78 to 3.36	10	0.004809	.0112 to .0292	Aggradation
414	341	1.78 to 3.36	10	0.004809	.0112 to .0292	Aggradation
418	341	1.78 to 3.36	10	0.007720	.0112 to .0292	Aggradation
422	341	1.78 to 3.36	10	0.007720	.0112 to .0292	Aggradation
422	341	1.78 to 3.36	10	0.007600	.0112 to .0292	Aggradation
425+25	1,595	2.23 to 4.15	110	0.007600	.0034 to .0082	Aggradation to Stable to Degradation
425+25	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
426	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
430	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
434	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
438	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
442	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
446	1595	2.23 to 4.15	110	0.007647	.0034 to .0082	Aggradation to Stable to Degradation
446	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
450	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
454	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
458	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
462	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
466	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
468+57	1595	2.23 to 4.15	110	0.007655	.0034 to .0082	Aggradation to Stable to Degradation
468+57	1595	2.23 to 4.15	110	0.007600	.0034 to .0082	Aggradation to Stable to Degradation
470	1595	2.23 to 4.15	110	0.007600	.0034 to .0082	Aggradation to Stable to Degradation
474	1595	2.23 to 4.15	110	0.007600	.0034 to .0082	Aggradation to Stable to Degradation
478	1595	2.23 to 4.15	110	0.007600	.0034 to .0082	Aggradation to Stable to Degradation

File: BQSUMTOY.WK1

The results of the equilibrium slope analysis indicate a potential for aggradation at all channel locations upstream of XSEC 422. This is a fully-lined section of channel with a 10-foot bottomwidth.

Downstream of XSEC 425+25, the channel is designed with a 110-foot wide earth bottom. Bed-slopes through this reach of channel are within the computed equilibrium slope envelope. However, the equilibrium slope calculations indicate this reach of channel may exhibit a dominant tendency for degradation, although under certain assumptions, the channel could experience slight aggradation, or be completely stable.

The aggradation potential upstream of XSEC 422 should be monitored through periodic channel inspections. Should substantial aggradation begin to occur, the channel should be cleaned (excavated) and the sediments uniformly deposited in the channel downstream of XSEC 425+25.

The aggradation potential downstream of XSEC 422 does not appear to be serious enough to warrant concern. The bank-lining toedown and drop structure dimensions are extended sufficiently deep to prevent undercutting by the worst-case assumption for long-term degradation.

In reviewing the profiles on Figure 3.1, it is clear that should the estimated worst-case scenario of long-term degradation occur, some short reaches of the channel will be left with only about 1.2 feet of residual bank-lining toedown. Based on risk assessment and economic factors, this residual dimension is considered acceptable. The logic used to support acceptance of this value is discussed as follows:

1. The channel reaches exposed to a residual toedown dimension of 1.2 feet are all reaches of uniform cross-section receiving assumed constant water and sediment discharges. Accordingly, the potential for general scour is theoretically zero.

2. With the dramatically reduced bed-slope that accompanies long-term degradation, the channel velocities will be greatly reduced, thus reducing the magnitude of bed-form troughs. At a slope of 0.0034 ft/ft and n=0.035, the average channel velocity will be reduced to 7.72 fps (based on a degraded channel bottomwidth of 72.4 feet, i.e.,

4.7 feet of vertical degradation). This velocity produces an antidune trough depth of 0.80 feet, which is less than the 1.2 feet of residual toedown.

3. Low-flow incisement will probably be reflected in the degraded bed-slope. Accordingly, the remaining magnitude of this phenomenon should be sufficiently small to warrant no serous concern.

4. The worst-case scenario of long-term degradation may never occur. An examination of Figure 3.1 indicates that there is a possibility that no degradation will occur. Accordingly, one can conclude that there is minimal risk of ever experiencing the estimated worst-case scenario. This risk would seem acceptable when considered in conjunction with the increased construction costs required to extend the bank-lining toedown beyond the recommended limits shown on Figure 3.1.

5. The Sverdrup Corporation has indicated an intent to use soil-cement for bank-lining purposes. Unlike loose rock riprap, the rigidity and durability of soil-cement will reduce the risk of a bank failure should minor, temporary undercutting occur.

6. As the name implies, long-term degradation is not a single-event phenomenon, i.e., it occurs over a long period of time. The time period will be directly related to the number and magnitude of flow events that the channel will experience. In low-rainfall, semiarid environments, such as Arizona, it is logical to conclude that long-term degradation will take many years to develop. Accordingly, there will be ample time to monitor the progression of such a phenomenon and take corrective action before the channel would sustain any damage. Should degradation prove to be more severe than anticipated, an obvious "fix" would be to install additional drop/grade control structures to stabilize the channel profile. This could easily be done at any time in the future.

Certainly, the design recommendations regarding the treatment of potential long-term degradation require substantial engineering judgement, both in the calculation of equilibrium slopes and in an assessment of the results of such

calculations. It is the author's opinion that the recommended design presents a practical combination of risk assessment, economics, and an ongoing inspection and maintenance program.

Some concluding comments are warranted regarding the interpretation and use of the equilibrium slope analysis. First of all, it should be emphasized that an equilibrium slope develops over a long period of time, in response to a wide range of flow conditions which, for calculation purposes, is simulated by the use of a single, dominant discharge. The actual bed-slope of the channel will probably oscillate around this theoretical equilibrium slope in response to the large variation in flood hydrographs that the channel will be exposed to over a long period of time. However, if the channel is designed within an equilibrium slope envelope, these oscillations should be minimized.

The numerous and complex assumptions required for an equilibrium slope analysis require that the computed slopes be viewed as possibly lying within a large confidence band, i.e., reasonable changes in a few key assumptions might produce a dramatic impact on the computed equilibrium slope. As a result, equilibrium slope calculations should not be viewed as a precise design parameter. However, they do provide an important tool in helping the engineer to design a channel that should provide much more stable performance than one which totally ignores the importance of sediment transport.

4.3 Drop Structure Scour

As discussed previously, the proposed channel design includes four exposed drop structures plus two additional buried grade control/drop structures as a safe-guard against long-term degradation. Although the design of these drop structures will be performed by the Sverdrup Corporation, guidance is included in this report on the estimated scour depths that could be expected to occur in the plunge pool at the base of each drop. The drop structures could be designed to withstand this plunge pool scour or some type of concrete or rock riprap stilling basin could be designed to prevent the scour.

In the absence of any type of erosion resistant stilling basin, Table 4.4 summarizes the scour depths and lengths that could be expected below each of the four exposed drop structures.

Scour depths for an unsubmerged overfall were computed with the Veronese Equation (Design of Small Dams, Bureau of Reclamation, 1977) as modified for use in the City of Tucson Standards Manual For Drainage Design And Floodplain Management, December 1989. This manual also presents an equation (Simons, Li & Associates, Inc., 1986) for scour below a submerged drop. These equations are presented as follows:

Free-Overall Drop:

$$Z_{lsf} = 1.32 q^{0.54} H_t^{0.225} - TW \text{.....Eq. 4.2}$$

where Z_{lsf} = depth of local scour due to a free-overfall drop (ft), measured below the streambed surface downstream of the drop

q = discharge per unit width of channel bottom (cfs/ft)

H_t = total drop in head, measured from the upstream energy gradeline to the downstream energy gradeline (ft)

TW = tailwater depth of flow at the downstream side of the drop structure (ft)

Submerged Drop:

$$Z_{lss} = 0.581 q^{0.667} (h/Y)^{0.411} [1-(h/Y)]^{-0.118} \text{.....Eq. 4.3}$$

where $h/Y \leq 0.99$, and

Z_{lss} = depth of local scour due to a submerged drop (ft), measured below the streambed surface downstream of the drop

q = discharge per unit width of channel bottom (cfs/ft)

h = drop height (ft)

Y = downstream depth of flow (ft)

Table 4.4
Toyota Arizona Proving Grounds
Scour Analysis Below Drop Structures
100-Year Event
Supercritical Flow, 4:1 Side-Slopes

Station	Q (cfs)	BW (ft)	q (cfs/ft)	Drop Height (ft)	Upstream EG (ft, MSL)	Downstream EG (ft, MSL)	Total Head Differential (ft)	Tailwater Elevation (ft, MSL)	Downstream Flow Depth (ft)	h/Y	Z(lsf) (ft)	Z(lss) (ft)	6.0*Z(lsf) (ft)	6.0*Z(lss) (ft)	12.0*Z(lsf) (ft)	12.0*Z(lss) (ft)	Scour Lengths x(sce) (ft)	Scour Lengths L(s) (ft)	Design Scour Depth (ft)
422+00	1200	10	120.00	2.4	1719.81	1718.15	1.66	1715.06	3.56	0.674	16.07	13.74	96.4	82.5	192.8	164.9	96.4	192.8	16.07
425+25	5596	110	50.87	3.0	1714.94	1712.04	2.90	1709.67	3.64	0.824	10.36	9.06	62.2	54.3	124.3	108.7	62.2	124.3	10.36
446+00	5596	110	50.87	3.0	1695.11	1692.21	2.90	1689.83	3.65	0.822	10.35	9.03	62.1	54.2	124.2	108.4	62.1	124.2	10.35
468+57	5596	110	50.87	2.0	1674.71	1672.80	1.91	1670.43	3.64	0.549	9.10	6.86	54.6	41.2	109.2	82.3	54.6	109.2	9.10

File: TYDRPSUP.WK1 Note: Calculations based on supercritical flow conditions downstream of each drop.

If h/Y>0.85, the predicted scour depth below a channel drop should be computed using both Equations 4.2 and 4.3. The smaller of the two values should then be used for design purposes.

Figure 4.1 illustrates the scour hole geometry that is described by the calculations in Table 4.4. Discussions with representatives of Simons, Li & Associates, Inc. indicate that the use of a 1:1 sloping face on the drop should not invalidate the use of Equations 4.2 and 4.3.

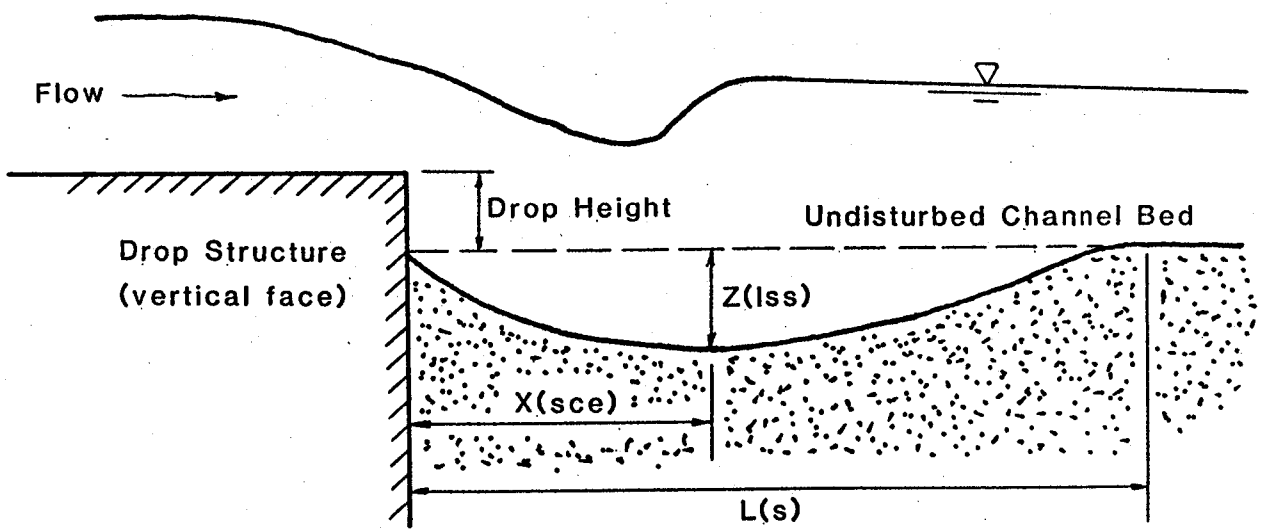
For conservatism, the energy gradelines and flow depths used in Table 4.4 are based on critical depth at the upstream drop face and on supercritical flow for the tailwater condition. This produces a slightly greater head differential across the drop than would exist if subcritical flow conditions were assumed for the tailwater.

Even though all four drops will be submerged during the 100-year event, the free-overfall scour depth is recommended for design since the h/y ratios are all less than 0.85. This also represents a conservative approach.

It is recommended that the two buried drop structures be designed to the same dimensions as used for the structure at XSEC 446. The channel cross-section and discharge are identical at all three locations.

It should be noted that the Sverdrup Corporation has indicated an intention to line the channel bottom below the drop at XSEC 422, thus eliminating the potential for local scour at this drop location.

One additional issue on the drop structure scour potential warrants discussion. Should the worst-case, long-term degradation profile occur, the drop structures will be exposed to larger drop heights than used in the calculations presented in Table 4.4. Under such conditions, the scour depths could increase from approximately 1 to 7 feet, depending on drop location. When referencing these deeper scour depths to the degraded bed profile, the toes of the drop structures would have to be extended deeper to contain the estimated scour hole with a fully degraded channel bed.



Source: City Of Tucson
"Standards Manual For Drainage Design",
December 1989

Toyota Arizona Proving Grounds	
Drop Structure Scour Dimensions	
	Figure 4.1

If desired, the design team could control the depths of these scour holes by the construction of an armored stilling basin, i.e., a baffled chute, riprap plunge pool, etc. However, if such an approach is pursued, it is very important that the base of the stilling basin be constructed below the elevation of the fully degraded bed profile. If this is not done, and the worst-case scenario of long-term degradation were to occur, the stilling basins would be undercut and fail, thus creating a new uncontrolled drop.

Based on assessment of risk and economics, it would seem prudent to design the plunge pools and drop structures to withstand the scour depths presented in Table 4.4. Should substantial long-term degradation occur, it would be a simple process to install an armored stilling basin (in future) to eliminate, or arrest, additional scour below the drop structures. From an economic standpoint, it would appear logical to defer the expense of such construction until a demonstrated need arises in the form of severe long-term degradation. As discussed previously, the slow development period for long-term degradation will give ample time to identify any problems and take corrective action.

Another advantage of taking a "wait and see" approach is eliminating the difficulty of designing and constructing an armored stilling basin that may ultimately be undercut and destroyed by long-term degradation. It would be much simpler and cost effective to build such a structure after the degradation occurs. The placement of large rock boulders at the base of the drop would probably be a preferred method of corrective action since such an approach would provide a flexible material that could more easily adapt to any continued degradation than could a rigid slab of concrete.

5 INSPECTION & MAINTENANCE REQUIREMENTS

Man's inability to precisely quantify natural processes such as hydrology, channel hydraulics, and sediment transport behavior (as well as predicting the interaction between these processes) prevents the design of a "perfect" flood control channel. As a result, all drainage systems must be constantly monitored to identify design imperfections and to take corrective maintenance action to re-establish the channel's ability to perform as intended.

Potential problem areas have already been discussed in previous sections of this report. However, it is considered important to re-emphasize and summarize these issues so that guidelines can be established for an operation and maintenance program. These guidelines are discussed as follows:

1. The channel should be inspected after any flow event, or in the absence of any flooding, at least twice a year.

2. Channel Invert - The inspection of the channel bottom should focus on documenting any significant build-ups of sediment or lowering of the channel due to scour and long-term degradation. Particular attention should be given to monitoring sediment accumulation in the fully lined section of channel upstream of XSEC 422. The depth of sediment accumulations in this area can be easily measured by scrapping away the sediment until the soil-cement channel bottom is revealed.

   Although only a guideline, if more than 2 feet of sediment depth is uniformly distributed through this upstream reach of channel, consideration should be given to excavating the sediments and depositing them in the unlined portions of the channel downstream of XSEC 425+25. This will help to offset long-term degradation in the unlined, downstream reaches of the channel.

   Should these periodic inspections reveal extreme changes in the bed profile, consideration should be given to surveying the channel profile and comparing the existing profile to the original design profile. Such a comparison will quickly show what trends are developing. Any necessary corrective action can then be taken.

3. Bank-Lining - At the time this report was prepared, the Sverdrup Corporation's intentions were to use soil-cement as a bank-lining material (and bottom-lining upstream of XSEC 425+25). As with all cement products, soil-cement will be prone to cracking. Accordingly, inspections should concentrate on locating and monitoring such cracks. If the cracks enlarge and differential settlement begins to occur, the reason for such occurrences should be determined so that corrective action can be taken.

   It will be especially important to monitor cracking and settlement along the north and east side of the channel bank that will be receiving the large lateral inflows. If water succeeds in scouring under the top of this bank, the structural integrity of the bank could be jeopardized.

   Should this bank-lining fail, large headcuts could be propagated upstream. These headcuts could also lead to unusually large sediment deposits occurring in the flood control channel.

4. Drop Structures - Assuming the drop structures are also to be built from soil-cement (or any other cement product), they should also be monitored for cracking and differential settlement. The scour basin (plunge pool) below each drop should also be examined, in conjunction with the channel bed, to detect any tendency for long-term degradation. Knowing the original design drop heights, a simple vertical measurement can be made to detect any changes in drop height. When making such measurements, care should be taken not to reference the measurement to the local scour hole that will probably materialize near the base of each drop. An attempt should be made to visually extend that portion of the undisturbed channel bed (that portion of the channel bed beyond the influence of the local scour hole) to an intersection point at the base of the drop structure. The drop height should be measured from this intersection point. Such a measurement should be a good indicator of any long-term elevation changes in the channel bed.

5. Unlined Embankments - Any reaches of channel that incorporate unlined (compacted earth) embankments or levees should be inspected for signs of erosion. If significant erosion is observed, corrective action should be taken.

Adherence to a periodic inspection and maintenance program should insure many years of satisfactory channel performance.

6 SUMMARY OF RECOMMENDATIONS

The preceding sections of this report present detailed discussions of the engineering methodologies and assumptions that were used in developing the hydraulic parameters required for the design of the proposed drainage channel. This concluding section of the report presents a summary of the recommendations that were provided to the Sverdrup Corporation for the design of the channel.

* Water Surface Profile - The 100-year water surface elevations presented in Table 3.3 should be used as a reference point for any design issues such as bank elevations and freeboard.

* Channel Invert - The channel invert elevations listed in Table 3.3, and shown on Figure 3.1, are recommended for the channel design.

* Bank-Lining Toedown - Bank-lining should be extended a minimum of 5.6 feet below the recommended channel invert, except in the vicinity of the drop structures where special scour calculations take precedence.

* Drop Structure Toedown - Scour depths and lengths are summarized in Table 4.4 for each drop structure. These dimensions are based on the original bed profile, with no long-term degradation. The grade control structures between XSECs 454 and 458 and XSECs 434 and 438 should be designed to the same dimensions as used for the structure at XSEC 446. The designer may want to consider the use of an armored stilling basin to contain the scour holes to more manageable dimensions. The base of any such stilling basins must be located below the elevation of the fully degraded bed profile. See the discussion in Section 4.3 regarding this issue.

* Freeboard - A minimum channel freeboard of 2.0 feet should be maintained for all sections of the channel downstream of XSEC 422. It is recommended that a minimum freeboard of 4.5 feet be used upstream of XSEC 422 because of the potential for long-term aggradation. Channel bank-lining should be extended to the top of the freeboard dimension. It should be noted that these freeboard dimensions only apply to the side of the channel bank adjacent to the test track. The opposite channel bank will be designed to receive lateral inflows.

* Inspection & Maintenance - A conscientious inspection and maintenance program should be pursued to identify any trends for excessive aggradation or degradation, and to identify any structural damage to the channel lining and drop structures. Corrective action should be taken to remedy any problems that are discovered. Section 5.0 of this report presents guidelines for an inspection and maintenance program.

Bibliography

Simons, Li & Associates, Inc., 1986, *Hydraulic Model Study of Local Scour Downstream of Rigid Grade-Control Structures*, prepared for Pima County Department of Transportation and Flood Control District, Tucson, Arizona

Zeller, M.E., & Fullerton, W.T., 1983, *A Theoretically Derived Sediment Transport Equation for Sand-Bed Channels in Arid Regions*, Proceedings of the D.B. Simons Symposium on Erosion and Sedimentation

APPENDIX A

Subcritical
HEC-2 Models

Toyota Arizona Proving Grounds

Model TOY101C4.IN/.OT - XSEC 506 TO 468+57
Model TOY102C4.IN/.OT - XSEC 468+57 TO 446
Model TOY103C.IN/.OT - XSEC 446 TO 425+25
Model TOY104C.IN/.OT - XSEC 425+25 TO 422
Model TOY105C.IN/.OT - XSEC 422 TO 374

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*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    24AUG91    TIME   17:41:53 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 24AUG91 17:41:53

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************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 506 - 468.57
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: TOY101C4.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      PROFILE ADJUSTED ON 8/23/91 TO MATCH ACCESS ROAD ELEVATIONS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

                2                        .0080                          0     1642

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1                                     -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38       43       1        42       8        26       68       4        17       33
      5       39       66

NC    .050     .050     .050      .1       .3
QT       2    5596     1595
X1   50600       21        0      848
X3                              170                  710
GR    1642        0     1640       78     1638      100     1636      106     1636      118
GR    1638      128     1640      178     1638      250     1638      294     1636      300
GR  1635.6      305     1636      310     1638      320     1640      393     1640      579
GR    1638      647     1640      707     1638      796   1633.8      810     1638      829
GR    1640      848

X1   50200       22        0     1240      415      415      415
X3                              225                  830
GR    1645        0     1644       88     1642      100     1640      128     1644      154
GR    1644      280     1642      440     1640      453   1639.4      463     1640      478
GR    1642      630     1644      678     1644      860     1642     1030     1640     1090
GR    1638     1095     1638     1118     1640     1134     1638     1158     1638     1180
GR    1642     1202     1644     1240

X1   49800       19      520     2070      420      420      420
X3                              900                 1590
GR    1650      520     1648      581     1646      679     1646      710     1648      824
GR    1648      984     1646     1177     1644     1190   1642.7     1200     1644     1214
GR    1645     1280     1644     1355     1646     1380     1647     1480     1646     1948
GR    1644     1970     1645     2015     1644     2045     1646     2070
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	49400	24	194	2079	415	415	415			
X3				710		1470				
GR	1654	194	1652	222	1650	255	1650	279	1652	298
GR	1652	456	1652	589	1650	608	1652	678	1650	972
GR	1648	1091	1646	1096	1645.3	1103	1646	1112	1648	1128
GR	1650	1207	1648	1405	1650	1430	1650	1470	1649	1530
GR	1650	1570	1651	1715	1650	1885	1650	2079		
X1	49000	25	45	2043	400	400	400			
X3				695		1350				
GR	1657	45	1656	138	1654	155	1654	182	1656	255
GR	1656	480	1655	522	1656	570	1656	800	1654	848
GR	1652	950	1653	1005	1652	1040	1650	1049	1648.3	1061
GR	1650	1072	1652	1140	1654	1187	1654	1306	1652	1491
GR	1652	1531	1654	1558	1654	1860	1656	1915	1656	2043
X1	48600	27	39	2057	402	402	402			
X3				805		1265				
GR	1660	39	1658	90	1656	146	1658	198	1660	346
GR	1658	510	1659	638	1658	745	1656	944	1654	961
GR	1654	1020	1652.2	1032	1654	1049	1656	1060	1656	1182
GR	1658	1207	1659	1306	1658	1410	1657	1460	1658	1510
GR	1659	1598	1658	1700	1656	1718	1658	1745	1660	1882
GR	1658	2010	1658	2057						
	48200	27	92	2019	400	400	400			
X3				910		1220				
GR	1662	92	1660	107	1659	120	1660	130	1662	147
GR	1663	263	1662	409	1663	540	1662	655	1662	768
GR	1660	812	1660	839	1661	889	1660	1020	1658	1033
GR	1656	1040	1655.7	1050	1656	1056	1658	1062	1660	1141
GR	1660	1195	1662	1218	1662	1359	1664	1420	1664	1630
GR	1662	1885	1662	2019						
NC			.041							
X1	47800	4	0	270	400	400	400			
GR	1678.3	0	1658.3	80	1658.3	190	1678.3	270		
X1	47636	0	0	0	164	164	164		1.21	
X1	47602	0	0	0	34	34	34		1.36	
X1	47400	0	0	0	217	217	217		1.65	
X1	47000	0	0	0	419	419	419		3.18	
X1	46857	0	0	0	143	143	143		1.09	

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

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*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV=     .100 CEHV=     .300
*SECNO 50600.000
3280 CROSS SECTION  50600.00 EXTENDED      1.43 FEET


3470 ENCROACHMENT STATIONS=      170.0     710.0  TYPE=      1  TARGET=      540.000
 50600.000      7.63   1641.43   1640.66   1642.00   1641.75       .32       .00       .00 100000.00
    5596.0        .0    5596.0        .0        .0    1223.9        .0        .0        .0 100000.00
       .00       .00      4.57       .00      .000      .050      .000      .000   1633.80    170.00
   .008026        0.        0.        0.         0        10         5       .00    540.00    710.00


*SECNO 50200.000
3280 CROSS SECTION  50200.00 EXTENDED       .78 FEET


3470 ENCROACHMENT STATIONS=      225.0     830.0  TYPE=      1  TARGET=      605.000
 50200.000      6.78   1644.78   1643.97       .00   1645.07       .30      3.32       .00 100000.00
    5596.0        .0    5596.0        .0        .0    1281.6        .0      11.9       5.5 100000.00
       .03       .00      4.37       .00      .000      .050      .000      .000   1638.00    225.00
   .007965      415.      415.      415.         2        13         0       .00    605.00    830.00


*SECNO 49800.000
3280 CROSS SECTION  49800.00 EXTENDED      2.22 FEET


3470 ENCROACHMENT STATIONS=      900.0    1590.0  TYPE=      1  TARGET=      690.000
 49800.000      5.51   1648.21   1647.36       .00   1648.48       .27      3.41       .00 100000.00
    5596.0        .0    5596.0        .0        .0    1335.8        .0      24.6      11.7 100000.00
       .05       .00      4.19       .00      .000      .050      .000      .000   1642.70    900.00
   .008268      420.      420.      420.         2        18         0       .00    690.00   1590.00


*SECNO 49400.000
3280 CROSS SECTION  49400.00 EXTENDED      1.43 FEET


3470 ENCROACHMENT STATIONS=      710.0    1470.0  TYPE=      1  TARGET=      760.000
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
           QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


49400.000     6.12   1651.42   1650.52       .00   1651.66       .24      3.17       .00 100000.00
   5596.0       .0    5596.0       .0        .0    1412.5        .0      37.6      18.4 100000.00
      .08      .00      3.96       .00      .000      .050      .000      .000   1645.30    762.52
  .007096     415.      415.      415.         2        10         0       .00    707.48   1470.00


*SECNO 49000.000

3470 ENCROACHMENT STATIONS=      695.0    1350.0  TYPE=      1  TARGET=      655.000
49000.000     6.57   1654.87   1654.32       .00   1655.29       .42      3.57       .05 100000.00
   5596.0       .0    5596.0       .0        .0    1080.7        .0      49.1      24.0 100000.00
      .10      .00      5.18       .00      .000      .050      .000      .000   1648.30    827.22
  .011583     400.      400.      400.         3         6         0       .00    522.78   1350.00


*SECNO 48600.000
3280 CROSS SECTION  48600.00 EXTENDED       .61 FEET


3470 ENCROACHMENT STATIONS=      805.0    1265.0  TYPE=      1  TARGET=      460.000
48600.000     6.41   1658.61   1657.55       .00   1658.96       .35      3.67       .01 100000.00
   5596.0       .0    5596.0       .0        .0    1175.7        .0      59.5      28.5 100000.00
      .13      .00      4.76       .00      .000      .050      .000      .000   1652.20    805.00
  .007378     402.      402.      402.         2        14         0       .00    460.00   1265.00


*SECNO 48200.000
3280 CROSS SECTION  48200.00 EXTENDED       .30 FEET


3470 ENCROACHMENT STATIONS=      910.0    1220.0  TYPE=      1  TARGET=      310.000
48200.000     6.59   1662.29   1661.79       .00   1662.99       .70      3.92       .10 100000.00
   5596.0       .0    5596.0       .0        .0     835.7        .0      68.7      32.1 100000.00
      .14      .00      6.70       .00      .000      .050      .000      .000   1655.70    910.00
  .013684     400.      400.      400.         2        10         0       .00    310.00   1220.00


*SECNO 47800.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.03

47800.000     6.44   1664.74   1662.38       .00   1665.38       .63      2.38       .01   1678.30
   5596.0       .0    5596.0       .0        .0     875.2        .0      76.6      34.2   1678.30
      .16      .00      6.39       .00      .000      .041      .000      .000   1658.30     54.22
  .003314     400.      400.      400.         3        14         0       .00    161.57    215.78
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
           QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 47636.000
 47636.000     5.75   1665.26   1663.59      .00   1666.10      .83      .66       .06   1679.51
    5596.0       .0    5596.0       .0       .0     764.0       .0     79.7      34.8   1679.51
       .17      .00      7.32      .00     .000      .041     .000     .000   1659.51     57.02
   .004967     164.      164.      164.        2        14        0      .00    155.96    212.98


*SECNO 47602.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 47602.000     4.08   1664.95   1664.95      .00   1666.78     1.83      .28       .30   1680.87
    5596.0       .0    5596.0       .0       .0     515.5       .0     80.2      35.0   1680.87
       .17      .00     10.85      .00     .000      .041     .000     .000   1660.87     63.68
   .016323      34.       34.       34.        0        19        0      .00    142.65    206.32


*SECNO 47400.000

3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.64

 47400.000     5.43   1667.95   1666.61      .00   1668.90      .95     2.03       .09   1682.52
    5596.0       .0    5596.0       .0       .0     714.4       .0     83.2      35.7   1682.52
       .18      .00      7.83      .00     .000      .041     .000     .000   1662.52     58.30
   .006076     217.      217.      217.        2         5        0      .00    153.39    211.70


*SECNO 47000.000
 47000.000     5.02   1670.72   1669.78      .00   1671.86     1.14     2.90       .06   1685.70
    5596.0       .0    5596.0       .0       .0     653.4       .0     89.8      37.1   1685.70
       .19      .00      8.56      .00     .000      .041     .000     .000   1665.70     59.91
   .007946     419.      419.      419.        3        15        0      .00    150.18    210.09


*SECNO 46857.000
 46857.000     5.07   1671.86   1670.87      .00   1672.98     1.12     1.12       .00   1686.79
    5596.0       .0    5596.0       .0       .0     659.5       .0     92.0      37.6   1686.79
       .20      .00      8.49      .00     .000      .041     .000     .000   1666.79     59.75
   .007728     143.      143.      143.        2        15        0      .00    150.50    210.25
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T1      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 506 - 468.57
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: TOY101C4.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      PROFILE ADJUSTED ON 8/23/91 TO MATCH ACCESS ROAD ELEVATIONS

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

              3                    .0080                           0    1640

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

```
*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV=     .100 CEHV=     .300
*SECNO 50600.000
3280 CROSS SECTION  50600.00 EXTENDED       .23 FEET


3470 ENCROACHMENT STATIONS=      170.0     710.0  TYPE=      1  TARGET=      540.000
 50600.000      6.43   1640.23   1639.41   1640.00   1640.35       .12       .00       .00 100000.00
    1595.0        .0    1595.0        .0        .0     577.8        .0        .0        .0 100000.00
       .00       .00      2.76       .00      .000      .050      .000      .000   1633.80    170.00
   .007912        0.        0.        0.         0        13         5       .00    540.00    710.00


*SECNO 50200.000

3470 ENCROACHMENT STATIONS=      225.0     830.0  TYPE=      1  TARGET=      605.000
 50200.000      5.10   1643.10   1642.19       .00   1643.26       .16      2.89       .01 100000.00
    1595.0        .0    1595.0        .0        .0     494.0        .0       5.1       4.0 100000.00
       .04       .00      3.23       .00      .000      .050      .000      .000   1638.00    352.11
   .006191      415.      415.      415.         3        18         0       .00    304.26    656.37


*SECNO 49800.000
3280 CROSS SECTION  49800.00 EXTENDED       .38 FEET


3470 ENCROACHMENT STATIONS=      900.0    1590.0  TYPE=      1  TARGET=      690.000
 49800.000      3.68   1646.38   1645.66       .00   1646.62       .24      3.34       .02 100000.00
    1595.0        .0    1595.0        .0        .0     405.7        .0       9.4       6.8 100000.00
       .07       .00      3.93       .00      .000      .050      .000      .000   1642.70   1139.89
   .010621      420.      420.      420.         3        14         0       .00    278.56   1418.45


*SECNO 49400.000
3280 CROSS SECTION  49400.00 EXTENDED       .06 FEET


3470 ENCROACHMENT STATIONS=      710.0    1470.0  TYPE=      1  TARGET=      760.000
 49400.000      4.76   1650.06   1649.29       .00   1650.18       .12      3.54       .01 100000.00
    1595.0        .0    1595.0        .0        .0     584.2        .0      14.2      10.6 100000.00
       .11       .00      2.73       .00      .000      .050      .000      .000   1645.30    963.05
   .006999      415.      415.      415.         4         8         0       .00    506.95   1470.00
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
 Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 49000.000

3470 ENCROACHMENT STATIONS=      695.0    1350.0  TYPE=      1  TARGET=      655.000
 49000.000      5.03   1653.33   1652.73       .00   1653.56       .23      3.35       .03 100000.00
    1595.0        .0    1595.0        .0        .0     417.2        .0      18.8      14.2 100000.00
       .14       .00      3.82       .00      .000      .050      .000      .000   1648.30    881.99
   .010186      400.      400.      400.         3        12         0       .00    289.35   1171.34


*SECNO 48600.000

3470 ENCROACHMENT STATIONS=      805.0    1265.0  TYPE=      1  TARGET=      460.000
 48600.000      4.69   1656.89   1655.80       .00   1657.06       .17      3.49       .01 100000.00
    1595.0        .0    1595.0        .0        .0     486.3        .0      22.9      17.1 100000.00
       .17       .00      3.28       .00      .000      .050      .000      .000   1652.20    855.43
   .007505      402.      402.      402.         3        18         0       .00    337.70   1193.13


*SECNO 48200.000

 ENCROACHMENT STATIONS=      910.0    1220.0  TYPE=      1  TARGET=      310.000
 00.000      5.09   1660.79   1660.34       .00   1661.07       .27      3.98       .03 100000.00
    1595.0        .0    1595.0        .0        .0     380.2        .0      26.9      20.0 100000.00
       .20       .00      4.20       .00      .000      .050      .000      .000   1655.70    916.49
   .013790      400.      400.      400.         3         6         0       .00    287.59   1204.09


*SECNO 47800.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  3.06

 47800.000      3.96   1662.26   1660.13       .00   1662.42       .16      1.34       .01   1678.30
    1595.0        .0    1595.0        .0        .0     498.3        .0      30.9      22.0   1678.30
       .23       .00      3.20       .00      .000      .041      .000      .000   1658.30     64.16
   .001472      400.      400.      400.         4        18         0       .00    141.68    205.84


*SECNO 47636.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .63

 47636.000      3.02   1662.53   1661.33       .00   1662.82       .29       .36       .04   1679.51
    1595.0        .0    1595.0        .0        .0     369.2        .0      32.6      22.5   1679.51
       .24       .00      4.32       .00      .000      .041      .000      .000   1659.51     67.90
   .003712      164.      164.      164.         2        14         0       .00    134.19    202.10
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 47602.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

47602.000	1.82	1662.69	1662.69	.00	1663.56	.87	.25	.17	1680.87
1595.0	.0	1595.0	.0	.0	213.6	.0	32.8	22.6	1680.87
.24	.00	7.47	.00	.000	.041	.000	.000	1660.87	72.72
.020792	34.	34.	34.	0	14	0	.00	124.57	197.28

*SECNO 47400.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.00

47400.000	2.74	1665.26	1664.34	.00	1665.62	.36	2.01	.05	1682.52
1595.0	.0	1595.0	.0	.0	331.1	.0	34.2	23.2	1682.52
.26	.00	4.82	.00	.000	.041	.000	.000	1662.52	69.05
.005212	217.	217.	217.	4	5	0	.00	131.90	200.95

*SECNO 47000.000

47000.000	2.31	1668.01	1667.52	.00	1668.53	.52	2.86	.05	1685.70
1595.0	.0	1595.0	.0	.0	274.9	.0	37.1	24.5	1685.70
.28	.00	5.80	.00	.000	.041	.000	.000	1665.70	70.78
.009344	419.	419.	419.	4	14	0	.00	128.45	199.22

*SECNO 46857.000

46857.000	2.48	1669.27	1668.61	.00	1669.72	.45	1.18	.01	1686.79
1595.0	.0	1595.0	.0	.0	296.6	.0	38.0	24.9	1686.79
.28	.00	5.38	.00	.000	.041	.000	.000	1666.79	70.10
.007360	143.	143.	143.	2	15	0	.00	129.79	199.90

THIS RUN EXECUTED 24AUG91 17:42:15

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	50600.000	5596.00	1641.43	1633.80	7.63	4.57	.54	540.00	50.00	.00	80.26	.00	.00
	50600.000	1595.00	1640.23	1633.80	6.43	2.76	.47	540.00	50.00	.00	79.12	.00	.00
	50200.000	5596.00	1644.78	1638.00	6.78	4.37	.53	605.00	50.00	10.12	79.65	415.00	415.00
	50200.000	1595.00	1643.10	1638.00	5.10	3.23	.45	304.26	50.00	10.12	61.91	415.00	415.00
	49800.000	5596.00	1648.21	1642.70	5.51	4.19	.53	690.00	50.00	11.19	82.68	420.00	835.00
	49800.000	1595.00	1646.38	1642.70	3.68	3.93	.57	278.56	50.00	11.19	106.21	420.00	835.00
	49400.000	5596.00	1651.42	1645.30	6.12	3.96	.49	707.48	50.00	6.27	70.96	415.00	1250.00
	49400.000	1595.00	1650.06	1645.30	4.76	2.73	.45	506.95	50.00	6.27	69.99	415.00	1250.00
	49000.000	5596.00	1654.87	1648.30	6.57	5.18	.63	522.78	50.00	7.50	115.83	400.00	1650.00
	49000.000	1595.00	1653.33	1648.30	5.03	3.82	.56	289.35	50.00	7.50	101.86	400.00	1650.00
	48600.000	5596.00	1658.61	1652.20	6.41	4.76	.52	460.00	50.00	9.70	73.78	402.00	2052.00
	48600.000	1595.00	1656.89	1652.20	4.69	3.28	.48	337.70	50.00	9.70	75.05	402.00	2052.00
	48200.000	5596.00	1662.29	1655.70	6.59	6.70	.72	310.00	50.00	8.75	136.84	400.00	2452.00
	48200.000	1595.00	1660.79	1655.70	5.09	4.20	.64	287.59	50.00	8.75	137.90	400.00	2452.00
*	47800.000	5596.00	1664.74	1658.30	6.44	6.39	.48	161.57	41.00	6.50	33.14	400.00	2852.00
*	47800.000	1595.00	1662.26	1658.30	3.96	3.20	.30	141.68	41.00	6.50	14.72	400.00	2852.00
	47636.000	5596.00	1665.26	1659.51	5.75	7.32	.58	155.96	41.00	7.38	49.67	164.00	3016.00
*	47636.000	1595.00	1662.53	1659.51	3.02	4.32	.46	134.19	41.00	7.38	37.12	164.00	3016.00
*	47602.000	5596.00	1664.95	1660.87	4.08	10.85	1.01	142.65	41.00	40.00	163.23	34.00	3050.00
*	47602.000	1595.00	1662.69	1660.87	1.82	7.47	1.01	124.57	41.00	40.00	207.92	34.00	3050.00
*	47400.000	5596.00	1667.95	1662.52	5.43	7.83	.64	153.39	41.00	7.60	60.76	217.00	3267.00
	47400.000	1595.00	1665.26	1662.52	2.74	4.82	.54	131.90	41.00	7.60	52.12	217.00	3267.00

SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
47000.000	5596.00	1670.72	1665.70	5.02	8.56	.72	150.18	41.00	7.59	79.46	419.00	3686.00
47000.000	1595.00	1668.01	1665.70	2.31	5.80	.70	128.45	41.00	7.59	93.44	419.00	3686.00
46857.000	5596.00	1671.86	1666.79	5.07	8.49	.71	150.50	41.00	7.62	77.28	143.00	3829.00
46857.000	1595.00	1669.27	1666.79	2.48	5.38	.63	129.79	41.00	7.62	73.60	143.00	3829.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=  47800.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  47800.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  47636.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  47602.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  47602.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  47602.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  47602.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  47400.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  47400.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    24AUG91    TIME   17:42:34 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
```

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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 24AUG91 17:42:34

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************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 468.57 - 446
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: TOY102C4.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                          -1                          0     1670

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1                                     -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43        1       42        8       26       68        4       17       33
     5       39       66

NC    .041     .041     .041       .1       .3
QT       2    5596     1595
X1   46857        4        0      270
GR  1688.8        0   1668.8       80   1668.8      190   1688.8      270

X1   46600        0        0        0      259      259      259                2.0

X1   46200        0        0        0      392      392      392                3.0

X1   45800        0        0        0      378      378      378                2.9

X1   45400        0        0        0      402      402      402                3.1

X1   45000        0        0        0      421      421      421                3.2

X1   44600        0        0        0      421      421      421                3.2
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 46857.000
3720 CRITICAL DEPTH ASSUMED

46857.000	4.08	1672.88	1672.88	1670.00	1674.71	1.83	.00	.00	1688.80
5596.0	.0	5596.0	.0	.0	515.9	.0	.0	.0	1688.80
.00	.00	10.85	.00	.000	.041	.000	.000	1668.80	63.66
.016285	0.	0.	0.	0	19	0	.00	142.67	206.34

*SECNO 46600.000

3301 HV CHANGED MORE THAN HVINS

WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.65

46600.000	5.45	1676.26	1674.89	.00	1677.20	.94	2.40	.09	1690.80
5596.0	.0	5596.0	.0	.0	719.1	.0	3.7	.9	1690.80
.01	.00	7.78	.00	.000	.041	.000	.000	1670.80	58.18
.005956	259.	259.	259.	3	5	0	.00	153.64	211.82

*SECNO 46200.000

46200.000	5.01	1678.81	1677.88	.00	1679.95	1.15	2.69	.06	1693.80
5596.0	.0	5596.0	.0	.0	651.4	.0	9.8	2.2	1693.80
.02	.00	8.59	.00	.000	.041	.000	.000	1673.80	59.96
.008021	392.	392.	392.	3	15	0	.00	150.07	210.04

*SECNO 45800.000

45800.000	5.10	1681.80	1680.78	.00	1682.90	1.10	2.94	.00	1696.70
5596.0	.0	5596.0	.0	.0	664.5	.0	15.5	3.6	1696.70
.03	.00	8.42	.00	.000	.041	.000	.000	1676.70	59.61
.007553	378.	378.	378.	3	15	0	.00	150.77	210.39

*SECNO 45400.000

45400.000	5.06	1684.86	1683.88	.00	1685.98	1.12	3.08	.01	1699.80
5596.0	.0	5596.0	.0	.0	658.7	.0	21.7	4.9	1699.80
.05	.00	8.50	.00	.000	.041	.000	.000	1679.80	59.77
.007756	402.	402.	402.	2	15	0	.00	150.46	210.23

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 45000.000

45000.000	5.10	1688.10	1687.08	.00	1689.20	1.10	3.22	.00	1703.00
5596.0	.0	5596.0	.0	.0	664.5	.0	28.0	6.4	1703.00
.06	.00	8.42	.00	.000	.041	.000	.000	1683.00	59.61
.007552	421.	421.	421.	1	15	0	.00	150.77	210.39

*SECNO 44600.000

44600.000	5.09	1691.29	1690.28	.00	1692.40	1.11	3.19	.00	1706.20
5596.0	.0	5596.0	.0	.0	663.2	.0	34.5	7.9	1706.20
.08	.00	8.44	.00	.000	.041	.000	.000	1686.20	59.65
.007600	421.	421.	421.	2	15	0	.00	150.70	210.35

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T4      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 468.57 - 446
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
        TOYOTA EAST CHANNEL            MODEL: TOY102C4.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              3                          -1                          0      1670

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    15                 -1                                  -1
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 46857.000
3720 CRITICAL DEPTH ASSUMED

46857.000	1.83	1670.63	1670.00	1670.00	1671.49	.86	.00	.00	1688.80
1595.0	.0	1595.0	.0	.0	214.5	.0	.0	.0	1688.80
.00	.00	7.44	.00	.000	.041	.000	.000	1668.80	72.69
.020516	0.	0.	0.	0	10	0	.00	124.63	197.31

*SECNO 46600.000

3301 HV CHANGED MORE THAN HVINS

WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.00

46600.000	2.75	1673.55	1672.62	.00	1673.90	.36	2.36	.05	1690.80
1595.0	.0	1595.0	.0	.0	332.6	.0	1.6	.8	1690.80
.02	.00	4.80	.00	.000	.041	.000	.000	1670.80	69.00
.005140	259.	259.	259.	4	5	0	.00	131.99	201.00

*SECNO 46200.000

46200.000	2.30	1676.10	1675.62	.00	1676.62	.53	2.67	.05	1693.80
1595.0	.0	1595.0	.0	.0	273.9	.0	4.4	1.9	1693.80
.03	.00	5.82	.00	.000	.041	.000	.000	1673.80	70.81
.009459	392.	392.	392.	4	14	0	.00	128.38	199.19

*SECNO 45800.000

45800.000	2.53	1679.23	1678.52	.00	1679.66	.43	3.02	.01	1696.70
1595.0	.0	1595.0	.0	.0	303.4	.0	6.9	3.1	1696.70
.05	.00	5.26	.00	.000	.041	.000	.000	1676.70	69.90
.006856	378.	378.	378.	3	15	0	.00	130.21	200.10

*SECNO 45400.000

45400.000	2.40	1682.20	1681.63	.00	1682.68	.48	3.00	.02	1699.80
1595.0	.0	1595.0	.0	.0	286.8	.0	9.6	4.3	1699.80
.07	.00	5.56	.00	.000	.041	.000	.000	1679.80	70.41
.008181	402.	402.	402.	3	15	0	.00	129.18	199.59

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 45000.000

45000.000	2.48	1685.48	1684.82	.00	1685.92	.45	3.24	.00	1703.00
1595.0	.0	1595.0	.0	.0	297.9	.0	12.4	5.5	1703.00
.10	.00	5.35	.00	.000	.041	.000	.000	1683.00	70.06
.007258	421.	421.	421.	2	15	0	.00	129.87	199.94

*SECNO 44600.000

44600.000	2.43	1688.63	1688.02	.00	1689.09	.47	3.17	.01	1706.20
1595.0	.0	1595.0	.0	.0	291.2	.0	15.3	6.8	1706.20
.12	.00	5.48	.00	.000	.041	.000	.000	1686.20	70.27
.007793	421.	421.	421.	2	15	0	.00	129.46	199.73

THIS RUN EXECUTED 24AUG91 17:42:42

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
*	46857.000	5596.00	1672.88	1668.80	4.08	10.85	1.01	142.67	41.00	.00	162.85	.00	.00
*	46857.000	1595.00	1670.63	1668.80	1.83	7.44	1.00	124.63	41.00	.00	205.16	.00	.00
*	46600.000	5596.00	1676.26	1670.80	5.45	7.78	.63	153.64	41.00	7.72	59.56	259.00	259.00
*	46600.000	1595.00	1673.55	1670.80	2.75	4.80	.53	131.99	41.00	7.72	51.40	259.00	259.00
	46200.000	5596.00	1678.81	1673.80	5.01	8.59	.73	150.07	41.00	7.65	80.21	392.00	651.00
	46200.000	1595.00	1676.10	1673.80	2.30	5.82	.70	128.38	41.00	7.65	94.59	392.00	651.00
	45800.000	5596.00	1681.80	1676.70	5.10	8.42	.71	150.77	41.00	7.67	75.53	378.00	1029.00
	45800.000	1595.00	1679.23	1676.70	2.53	5.26	.61	130.21	41.00	7.67	68.56	378.00	1029.00
	45400.000	5596.00	1684.86	1679.80	5.06	8.50	.72	150.46	41.00	7.71	77.56	402.00	1431.00
	45400.000	1595.00	1682.20	1679.80	2.40	5.56	.66	129.18	41.00	7.71	81.81	402.00	1431.00
	45000.000	5596.00	1688.10	1683.00	5.10	8.42	.71	150.77	41.00	7.60	75.52	421.00	1852.00
	45000.000	1595.00	1685.48	1683.00	2.48	5.35	.62	129.87	41.00	7.60	72.58	421.00	1852.00
	44600.000	5596.00	1691.29	1686.20	5.09	8.44	.71	150.70	41.00	7.60	76.00	421.00	2273.00
	44600.000	1595.00	1688.63	1686.20	2.43	5.48	.64	129.46	41.00	7.60	77.93	421.00	2273.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=  46857.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  46857.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=  46600.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  46600.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    29AUG91    TIME   15:09:19 *
*****************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

END OF BANNER

THIS RUN EXECUTED 29AUG91 15:09:19

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*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
*************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 446 - 425+25
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: TOY103C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                           -1                            0      1694

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1                 -1                                        -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        43         1        42         8        26        68         4        17        33
      5        39        66

NC    .050      .050      .041        .1        .3
QT       2     5596      1595
X1   44600         4         0       270
GR  1709.2         0    1689.2        80    1689.2       190    1709.2       270

X1   44200         0         0         0       421       421       421                  3.2

X1   43800         0         0         0       421       421       421                  3.2

X1   43400         0         0         0       421       421       421                  3.3

X1   43000         0         0         0       421       421       421                  3.2

X1   42600         0         0         0       421       421       421                  3.2

X1   42525         0         0         0        96        96        96                  .73
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 44600.000
3720 CRITICAL DEPTH ASSUMED

44600.000	4.09	1693.29	1693.29	1694.00	1695.11	1.82	.00	.00	1709.20
5596.0	.0	5596.0	.0	.0	517.1	.0	.0	.0	1709.20
.00	.00	10.82	.00	.000	.041	.000	.000	1689.20	63.63
.016171	0.	0.	0.	0	10	0	.00	142.74	206.37

*SECNO 44200.000

3301 HV CHANGED MORE THAN HVINS

WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.72

44200.000	5.59	1697.99	1696.48	.00	1698.88	.89	3.67	.09	1712.40
5596.0	.0	5596.0	.0	.0	740.7	.0	6.1	1.4	1712.40
.02	.00	7.55	.00	.000	.041	.000	.000	1692.40	57.62
.005450	421.	421.	421.	3	5	0	.00	154.76	212.38

*SECNO 43800.000

43800.000	4.98	1700.58	1699.69	.00	1701.74	1.16	2.78	.08	1715.60
5596.0	.0	5596.0	.0	.0	647.4	.0	12.8	2.9	1715.60
.03	.00	8.64	.00	.000	.041	.000	.000	1695.60	60.07
.008172	421.	421.	421.	3	15	0	.00	149.86	209.93

*SECNO 43400.000

43400.000	5.07	1703.97	1702.98	.00	1705.09	1.12	3.35	.00	1718.90
5596.0	.0	5596.0	.0	.0	659.4	.0	19.1	4.4	1718.90
.04	.00	8.49	.00	.000	.041	.000	.000	1698.90	59.75
.007730	421.	421.	421.	2	15	0	.00	150.50	210.25

*SECNO 43000.000

43000.000	5.10	1707.20	1706.18	.00	1708.30	1.10	3.21	.00	1722.10
5596.0	.0	5596.0	.0	.0	665.6	.0	25.5	5.8	1722.10
.06	.00	8.41	.00	.000	.041	.000	.000	1702.10	59.58
.007516	421.	421.	421.	2	15	0	.00	150.83	210.42

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 42600.000

42600.000	5.08	1710.38	1709.38	.00	1711.48	1.11	3.18	.00	1725.30
5596.0	.0	5596.0	.0	.0	663.2	.0	31.9	7.3	1725.30
.07	.00	8.44	.00	.000	.041	.000	.000	1705.30	59.65
.007597	421.	421.	421.	1	15	0	.00	150.70	210.35

*SECNO 42525.000

42525.000	5.08	1711.11	1710.11	.00	1712.22	1.11	.73	.00	1726.03
5596.0	.0	5596.0	.0	.0	661.3	.0	33.4	7.6	1726.03
.07	.00	8.46	.00	.000	.041	.000	.000	1706.03	59.70
.007665	96.	96.	96.	0	15	0	.00	150.60	210.30

```
T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 446 - 425+25
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: TOY103C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

              3                     -1                      0      1694

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 44600.000
3720 CRITICAL DEPTH ASSUMED

44600.000	1.82	1691.02	1691.02	1694.00	1691.89	.87	.00	.00	1709.20
1595.0	.0	1595.0	.0	.0	213.5	.0	.0	.0	1709.20
.00	.00	7.47	.00	.000	.041	.000	.000	1689.20	72.72
.020825	0.	0.	0.	0	17	0	.00	124.56	197.28

*SECNO 44200.000

3301 HV CHANGED MORE THAN HVINS

WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.11

44200.000	2.83	1695.23	1694.22	.00	1695.56	.34	3.62	.05	1712.40
1595.0	.0	1595.0	.0	.0	342.9	.0	2.7	1.2	1712.40
.03	.00	4.65	.00	.000	.041	.000	.000	1692.40	68.69
.004675	421.	421.	421.	5	5	0	.00	132.61	201.31

*SECNO 43800.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .68

43800.000	2.26	1697.86	1697.42	.00	1698.41	.55	2.78	.06	1715.60
1595.0	.0	1595.0	.0	.0	269.0	.0	5.6	2.5	1715.60
.04	.00	5.93	.00	.000	.041	.000	.000	1695.60	70.96
.010006	421.	421.	421.	4	14	0	.00	128.08	199.04

*SECNO 43400.000

43400.000	2.53	1701.43	1700.72	.00	1701.86	.43	3.44	.01	1718.90
1595.0	.0	1595.0	.0	.0	304.1	.0	8.4	3.8	1718.90
.07	.00	5.24	.00	.000	.041	.000	.000	1698.90	69.87
.006803	421.	421.	421.	4	15	0	.00	130.25	200.13

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 43000.000									
43000.000	2.41	1704.51	1703.93	.00	1704.98	.48	3.11	.01	1722.10
1595.0	.0	1595.0	.0	.0	288.2	.0	11.3	5.0	1722.10
.09	.00	5.53	.00	.000	.041	.000	.000	1702.10	70.36
.008054	421.	421.	421.	3	15	0	.00	129.27	199.64
*SECNO 42600.000									
42600.000	2.47	1707.77	1707.12	.00	1708.22	.45	3.24	.00	1725.30
1595.0	.0	1595.0	.0	.0	296.7	.0	14.1	6.3	1725.30
.11	.00	5.38	.00	.000	.041	.000	.000	1705.30	70.10
.007349	421.	421.	421.	3	15	0	.00	129.80	199.90
*SECNO 42525.000									
42525.000	2.45	1708.48	1707.85	.00	1708.94	.46	.72	.00	1726.03
1595.0	.0	1595.0	.0	.0	294.0	.0	14.8	6.5	1726.03
.11	.00	5.43	.00	.000	.041	.000	.000	1706.03	70.19
.007569	96.	96.	96.	2	15	0	.00	129.63	199.81

THIS RUN EXECUTED 29AUG91 15:09:27

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
*	44600.000	5596.00	1693.29	1689.20	4.09	10.82	1.00	142.74	41.00	.00	161.71	.00	.00
*	44600.000	1595.00	1691.02	1689.20	1.82	7.47	1.01	124.56	41.00	.00	208.25	.00	.00
*	44200.000	5596.00	1697.99	1692.40	5.59	7.55	.61	154.76	41.00	7.60	54.50	421.00	421.00
*	44200.000	1595.00	1695.23	1692.40	2.83	4.65	.51	132.61	41.00	7.60	46.75	421.00	421.00
	43800.000	5596.00	1700.58	1695.60	4.98	8.64	.73	149.86	41.00	7.60	81.72	421.00	842.00
	43800.000	1595.00	1697.86	1695.60	2.26	5.93	.72	128.08	41.00	7.60	100.06	421.00	842.00
	43400.000	5596.00	1703.97	1698.90	5.07	8.49	.71	150.50	41.00	7.84	77.30	421.00	1263.00
	43400.000	1595.00	1701.43	1698.90	2.53	5.24	.60	130.25	41.00	7.84	68.03	421.00	1263.00
	43000.000	5596.00	1707.20	1702.10	5.10	8.41	.71	150.83	41.00	7.60	75.16	421.00	1684.00
	43000.000	1595.00	1704.51	1702.10	2.41	5.53	.65	129.27	41.00	7.60	80.54	421.00	1684.00
	42600.000	5596.00	1710.38	1705.30	5.08	8.44	.71	150.70	41.00	7.60	75.97	421.00	2105.00
	42600.000	1595.00	1707.77	1705.30	2.47	5.38	.63	129.80	41.00	7.60	73.49	421.00	2105.00
	42525.000	5596.00	1711.11	1706.03	5.08	8.46	.71	150.60	41.00	7.60	76.65	96.00	2201.00
	42525.000	1595.00	1708.48	1706.03	2.45	5.43	.63	129.63	41.00	7.60	75.69	96.00	2201.00

MMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=  44600.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  44600.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=  44200.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  44200.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  43800.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    29AUG91    TIME   15:24:13 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 29AUG91 15:24:13

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************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 425+25 - 422
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: TOY104C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                          -1                          0      1712

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1                                   -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43        1       42        8       26       68        4       17       33
     5       39       66

NC    .033     .033     .033       .1       .3
QT       2     5596     1595
X1   42525        4        0      270
GR  1729.0        0  1709.03       80  1709.03      190  1729.03      270

QT       2     3398      968
X1   42385        4        0      220      150      150      150
GR  1730.2        0  1710.17       80  1710.17      140  1730.17      220

QT       2     1200      341
NC                      .026
X1   42210        4        0      170      150      150      150
GR  1731.3        0  1711.31       80  1711.31       90  1731.31      170

X1   42200        0        0        0       25       25       25                .19
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
[illegible]	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
[illegible]IME---	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 42525.000
3720 CRITICAL DEPTH ASSUMED

42525.000	4.09	1713.12	1713.12	1712.00	1714.94	1.82	.00	.00	1729.00
5596.0	.0	5596.0	.0	.0	516.2	.0	.0	.0	1729.03
.00	.00	10.84	.00	.000	.033	.000	.000	1709.03	63.63
.010532	0.	0.	0.	0	10	0	.00	142.71	206.34

*SECNO 42385.000

3301 HV CHANGED MORE THAN HVINS

42385.000	4.93	1715.10	1714.36	.00	1716.26	1.16	1.25	.07	1730.20
[illegible]3398.0	.0	3398.0	.0	.0	392.5	.0	1.6	.4	1730.17
[illegible].00	.00	8.66	.00	.000	.033	.000	.000	1710.17	60.33
.006015	150.	150.	150.	3	8	0	.00	99.38	159.70

*SECNO 42210.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .33

42210.000	4.62	1715.93	1715.82	.00	1717.23	1.30	.93	.04	1731.30
1200.0	.0	1200.0	.0	.0	131.3	.0	2.5	.7	1731.31
.01	.00	9.14	.00	.000	.026	.000	.000	1711.31	61.54
.006696	150.	150.	150.	2	11	0	.00	46.92	108.45

*SECNO 42200.000

42200.000	4.59	1716.09	1716.02	.00	1717.40	1.32	.17	.01	1731.49
1200.0	.0	1200.0	.0	.0	130.2	.0	2.5	.7	1731.50
.01	.00	9.22	.00	.000	.026	.000	.000	1711.50	61.63
.006848	25.	25.	25.	0	8	0	.00	46.73	108.36

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T1      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 425+25 - 422
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
        TOYOTA EAST CHANNEL            MODEL: TOY104C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

              3                     -1                      0      1712

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 42525.000

3720 CRITICAL DEPTH ASSUMED

42525.000	1.82	1710.85	1710.85	1712.00	1711.72	.87	.00	.00	1729.00
1595.0	.0	1595.0	.0	.0	213.3	.0	.0	.0	1729.03
.00	.00	7.48	.00	.000	.033	.000	.000	1709.03	72.72
.013530	0.	0.	0.	0	13	0	.00	124.56	197.27

*SECNO 42385.000

42385.000	2.48	1712.65	1712.08	.00	1713.13	.48	1.38	.04	1730.20
968.0	.0	968.0	.0	.0	173.3	.0	.7	.4	1730.17
.01	.00	5.58	.00	.000	.033	.000	.000	1710.17	70.10
.005526	150.	150.	150.	2	8	0	.00	79.82	149.92

*SECNO 42210.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

42210.000	2.41	1713.72	1713.72	.00	1714.53	.81	.92	.10	1731.30
341.0	.0	341.0	.0	.0	47.2	.0	1.0	.5	1731.31
.01	.00	7.22	.00	.000	.026	.000	.000	1711.31	70.37
.008653	150.	150.	150.	0	8	0	.00	29.26	99.63

*SECNO 42200.000

42200.000	2.54	1714.04	1713.90	.00	1714.73	.69	.19	.01	1731.49
341.0	.0	341.0	.0	.0	51.0	.0	1.1	.6	1731.50
.01	.00	6.68	.00	.000	.026	.000	.000	1711.50	69.86
.007009	25.	25.	25.	3	5	0	.00	30.27	100.13

THIS RUN EXECUTED 29AUG91 15:24:17

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HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
*	42525.000	5596.00	1713.12	1709.03	4.09	10.84	1.00	142.71	33.00	.00	105.32	.00	.00
*	42525.000	1595.00	1710.85	1709.03	1.82	7.48	1.01	124.56	33.00	.00	135.30	.00	.00
	42385.000	3398.00	1715.10	1710.17	4.93	8.66	.77	99.38	33.00	7.60	60.15	150.00	150.00
	42385.000	968.00	1712.65	1710.17	2.48	5.58	.67	79.82	33.00	7.60	55.26	150.00	150.00
	210.000	1200.00	1715.93	1711.31	4.62	9.14	.96	46.92	26.00	7.60	66.96	150.00	300.00
	210.000	341.00	1713.72	1711.31	2.41	7.22	1.00	29.26	26.00	7.60	86.53	150.00	300.00
	42200.000	1200.00	1716.09	1711.50	4.59	9.22	.97	46.73	26.00	7.60	68.48	25.00	325.00
	42200.000	341.00	1714.04	1711.50	2.54	6.68	.91	30.27	26.00	7.60	70.09	25.00	325.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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CAUTION SECNO=  42525.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  42525.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=  42210.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=  42210.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  42210.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY
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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    02SEP91    TIME   15:17:34 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX             XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 02SEP91 15:17:35

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*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
*************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 422 - 374
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: TOY105C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                          -1                          0      1720

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1                                   -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43        1       42        8       26       68        4       17       33
     5       39       66

NC    .050     .050     .026       .1       .3
QT       2     1200      341
X1   42200        4        0      170
GR  1733.9        0   1713.9       80   1713.9       90   1733.9      170

X1   41800        0        0        0      421      421      421                3.2

X1   41400        0        0        0      421      421      421                3.3

X1   41000        0        0        0      421      421      421                2.0

X1   40600        0        0        0      421      421      421                2.0

X1   40200        0        0        0      421      421      421                2.1

X1   39800        0        0        0      421      421      421                2.0

X1   39400        0        0        0      421      421      421                2.0

X1   39000        0        0        0      421      421      421                2.0
```

	38600	0	0	0	421	421	421	2.1
X1	38200	0	0	0	380	380	380	1.8
QT	2	579	252					
X1	37800	0	0	0	414	414	414	2.0
X1	37400	0	0	0	397	397	397	1.9

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 42200.000
3720 CRITICAL DEPTH ASSUMED

42200.000	4.51	1718.41	1718.41	1720.00	1719.81	1.40	.00	.00	1733.90
1200.0	.0	1200.0	.0	.0	126.4	.0	.0	.0	1733.90
.00	.00	9.49	.00	.000	.026	.000	.000	1713.90	61.96
.007409	0.	0.	0.	0	18	0	.00	46.08	108.04

*SECNO 41800.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

41800.000	4.52	1721.62	1721.62	.00	1723.01	1.39	3.11	.00	1737.10
1200.0	.0	1200.0	.0	.0	126.8	.0	1.2	.4	1737.10
.01	.00	9.47	.00	.000	.026	.000	.000	1717.10	61.93
.007359	421.	421.	421.	0	5	0	.00	46.13	108.07

*SECNO 41400.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

41400.000	4.51	1724.91	1724.91	.00	1726.31	1.39	3.10	.00	1740.40
1200.0	.0	1200.0	.0	.0	126.7	.0	2.4	.9	1740.40
.02	.00	9.47	.00	.000	.026	.000	.000	1720.40	61.94
.007370	421.	421.	421.	0	5	0	.00	46.12	108.06

*SECNO 41000.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.41

41000.000	5.27	1727.67	1726.91	.00	1728.50	.84	2.14	.06	1742.40
1200.0	.0	1200.0	.0	.0	163.5	.0	3.9	1.4	1742.40
.04	.00	7.34	.00	.000	.026	.000	.000	1722.40	58.94
.003711	421.	421.	421.	2	5	0	.00	52.11	111.06

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 40600.000									
40600.000	4.92	1729.32	1728.91	.00	1730.37	1.05	1.81	.06	1744.40
1200.0	.0	1200.0	.0	.0	146.2	.0	5.3	1.9	1744.40
.05	.00	8.21	.00	.000	.026	.000	.000	1724.40	60.31
.005011	421.	421.	421.	3	15	0	.00	49.39	109.69
*SECNO 40200.000									
40200.000	4.93	1731.43	1731.01	.00	1732.47	1.04	2.10	.00	1746.50
1200.0	.0	1200.0	.0	.0	146.6	.0	6.8	2.3	1746.50
.07	.00	8.19	.00	.000	.026	.000	.000	1726.50	60.28
.004977	421.	421.	421.	2	11	0	.00	49.45	109.72
*SECNO 39800.000									
39800.000	5.01	1733.51	1733.01	.00	1734.50	.99	2.02	.01	1748.50
1200.0	.0	1200.0	.0	.0	150.6	.0	8.2	2.8	1748.50
.08	.00	7.97	.00	.000	.026	.000	.000	1728.50	59.95
.004625	421.	421.	421.	2	11	0	.00	50.10	110.05
*SECNO 39400.000									
39400.000	4.98	1735.48	1735.01	.00	1736.49	1.01	1.98	.01	1750.50
1200.0	.0	1200.0	.0	.0	148.6	.0	9.6	3.3	1750.50
.10	.00	8.07	.00	.000	.026	.000	.000	1730.50	60.11
.004793	421.	421.	421.	2	11	0	.00	49.78	109.89
*SECNO 39000.000									
39000.000	4.99	1737.49	1737.01	.00	1738.49	1.00	2.00	.00	1752.50
1200.0	.0	1200.0	.0	.0	149.5	.0	11.1	3.8	1752.50
.11	.00	8.03	.00	.000	.026	.000	.000	1732.50	60.04
.004722	421.	421.	421.	2	11	0	.00	49.91	109.96
*SECNO 38600.000									
38600.000	4.91	1739.51	1739.11	.00	1740.57	1.06	2.06	.02	1754.60
1200.0	.0	1200.0	.0	.0	145.4	.0	12.5	4.3	1754.60
.13	.00	8.25	.00	.000	.026	.000	.000	1734.60	60.37
.005088	421.	421.	421.	1	11	0	.00	49.25	109.63

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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
             QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 38200.000
 38200.000      5.03   1741.43   1740.91       .00   1742.41       .97      1.82       .01   1756.40
    1200.0        .0    1200.0        .0        .0     151.7        .0      13.8       4.7   1756.40
       .14       .00      7.91       .00      .000      .026      .000      .000   1736.40     59.87
   .004539      380.      380.      380.         2        11         0       .00     50.27    110.13


*SECNO 37800.000

3301 HV CHANGED MORE THAN HVINS

 37800.000      4.92   1743.32   1741.55       .00   1743.56       .24      1.09       .07   1758.40
     579.0        .0     579.0        .0        .0     146.0        .0      15.2       5.2   1758.40
       .17       .00      3.96       .00      .000      .026      .000      .000   1738.40     60.32
   .001170      414.      414.      414.         2        14         0       .00     49.36    109.68


*SECNO 37400.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .48

     0.000      3.53   1743.83   1743.45       .00   1744.55       .71       .84       .14   1760.30
     579.0        .0     579.0        .0        .0      85.3        .0      16.3       5.6   1760.30
       .19       .00      6.78       .00      .000      .026      .000      .000   1740.30     65.86
   .004986      397.      397.      397.         3        14         0       .00     38.28    104.14
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T1      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 422 - 374
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
        TOYOTA EAST CHANNEL            MODEL: TOY105C.IN,  SUBCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

                3                         -1                         0      1720

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    15                 -1                                  -1
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
             QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS



CCHV=     .100 CEHV=     .300
*SECNO 42200.000
3720 CRITICAL DEPTH ASSUMED
 42200.000      2.40   1716.30   1716.30   1720.00   1717.12       .82       .00       .00   1733.90
     341.0        .0     341.0        .0        .0      46.9        .0        .0        .0   1733.90
       .00       .00      7.26       .00      .000      .026      .000      .000   1713.90     70.41
   .008798        0.        0.        0.         0        17         0       .00     29.17     99.59


*SECNO 41800.000
 41800.000      2.57   1719.67   1719.50       .00   1720.33       .67      3.20       .02   1737.10
     341.0        .0     341.0        .0        .0      52.0        .0        .5        .3   1737.10
       .02       .00      6.55       .00      .000      .026      .000      .000   1717.10     69.73
   .006642      421.      421.      421.         3         5         0       .00     30.54    100.27


*SECNO 41400.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 41400.000      2.40   1722.80   1722.80       .00   1723.62       .82      3.20       .05   1740.40
     341.0        .0     341.0        .0        .0      47.0        .0       1.0        .6   1740.40
       .03       .00      7.26       .00      .000      .026      .000      .000   1720.40     70.41
   .008783      421.      421.      421.         0        11         0       .00     29.18     99.59


*SECNO 41000.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.61

 41000.000      3.02   1725.42   1724.80       .00   1725.83       .41      2.17       .04   1742.40
     341.0        .0     341.0        .0        .0      66.7        .0       1.5        .9   1742.40
       .06       .00      5.12       .00      .000      .026      .000      .000   1722.40     67.92
   .003381      421.      421.      421.         3         5         0       .00     34.15    102.08


*SECNO 40600.000
 40600.000      2.69   1727.09   1726.80       .00   1727.67       .58      1.79       .05   1744.40
     341.0        .0     341.0        .0        .0      55.7        .0       2.1       1.2   1744.40
       .08       .00      6.12       .00      .000      .026      .000      .000   1724.40     69.25
   .005504      421.      421.      421.         3        15         0       .00     31.49    100.75
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 40200.000									
40200.000	2.79	1729.29	1728.90	.00	1729.80	.51	2.13	.01	1746.50
341.0	.0	341.0	.0	.0	59.3	.0	2.7	1.5	1746.50
.10	.00	5.75	.00	.000	.026	.000	.000	1726.50	68.81
.004655	421.	421.	421.	2	11	0	.00	32.38	101.19
*SECNO 39800.000									
39800.000	2.77	1731.27	1730.90	.00	1731.80	.53	2.00	.00	1748.50
341.0	.0	341.0	.0	.0	58.4	.0	3.2	1.8	1748.50
.12	.00	5.83	.00	.000	.026	.000	.000	1728.50	68.91
.004834	421.	421.	421.	2	15	0	.00	32.17	101.09
*SECNO 39400.000									
39400.000	2.79	1733.29	1732.90	.00	1733.81	.52	2.01	.00	1750.50
341.0	.0	341.0	.0	.0	59.1	.0	3.8	2.1	1750.50
.14	.00	5.77	.00	.000	.026	.000	.000	1730.50	68.84
.004700	421.	421.	421.	1	11	0	.00	32.33	101.16
*SECNO 39000.000									
39000.000	2.78	1735.28	1734.90	.00	1735.80	.52	1.99	.00	1752.50
341.0	.0	341.0	.0	.0	58.8	.0	4.4	2.4	1752.50
.16	.00	5.80	.00	.000	.026	.000	.000	1732.50	68.87
.004762	421.	421.	421.	1	15	0	.00	32.25	101.13
*SECNO 38600.000									
38600.000	2.73	1737.33	1737.01	.00	1737.88	.55	2.07	.01	1754.60
341.0	.0	341.0	.0	.0	57.4	.0	4.9	2.8	1754.60
.18	.00	5.94	.00	.000	.026	.000	.000	1734.60	69.04
.005067	421.	421.	421.	1	11	0	.00	31.92	100.96
*SECNO 38200.000									
38200.000	2.81	1739.21	1738.80	.00	1739.72	.51	1.83	.00	1756.40
341.0	.0	341.0	.0	.0	59.5	.0	5.4	3.0	1756.40
.19	.00	5.73	.00	.000	.026	.000	.000	1736.40	68.78
.004602	380.	380.	380.	1	11	0	.00	32.44	101.22

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 37800.000

37800.000	2.63	1741.03	1740.44	.00	1741.37	.34	1.64	.02	1758.40
252.0	.0	252.0	.0	.0	54.0	.0	6.0	3.3	1758.40
.22	.00	4.67	.00	.000	.026	.000	.000	1738.40	69.47
.003274	414.	414.	414.	2	19	0	.00	31.05	100.53

*SECNO 37400.000

37400.000	2.30	1742.60	1742.34	.00	1743.11	.51	1.69	.05	1760.30
252.0	.0	252.0	.0	.0	44.0	.0	6.4	3.6	1760.30
.24	.00	5.73	.00	.000	.026	.000	.000	1740.30	70.82
.005733	397.	397.	397.	0	15	0	.00	28.36	99.18

THIS RUN EXECUTED 02SEP91 15:17:52

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
*	42200.000	1200.00	1718.41	1713.90	4.51	9.49	1.01	46.08	26.00	.00	74.09	.00	.00
*	42200.000	341.00	1716.30	1713.90	2.40	7.26	1.01	29.17	26.00	.00	87.98	.00	.00
*	41800.000	1200.00	1721.62	1717.10	4.52	9.47	1.01	46.13	26.00	7.60	73.59	421.00	421.00
	41800.000	341.00	1719.67	1717.10	2.57	6.55	.88	30.54	26.00	7.60	66.42	421.00	421.00
	41400.000	1200.00	1724.91	1720.40	4.51	9.47	1.01	46.12	26.00	7.84	73.70	421.00	842.00
	41400.000	341.00	1722.80	1720.40	2.40	7.26	1.01	29.18	26.00	7.84	87.83	421.00	842.00
*	41000.000	1200.00	1727.67	1722.40	5.27	7.34	.73	52.11	26.00	4.75	37.11	421.00	1263.00
*	41000.000	341.00	1725.42	1722.40	3.02	5.12	.65	34.15	26.00	4.75	33.81	421.00	1263.00
	40600.000	1200.00	1729.32	1724.40	4.92	8.21	.84	49.39	26.00	4.75	50.11	421.00	1684.00
	40600.000	341.00	1727.09	1724.40	2.69	6.12	.81	31.49	26.00	4.75	55.04	421.00	1684.00
	40200.000	1200.00	1731.43	1726.50	4.93	8.19	.84	49.45	26.00	4.99	49.77	421.00	2105.00
	40200.000	341.00	1729.29	1726.50	2.79	5.75	.75	32.38	26.00	4.99	46.55	421.00	2105.00
	39800.000	1200.00	1733.51	1728.50	5.01	7.97	.81	50.10	26.00	4.75	46.25	421.00	2526.00
	39800.000	341.00	1731.27	1728.50	2.77	5.83	.76	32.17	26.00	4.75	48.34	421.00	2526.00
	39400.000	1200.00	1735.48	1730.50	4.98	8.07	.82	49.78	26.00	4.75	47.93	421.00	2947.00
	39400.000	341.00	1733.29	1730.50	2.79	5.77	.75	32.33	26.00	4.75	47.00	421.00	2947.00
	39000.000	1200.00	1737.49	1732.50	4.99	8.03	.82	49.91	26.00	4.75	47.22	421.00	3368.00
	39000.000	341.00	1735.28	1732.50	2.78	5.80	.76	32.25	26.00	4.75	47.62	421.00	3368.00
	38600.000	1200.00	1739.51	1734.60	4.91	8.25	.85	49.25	26.00	4.99	50.88	421.00	3789.00
	38600.000	341.00	1737.33	1734.60	2.73	5.94	.78	31.92	26.00	4.99	50.67	421.00	3789.00
	38200.000	1200.00	1741.43	1736.40	5.03	7.91	.80	50.27	26.00	4.74	45.39	380.00	4169.00
	38200.000	341.00	1739.21	1736.40	2.81	5.73	.75	32.44	26.00	4.74	46.02	380.00	4169.00

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	37800.000	579.00	1743.32	1738.40	4.92	3.96	.41	49.36	26.00	4.83	11.70	414.00	4583.00
	37800.000	252.00	1741.03	1738.40	2.63	4.67	.62	31.05	26.00	4.83	32.74	414.00	4583.00
*	37400.000	579.00	1743.83	1740.30	3.53	6.78	.80	38.28	26.00	4.79	49.86	397.00	4980.00
	37400.000	252.00	1742.60	1740.30	2.30	5.73	.81	28.36	26.00	4.79	57.33	397.00	4980.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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CAUTION SECNO=  42200.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  42200.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

CAUTION SECNO=  41800.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  41800.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=  41400.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  41400.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  41400.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  41400.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  41000.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  41000.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  37400.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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APPENDIX B

Supercritical
HEC-2 Models

Toyota Arizona Proving Grounds

Model SUP101C4.IN/.OT - XSEC 506 TO 468+57
Model SUP102C4.IN/.OT - XSEC 468+57 TO 446
Model SUP103C.IN/.OT - XSEC 446 TO 425+25
Model SUP104C.IN/.OT - XSEC 425+25 TO 422
Model SUP105C.IN/.OT - XSEC 422 TO 374

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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    02SEP91    TIME   15:39:55 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 02SEP91 15:39:55

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*************************************
HEC-2 WATER SURFACE PROFILES

Version   4.5.1;  September 1990
*************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 506 - 468.57
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: SUP101C4.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      PROFILE ADJUSTED ON 8/23/91 TO MATCH ACCESS ROAD ELEVATIONS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                 1      .0076                      0      1669

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    1                 -1                                     -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43       1        42       8        26       68       4        17       33
    5        39       66

NC    .023     .023     .023     .1       .3
QT    2        5596     1595
X1    46857    4        0        270      143      143      143
GR    1686.8   0        1666.79  80       1666.79  190      1686.8   270

X1    47000    0        0        0        419      419      419                -1.09

X1    47400    0        0        0        217      217      217                -3.18

X1    47602    0        0        0        34       34       34                 -1.65

X1    47636    0        0        0        164      164      164                -1.36

X1    47800    0        0        0        400      400      400                -1.21

NC    .040     .040     .035     .1       .3
X1    48200    27       92       2019     400      400      400
X3                                 910              1220
GR    1662     92       1660     107      1659     120      1660     130      1662     147
GR    1663     263      1662     409      1663     540      1662     655      1662     768
GR    1660     812      1660     839      1661     889      1660     1020     1658     1033
GR    1656     1040     1655.7   1050     1656     1056     1658     1062     1660     1141
GR    1660     1195     1662     1218     1662     1359     1664     1420     1664     1630
GR    1662     1885     1662     2019
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	48600	27	39	2057	402	402	402			
X3				805		1265				
GR	1660	39	1658	90	1656	146	1658	198	1660	346
GR	1658	510	1659	638	1658	745	1656	944	1654	961
GR	1654	1020	1652.2	1032	1654	1049	1656	1060	1656	1182
GR	1658	1207	1659	1306	1658	1410	1657	1460	1658	1510
GR	1659	1598	1658	1700	1656	1718	1658	1745	1660	1882
GR	1658	2010	1658	2057						
X1	49000	25	45	2043	400	400	400			
X3				695		1350				
GR	1657	45	1656	138	1654	155	1654	182	1656	255
GR	1656	480	1655	522	1656	570	1656	800	1654	848
GR	1652	950	1653	1005	1652	1040	1650	1049	1648.3	1061
GR	1650	1072	1652	1140	1654	1187	1654	1306	1652	1491
GR	1652	1531	1654	1558	1654	1860	1656	1915	1656	2043
X1	49400	24	194	2079	415	415	415			
X3				710		1470				
GR	1654	194	1652	222	1650	255	1650	279	1652	298
GR	1652	456	1652	589	1650	608	1652	678	1650	972
GR	1648	1091	1646	1096	1645.3	1103	1646	1112	1648	1128
GR	1650	1207	1648	1405	1650	1430	1650	1470	1649	1530
GR	1650	1570	1651	1715	1650	1885	1650	2079		
	49800	19	520	2070	420	420	420			
				900		1590				
GR	1650	520	1648	581	1646	679	1646	710	1648	824
GR	1648	984	1646	1177	1644	1190	1642.7	1200	1644	1214
GR	1645	1280	1644	1355	1646	1380	1647	1480	1646	1948
GR	1644	1970	1645	2015	1644	2045	1646	2070		
X1	50200	22	0	1240	415	415	415			
X3				225		830				
GR	1645	0	1644	88	1642	100	1640	128	1644	154
GR	1644	280	1642	440	1640	453	1639.4	463	1640	478
GR	1642	630	1644	678	1644	860	1642	1030	1640	1090
GR	1638	1095	1638	1118	1640	1134	1638	1158	1638	1180
GR	1642	1202	1644	1240						
X1	50600	21	0	848						
X3				170		710				
GR	1642	0	1640	78	1638	100	1636	106	1636	118
GR	1638	128	1640	178	1638	250	1638	294	1636	300
GR	1635.6	305	1636	310	1638	320	1640	393	1640	579
GR	1638	647	1640	707	1638	796	1633.8	810	1638	829
GR	1640	848								

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 46857.000

46857.000	3.64	1670.43	1670.88	1669.00	1672.80	2.37	.00	.00	1686.80
5596.0	.0	5596.0	.0	.0	453.0	.0	.0	.0	1686.80
.00	.00	12.35	.00	.000	.023	.000	.000	1666.79	65.46
.007637	0.	0.	0.	0	14	4	.00	139.08	204.54

*SECNO 47000.000

47000.000	3.66	1669.36	1669.79	.00	1671.71	2.34	1.08	.01	1685.71
5596.0	.0	5596.0	.0	.0	455.7	.0	1.5	.5	1685.71
.00	.00	12.28	.00	.000	.023	.000	.000	1665.70	65.38
.007498	143.	143.	143.	7	8	0	.00	139.24	204.62

*SECNO 47400.000

[illegible].000	3.63	1666.15	1666.61	.00	1668.52	2.38	3.18	.00	1682.53
[illegible]596.0	.0	5596.0	.0	.0	452.2	.0	5.9	1.8	1682.53
.01	.00	12.38	.00	.000	.023	.000	.000	1662.52	65.48
.007679	419.	419.	419.	5	8	0	.00	139.04	204.52

*SECNO 47602.000

47602.000	3.65	1664.52	1664.96	.00	1666.87	2.34	1.65	.01	1680.88
5596.0	.0	5596.0	.0	.0	455.5	.0	8.1	2.5	1680.88
.02	.00	12.28	.00	.000	.023	.000	.000	1660.87	65.39
.007507	217.	217.	217.	5	8	0	.00	139.23	204.61

*SECNO 47636.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.50

47636.000	2.88	1662.39	1663.60	.00	1666.34	3.94	.37	.16	1679.52
5596.0	.0	5596.0	.0	.0	351.1	.0	8.4	2.6	1679.52
.02	.00	15.94	.00	.000	.023	.000	.000	1659.51	68.45
.016815	34.	34.	34.	11	8	0	.00	133.10	201.55

```
 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
           QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 47800.000

3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .59

 47800.000      3.92   1662.22   1662.39       .00   1664.23      2.01      1.53       .58   1678.31
    5596.0        .0    5596.0        .0        .0    492.1        .0      10.0       3.1   1678.31
       .02       .00     11.37       .00      .000      .023      .000      .000   1658.30     64.34
   .005923      164.      164.      164.         3        11         0       .00    141.31    205.66


CCHV=     .100 CEHV=     .300
*SECNO 48200.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
     CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      910.0    1220.0  TYPE=      1  TARGET=      310.000
 48200.000      6.02   1661.72   1661.72       .00   1662.84      1.12      3.53      2.96 100000.00
    5596.0        .0    5596.0        .0        .0     657.7        .0      15.3       5.2 100000.00
       .04       .00      8.51       .00      .000      .035      .000      .000   1655.70    910.00
   .014506      400.      400.      400.        20        14         0       .00    304.75   1214.75


*SECNO 48600.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      805.0    1265.0  TYPE=      1  TARGET=      460.000
 48600.000      5.37   1657.57   1657.57       .00   1658.46       .89      5.68       .89 100000.00
    5596.0        .0    5596.0        .0        .0     739.1        .0      21.7       8.4 100000.00
       .05       .00      7.57       .00      .000      .035      .000      .000   1652.20    805.00
   .013900      400.      400.      400.        20        10         0       .00    396.59   1201.59


*SECNO 49000.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
           QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      695.0    1350.0  TYPE=      1  TARGET=      655.000
 49000.000      6.03   1654.33   1654.33       .00   1655.08       .76      5.77      1.04 100000.00
    5596.0        .0    5596.0        .0        .0     802.0        .0      28.8      12.6 100000.00
       .07       .00      6.98       .00      .000      .035      .000      .000   1648.30    840.17
   .014818      402.      402.      402.        20         9         0       .00    509.82   1350.00


*SECNO 49400.000
3280 CROSS SECTION  49400.00 EXTENDED       .49 FEET

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      710.0    1470.0  TYPE=      1  TARGET=      760.000
 49400.000      5.19   1650.49   1650.49       .00   1651.22       .73      6.19      7.15 100000.00
    5596.0        .0    5596.0        .0        .0     817.3        .0      36.3      17.5 100000.00
       .08       .00      6.85       .00      .000      .035      .000      .000   1645.30    899.45
   .016151      400.      400.      400.        20         9         0       .00    570.55   1470.00


*SECNO 49800.000
3280 CROSS SECTION  49800.00 EXTENDED      1.39 FEET

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      900.0    1590.0  TYPE=      1  TARGET=      690.000
 49800.000      4.69   1647.39   1647.39       .00   1648.09       .70      6.31      5.13 100000.00
    5596.0        .0    5596.0        .0        .0     833.2        .0      44.1      22.8 100000.00
       .10       .00      6.72       .00      .000      .035      .000      .000   1642.70   1042.89
   .014318      415.      415.      415.        20        10         0       .00    547.11   1590.00


*SECNO 50200.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3470 ENCROACHMENT STATIONS= 225.0 830.0 TYPE= 1 TARGET= 605.000

50200.000	5.71	1643.71	1643.71	.00	1644.70	1.00	6.18	6.16	100000.00
5596.0	.0	5596.0	.0	.0	698.4	.0	51.5	27.3	100000.00
.11	.00	8.01	.00	.000	.035	.000	.000	1638.00	303.43
.015145	420.	420.	420.	20	12	0	.00	367.54	670.97

*SECNO 50600.000
3280 CROSS SECTION 50600.00 EXTENDED .64 FEET

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 170.0 710.0 TYPE= 1 TARGET= 540.000

50600.000	6.84	1640.64	1640.64	.00	1641.40	.77	6.53	9.23	100000.00
5596.0	.0	5596.0	.0	.0	797.1	.0	58.6	31.6	100000.00
.13	.00	7.02	.00	.000	.035	.000	.000	1633.80	170.00
.016364	415.	415.	415.	20	12	0	.00	540.00	710.00

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T1      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 506 - 468.57
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: SUP101C4.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      PROFILE ADJUSTED ON 8/23/91 TO MATCH ACCESS ROAD ELEVATIONS

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

             3               1     .0076                           0     1669

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 46857.000

46857.000	1.74	1668.53	1668.61	1669.00	1669.48	.96	.00	.00	1686.80
1595.0	.0	1595.0	.0	.0	203.1	.0	.0	.0	1686.80
.00	.00	7.85	.00	.000	.023	.000	.000	1666.79	73.06
.007677	0.	0.	0.	0	15	5	.00	123.89	196.94

*SECNO 47000.000

47000.000	1.74	1667.44	1667.52	.00	1668.39	.95	1.09	.00	1685.71
1595.0	.0	1595.0	.0	.0	203.8	.0	.7	.4	1685.71
.01	.00	7.83	.00	.000	.023	.000	.000	1665.70	73.03
.007597	143.	143.	143.	2	8	0	.00	123.93	196.97

*SECNO 47400.000

[illegible].000	1.74	1664.26	1664.34	.00	1665.21	.95	3.18	.00	1682.53
1595.0	.0	1595.0	.0	.0	203.8	.0	2.6	1.6	1682.53
.02	.00	7.83	.00	.000	.023	.000	.000	1662.52	73.03
.007592	419.	419.	419.	2	8	0	.00	123.93	196.97

*SECNO 47602.000

47602.000	1.74	1662.61	1662.69	.00	1663.56	.95	1.65	.00	1680.88
1595.0	.0	1595.0	.0	.0	203.7	.0	3.6	2.2	1680.88
.03	.00	7.83	.00	.000	.023	.000	.000	1660.87	73.04
.007606	217.	217.	217.	2	8	0	.00	123.93	196.96

*SECNO 47636.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.03

47636.000	1.15	1660.66	1661.33	.00	1662.96	2.30	.46	.13	1679.52
1595.0	.0	1595.0	.0	.0	131.2	.0	3.8	2.3	1679.52
.03	.00	12.16	.00	.000	.023	.000	.000	1659.51	75.42
.031265	34.	34.	34.	7	8	0	.00	119.15	194.58

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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
           QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 47800.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 47800.000      1.82   1660.12   1660.12       .00   1660.99       .87      2.02      1.53   1678.31
    1595.0        .0    1595.0       .0        .0     213.4        .0       4.4       2.8   1678.31
       .03       .00      7.47       .00      .000      .023      .000      .000   1658.30     72.72
   .006555      164.      164.      164.        20        14         0       .00    124.55    197.28


CCHV=     .100 CEHV=     .300
*SECNO 48200.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      910.0    1220.0  TYPE=      1  TARGET=      310.000
  0.000      4.65   1660.35   1660.35       .00   1660.90       .55      3.88      1.47 100000.00
 595.0        .0    1595.0       .0        .0     267.0        .0       6.6       4.4 100000.00
       .05       .00      5.97       .00      .000      .035      .000      .000   1655.70    974.35
   .015793      400.      400.      400.        20        19         0       .00    224.66   1199.01


*SECNO 48600.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      805.0    1265.0  TYPE=      1  TARGET=      460.000
 48600.000      3.95   1656.15   1656.15       .00   1656.70       .56      6.88       .03 100000.00
    1595.0        .0    1595.0       .0        .0     266.1        .0       9.1       6.6 100000.00
       .07       .00      5.99       .00      .000      .035      .000      .000   1652.20    929.44
   .018815      400.      400.      400.        20         9         0       .00    254.39   1183.83


*SECNO 49000.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 695.0 1350.0 TYPE= 1 TARGET= 655.000

49000.000	4.41	1652.71	1652.71	.00	1653.32	.60	7.28	4.56	100000.00
1595.0	.0	1595.0	.0	.0	255.6	.0	11.5	8.7	100000.00
.09	.00	6.24	.00	.000	.035	.000	.000	1648.30	913.65
.017447	402.	402.	402.	20	8	0	.00	217.25	1156.75

*SECNO 49400.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 710.0 1470.0 TYPE= 1 TARGET= 760.000

49400.000	3.99	1649.29	1649.29	.00	1649.79	.50	7.54	8.69	100000.00
1595.0	.0	1595.0	.0	.0	280.3	.0	13.9	11.2	100000.00
.11	.00	5.69	.00	.000	.035	.000	.000	1645.30	1014.48
.020406	400.	400.	400.	20	9	0	.00	307.73	1421.08

*SECNO 49800.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 900.0 1590.0 TYPE= 1 TARGET= 690.000

49800.000	3.01	1645.71	1645.71	.00	1646.32	.60	7.30	7.29	100000.00
1595.0	.0	1595.0	.0	.0	255.9	.0	16.5	13.6	100000.00
.13	.00	6.23	.00	.000	.035	.000	.000	1642.70	1178.86
.015308	415.	415.	415.	20	14	0	.00	197.57	1376.43

*SECNO 50200.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 225.0 830.0 TYPE= 1 TARGET= 605.000

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
50200.000	4.12	1642.12	1642.12	.00	1642.77	.66	6.99	6.68	100000.00
1595.0	.0	1595.0	.0	.0	245.2	.0	18.9	15.5	100000.00
.15	.00	6.50	.00	.000	.035	.000	.000	1638.00	430.73
.018155	420.	420.	420.	20	14	0	.00	202.05	632.78

*SECNO 50600.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 170.0 710.0 TYPE= 1 TARGET= 540.000

50600.000	5.60	1639.40	1639.40	.00	1639.94	.54	7.59	11.35	100000.00
1595.0	.0	1595.0	.0	.0	271.0	.0	21.4	17.7	100000.00
.17	.00	5.89	.00	.000	.035	.000	.000	1633.80	199.43
.018402	415.	415.	415.	20	15	0	.00	261.75	689.14

THIS RUN EXECUTED 02SEP91 15:40:39

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	46857.000	5596.00	1670.43	1666.79	3.64	12.35	1.21	139.08	23.00	.00	76.37	.00	3829.00
	46857.000	1595.00	1668.53	1666.79	1.74	7.85	1.08	123.89	23.00	.00	76.77	.00	3829.00
	47000.000	5596.00	1669.36	1665.70	3.66	12.28	1.20	139.24	23.00	-7.62	74.98	143.00	3686.00
	47000.000	1595.00	1667.44	1665.70	1.74	7.83	1.08	123.93	23.00	-7.62	75.97	143.00	3686.00
	[illegible]400.000	5596.00	1666.15	1662.52	3.63	12.38	1.21	139.04	23.00	-7.59	76.79	419.00	3267.00
	[illegible]400.000	1595.00	1664.26	1662.52	1.74	7.83	1.08	123.93	23.00	-7.59	75.92	419.00	3267.00
	47602.000	5596.00	1664.52	1660.87	3.65	12.28	1.20	139.23	23.00	-7.60	75.07	217.00	3050.00
	47602.000	1595.00	1662.61	1660.87	1.74	7.83	1.08	123.93	23.00	-7.60	76.06	217.00	3050.00
*	47636.000	5596.00	1662.39	1659.51	2.88	15.94	1.73	133.10	23.00	-40.00	168.15	34.00	3016.00
*	47636.000	1595.00	1660.66	1659.51	1.15	12.16	2.04	119.15	23.00	-40.00	312.65	34.00	3016.00
*	47800.000	5596.00	1662.22	1658.30	3.92	11.37	1.07	141.31	23.00	-7.38	59.23	164.00	2852.00
*	47800.000	1595.00	1660.12	1658.30	1.82	7.47	1.01	124.55	23.00	-7.38	65.55	164.00	2852.00
*	48200.000	5596.00	1661.72	1655.70	6.02	8.51	1.02	304.75	35.00	-6.50	145.06	400.00	2452.00
*	48200.000	1595.00	1660.35	1655.70	4.65	5.97	.97	224.66	35.00	-6.50	157.93	400.00	2452.00
*	48600.000	5596.00	1657.57	1652.20	5.37	7.57	.98	396.59	35.00	-8.75	139.00	400.00	2052.00
*	48600.000	1595.00	1656.15	1652.20	3.95	5.99	1.03	254.39	35.00	-8.75	188.15	400.00	2052.00
*	49000.000	5596.00	1654.33	1648.30	6.03	6.98	.98	509.82	35.00	-9.70	148.18	402.00	1650.00
*	49000.000	1595.00	1652.71	1648.30	4.41	6.24	1.07	217.25	35.00	-9.70	174.47	402.00	1650.00
*	49400.000	5596.00	1650.49	1645.30	5.19	6.85	1.01	570.55	35.00	-7.50	161.51	400.00	1250.00
*	49400.000	1595.00	1649.29	1645.30	3.99	5.69	1.21	307.73	35.00	-7.50	204.06	400.00	1250.00
*	[illegible]9800.000	5596.00	1647.39	1642.70	4.69	6.72	.96	547.11	35.00	-6.27	143.18	415.00	835.00
	[illegible]800.000	1595.00	1645.71	1642.70	3.01	6.23	.97	197.57	35.00	-6.27	153.08	415.00	835.00

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
*	50200.000	5596.00	1643.71	1638.00	5.71	8.01	1.02	367.54	35.00	-11.19	151.45	420.00	415.00
*	50200.000	1595.00	1642.12	1638.00	4.12	6.50	1.04	202.05	35.00	-11.19	181.55	420.00	415.00
*	50600.000	5596.00	1640.64	1633.80	6.84	7.02	1.02	540.00	35.00	-10.12	163.64	415.00	.00
*	50600.000	1595.00	1639.40	1633.80	5.60	5.89	1.39	261.75	35.00	-10.12	184.02	415.00	.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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WARNING SECNO=  47636.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  47636.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  47800.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=  47800.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  47800.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  47800.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  48200.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  48200.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  48200.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  48200.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  48200.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  48200.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  48600.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  48600.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  48600.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  48600.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  48600.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  48600.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  49000.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49000.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49000.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  49000.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49000.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49000.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  49400.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49400.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49400.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  49400.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49400.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49400.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  49800.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49800.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49800.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  49800.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  49800.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  49800.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  50200.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  50200.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  50200.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  50200.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  50200.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  50200.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  50600.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
```

```
CAUTION SECNO=  50600.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  50600.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  50600.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  50600.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  50600.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL
```

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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    02SEP91    TIME   15:41:05 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX             XXXXX
X     X  X       X     X           X     X
X     X  X       X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X       X                 X
X     X  X       X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 02SEP91 15:41:06

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HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
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T1 TOYOTA DESERT PROVING GROUNDS, 100-YEAR EVENT, XSEC 468.57 - 446
T2 HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3 TOYOTA EAST CHANNEL MODEL: SUP102C4.IN, SUPERCRITICAL FLOW
T4 ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		2		1	.0076			0	1689	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

	38	43	1	42	8	26	68	4	17	33
	5	39	66							

NC	.023	.023	.023	.1	.3					
QT	2	5596	1595							
X1	44600	4	0	270	421	421	421			
GR	1706.2	0	1686.2	80	1686.2	190	1706.2	270		
X1	45000	0	0	0	421	421	421			-3.2
X1	45400	0	0	0	402	402	402			-3.2
X1	45800	0	0	0	378	378	378			-3.1
X1	46200	0	0	0	392	392	392			-2.9
X1	46600	0	0	0	259	259	259			-3.0
X1	46857	0	0	0						-2.0

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 44600.000

44600.000	3.63	1689.83	1690.29	1689.00	1692.21	2.38	.00	.00	1706.20
5596.0	.0	5596.0	.0	.0	452.3	.0	.0	.0	1706.20
.00	.00	12.37	.00	.000	.023	.000	.000	1686.20	65.47
.007676	0.	0.	0.	0	11	4	.00	139.05	204.53

*SECNO 45000.000

45000.000	3.65	1686.65	1687.09	.00	1689.00	2.35	3.20	.01	1703.00
5596.0	.0	5596.0	.0	.0	455.1	.0	4.4	1.3	1703.00
.01	.00	12.30	.00	.000	.023	.000	.000	1683.00	65.39
.007530	421.	421.	421.	5	8	0	.00	139.22	204.61

*SECNO 45400.000

[illegible].000	3.63	1683.43	1683.89	.00	1685.80	2.37	3.20	.00	1699.80
[illegible]596.0	.0	5596.0	.0	.0	452.6	.0	8.8	2.7	1699.80
.02	.00	12.37	.00	.000	.023	.000	.000	1679.80	65.46
.007661	421.	421.	421.	5	8	0	.00	139.07	204.54

*SECNO 45800.000

45800.000	3.62	1680.32	1680.79	.00	1682.71	2.39	3.09	.00	1696.70
5596.0	.0	5596.0	.0	.0	451.4	.0	12.9	4.0	1696.70
.03	.00	12.40	.00	.000	.023	.000	.000	1676.70	65.50
.007722	402.	402.	402.	5	8	0	.00	139.00	204.50

*SECNO 46200.000

46200.000	3.64	1677.44	1677.89	.00	1679.80	2.36	2.90	.01	1693.80
5596.0	.0	5596.0	.0	.0	453.8	.0	16.9	5.2	1693.80
.04	.00	12.33	.00	.000	.023	.000	.000	1673.80	65.43
.007597	378.	378.	378.	5	8	0	.00	139.14	204.57

*SECNO 46600.000

46600.000	3.63	1674.43	1674.89	.00	1676.81	2.38	2.99	.00	1690.80
5596.0	.0	5596.0	.0	.0	452.3	.0	20.9	6.4	1690.80
.05	.00	12.37	.00	.000	.023	.000	.000	1670.80	65.47
[illegible]007671	392.	392.	392.	6	8	0	.00	139.06	204.53

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 46857.000

46857.000	3.63	1672.43	1672.89	.00	1674.82	2.38	1.99	.00	1688.80
5596.0	.0	5596.0	.0	.0	451.6	.0	23.6	7.3	1688.80
.05	.00	12.39	.00	.000	.023	.000	.000	1668.80	65.49
.007712	259.	259.	259.	6	8	0	.00	139.01	204.51

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T1      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 468.57 - 446
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: SUP102C4.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

              3               1    .0076                       0    1689

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 44600.000

44600.000	1.74	1687.94	1688.02	1689.00	1688.89	.95	.00	.00	1706.20
1595.0	.0	1595.0	.0	.0	203.5	.0	.0	.0	1706.20
.00	.00	7.84	.00	.000	.023	.000	.000	1686.20	73.04
.007633	0.	0.	0.	0	14	5	.00	123.92	196.96

*SECNO 45000.000

45000.000	1.74	1684.74	1684.82	.00	1685.69	.95	3.21	.00	1703.00
1595.0	.0	1595.0	.0	.0	203.8	.0	2.0	1.2	1703.00
.01	.00	7.83	.00	.000	.023	.000	.000	1683.00	73.03
.007593	421.	421.	421.	2	8	0	.00	123.94	196.97

*SECNO 45400.000

00.000	1.73	1681.53	1681.62	.00	1682.49	.95	3.20	.00	1699.80
1595.0	.0	1595.0	.0	.0	203.7	.0	3.9	2.4	1699.80
.03	.00	7.83	.00	.000	.023	.000	.000	1679.80	73.03
.007610	421.	421.	421.	2	8	0	.00	123.93	196.97

*SECNO 45800.000

45800.000	1.73	1678.43	1678.52	.00	1679.40	.96	3.09	.00	1696.70
1595.0	.0	1595.0	.0	.0	202.5	.0	5.8	3.5	1696.70
.04	.00	7.88	.00	.000	.023	.000	.000	1676.70	73.07
.007754	402.	402.	402.	3	8	0	.00	123.85	196.93

*SECNO 46200.000

46200.000	1.73	1675.53	1675.62	.00	1676.49	.95	2.91	.00	1693.80
1595.0	.0	1595.0	.0	.0	203.5	.0	7.6	4.6	1693.80
.06	.00	7.84	.00	.000	.023	.000	.000	1673.80	73.04
.007628	378.	378.	378.	2	8	0	.00	123.92	196.96

*SECNO 46600.000

46600.000	1.73	1672.53	1672.62	.00	1673.49	.96	3.00	.00	1690.80
1595.0	.0	1595.0	.0	.0	203.0	.0	9.4	5.7	1690.80
.07	.00	7.86	.00	.000	.023	.000	.000	1670.80	73.06
007689	392.	392.	392.	2	8	0	.00	123.89	196.94

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 46857.000

46857.000	1.73	1670.53	1670.62	.00	1671.49	.96	2.00	.00	1688.80
1595.0	.0	1595.0	.0	.0	202.6	.0	10.6	6.5	1688.80
.08	.00	7.87	.00	.000	.023	.000	.000	1668.80	73.07
.007733	259.	259.	259.	2	8	0	.00	123.86	196.93

THIS RUN EXECUTED 02SEP91 15:41:16

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
44600.000	5596.00	1689.83	1686.20	3.63	12.37	1.21	139.05	23.00	.00	76.76	.00	2273.00
44600.000	1595.00	1687.94	1686.20	1.74	7.84	1.08	123.92	23.00	.00	76.33	.00	2273.00
45000.000	5596.00	1686.65	1683.00	3.65	12.30	1.20	139.22	23.00	-7.60	75.30	421.00	1852.00
45000.000	1595.00	1684.74	1683.00	1.74	7.83	1.08	123.94	23.00	-7.60	75.93	421.00	1852.00
45400.000	5596.00	1683.43	1679.80	3.63	12.37	1.21	139.07	23.00	-7.60	76.61	421.00	1431.00
45400.000	1595.00	1681.53	1679.80	1.73	7.83	1.08	123.93	23.00	-7.60	76.10	421.00	1431.00
45800.000	5596.00	1680.32	1676.70	3.62	12.40	1.21	139.00	23.00	-7.71	77.22	402.00	1029.00
45800.000	1595.00	1678.43	1676.70	1.73	7.88	1.09	123.85	23.00	-7.71	77.54	402.00	1029.00
46200.000	5596.00	1677.44	1673.80	3.64	12.33	1.20	139.14	23.00	-7.67	75.97	378.00	651.00
46200.000	1595.00	1675.53	1673.80	1.73	7.84	1.08	123.92	23.00	-7.67	76.28	378.00	651.00
46600.000	5596.00	1674.43	1670.80	3.63	12.37	1.21	139.06	23.00	-7.65	76.71	392.00	259.00
46600.000	1595.00	1672.53	1670.80	1.73	7.86	1.08	123.89	23.00	-7.65	76.89	392.00	259.00
46857.000	5596.00	1672.43	1668.80	3.63	12.39	1.21	139.01	23.00	-7.72	77.12	259.00	.00
46857.000	1595.00	1670.53	1668.80	1.73	7.87	1.08	123.86	23.00	-7.72	77.33	259.00	.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    29AUG91    TIME   16:04:55 *
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX             XXXXX
X     X  X       X     X           X     X
X     X  X       X                       X
XXXXXXX  XXXX    X         XXXXX    XXXXX
X     X  X       X                 X
X     X  X       X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 29AUG91 16:04:55

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**************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
**************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 446 - 425+25
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: SUP103C.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                   1     .0076                           0      1708

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1                 -1                                        -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        43         1        42         8        26        68         4        17        33
      5        39        66

NC    .023      .023      .023        .1        .3
QT       2     5596      1595
X1   42525         4         0       270        96        96        96
GR  1726.0         0   1706.03        80   1706.03       190   1726.03       270

X1   42600         0         0         0       421       421       421                  -.73

X1   43000         0         0         0       421       421       421                  -3.2

X1   43400         0         0         0       421       421       421                  -3.2

X1   43800         0         0         0       421       421       421                  -3.3

X1   44200         0         0         0       421       421       421                  -3.2

X1   44600         0         0         0                                               -3.2
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 42525.000

42525.000	3.64	1709.67	1710.11	1708.00	1712.04	2.36	.00	.00	1726.00
5596.0	.0	5596.0	.0	.0	453.4	.0	.0	.0	1726.03
.00	.00	12.34	.00	.000	.023	.000	.000	1706.03	65.42
.007616	0.	0.	0.	0	17	4	.00	139.14	204.56

*SECNO 42600.000

42600.000	3.63	1708.93	1709.39	.00	1711.30	2.37	.73	.00	1725.27
5596.0	.0	5596.0	.0	.0	452.9	.0	1.0	.3	1725.30
.00	.00	12.36	.00	.000	.023	.000	.000	1705.30	65.43
.007646	96.	96.	96.	8	8	0	.00	139.11	204.54

*SECNO 43000.000

00.000	3.65	1705.75	1706.19	.00	1708.10	2.35	3.20	.01	1722.07
5596.0	.0	5596.0	.0	.0	455.0	.0	5.4	1.7	1722.10
.01	.00	12.30	.00	.000	.023	.000	.000	1702.10	65.37
.007535	421.	421.	421.	5	8	0	.00	139.23	204.61

*SECNO 43400.000

43400.000	3.62	1702.52	1702.99	.00	1704.90	2.37	3.20	.00	1718.87
5596.0	.0	5596.0	.0	.0	452.6	.0	9.8	3.0	1718.90
.02	.00	12.36	.00	.000	.023	.000	.000	1698.90	65.44
.007660	421.	421.	421.	5	8	0	.00	139.09	204.54

*SECNO 43800.000

43800.000	3.59	1699.19	1699.69	.00	1701.62	2.42	3.28	.00	1715.57
5596.0	.0	5596.0	.0	.0	447.9	.0	14.1	4.3	1715.60
.03	.00	12.49	.00	.000	.023	.000	.000	1695.60	65.58
.007907	421.	421.	421.	5	8	0	.00	138.83	204.40

*SECNO 44200.000

44200.000	3.69	1696.09	1696.49	.00	1698.39	2.30	3.19	.04	1712.37
5596.0	.0	5596.0	.0	.0	460.1	.0	18.5	5.7	1712.40
.04	.00	12.16	.00	.000	.023	.000	.000	1692.40	65.23
.007283	421.	421.	421.	4	8	0	.00	139.52	204.75

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 44600.000

44600.000	3.62	1692.82	1693.29	.00	1695.21	2.39	3.16	.01	1709.17
5596.0	.0	5596.0	.0	.0	450.8	.0	22.9	7.0	1709.20
.05	.00	12.41	.00	.000	.023	.000	.000	1689.20	65.49
.007753	421.	421.	421.	5	8	0	.00	138.99	204.48

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T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 446 - 425+25
        HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL              MODEL: SUP103C.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

             3               1     .0076                       0     1708

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

    15               -1                              -1
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 42525.000

42525.000	1.75	1707.78	1707.85	1708.00	1708.72	.94	.00	.00	1726.00
1595.0	.0	1595.0	.0	.0	204.7	.0	.0	.0	1726.03
.00	.00	7.79	.00	.000	.023	.000	.000	1706.03	72.99
.007492	0.	0.	0.	0	11	4	.00	124.01	197.00

*SECNO 42600.000

42600.000	1.74	1707.04	1707.12	.00	1708.00	.95	.73	.00	1725.27
1595.0	.0	1595.0	.0	.0	203.6	.0	.4	.3	1725.30
.00	.00	7.83	.00	.000	.023	.000	.000	1705.30	73.03
.007622	96.	96.	96.	4	8	0	.00	123.93	196.96

*SECNO 43000.000

[illegible].000	1.74	1703.84	1703.92	.00	1704.79	.95	3.21	.00	1722.07
[illegible]595.0	.0	1595.0	.0	.0	203.7	.0	2.4	1.5	1722.10
.02	.00	7.83	.00	.000	.023	.000	.000	1702.10	73.03
.007613	421.	421.	421.	2	8	0	.00	123.94	196.96

*SECNO 43400.000

43400.000	1.74	1700.64	1700.72	.00	1701.59	.95	3.20	.00	1718.87
1595.0	.0	1595.0	.0	.0	203.9	.0	4.4	2.7	1718.90
.03	.00	7.82	.00	.000	.023	.000	.000	1698.90	73.02
.007588	421.	421.	421.	2	8	0	.00	123.95	196.97

*SECNO 43800.000

43800.000	1.72	1697.32	1697.42	.00	1698.30	.98	3.28	.00	1715.57
1595.0	.0	1595.0	.0	.0	200.4	.0	6.3	3.9	1715.60
.05	.00	7.96	.00	.000	.023	.000	.000	1695.60	73.13
.008012	421.	421.	421.	3	8	0	.00	123.73	196.86

*SECNO 44200.000

44200.000	1.77	1694.17	1694.22	.00	1695.09	.92	3.20	.02	1712.37
1595.0	.0	1595.0	.0	.0	207.2	.0	8.3	5.1	1712.40
.06	.00	7.70	.00	.000	.023	.000	.000	1692.40	72.91
[illegible]007201	421.	421.	421.	2	8	0	.00	124.17	197.08

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 44600.000

44600.000	1.72	1690.92	1691.02	.00	1691.90	.98	3.18	.01	1709.17
1595.0	.0	1595.0	.0	.0	201.0	.0	10.3	6.3	1709.20
.08	.00	7.94	.00	.000	.023	.000	.000	1689.20	73.11
.007941	421.	421.	421.	3	8	0	.00	123.77	196.88

THIS RUN EXECUTED 29AUG91 16:05:02

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
42525.000	5596.00	1709.67	1706.03	3.64	12.34	1.20	139.14	23.00	.00	76.16	.00	2201.00
42525.000	1595.00	1707.78	1706.03	1.75	7.79	1.07	124.01	23.00	.00	74.92	.00	2201.00
42600.000	5596.00	1708.93	1705.30	3.63	12.36	1.21	139.11	23.00	-7.60	76.46	96.00	2105.00
42600.000	1595.00	1707.04	1705.30	1.74	7.83	1.08	123.93	23.00	-7.60	76.22	96.00	2105.00
[illegible]000.000	5596.00	1705.75	1702.10	3.65	12.30	1.20	139.23	23.00	-7.60	75.35	421.00	1684.00
[illegible]000.000	1595.00	1703.84	1702.10	1.74	7.83	1.08	123.94	23.00	-7.60	76.13	421.00	1684.00
43400.000	5596.00	1702.52	1698.90	3.62	12.36	1.21	139.09	23.00	-7.60	76.60	421.00	1263.00
43400.000	1595.00	1700.64	1698.90	1.74	7.82	1.08	123.95	23.00	-7.60	75.88	421.00	1263.00
43800.000	5596.00	1699.19	1695.60	3.59	12.49	1.23	138.83	23.00	-7.84	79.07	421.00	842.00
43800.000	1595.00	1697.32	1695.60	1.72	7.96	1.10	123.73	23.00	-7.84	80.12	421.00	842.00
44200.000	5596.00	1696.09	1692.40	3.69	12.16	1.18	139.52	23.00	-7.60	72.83	421.00	421.00
44200.000	1595.00	1694.17	1692.40	1.77	7.70	1.05	124.17	23.00	-7.60	72.01	421.00	421.00
44600.000	5596.00	1692.82	1689.20	3.62	12.41	1.21	138.99	23.00	-7.60	77.53	421.00	.00
44600.000	1595.00	1690.92	1689.20	1.72	7.94	1.10	123.77	23.00	-7.60	79.41	421.00	.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    29AUG91    TIME   16:19:25 *
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX             XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 29AUG91 16:19:26

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**************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
**************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 425+25 - 422
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: SUP104C.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5      MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                 1      .0076                      0      1714

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    1                 -1                                      -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43        1       42        8       26       68        4       17       33
     5       39       66

NC    .016     .016     .016       .1       .3
QT       2     1200      341
X1   42200        4        0      150       25       25       25
GR  1731.5        0  1711.50       80  1711.50       90  1731.50      170

X1   42210        0        0        0      150      150      150                -.19

QT       2     3398      968
X1   42385        4        0      220      150      150      150
GR  1730.2        0  1710.17       80  1710.17      140  1730.17      220

QT       2     5596     1595
X1   42525        4        0      270
GR  1729.0        0  1709.03       80  1709.03      190  1729.03      270
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 42200.000

42200.000	3.56	1715.06	1716.06	1714.00	1718.15	3.08	.00	.00	1731.50
1200.0	.0	903.6	296.4	.0	61.1	25.4	.0	.0	1711.50
.00	.00	14.80	11.66	.000	.016	.016	.000	1711.50	65.74
.007592	0.	0.	0.	0	14	5	.00	38.52	104.26

*SECNO 42210.000

42210.000	3.58	1714.89	1715.85	.00	1717.95	3.06	.19	.01	1731.31
1200.0	.0	903.4	296.6	.0	61.2	25.5	.0	.0	1711.31
.00	.00	14.75	11.63	.000	.016	.016	.000	1711.31	65.71
.007532	25.	25.	25.	9	11	0	.00	38.57	104.29

*SECNO 42385.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .35

42385.000	3.11	1713.28	1714.37	.00	1716.81	3.53	1.10	.05	1730.20
3398.0	.0	3398.0	.0	.0	225.5	.0	.6	.2	1730.17
.00	.00	15.07	.00	.000	.016	.000	.000	1710.17	67.57
.007243	150.	150.	150.	5	8	0	.00	84.88	152.45

*SECNO 42525.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .61

42525.000	2.98	1712.01	1713.11	.00	1715.70	3.69	1.10	.02	1729.00
5596.0	.0	5596.0	.0	.0	363.0	.0	1.6	.6	1729.03
.01	.00	15.42	.00	.000	.016	.000	.000	1709.03	68.07
.007337	150.	150.	150.	5	11	0	.00	133.84	201.91

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      TOYOTA DESERT PROVING GROUNDS,   10-YEAR EVENT, XSEC 425+25 - 422
      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3    TOYOTA EAST CHANNEL            MODEL: SUP104C.IN,  SUPERCRITICAL FLOW
T4    ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES
T5    MODIFIED FOR REVISED DROP LOCATION ON 8/29/91

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              3                 1      .0076                       0      1714

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    15                -1                          -1
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 42200.000

42200.000	1.93	1713.43	1713.93	1714.00	1715.03	1.60	.00	.00	1731.50
341.0	.0	283.1	57.9	.0	26.8	7.5	.0	.0	1711.50
.00	.00	10.57	7.76	.000	.016	.016	.000	1711.50	72.27
.007613	0.	0.	0.	0	8	6	.00	25.45	97.73

*SECNO 42210.000

42210.000	1.93	1713.24	1713.73	.00	1714.84	1.60	.19	.00	1731.31
341.0	.0	283.1	57.9	.0	26.8	7.5	.0	.0	1711.31
.00	.00	10.58	7.76	.000	.016	.016	.000	1711.31	72.28
.007617	25.	25.	25.	13	11	0	.00	25.45	97.72

*SECNO 42385.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .41

42385.000	1.34	1711.51	1712.08	.00	1713.38	1.87	1.44	.03	1730.20
968.0	.0	968.0	.0	.0	88.3	.0	.2	.2	1730.17
.00	.00	10.96	.00	.000	.016	.000	.000	1710.17	74.61
.010448	150.	150.	150.	5	5	0	.00	70.79	145.40

*SECNO 42525.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .53

42525.000	1.37	1710.40	1710.85	.00	1711.96	1.55	1.33	.09	1729.00
1595.0	.0	1595.0	.0	.0	159.5	.0	.7	.5	1729.03
.01	.00	10.00	.00	.000	.016	.000	.000	1709.03	74.47
.008049	150.	150.	150.	4	11	0	.00	121.06	195.52

THIS RUN EXECUTED 29AUG91 16:19:31

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	42200.000	1200.00	1715.06	1711.50	3.56	14.80	1.64	38.52	16.00	.00	75.92	.00	325.00
	42200.000	341.00	1713.43	1711.50	1.93	10.57	1.52	25.45	16.00	.00	76.13	.00	325.00
	42210.000	1200.00	1714.89	1711.31	3.58	14.75	1.64	38.57	16.00	-7.60	75.32	25.00	300.00
	42210.000	341.00	1713.24	1711.31	1.93	10.58	1.52	25.45	16.00	-7.60	76.17	25.00	300.00
	42385.000	3398.00	1713.28	1710.17	3.11	15.07	1.63	84.88	16.00	-7.60	72.43	150.00	150.00
	42385.000	968.00	1711.51	1710.17	1.34	10.96	1.73	70.79	16.00	-7.60	104.48	150.00	150.00
*	42525.000	5596.00	1712.01	1709.03	2.98	15.42	1.65	133.84	16.00	-7.60	73.37	150.00	.00
*	42525.000	1595.00	1710.40	1709.03	1.37	10.00	1.53	121.06	16.00	-7.60	80.49	150.00	.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=  42385.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  42385.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  42525.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  42525.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.5.1;  September 1990      *
*                                        *
*  RUN DATE    02SEP91    TIME   17:45:00 *
*****************************************
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*************************************
*  U.S. ARMY CORPS OF ENGINEERS
*  HYDROLOGIC ENGINEERING CENTER
*  609 SECOND STREET, SUITE D
*  DAVIS, CALIFORNIA 95616-4687
*          (916) 756-1104
*************************************
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X     X  XXXXXXX   XXXXX             XXXXX
X     X  X       X     X           X     X
X     X  X       X                       X
XXXXXXX  XXXX     X         XXXXX   XXXXX
X     X  X       X                 X
X     X  X       X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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END OF BANNER

THIS RUN EXECUTED 02SEP91 17:45:00

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**************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
**************************************


T1      TOYOTA DESERT PROVING GROUNDS,   100-YEAR EVENT, XSEC 422 - 374
T2      HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
T3      TOYOTA EAST CHANNEL            MODEL: SUP105C.IN,  SUPERCRITICAL FLOW
T4      ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                  1   .004809                           0     1742

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1                                     -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38       43        1       42        8       26       68        4       17       33
      5       39       66

NC    .016     .016     .016       .1       .3
QT       2     579      252
X1   37400       4        0      170      397      397      397
GR  1760.3       0   1740.3       80   1740.3       90   1760.3      170

X1   37800       0        0        0      414      414      414                -1.9

QT       2    1200      341
X1   38200       0        0        0      380      380      380                -2.0

X1   38600       0        0        0      421      421      421                -1.8

X1   39000       0        0        0      421      421      421                -2.1

X1   39400       0        0        0      421      421      421                -2.0

X1   39800       0        0        0      421      421      421                -2.0

X1   40200       0        0        0      421      421      421                -2.0

X1   40600       0        0        0      421      421      421                -2.1
```

	41000	0	0	0	421	421	421	-2.0
X1	41400	0	0	0	421	421	421	-2.0
X1	41800	0	0	0	421	421	421	-3.3
X1	42200	0	0					-3.2

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 37400.000

37400.000	2.84	1743.14	1743.46	1742.00	1744.56	1.42	.00	.00	1760.30
579.0	.0	579.0	.0	.0	60.5	.0	.0	.0	1760.30
.00	.00	9.56	.00	.000	.016	.000	.000	1740.30	68.66
.004796	0.	0.	0.	0	14	5	.00	32.69	101.34

*SECNO 37800.000

37800.000	2.84	1741.24	1741.55	.00	1742.65	1.42	1.90	.00	1758.40
579.0	.0	579.0	.0	.0	60.6	.0	.6	.3	1758.40
.01	.00	9.55	.00	.000	.016	.000	.000	1738.40	68.65
.004779	397.	397.	397.	5	8	0	.00	32.71	101.35

*SECNO 38200.000

[illegible]0 TRIALS ATTEMPTED WSEL,CWSEL

[illegible] PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

38200.000	4.51	1740.91	1740.91	.00	1742.31	1.40	1.36	.03	1756.40
1200.0	.0	1200.0	.0	.0	126.4	.0	1.4	.7	1756.40
.02	.00	9.49	.00	.000	.016	.000	.000	1736.40	61.96
.002808	414.	414.	414.	20	14	0	.00	46.07	108.04

*SECNO 38600.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.40

38600.000	3.86	1738.46	1739.12	.00	1740.77	2.31	1.45	.09	1754.60
1200.0	.0	1200.0	.0	.0	98.5	.0	2.4	1.1	1754.60
.03	.00	12.18	.00	.000	.016	.000	.000	1734.60	64.53
.005505	380.	380.	380.	5	5	0	.00	40.94	105.47

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 39000.000									
39000.000	4.02	1736.52	1737.03	.00	1738.56	2.04	2.13	.08	1752.50
1200.0	.0	1200.0	.0	.0	104.7	.0	3.4	1.5	1752.50
.04	.00	11.46	.00	.000	.016	.000	.000	1732.50	63.93
.004668	421.	421.	421.	5	8	0	.00	42.13	106.07
*SECNO 39400.000									
39400.000	4.01	1734.51	1735.02	.00	1736.57	2.06	1.98	.00	1750.50
1200.0	.0	1200.0	.0	.0	104.1	.0	4.4	1.9	1750.50
.05	.00	11.53	.00	.000	.016	.000	.000	1730.50	63.99
.004739	421.	421.	421.	6	8	0	.00	42.02	106.01
*SECNO 39800.000									
39800.000	4.01	1732.51	1733.02	.00	1734.57	2.07	2.00	.00	1748.50
1200.0	.0	1200.0	.0	.0	104.0	.0	5.4	2.3	1748.50
.06	.00	11.54	.00	.000	.016	.000	.000	1728.50	64.00
.004753	421.	421.	421.	6	8	0	.00	42.00	106.00
*SECNO 40200.000									
40200.000	4.01	1730.51	1731.02	.00	1732.57	2.07	2.00	.00	1746.50
1200.0	.0	1200.0	.0	.0	104.0	.0	6.4	2.7	1746.50
.07	.00	11.54	.00	.000	.016	.000	.000	1726.50	64.00
.004752	421.	421.	421.	6	8	0	.00	42.00	106.00
*SECNO 40600.000									
40600.000	3.96	1728.36	1728.92	.00	1730.51	2.15	2.06	.01	1744.40
1200.0	.0	1200.0	.0	.0	101.9	.0	7.4	3.1	1744.40
.08	.00	11.77	.00	.000	.016	.000	.000	1724.40	64.20
.005019	421.	421.	421.	6	8	0	.00	41.60	105.80
*SECNO 41000.000									
41000.000	4.03	1726.43	1726.93	.00	1728.45	2.02	2.02	.04	1742.40
1200.0	.0	1200.0	.0	.0	105.2	.0	8.4	3.5	1742.40
.09	.00	11.40	.00	.000	.016	.000	.000	1722.40	63.88
.004604	421.	421.	421.	5	8	0	.00	42.23	106.12

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 41400.000

41400.000	4.01	1724.41	1724.92	.00	1726.47	2.07	1.97	.00	1740.40
1200.0	.0	1200.0	.0	.0	104.0	.0	9.4	3.9	1740.40
.10	.00	11.54	.00	.000	.016	.000	.000	1720.40	64.00
.004750	421.	421.	421.	6	8	0	.00	42.00	106.00

*SECNO 41800.000

3301 HV CHANGED MORE THAN HVINS

41800.000	3.50	1720.60	1721.62	.00	1723.76	3.15	2.61	.11	1737.10
1200.0	.0	1200.0	.0	.0	84.2	.0	10.3	4.3	1737.10
.11	.00	14.25	.00	.000	.016	.000	.000	1717.10	65.98
.008410	421.	421.	421.	6	8	0	.00	38.04	104.02

*SECNO 42200.000

42200.000	3.62	1717.52	1718.41	.00	1720.37	2.84	3.30	.09	1733.90
1200.0	.0	1200.0	.0	.0	88.7	.0	11.2	4.6	1733.90
.12	.00	13.54	.00	.000	.016	.000	.000	1713.90	65.52
.007315	421.	421.	421.	7	11	0	.00	38.97	104.48

T3 TOYOTA DESERT PROVING GROUNDS, 10-YEAR EVENT, XSEC 422 - 374
HYDRAULIC ANALYSIS OF INTERCEPTOR CHANNEL ALONG EAST SIDE OF TRACK
TOYOTA EAST CHANNEL MODEL: SUP105C.IN, SUPERCRITICAL FLOW
T4 ALL FLOWS CONFINED TO 4-POINT TRAP SECTION, 4:1 SIDESLOPES

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		3		1	.004809			0	1742	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15		-1				-1			

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300

*SECNO 37400.000

37400.000	1.88	1742.18	1742.34	1742.00	1743.09	.91	.00	.00	1760.30
252.0	.0	252.0	.0	.0	33.0	.0	.0	.0	1760.30
.00	.00	7.64	.00	.000	.016	.000	.000	1740.30	72.47
.004804	0.	0.	0.	0	11	5	.00	25.06	97.53

*SECNO 37800.000

37800.000	1.89	1740.29	1740.44	.00	1741.19	.90	1.90	.00	1758.40
252.0	.0	252.0	.0	.0	33.1	.0	.3	.2	1758.40
.01	.00	7.61	.00	.000	.016	.000	.000	1738.40	72.45
.004757	397.	397.	397.	4	8	0	.00	25.09	97.55

*SECNO 38200.000

3720 TRIALS ATTEMPTED WSEL,CWSEL

3000 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

38200.000	2.40	1738.80	1738.80	.00	1739.62	.82	1.59	.04	1756.40
341.0	.0	341.0	.0	.0	47.0	.0	.7	.5	1756.40
.03	.00	7.26	.00	.000	.016	.000	.000	1736.40	70.41
.003321	414.	414.	414.	20	11	0	.00	29.19	99.59

*SECNO 38600.000

38600.000	2.09	1736.69	1737.00	.00	1737.93	1.24	1.65	.04	1754.60
341.0	.0	341.0	.0	.0	38.2	.0	1.1	.7	1754.60
.04	.00	8.94	.00	.000	.016	.000	.000	1734.60	71.67
.005884	380.	380.	380.	4	5	0	.00	26.66	98.33

*SECNO 39000.000

39000.000	2.25	1734.75	1734.91	.00	1735.74	.99	2.11	.07	1752.50
341.0	.0	341.0	.0	.0	42.7	.0	1.4	1.0	1752.50
.06	.00	7.99	.00	.000	.016	.000	.000	1732.50	71.01
.004326	421.	421.	421.	3	8	0	.00	27.98	98.99

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 39400.000									
39400.000	2.17	1732.67	1732.90	.00	1733.77	1.10	1.96	.01	1750.50
341.0	.0	341.0	.0	.0	40.5	.0	1.8	1.3	1750.50
.07	.00	8.43	.00	.000	.016	.000	.000	1730.50	71.33
.005008	421.	421.	421.	4	8	0	.00	27.34	98.67
*SECNO 39800.000									
39800.000	2.23	1730.73	1730.90	.00	1731.75	1.02	2.00	.02	1748.50
341.0	.0	341.0	.0	.0	42.0	.0	2.2	1.5	1748.50
.09	.00	8.11	.00	.000	.016	.000	.000	1728.50	71.10
.004507	421.	421.	421.	3	8	0	.00	27.80	98.90
*SECNO 40200.000									
40200.000	2.18	1728.68	1728.90	.00	1729.77	1.09	1.98	.01	1746.50
341.0	.0	341.0	.0	.0	40.8	.0	2.6	1.8	1746.50
.10	.00	8.36	.00	.000	.016	.000	.000	1726.50	71.28
.004900	421.	421.	421.	4	8	0	.00	27.43	98.72
*SECNO 40600.000									
40600.000	2.17	1726.57	1726.80	.00	1727.68	1.11	2.09	.00	1744.40
341.0	.0	341.0	.0	.0	40.4	.0	3.0	2.1	1744.40
.11	.00	8.44	.00	.000	.016	.000	.000	1724.40	71.34
.005027	421.	421.	421.	4	8	0	.00	27.32	98.66
*SECNO 41000.000									
41000.000	2.23	1724.63	1724.80	.00	1725.65	1.02	2.00	.03	1742.40
341.0	.0	341.0	.0	.0	42.1	.0	3.4	2.3	1742.40
.13	.00	8.10	.00	.000	.016	.000	.000	1722.40	71.09
.004494	421.	421.	421.	3	8	0	.00	27.81	98.91
*SECNO 41400.000									
41400.000	2.18	1722.58	1722.80	.00	1723.67	1.09	1.98	.01	1740.40
341.0	.0	341.0	.0	.0	40.8	.0	3.8	2.6	1740.40
.14	.00	8.36	.00	.000	.016	.000	.000	1720.40	71.29
.004907	421.	421.	421.	4	8	0	.00	27.43	98.71

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 41800.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.43

41800.000	1.82	1718.92	1719.50	.00	1720.74	1.82	2.86	.07	1737.10
341.0	.0	341.0	.0	.0	31.5	.0	4.2	2.8	1737.10
.15	.00	10.82	.00	.000	.016	.000	.000	1717.10	72.71
.009986	421.	421.	421.	5	8	0	.00	24.58	97.29

*SECNO 42200.000

3301 HV CHANGED MORE THAN HVINS

42200.000	2.05	1715.95	1716.30	.00	1717.27	1.32	3.32	.15	1733.90
341.0	.0	341.0	.0	.0	37.0	.0	4.5	3.1	1733.90
.16	.00	9.21	.00	.000	.016	.000	.000	1713.90	71.84
006391	421.	421.	421.	4	11	0	.00	26.32	98.16

THIS RUN EXECUTED 02SEP91 17:45:19

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

TOYOTA EAST CHANNEL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	37400.000	579.00	1743.14	1740.30	2.84	9.56	1.24	32.69	16.00	.00	47.96	.00	4980.00
	37400.000	252.00	1742.18	1740.30	1.88	7.64	1.17	25.06	16.00	.00	48.04	.00	4980.00
	37800.000	579.00	1741.24	1738.40	2.84	9.55	1.24	32.71	16.00	-4.79	47.79	397.00	4583.00
	37800.000	252.00	1740.29	1738.40	1.89	7.61	1.17	25.09	16.00	-4.79	47.57	397.00	4583.00
	[illegible]200.000	1200.00	1740.91	1736.40	4.51	9.49	1.01	46.07	16.00	-4.83	28.08	414.00	4169.00
	[illegible]200.000	341.00	1738.80	1736.40	2.40	7.26	1.01	29.19	16.00	-4.83	33.21	414.00	4169.00
*	38600.000	1200.00	1738.46	1734.60	3.86	12.18	1.38	40.94	16.00	-4.74	55.05	380.00	3789.00
	38600.000	341.00	1736.69	1734.60	2.09	8.94	1.32	26.66	16.00	-4.74	58.84	380.00	3789.00
	39000.000	1200.00	1736.52	1732.50	4.02	11.46	1.28	42.13	16.00	-4.99	46.68	421.00	3368.00
	39000.000	341.00	1734.75	1732.50	2.25	7.99	1.14	27.98	16.00	-4.99	43.26	421.00	3368.00
	39400.000	1200.00	1734.51	1730.50	4.01	11.53	1.29	42.02	16.00	-4.75	47.39	421.00	2947.00
	39400.000	341.00	1732.67	1730.50	2.17	8.43	1.22	27.34	16.00	-4.75	50.08	421.00	2947.00
	39800.000	1200.00	1732.51	1728.50	4.01	11.54	1.29	42.00	16.00	-4.75	47.53	421.00	2526.00
	39800.000	341.00	1730.73	1728.50	2.23	8.11	1.16	27.80	16.00	-4.75	45.07	421.00	2526.00
	40200.000	1200.00	1730.51	1726.50	4.01	11.54	1.29	42.00	16.00	-4.75	47.52	421.00	2105.00
	40200.000	341.00	1728.68	1726.50	2.18	8.36	1.21	27.43	16.00	-4.75	49.00	421.00	2105.00
	40600.000	1200.00	1728.36	1724.40	3.96	11.77	1.33	41.60	16.00	-4.99	50.19	421.00	1684.00
	40600.000	341.00	1726.57	1724.40	2.17	8.44	1.22	27.32	16.00	-4.99	50.27	421.00	1684.00
	41000.000	1200.00	1726.43	1722.40	4.03	11.40	1.27	42.23	16.00	-4.75	46.04	421.00	1263.00
	41000.000	341.00	1724.63	1722.40	2.23	8.10	1.16	27.81	16.00	-4.75	44.94	421.00	1263.00
	[illegible]400.000	1200.00	1724.41	1720.40	4.01	11.54	1.29	42.00	16.00	-4.75	47.50	421.00	842.00
	[illegible]00.000	341.00	1722.58	1720.40	2.18	8.36	1.21	27.43	16.00	-4.75	49.07	421.00	842.00

	SECNO	Q	CWSEL	ELMIN	DEPTH	VCH	FRCH	TOPWID	K*XNCH	K*CHSL	10*KS	XLCH	CUMDS
	41800.000	1200.00	1720.60	1717.10	3.50	14.25	1.69	38.04	16.00	-7.84	84.10	421.00	421.00
*	41800.000	341.00	1718.92	1717.10	1.82	10.82	1.68	24.58	16.00	-7.84	99.86	421.00	421.00
	42200.000	1200.00	1717.52	1713.90	3.62	13.54	1.58	38.97	16.00	-7.60	73.15	421.00	.00
	42200.000	341.00	1715.95	1713.90	2.05	9.21	1.37	26.32	16.00	-7.60	63.91	421.00	.00

MARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=  38200.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  38200.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  38200.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=  38200.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  38200.000  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  38200.000  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=  38600.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  41800.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

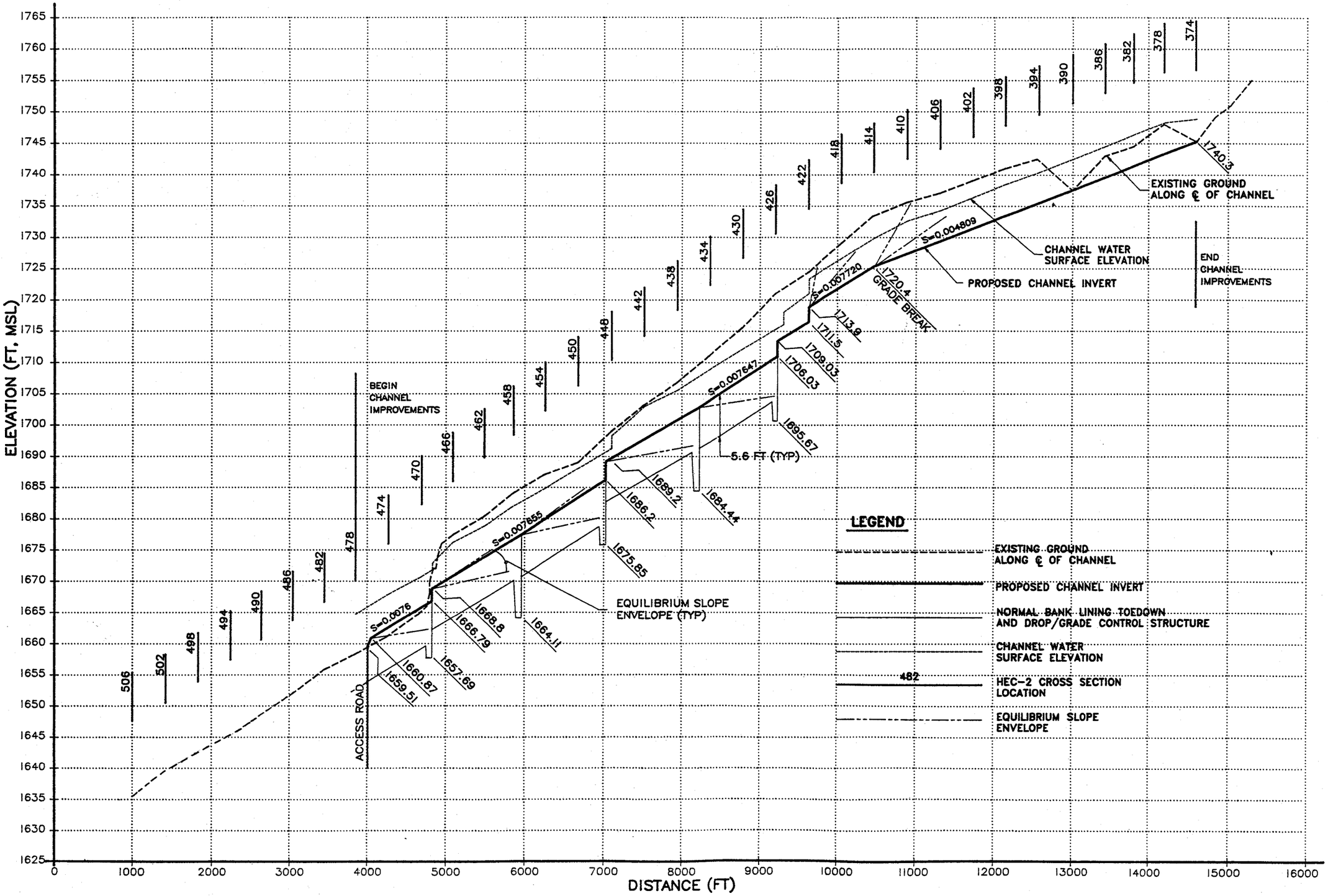


FIGURE 3.1
TOYOTA ARIZONA PROVING GROUNDS
EAST DIVERSION CHANNEL
REVISED 8/29/91

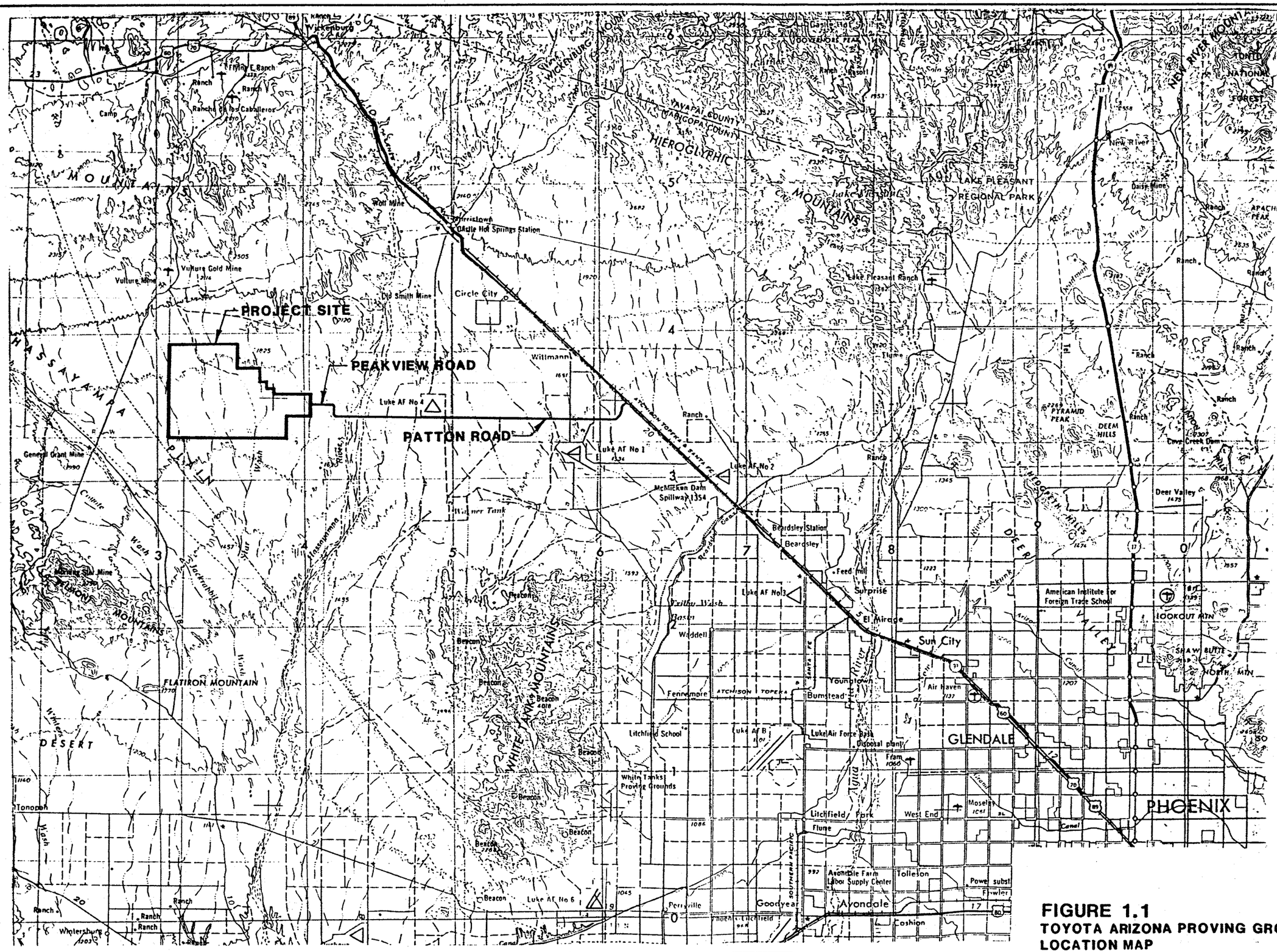
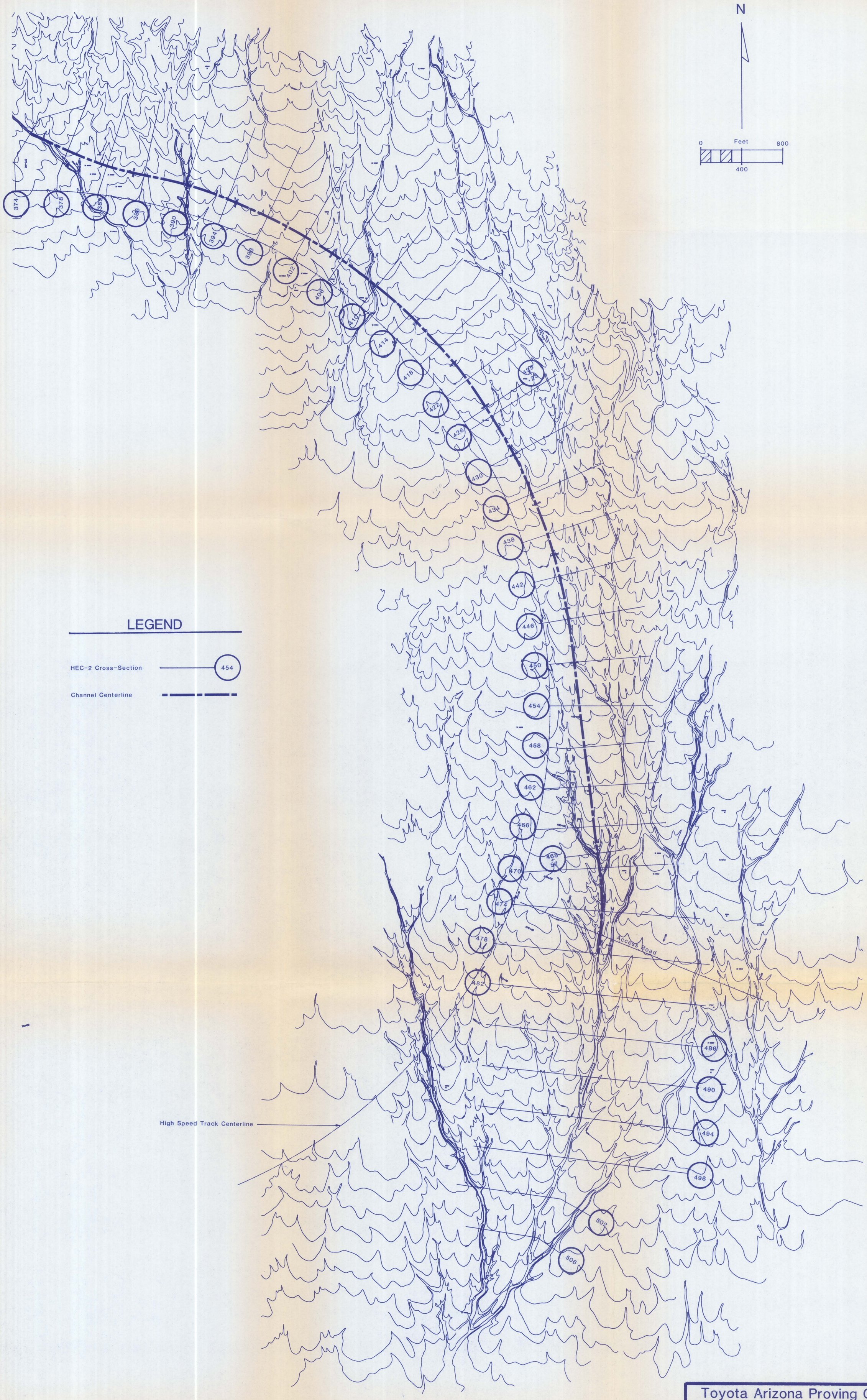


FIGURE 1.1
TOYOTA ARIZONA PROVING GROUND LOCATION MAP



Toyota Arizona Proving Grounds		
East Diversion Channel Alignment		
RLW	9/1/91	Plate 1

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS
SOIL & FOUNDATION ENGINEERING • ENGINEERING GEOLOGY • HYDROGEOLOGY
MATERIALS ENGINEERING • MATERIALS TESTING • ENVIRONMENTAL SERVICES

August 7, 1991

Taisei-Bechtel Joint Venture
Suite 1110
2700 North Central Avenue
Phoenix, AZ 85004

SHB Job No. E91-43
Letter No. 28

Attention: T. Selcuk Atalik, Ph.D.
Engineering Manager

RE: Toyota Arizona Proving Ground Project
Contract No. 21177-TSC-G01
Maricopa County, Arizona

Gentlemen:

Presented herein is a summary of percolation testing completed on July 31 and August 1, 1991 at the referenced project site. A discussion of test procedures and results is presented in the following paragraphs.

Seven percolation tests were completed very near the locations previously staked by Rick Engineering Company. The tests generally were conducted in accordance with ADEQ procedures* for disposal

*Arizona Department of Environmental Quality (ADEQ) Engineering Bulletin No. 12, Minimum Requirements for the Design and Installation of Septic Tank Systems and Alternative On-Site Disposal Systems, June 1989.

REPLY TO: 3232 W. VIRGINIA, PHOENIX, ARIZONA 85009

PHOENIX	TUCSON	ALBUQUERQUE	SANTA FE	SALT LAKE CITY	EL PASO	RENO/SPARKS
(602) 272-6848	(602) 792-2779	(505) 884-0950	(505) 471-7836	(801) 266-0720	(915) 564-1017	(702) 331-2375
FAX 272-7239	FAX 888-0014	FAX 884-1694	FAX 438-7156	FAX 266-0727	FAX 562-7739	FAX 331-4153

trenches and beds. Test pits were excavated at each location to a depth of about 2 feet. A 12-inch square by 12-inch deep hole was then hand dug in the bottom of the test pit. The hole was then filled with water in the manner detailed for each location in Table 1 attached.

Test locations, the type of soil encountered and detailed test results are also presented in Table 1. Percolation rates of about 2 to about 9 minutes per inch were determined for 6 of the 7 locations. A rate of 62 minutes per inch was determined for the location at the cornering course (Test P-4). However, as noted in Table 1, some difficulty was encountered in performing this test. Introduction of water caused the sides of the hole to spall and cave, likely as a result of the higher clay content and desiccated, hard condition of the soil being tested.

It is our understanding that the retention area adjacent to the cornering course will be about 500 feet by 500 feet in plan dimensions. Considering this and the results of the other six percolation tests, it is recommended that the result of Test P-4 not be utilized for design. It is noted that Test P-1 was performed at a location south of the cornering course in a similar soil. A percolation rate of 9.2 minutes per inch was determined at this location. It is recommended that a percolation rate of 15 minutes per inch be utilized for the cornering course retention basin.

Should you have any questions concerning the test results or recommendations presented herein, please do not hesitate in contacting our firm.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By _____
Lawrence A. Hansen, Ph.D., P.E.

Copies: Addressee (3)
Sverdrup Corporation
Attn: Doug Peters, P.E. (1)

ns/J7/8-6-91

TABLE 1

Summary of Percolation Testing

Test No.	Location	USCS Class.	Trial	Percolation Rate Minutes/Inch	Comments
P-1	Oval Track Sta. 11+50 100' Rt.	SC	1 2 3	7.3 8.3 9.2	Filled to 12" depth, water seeped away in 30 minutes. Refilled to 12" depth, let water seep to 6" depth in 20 minutes, then conducted test.
P-2	Oval Track Sta. 58+50 100' Rt.	SM	1 2 3	3.3 3.8 3.6	Filled to 12" depth, water seeped away in 15 minutes. Refilled to 12" depth, let water seep to 6" depth in 15 minutes, then conducted test.
P-3	Oval Track Sta. 80+00 100' Rt.	SM	1 2 3	1.7 2.0 2.0	Filled to 12" depth, water seeped away in 10 minutes. Refilled to 12" depth, let water seep to 6" depth in 10 minutes, then conducted test.
P-4	Cornering Course Sta. 27+50 100' Rt.	SC	1	62.	Filled to 12" depth, water seeped away in 20 minutes. Refilled to 12" depth, let water seep to 6" depth in 40 minutes. Because of caving of the sides of the hole, 18" diameter by 7" deep hole remained. Conducted test in this hole.
P-5	Oval Track Sta. 334+00 125' Rt.	SM/ SC	1 2 3	3.9 4.2 4.3	Filled to 12" depth, water seeped away in 18 minutes. Refilled to 12" depth, let water seep to 6" depth in 13 minutes, then conducted test.
P-6	Oval Track Sta. 291+00 125' Rt.	SM	1 2 3	2.8 2.4 2.6	Filled to 12" depth, water seeped away in 15 minutes. Refilled to 12" depth, let water seep to 6" depth in 10 minutes, then conducted test.
P-76	Oval Track Sta. 260+00 125' Rt.	SM	1 2 3	2.1 2.2 2.3	Filled to 12" depth, water seeped away in 15 minutes. Refilled to 12" depth, let water seep to 6" depth in 10 minutes, then conducted test.