CITY OF SCOTTSDALE

# DESERT GREENBELT PROJECT
# PIMA ROAD CHANNEL

## RECOMMENDED DESIGN CONCEPT AND CONSTRUCTION COST ESTIMATE



The Desert Greenbelt
SCOTTSDALE, ARIZONA

*George V. Sabol Consulting Engineers, Inc.*
Scottdale, Arizona

June 1997

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## INTRODUCTION

### Background

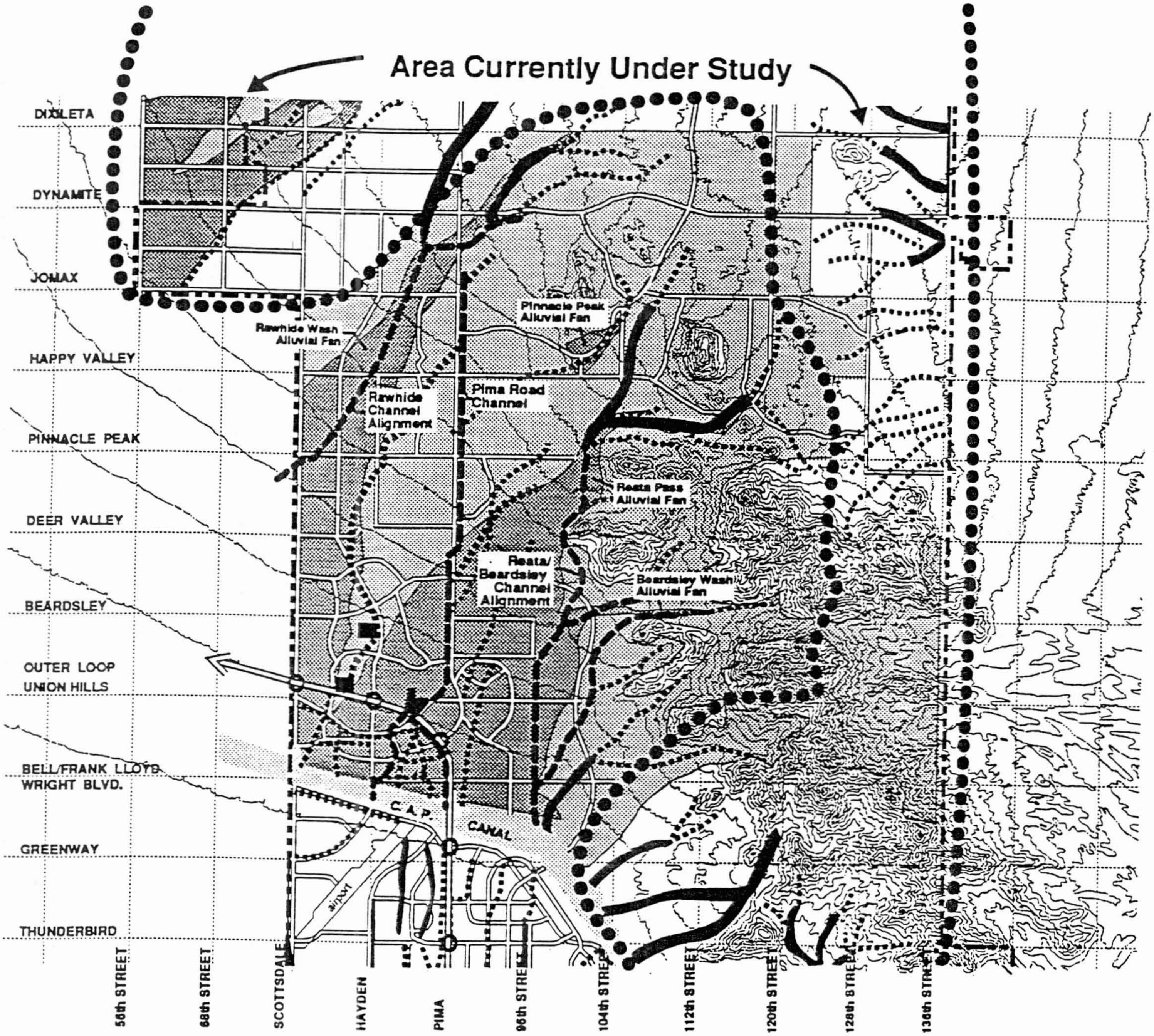
The City of Scottsdale established the Desert Greenbelt Project by amendment of the Drainage Element of the General Plan in November 1992. The Desert Greenbelt Project is the implementation of a City policy to effectively manage stormwaters on a regional basis, while providing passive recreational opportunities for the community in a natural desert setting. The Desert Greenbelt Project is to provide effective flood control and open space amenities within the environmentally sensitive Sonoran desert, while balancing homeowner concerns, development objectives, public safety, landholder requirements and City-wide goals. Clearly, the Desert Greenbelt Project is a multi-objective public works project that must achieve technical, environmental, aesthetic, recreational, and public safety goals while remaining within the financial constraints of prudent community expenditures for such projects.

The Desert Greenbelt Project, as shown in Figure 1, consists of three individual project corridors; Reata Pass/Beardsley Wash, Rawhide Wash, and the Pima Road Channel. This report addresses the Pima Road Channel.

In June 1996, the City of Scottsdale requested that George V. Sabol Consulting Engineers, Inc. (GVSCE) review two concepts for the Pima Road Channel. Concept 1 is the design alternative that was developed by Greiner, Inc., the consultant to the City of Scottsdale for the Desert Greenbelt Project. Concept A is the design alternative that was developed by Pacific Advanced Civil Engineering, Inc. (PACE) which was retained by Grayhawk Development to investigate an alternative to the proposed Pima Road Channel design. The results of the review of Concept 1 and Concept A are presented in the Concept Review report, November 1996, by GVSCE. That report presents the basis for the recommended Pima Road Channel concept that is described herein.

### Purpose

The purpose of this report is to describe, in more detail, the recommended Pima Road Channel that is briefly described in the Concept Review report. A construction cost estimate for the recommended Pima Road Channel project is presented. The cost estimate is based on preliminary sizing of the channel and detention basins as determined from the results of the revised hydrology study.




# • Drainage Plan

- Major Wash Corridor
- Desert Greenbelt Wash
- Secondary Wash Corridor
- Special Flood Hazard Area
- Moderate Flood Potential Area
- Area Currently Under Study

*Amended November 1992*
*Resolution No. 3717*

**PUBLIC FACILITIES ELEMENT**

Locations depicted on this map are generalized

North
1 mile

**FIGURE 1**

**general plan**
**Scottsdale, Arizona**

**Source of Information**

The major source of information for this report is obtained from the Concept Review report and the Design Hydrology Memorandum, December 1996, by GVSCE. Additional information, maps, land ownership, cost data, and analyses are obtained from file data of Greiner, PACE and GVSCE. In addition, certain information was obtained from City of Scottsdale staff. Where appropriate, the source of information is identified.

## RECOMMENDED DESIGN CONCEPT

The recommendations for the Pima Road Channel are presented in the Concept Review report (Recommendations and Appendix D of that report). That recommendation includes three detention basins located at Happy Valley Road, Deer Valley Road, and Union Hills Drive. The channel would be fully lined, although certain sections of the channel could have unlined channel beds, contingent upon final hydraulic analyses including sediment transport. As an alternative to the channel configuration, a buried conduit should be considered from the Deer Valley basin outlet extending south to Thompson Peak Parkway, or Beardsley Road, and possibly as far as Hualapai Road. Numerous engineering, aesthetics, cost and other factors must be considered in evaluating the channel versus buried conduit alternatives. The slope of the channel and the energy grade line would be reduced by use of energy dissipator/grade control structures. The recommended material for the channel and the energy dissipator structures is soil cement. A buried conduit will provide the outlet from the Union Hills basin to the outfall at the TPC Golf Course in the CAP basin. Plate 1 illustrates the alignment of the Pima Road Channel and the major drainage features.

It is recommended that the Pima Road Channel and the detention basins be sized for the 100-year, 6-hour storm (see the Design Hydrology Memorandum for a discussion and reservoir routing results). The hydraulic performance of the channel and basins would be determined and evaluated for a 100-year, 24-hour storm. The risk of flooding from the 24-hour storm will be assessed, and, if deemed appropriate, design considerations will be incorporated for the 24-hour storm.

Two options are provided for the Deer Valley detention basin. Option 1 has the collector channel along the north boundary of the DC Ranch property discharging into the Deer Valley basin. The waters from that collector channel are joined with incoming water from the Pima Road Channel which is then routed through the basin outlet works into the continuation of the Pima Road Channel to the south of Deer Valley Road. Option 2 has that collector channel bypassing the Deer Valley basin and discharging directly into the Pima Road Channel south of the Deer Valley basin. Descriptions of both options and separate cost estimates are provided. The following is a presentation of each major element of the recommended Pima Road Channel.

**Detention Basin Sizing**

The capacity of the three detention basins, as presented herein, are based on the hydrology from the Design Hydrology Memorandum and certain criteria as to maximum embankment height, basin drain times, and other factors. Changes to those criteria will have an impact on the basin capacity requirements and design discharges for the downstream receiving channels. A system operation study should be performed to optimize the performance and cost of the Pima Road Channel. That operation study will result in refinement of the basin sizes and discharge requirements for the channel. The basin capacities and channel discharges in this report are for preliminary, concept design purposes only.

At final design, spillway operation studies should be performed to assess the impact of reasonably prudent discharges in excess of the 100-year, 6-hour storm design flood. To the extent practical, drainage paths for spillway releases should be identified and accommodated at final design.

The basins may result in maximum water levels above natural grade at the berms, during passage of the design flood. The basins should be designed to impound less than 50 acre-feet above the natural grade and have embankment height of less than 6 feet. Such basins should not be classified as jurisdictional dams by the Arizona Department of Water Resources.

The spillways of the basins should be designed to safely pass inflows in excess of the design flood without releasing impounded waters. The use of a soil cement, or other erosion resistant material for the core of the embankment/spillway will be required.

**Happy Valley Basin**

Preliminary design of the Happy Valley basin with a 48 inch outlet conduit indicates that 182 acre-feet of storage volume is required. The excavation volume is about 436,000 cubic yards. An earthen embankment would be constructed along the southwestern edge of the basin to provide additional storage capacity. The embankment would contain a soil cement spillway that would be concealed by the earthen embankment and appropriate landscaping. The spillway would operate for flood events that are larger than that produced by the 100-year, 6-hour storm. The hydraulic height of the embankment/spillway would not exceed 6 feet and the basin would not be a jurisdictional dam under regulations of the Arizona Department of Water Resources (ADWR). The embankment/spillway would be designed to direct spillway discharges into a swale that would drain to the Pima Road Channel south of Happy Valley Road.

The preliminary layout of the Happy Valley basin is shown in Plate 2. The basin is configured to present a nonobtrusive facility that has opportunity for passive recreational use. With appropriate landscaping, the basin will be environmentally and aesthetically fitting to the Desert Greenbelt Project. Undisturbed buffer zones of Sonoran desert are provided around the basin.

**Deer Valley Basin**

Preliminary design of the Deer Valley basin was performed for both Option 1 and Option 2. For Option 1 with the Deer Valley collector channel discharging to the basin, using a 60 inch outlet conduit results in a storage volume of 177 acre-feet. The excavation volume for Option 1 is about 710,000 cubic yards. For Option 2 with the Deer Valley collector channel bypassing the basin and discharging directly to the Pima Road Channel, using a 54 inch outlet conduit results in a storage volume of 130 acre-feet. The excavation volume for Option 2 is about 462,000 cubic yards. The preliminary layouts for the Deer Valley basin under Options 1 and 2 are shown in Plates 3 and 4, respectively.

The basin would be constructed with an earthen embankment and spillway as generally described for the Happy Valley basin. The operation of the spillway for events larger than the design flood (100-year, 6-hour storm) will need to be evaluated. Spillway discharges will be directed toward the Pima Road Channel south of the Deer Valley Road alignment. Under Option 2, spillway discharges can be directed toward the bypass channel which may provide adequate conveyance capacity for much or all of the spillway discharge.

Under both Option 1 and Option 2, the outlet conduit from the Deer Valley basin will pass under Pima Road and discharge into the Pima Road Channel on the west side of Pima Road. Under Option 2, a separate conduit will be needed to convey runoff from the bypass channel to the connecting Pima Road Channel. A box culvert should be adequate for the Pima Road crossing of the bypass channel. No bridge crossing of Pima Road is required with the recommended concept.

The preliminary layouts of the Deer Valley basin, as shown in Plates 3 and 4, are configured to present nonobtrusive facilities for passive recreational use. Undisturbed buffer zones of Sonoran desert are provided around both basins. Less land area is required for the basin under Option 2. That unused land area can be left in its natural state to enhance the Desert Greenbelt Project, or certain portions could be sold by the City for land development. With appropriate landscaping, the basin will be environmentally and aesthetically fitting to the Desert Greenbelt Project.

**Union Hills Basin**

Preliminary design of the Union Hills basin was performed for discharges from the Deer Valley basin under both Options 1 and 2. For Option 1 with a 78 inch outlet conduit at the Union Hills basin, the required storage volume is 312 acre-feet. The excavation volume under Option 1 is 680,000 cubic yards. For Option 2 with an 84 inch outlet conduit, the required storage volume is 330 acre-feet. The excavation volume for Option 2 is 720,000 cubic yards. The preliminary layouts for the Union Hills basin under Options 1 and 2 are shown in Plates 5 and 6, respectively.

The basin would be constructed with an earthen embankment and spillway as generally described for the Happy Valley basin. The operation of the spillway for events larger than the design flood (100-year, 6-hour storm) will need to be evaluated and considered in conjunction with drainage for the Pima Freeway.

The outlet from the Union Hills basin will be by cast in place concrete conduit. It is presently envisioned that the conduit will follow the Pima Freeway and cross the freeway near the present alignment of Pima Road (see Plate 1). From there, the conduit will head south across the Perimeter Center, under Bell Road, and ultimately outfall in the CAP basin.

The preliminary layouts of the Union Hills basin, as shown in Plates 5 and 6, are configured to provide environmental and aesthetic treatment for the Desert Greenbelt Project. The City of Scottsdale may want to provide recreational facilities within the Union Hills basin, and such facilities would need to be incorporated into the design. A considerable portion of the parcel of land that would need to be acquired is not needed for the basin. That land could be used for other purposes, such as recreation facilities, or sold by the City of Scottsdale.

A summary of the excavation volumes for the detention basins is provided in Table 1. The excavation volumes for those detention basins under design conditions that were used by Greiner and PACE are also shown in Table 1 for comparison purposes. Differences in volumes are a result of hydrology, design storm assumptions (6-hour versus 24-hour), number of detention basins, and other factors. It is noted that the total excavation volume for the three recommended detention basins is 1,826,000 cubic yards for Option 1 and 1,618,000 cubic yards for Option 2. By comparison, the single basin at Union Hills under the Greiner Concept 1 is 2,086,000 cubic yards. Therefore, the three detention basin concept requires 260,000 cubic yards less excavation for Option 1 and 468,000 cubic yards less excavation for Option 2 than does the single large detention basin at Union Hills under Concept 1.

**TABLE 1**

**Detention basin excavation volumes**

| | Excavation Volumes, in thousands of cubic yards | | | | |
|---|---|---|---|---|---|
| | Recommended | | Concept A | | Concept 1 |
| Location (1) | Option 1 (2) | Option 2 (3) | PACE[a] (4) | Greiner[b] (5) | Greiner[b] (6) |
| Happy Valley | 436 | 436 | 690 | 709 | ---- |
| Deer Valley | 710 | 462 | 940 | 875 | ---- |
| Union Hills | 680 | 720 | 900 | 2,111 | 2,086 |
| Total | 1,826 | 1,618 | 2,530 | 3,695 | 2,086 |

Notes: [a] - Excavation volumes taken from PACE letter to Brian Baehr, 5 June 1996

[b] - Happy Valley and Deer Valley detention basin excavation volumes taken from Greiner memorandum to Mark Landsiedel, 5 June 1996
Union Hills detention basin excavation volumes taken from Greiner Basin Alternative report, May 1996

General Note: Detention basins by Greiner and PACE are sized for the 100-year, 24-hour storm. The recommended basins are sized for the 100-year, 6-hour storm.

**Channel**

The Pima Road Channel consists of three segments, as shown in Plate 1. The northern most segment extends from about ¼ mile north of Jomax Road to the Happy Valley basin. The middle segment connects the Happy Valley basin to the Deer Valley basin. Both of those segments are on the east side of Pima Road. The lower segment extends from the Deer Valley basin to the Union Hills basin, and that segment of channel is on the west side of Pima Road. Floodwaters conveyed in the Pima Road Channel cross Pima Road near the Deer Valley road alignment by a buried conduit from the Deer Valley basin and by a box culvert for the bypass channel for the Option 2 configuration.

Only preliminary hydraulic analyses were performed for the conceptual design of the channel and the energy dissipator/grade control structures. At final design, adequate hydraulic analyses need to be performed to set the channel design depths and freeboard requirements. Also, extensive hydraulic analyses, including the use of physical model studies, will be included to design the energy dissipator/grade control structures and to verify their performance.

It is understood that lateral inflow to the channel will be at designated junctions from lateral collector channels. Uncontrolled sheetflow should not be allowed to enter the channel. The design of the lateral inflow junctions are critical design issues that will need to be adequately addressed at final design.

It is recommended that the channel be constructed of soil cement. A typical channel cross section is shown in Figure 2. The bank lining is stair-stepped with a 1V:2H slope. Each lift of soil cement is about 1 foot. At a depth of about 2 feet, a 4-foot wide bench is recommended to enhance the safety aspect of the channel. That bench would facilitate emergency escape of persons in the channel during flow events. The soil cement extends vertically to slightly above the freeboard. The freeboard would be 25 percent of the specific energy. For preliminary sizing purposes, it is assumed that the normal depth of flow in the channel is 3 feet. The freeboard will be about 2 feet. Therefore, the bank lining will be about 5 feet. Above the soil cement bank lining, the channel bank will be unlined soil at a slope of 1V:3H, and will be of variable depth. The bank lining above the 4-foot wide bench will be covered with soil and the unlined bank will be revegetated.

An alternative channel cross section is shown in Figure 3. That configuration has a parabolic channel invert and somewhat different bank lining. The advantage of the alternative configuration is that low flows are kept away from the channel banks and the highest flow velocities are in the center of the channel. The gradual change in flow depth across the channel would enhance safety in the event of a person needing to exit the channel during a flood.

Flow velocities in the channel will be reduced by energy dissipator/grade control structures. The vertical drop at each structure will be about 6 feet to achieve a drop height of about twice the flow depth. The face of the drop will be stair-stepped to enhance safety of the structures for incidental use during times of no flow. The slope of the channel will be reduced to about 1 percent. A stilling basin will be incorporated into the channel below

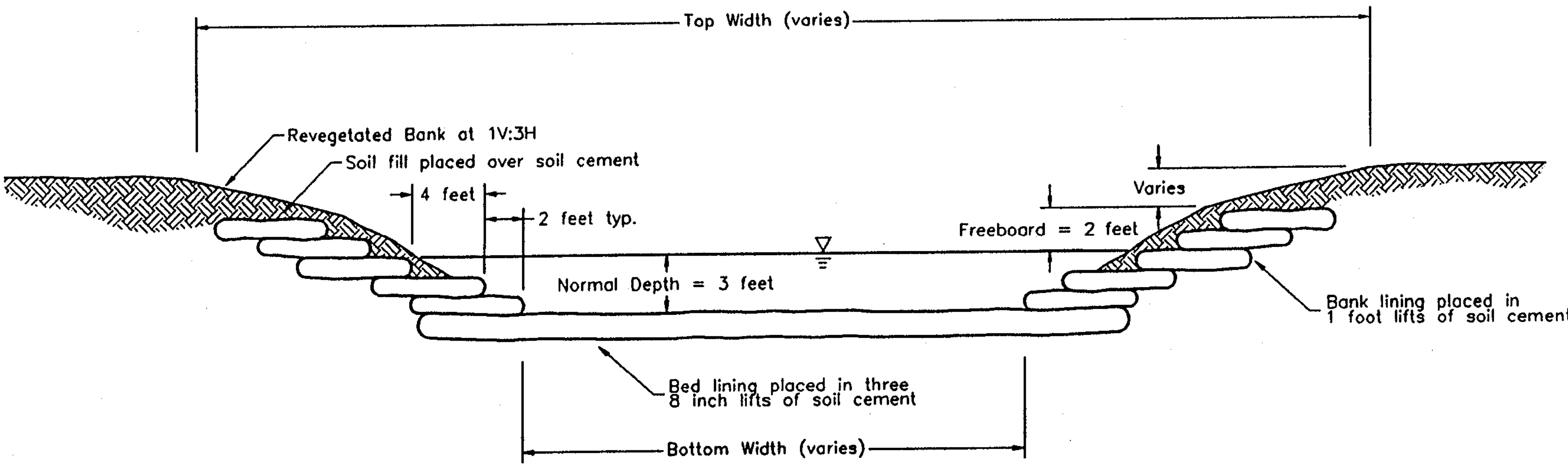



**FIGURE 2**

**Typical section for the Pima Road Channel**

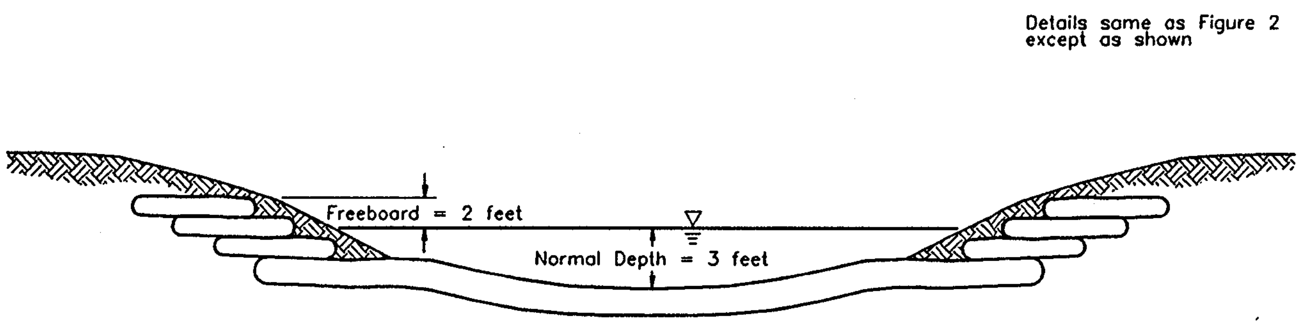



**FIGURE 3**

**Alternative section for the Pima Road Channel parabolic invert**

each drop structure. Those structures will be modeled after the NMSU-type structure that has been used in Albuquerque and is illustrated in Figure 4. Final design of the drop structures will be performed by hydraulic model studies. The recessed floor of the stilling basin will be filled with sand to improve the incidental use of the basin during non flow periods and to aid in aesthetics. The sand will scour out during large flood events allowing the stilling basins to be fully functional as energy dissipators. The energy dissipator/drop structures will be constructed of soil cement and will be similar in appearance to the channel lining.

A profile of the channel is shown in the three sheets of Plate 7. The segment of channel upstream of the Happy Valley basin will have 10 drop structures with an average of 490 feet between the structures. Between the Happy Valley and the Deer Valley basins, there will be 12 structures located about 717 feet apart. Between the Deer Valley and the Union Hills basin, there will be 19 structures located about 734 feet apart.

The width of the Pima Road Channel will vary throughout its length. The bottom width will vary as a function of discharge, and the top width will vary as a function of channel depth which decreases downstream of each drop structure. The channel width will increase at each inflow concentration point (see the Design Hydrology Memorandum). Immediately below the Happy Valley and Deer Valley basins, the channel bottom width is relatively narrow. The excavated top width of the channel (see Figures 2 and 3) is larger on the downstream side of each drop structure. That top width decreases in a downstream direction and is a minimum immediately upstream of each drop structure. This sequence of varying width progresses throughout the channel depending upon the location and spacing of drop structures (see Plate 7). The varying channel widths may facilitate the visual aesthetics of the channel by breaking up an otherwise linear effect. Some curvature would be incorporated in the alignment of the channel.

Table 2 indicates the size of channel bottom and top widths for the various segments of the channel. The sizes in Table 2 are preliminary and are based on the assumption of 3-foot normal depth in the channel. The channel widths will be determined based on final hydraulic analyses which has not been performed. The hydraulic calculations that are used as the basis of the concept design and cost estimate are provided in Appendix A.

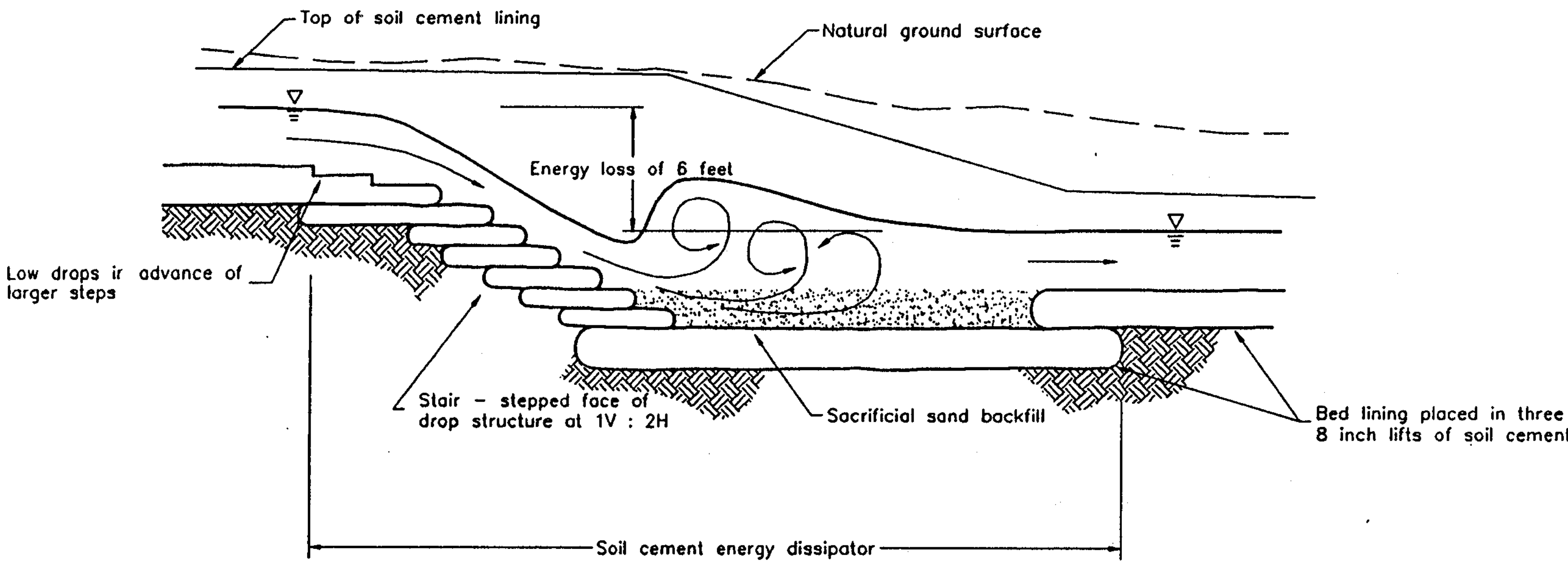



**FIGURE 4**

**Energy dissipator/grade control structure for the Pima Road Channel**

## TABLE 2
**Summary of Pima Road Channel bottom and top widths (see Figure 2 for definition of bottom and top widths)**

| Description of Pima Road Channel Reach | | Plate 7 Reference Reach(s) | Option 1 | | | Option 2 | | |
|---|---|---|---|---|---|---|---|---|
| | | | Bottom Width | Top Width | | Bottom Width | Top Width | |
| Upstream Limit (from) | Downstream Limit (to) | | feet | Minimum feet | Maximum feet | feet | Minimum feet | Maximum feet |
| (1) | | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1,000 feet north of Jomax Road | Jomax Road | 1 | 32 | 52 | 88 | 32 | 52 | 88 |
| Jomax Road | 2,400 south of Jomax Road | 1 and 2 | 38 | 58 | 94 | 38 | 58 | 94 |
| 2,400 feet south of Jomax Road | Happy Valley Detention Basin (HVDB) | 2 | 42 | 62 | 98 | 42 | 62 | 98 |
| HVDB outlet conduit discharge location | 1,300 feet south of Happy Valley Road | 3 | 6 | 26 | 62 | 6 | 26 | 62 |
| 1,300 feet south of Happy Valley Road | 3,100 feet south of Happy Valley Road | 4 | 27 | 47 | 83 | 27 | 47 | 83 |
| 3,100 feet south of Happy Valley Road | Pinnacle Peak Road | 5 | 48 | 68 | 104 | 48 | 68 | 104 |
| Pinnacle Peak Road | Deer Valley Detention Basin (DVDB) | 5 and 6 | 50 | 70 | 106 | 50 | 70 | 106 |
| DVDB outlet conduit discharge location | 900 feet south of Deer Valley Road | 7 | 7 | 27 | 63 | 32 | 52 | 88 |
| 900 feet south of Deer Valley Road | 1,900 feet south of Deer Valley Road | 8 | 8 | 28 | 64 | 32 | 52 | 88 |
| 1,900 feet south of Deer Valley Road | 300 feet north of Beardsley Road | 8 | 58 | 78 | 114 | 63 | 83 | 119 |
| 300 feet north of Beardsley Road | 2,200 feet south of Beardsley Road | 9 | 68 | 88 | 124 | 72 | 92 | 128 |
| 2,200 feet south of Beardsley Road | Union Hills Detention Basin | 10 | 78 | 98 | 134 | 82 | 102 | 138 |

Although it is recommended that the bed of the channel be lined because of scour and sediment transport reasons, there may be opportunities to have some portions of the channel with an unlined bed. An unlined bed channel will be considered for reaches of the channel that are upstream of each basin, and that have sufficient lateral inflow to deliver sediment to the channel.

**Trail and Path System**

The trail and path system will exist outside of the Pima Road Channel, although the channel, as described, could be entered and crossed by hikers and equestrians without undue difficulty. The channel will not be used as the grade separated crossings at roads. Separate structures are proposed for that purpose. For the intent of this report and cost estimate, it is assumed that the grade separated crossings consist of 10-foot high by 20-foot wide box culverts of sufficient length to pass beneath each road. The ramps into the crossing structures have a 1V:20H slope. The location of grade separated crossings is shown in Plate 1.

**Culverts and Bridges**

The Happy Valley and Deer Valley detention basins result in significantly reduced discharges as compared to the no detention basin concept. Additionally, the flow velocities in the channel will be reduced from the no detention basin concept because of the drop structures and reduced channel slope. Therefore, many of the roadway crossings of the Pima Road Channel can be by culvert as opposed to bridges. For the intent of this report, it is assumed that culverts will be used where the discharge in the channel is less than 2,000 cfs. Based on this criteria, bridges are required at Hualapai Road and an access road into the Water Campus off Union Hills Drive, and culverts are required at Jomax Road, Desert Highlands Drive, Pinnacle Peak Road, Los Gatos Drive, and Thompson Peak Parkway. The location of bridges and culverts are shown in Plate 1.

If a buried conduit below the Deer Valley basin is used rather than the channel, then the culvert at Thompson Peak Parkway and possibly the bridge at Hualapai Road could be eliminated. Those factors need to be considered in the cost analysis of the channel versus buried conduit alternatives. That alternative and costs are not provided in this report.

## CONSTRUCTION COST ESTIMATE

Construction cost estimates are provided for both Option 1 and Option 2 in Tables 3 and 4, respectively, and summarized in Table 5. The total cost for Option 1 is estimated at $36,752,000, and the cost for Option 2 is estimated at $36,978,000. The cost differential for these options does not provide a basis for the selection of one option over the other. The selection of either Option 1 or Option 2 should be based on environmental and aesthetic considerations at the Deer Valley basin and the approximate 1 mile segment of channel downstream of that basin that will be affected by those two options. Other consideration for Option 2 is that the bypass channel can be used to intercept all or some of spillway discharges in the event of spillway operation at the Deer Valley basin.

The land acquisition by purchase, lease, and drainage easement is identified in Plate 8. Some of the land to be acquired is held by the State of Arizona and managed by the State Land Department. By law, the value of State land must be determined by appraisal. As with other costs shown in Table 6, the land acquisition costs are best estimates. The actual land acquisition costs could vary appreciably due to many factors that could exist at the time of acquisition. The basis of the land acquisition cost is shown in Table 6.

## TABLE 3
## Cost Estimate for the Pima Road Channel Project
## Option 1 - Without Bypass at Deer Valley Road Basin

| Item NO. (1) | DESCRIPTION (2) | Quantity (3) | Unit (4) | Unit Cost (5) | Total Cost (6) | REMARKS (7) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 1 | PROJECT SIGNAGE | 1 | LS | $75,000.00 | $75,000 | Cost estimated by Greiner (1996) |
| | | | | | | |
| 2 | HAPPY VALLEY ROAD BASIN | | | | | |
| | (a) Vegetation Salvage | 23 | ACRES | $21,780.00 | $500,940 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 23 | ACRES | $1,600.00 | $36,800 | Basin area is 23 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 436,000 | CY | $3.00 | $1,308,000 | Excavation and hauling @ $3.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (1100 ft long) | 9,600 | CY | $1.30 | $12,480 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC) | 2,600 | CY | $50.00 | $130,000 | RCC Inner Core @ $50.00/CY from GVSCE (1996) |
| | - Final Grading | 25,000 | SY | $0.25 | $6,250 | Finish Grading for 1100-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Concrete Inlet Headwall | 1 | LS | $3,000.00 | $3,000 | Average bid cost projected from 36" RCP from FCDMC (1995) |
| | - Outlet Conduit (48" diam x 600 ft RCP) | 600 | LF | $110.00 | $66,000 | Cost from ADOT (1995) |
| | - Storm Drain Manhole | 1 | EACH | $6,700.00 | $6,700 | MAG Std. Detail No. 522 for 48-inch RCP; Average bid cost from FCDMC (1995) |
| | - Concrete Outlet Headwall | 1 | LS | $3,800.00 | $3,800 | Average bid cost from FCDMC (1995) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE (1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 1,800 | CY | $50.00 | $90,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 1,500 | CY | $50.00 | $75,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (i) Final Grading | 50,000 | SY | $0.25 | $12,500 | Finish Grading for 2200-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (j) Slope Erosion Protection | 3 | ACRES | $43,560.00 | $130,680 | Exterior embankment slope, max. area of 3 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 20 | ACRES | $43,560.00 | $871,200 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$3,268,350** | |
| | | | | | | |
| 3 | DEER VALLEY ROAD BASIN | | | | | |
| | (a) Vegetation Salvage | 27 | ACRES | $21,780.00 | $588,060 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 27 | ACRES | $1,600.00 | $43,200 | Basin area is 27 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 713,000 | CY | $3.00 | $2,139,000 | Excavation and hauling @ $3.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (950 ft long) | 4,800 | CY | $1.30 | $6,240 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC) | 1,700 | CY | $50.00 | $85,000 | RCC Inner Core @ $50.00/CY from GVSCE (1996) |
| | - Final Grading | 22,000 | SY | $0.25 | $5,500 | Finish Grading for 950-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Concrete Inlet Headwall | 1 | LS | $5,000.00 | $5,000 | Projected from 36-inch RCP inlet headwall from FCDMC (1995) |
| | - Outlet Conduit (60" x 700 ft RCP) | 700 | LF | $150.00 | $105,000 | Unit cost from ADOT (1995) |
| | - Storm Drain Manhole | 1 | EACH | $6,700.00 | $6,700 | Average bid cost from FCDMC (1996) |
| | - Concrete Outlet Headwall | 1 | LS | $5,000.00 | $5,000 | Bid cost from FCDMC (1996) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE (1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 2,600 | CY | $50.00 | $130,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 1,000 | CY | $50.00 | $50,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (i) Final Grading | 70,000 | SY | $0.25 | $17,500 | Finish Grading for 2400-ft x 250-ft corridor @ $ 0.25/SY by PACE (1996a) |
| | (j) Slope Erosion Protection | 2.5 | ACRES | $43,560.00 | $108,900 | Exterior embankment slope, max. area of 2.5 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 24.5 | ACRES | $43,560.00 | $1,067,220 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$4,377,320** | |
| | | | | | | |
| 4 | UNION HILLS DRIVE BASIN | | | | | |

## TABLE 3
## Cost Estimate for the Pima Road Channel Project
## Option 1 - Without Bypass at Deer Valley Road Basin

| Item NO. | DESCRIPTION | Quantity | Unit | Unit Cost | Total Cost | REMARKS |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | | | | | |
| | (a) Vegetation Salvage | 35 | ACRES | $21,780.00 | $762,300 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 35 | ACRES | $1,600.00 | $56,000 | Basin area is 35 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 680,000 | CY | $2.00 | $1,360,000 | Excavation and hauling as part of Pima Freeway @ $2.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (2100 ft long) | 16,000 | CY | $1.30 | $20,800 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC)) | 4,500 | CY | $50.00 | $225,000 | RCC Inner Core @ $50.00/CY from GVSCE (1996) |
| | - Final Grading | 47,000 | SY | $0.25 | $11,750 | Finish Grading for 2100-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Inlet Headwall | 1 | LS | $5,000.00 | $5,000 | Lump sum for headwall from FCDMC (1996) |
| | - Outlet Conduit (78" RCP) | 7,500 | LF | $145.00 | $1,087,500 | CIP unit cost; 1993 ADOT bid price, adjusted by 25% |
| | - Storm Drain Manholes @ 500-ft spacing | 14 | EACH | $6,700.00 | $93,800 | Average bid cost from FCDMC (1996) |
| | - Outlet Headwall | 1 | LS | $6,700.00 | $6,700 | Average bid cost from FCDMC (1996) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE (1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 2,000 | CY | $50.00 | $100,000 | Dumped riprap for main inlet @ $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 1,500 | CY | $50.00 | $75,000 | Dumped riprap for three inlets @ $50.00/CY (SFC,1996) |
| | (i) Final Grading | 47,000 | SY | $0.25 | $11,750 | Finish Grading for 3500-ft x 120-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (j) Slope Erosion Protection | 4 | ACRES | $43,560.00 | $174,240 | Exterior embankment slope, max. area of 4 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 31 | ACRES | $43,560.00 | $1,350,360 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$5,355,200** | |
| | | | | | | |
| 5 | **BRIDGE AND CULVERT CROSSINGS** | | | | | |
| | (a) Jomax Road | 60 | LF | $1,215.00 | $72,900 | Unit cost for 4-10' x 6' Box Culvert @ $1215.00/LF by SFC (1996) |
| | (b) Desert Highland Drive | 60 | LF | $1,215.00 | $72,900 | Unit cost for 4-10' x 6' Box Culvert @ $1215.00/LF by SFC (1996) |
| | (c) Pinnacle Peak Road | 60 | LF | $1,495.00 | $89,700 | Unit cost for 5-10' x 6' Box Culvert @ $1495.00/LF by SFC (1996) |
| | (d) Los Gatos Drive | 60 | LF | $1,495.00 | $89,700 | Unit cost for 5-10' x 6' Box Culvert @ $1495.00/LF by SFC (1996) |
| | (e) Thompson Peak Parkway Culvert | 120 | LF | $1,770.00 | $212,400 | Unit cost for 6-10' x 6' Box Culvert @ $1,770.00/LF by SFC (1996) |
| | (f) Hualapai Road Bridge | 7,200 | SF | $45.00 | $324,000 | 120 ft x 60ft wide for 4-lane plan @ $ 45.00/SF by Greiner (1996); Length < 150 ft; |
| | (g) Water Campus Access Bridge | 3,300 | SF | $45.00 | $148,500 | 110 ft x 30ft wide for 2-lane plan @ $ 45.00/SF by Greiner (1996); Length < 150 ft; |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$1,010,100** | |
| | | | | | | |
| 6 | **GRADE-SEPARATED CROSSINGS** | | | | | |
| | (a) Happy Valley Road | 1 | LS | $190,050.00 | $190,050 | The lump sum costs are determined from the ff. unit costs: excavation and haul |
| | (b) Pinnacle Peak Road | 1 | LS | $165,000.00 | $165,000 | @ $3.00/CY; retaining wall @ $15.00/SF (ADOT, 1995); and box culvert (1-20'x10') |
| | (c) North Pima Road | 1 | LS | $215,850.00 | $215,850 | @ $860/LF (SFC, 1996). Total quantity estimates are 1500 CY earthwork, 7210 SF |
| | (d) Thompson Peak Parkway | 1 | LS | $215,850.00 | $215,850 | concrete wall, and crossing lengths of 60 ft (for Pinnacle Peak Road and Hualapai |
| | (e) Hualapai Road | 1 | LS | $165,000.00 | $165,000 | Road), 90 ft (for Happy Valley Road), and 120 ft (for North Pima Road and |
| | | | | | | Thompson Peak Parkway). |
| | **Sub-Total Cost** | | | | **$951,750** | |
| | | | | | | |
| 7 | **CHANNEL** | | | | | |
| | (a) Vegetation Salvage | 55.0 | ACRES | $21,780.00 | $1,197,900 | Salvage of existing plants @ $0.5/SF by Greiner (1996); |
| | (b) Clearing and Grubbing | 55.0 | ACRES | $1,600.00 | $88,000 | Clearing and grubbing area is 55 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 673,500 | CY | $3.00 | $2,020,500 | Roadway excavation and short haul @ $ 3.00/CY |
| | (d) Soil Cement Lining (Channel) | 188,500 | CY | $27.00 | $5,089,500 | Soil cement @ $27.00/CY per information from Mr. K. Hansen. |
| | (e) Soil Cement Lining (Drops and S.Basins) | 40,000 | CY | $30.00 | $1,200,000 | Unit cost is about 10% higher for drops and stilling basins; |
| | (f) Landscaping/Revegetation/Irrigation | 17.0 | ACRES | $43,560.00 | $740,520 | Unit cost by Carol Shuler |

## TABLE 3
## Cost Estimate for the Pima Road Channel Project
## Option 1 - Without Bypass at Deer Valley Road Basin

| Item NO. (1) | DESCRIPTION (2) | Quantity (3) | Unit (4) | Unit Cost (5) | Total Cost (6) | REMARKS (7) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | Sub-Total Cost | | | | **$10,336,420** | |
| | | | | | | |
| 8 | MULTI-USE CONCRETE PATH | 30,000 | LF | $15.00 | **$450,000** | Total length from Jomax to Union Hills Det. Basin is 30,000 ft; cost by PACE (1996) |
| | | | | | | |
| 9 | HORSE TRAIL | 30,000 | LF | $0.25 | **$7,500** | Total length from Jomax to Union Hills Det. Basin is 30,000 ft; cost by PACE (1996) |
| | | | | | | |
| 10 | UTILITY RELOCATION | 1 | LS | $705,855.00 | **$705,855** | Cost based on the estimate by Greiner (30% design) |
| | | | | | | |
| 11 | BYPASS CHANNEL (DEER VALLEY) | - | - | - | - | No bypass channel for Option 1 |
| | | | | | | |
| | **SUB-TOTAL** | | | | **$26,537,495** | |
| | | | | | | |
| 12 | LAND ACQUISITION AND EASEMENT | | | | | |
| | 12.1 PURCHASE | | | | | |
| | (a) Channel | 37 | ACRES | $16,000.00 | $592,000 | Total land acquisition area is 37 acres - leased from State Land Department. |
| | (b) Happy Valley Road Basin | 32 | ACRES | $32,000.00 | $1,024,000 | Total detention area is 32 acres from State Land; unit cost is from Greiner (1996) |
| | (c) Deer Valley Road Basin | 33.5 | ACRES | $32,000.00 | $1,072,000 | Total detention area is 33.5 acres from State Land; unit cost is from Greiner (1996) |
| | (d) Union Hills Drive Basin | 43.5 | ACRES | $32,000.00 | $1,392,000 | Total detention area is 43.5 acres from State Land; unit cost is from Greiner (1996) |
| | 12.2 DRAINAGE EASEMENT (TO CAP BASIN) | 10.6 | ACRES | $21,300.00 | $225,780 | Total easement for underground conduit from Union Hills DB to CAP Basin is 17.2 |
| | | | | | | acres but only about 10.6 acres will be purchased ; |
| | Sub-Total Cost | | | | **$4,305,780** | |
| | | | | | | |
| 13 | ENGINEERING | 10 | PERCENT | $26,537,495.00 | **$2,653,750** | 10% of estimated cost (excluding land acquisition and easement); |
| 14 | CONTINGENCY | 15 | PERCENT | $26,537,495.00 | **$3,980,624** | 15% of estimated cost (excluded land acquisition and easement); |
| | | | | | | |
| | **TOTAL ESTIMATED COST** | | | | **$37,477,649** | |


REFERENCES:

(1) Greiner, Inc. (1995), "City of Scottsdale Desert Greenbelt Project", Final Report, Volume 1 - Project Overview Specific Options, June 1995.
(2) Greiner, Inc. (1996), " Pima Road Cost Comparisons", a memorandum submitted to the City of Scottsdale dated June 18, 1996.
(3) PACE (1996), " Pima Road Cost Comparison- With and Without Detention", submitted to the City of Scottsdale date August 14, 1996.
(4) ADOT (1995), "Construction Costs 1995", prepared by the Contracts and Specification Section of the Highways Division, Arizona Dept. of Transportation.
(5) FCDMC (1996), " Bid Estimates for Tenth Street Detention Facility and Cactus Road Drain", dated February 28, 1996 and March 19, 1996.
(6) SFC (1996), "Unit Costs for the Gila River Indian Communities Alternative Alignment Studies", dated March 1, 1996.
(7) GVSCE (1996), "Fountain Hills ADMP", Interim Report dated November 1996.

# TABLE 4
## Cost Estimate for the Pima Road Channel Project
## Option 2 - With Bypass at Deer Valley Road Basin

| Item NO. (1) | DESCRIPTION (2) | Quantity (3) | Unit (4) | Unit Cost (5) | Total Cost (6) | REMARKS (7) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 1 | **PROJECT SIGNAGE** | 1 | LS | $75,000.00 | **$75,000** | Cost estimated by Greiner (1996) |
| | | | | | | |
| 2 | **HAPPY VALLEY ROAD BASIN** | | | | | |
| | (a) Vegetation Salvage | 23 | ACRES | $21,780.00 | $500,940 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 23 | ACRES | $1,600.00 | $36,800 | Basin area is 23 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 436,000 | CY | $3.00 | $1,308,000 | Excavation and hauling @ $3.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (1100 ft long) | 9,600 | CY | $1.30 | $12,480 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC) | 2,600 | CY | $50.00 | $130,000 | RCC Inner Core @ $50.00/CY by GVSCE (1996) |
| | - Final Grading | 25,000 | SY | $0.25 | $6,250 | Finish Grading for 1100-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Concrete Inlet Headwall | 1 | LS | $3,000.00 | $3,000 | Average bid cost projected from 36" RCP from FCDMC (1995) |
| | - Outlet Conduit (48" diam x 600 ft RCP) | 600 | LF | $110.00 | $66,000 | Cost from ADOT (1995) |
| | - Storm Drain Manhole | 1 | EACH | $6,700.00 | $6,700 | MAG Std. Detail No. 522 for 48-inch RCP; Average bid cost from FCDMC (1995) |
| | - Concrete Outlet Headwall | 1 | LS | $3,800.00 | $3,800 | Average bid cost from FCDMC (1995) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE(1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 1,800 | CY | $50.00 | $90,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 1,500 | CY | $50.00 | $75,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (i) Final Grading | 50,000 | SY | $0.25 | $12,500 | Finish Grading for 2200-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (j) Slope Erosion Protection | 3 | ACRES | $43,560.00 | $130,680 | Exterior embankment slope, max. area of 3 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 20 | ACRES | $43,560.00 | $871,200 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$3,268,350** | |
| | | | | | | |
| 3 | **DEER VALLEY ROAD BASIN** | | | | | |
| | (a) Vegetation Salvage | 21.5 | ACRES | $21,780.00 | $468,270 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 21.5 | ACRES | $1,600.00 | $34,400 | Basin area is 21.5 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 463,000 | CY | $3.00 | $1,389,000 | Excavation and hauling @ $3.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (950 ft long) | 4,800 | CY | $1.30 | $6,240 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC) | 1,700 | CY | $50.00 | $85,000 | RCC Inner Core @ $50.00/CY by GVSCE (1996) |
| | - Final Grading | 22,000 | SY | $0.25 | $5,500 | Finish Grading for 950-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Concrete Inlet Headwall | 1 | LS | $5,000.00 | $5,000 | Projected from 36-inch RCP inlet headwall from FCDMC (1995) |
| | - Outlet Conduit (60" diameter x 700 ft RCP) | 700 | LF | $150.00 | $105,000 | Unit cost from ADOT (1995) |
| | - Storm Drain Manhole | 1 | EACH | $6,700.00 | $6,700 | Average bid cost from FCDMC (1996) |
| | - Concrete Outlet Headwall | 1 | LS | $5,000.00 | $5,000 | Bid cost from FCDMC (1996) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE (1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 2,600 | CY | $50.00 | $130,000 | Dumped riprap is $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 0 | CY | $50.00 | $0 | A bypass channel is provided for Option 2 (see Item No. 11) |
| | (i) Final Grading | 40,000 | SY | $0.25 | $10,000 | Finish Grading for 2400-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996a) |
| | (j) Slope Erosion Protection | 2.5 | ACRES | $43,560.00 | $108,900 | Exterior embankment slope, max. area of 2.5 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 19.0 | ACRES | $43,560.00 | $827,640 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$3,201,650** | |

## TABLE 4
## Cost Estimate for the Pima Road Channel Project
## Option 2 - With Bypass at Deer Valley Road Basin

| Item NO. (1) | DESCRIPTION (2) | Quantity (3) | Unit (4) | Unit Cost (5) | Total Cost (6) | REMARKS (7) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 4 | UNION HILLS DRIVE BASIN | | | | | |
| | (a) Vegetation Salvage | 37.5 | ACRES | $21,780.00 | $816,750 | Salvage of existing plants @ $0.5/SF by Greiner (1996) |
| | (b) Clearing and Grubbing | 37.5 | ACRES | $1,600.00 | $60,000 | Basin area is 37.5 acres @ $1,600/acre by PACE (1996) |
| | (c) Excavation | 720,000 | CY | $2.00 | $1,440,000 | Excavation and hauling as part of Pima Freeway @ $2.00/CY |
| | (d) Spillway and Embankment | | | | | |
| | - Embankment (2500 ft long) | 17,000 | CY | $1.30 | $22,100 | For spreading fill from scraper operation and compaction @ $ 1.30/CY |
| | - Inner Core (RCC) | 5,000 | CY | $50.00 | $250,000 | RCC Inner Core @ $50.00/CY by GVSCE (1996) |
| | - Final Grading | 56,000 | SY | $0.25 | $14,000 | Finish Grading for 2500-ft x 200-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (e) Low-Level Outlet Works | | | | | |
| | - Inlet Headwall | 1 | LS | $5,000.00 | $5,000 | Lump sum for headwall from FCDMC (1996) |
| | - Outlet Conduit (84" RCP) | 7,500 | LF | $150.00 | $1,125,000 | CIP unit cost; 1993 ADOT bid price, adjusted by 25% |
| | - Storm Drain Manholes @ 500-ft spacing | 14 | EACH | $6,700.00 | $93,800 | Average bid cost from FCDMC (1996) |
| | - Outlet Headwall | 1 | LS | $6,700.00 | $6,700 | Average bid cost from FCDMC (1996) |
| | (f) Outlet Stilling Basin (Concrete) | 1 | LS | $15,000.00 | $15,000 | Average unit cost from PACE (1996) and Greiner (1996) |
| | (g) Channel Inlet (Riprap) | 2,000 | CY | $50.00 | $100,000 | Dumped riprap for main inlet @ $50.00/CY (SFC,1996) |
| | (h) Collector Channel Inlet (Riprap) | 1,500 | CY | $50.00 | $75,000 | Dumped riprap for 3 inlets @ $50.00/CY (SFC,1996) |
| | (i) Final Grading | 47,000 | SY | $0.25 | $11,750 | Finish Grading for 3500-ft x 120-ft corridor @ $ 0.25/SY by PACE (1996) |
| | (j) Slope Erosion Protection | 5 | ACRES | $43,560.00 | $217,800 | Exterior embankment slope, max. area of 5 acres @ $ 1.00/SF by PACE (1996) |
| | (k) Landscaping/Revegetation/Irrigation | 32.5 | ACRES | $43,560.00 | $1,415,700 | Unit cost by Carol Shuler |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$5,668,600** | |
| | | | | | | |
| 5 | BRIDGE AND CULVERT CROSSINGS | | | | | |
| | (a) Jomax Road | 60 | LF | $1,215.00 | $72,900 | Unit cost for 4-10' x 6' Box Culvert @ $1215.00/LF by SFC (1996) |
| | (b) Desert Highland Drive | 60 | LF | $1,215.00 | $72,900 | Unit cost for 4-10' x 6' Box Culvert @ $1215.00/LF by SFC (1996) |
| | (c) Pinnacle Peak Road | 60 | LF | $1,495.00 | $89,700 | Unit cost for 5-10' x 6' Box Culvert @ $1495.00/LF by SFC (1996) |
| | (d) Los Gatos Drive | 60 | LF | $1,495.00 | $89,700 | Unit cost for 5-10' x 6' Box Culvert @ $1495.00/LF by SFC (1996) |
| | (f) Thompson Peak Parkway Culvert | 120 | LS | $1,770.00 | $212,400 | Unit cost for 6-10' x 6' Box Culvert @ $1,770.00/LF by SFC (1996) |
| | (g) Hualapai Road Bridge | 7,200 | SF | $45.00 | $324,000 | 120 ft x 60ft wide for 4-lane plan @ $ 45.00/SF by Greiner (1996); Length < 150 ft; |
| | (h) Water Campus Access Bridge | 3,300 | SF | $45.00 | $148,500 | 110 ft x 30ft wide for 2-lane plan @ $ 45.00/SF by Greiner (1996); Length < 150 ft; |
| | | | | | | |
| | **Sub-Total Cost** | | | | **$1,010,100** | |
| | | | | | | |
| 6 | GRADE-SEPARATED CROSSINGS | | | | | |
| | (a) Happy Valley Road | 1 | LS | $190,050.00 | $190,050 | The lump sum costs are determined from the ff. unit costs: excavation and haul |
| | (b) Pinnacle Peak Road | 1 | LS | $165,000.00 | $165,000 | @ $3.00/CY; retaining wall @ $15.00/SF (ADOT, 1995); and box culvert (1-20'x10') |
| | (c) North Pima Road | 1 | LS | $215,850.00 | $215,850 | @ $860/LF (SFC, 1996). Total quantity estimates are 1500 CY earthwork, 7210 SF |
| | (d) Thompson Peak Parkway | 1 | LS | $215,850.00 | $215,850 | concrete wall, and crossing lengths of 60 ft (for Pinnacle Peak Road and Hualapai |
| | (e) Hualapai Road | 1 | LS | $165,000.00 | $165,000 | Road), 90 ft (for Happy Valley Road), and 120 ft (for North Pima Road and |
| | | | | | | Thompson Peak Parkway). |
| | **Sub-Total Cost** | | | | **$951,750** | |
| | | | | | | |
| 7 | CHANNEL | | | | | |
| | (a) Vegetation Salvage | 56.8 | ACRES | $21,780.00 | $1,237,104 | Salvage of existing plants @ $0.5/SF by Greiner (1996); |
| | (b) Clearing and Grubbing | 56.8 | ACRES | $1,600.00 | $90,880 | Clearing and grubbing area is 55 acres @ $1,600/acre by PACE (1996) |

## TABLE 4
## Cost Estimate for the Pima Road Channel Project
## Option 2 - With Bypass at Deer Valley Road Basin

| Item NO. (1) | DESCRIPTION (2) | Quantity (3) | Unit (4) | Unit Cost (5) | Total Cost (6) | REMARKS (7) |
|---|---|---|---|---|---|---|
| | (c) Excavation | 703,000 | CY | $3.00 | $2,109,000 | Roadway excavation and short haul @ $ 2.00/CY by Greiner (1996) |
| | (d) Soil Cement Lining (Channel) | 194,500 | CY | $27.00 | $5,251,500 | Soil cement @ $27.00/CY per information from Mr. K. Hansen. |
| | (e) Soil Cement Lining (Drops and S.Basins) | 43,000 | CY | $30.00 | $1,290,000 | Unit cost is about 10% higher for drops and stilling basins; |
| | (f) Landscaping/Revegetation/Irrigation | 17.0 | ACRES | $43,560.00 | $740,520 | Unit cost by Carol Shuler |
| | Sub-Total Cost | | | | **$10,719,004** | |
| 8 | **MULTI-USE CONCRETE PATH** | 30,000 | LF | $15.00 | **$450,000** | Total length from Jomax to Union Hills Det. Basin is 30,000 ft; cost by PACE (1996) |
| 9 | **HORSE TRAIL** | 30,000 | LF | $0.25 | **$7,500** | Total length from Jomax to Union Hills Det. Basin is 30,000 ft; cost by PACE (1996) |
| 10 | **UTILITY RELOCATION** | 1 | LS | $705,855.00 | **$705,855** | Cost based on the estimate by Greiner (30% design) |
| 11 | **BYPASS CHANNEL (DEER VALLEY)** | 1 | LS | $661,000.00 | **$661,000** | Deer Valley collector channel and RCB |
| | **SUB-TOTAL** | | | | **$26,718,809** | |
| 12 | **LAND ACQUISITION AND EASEMENT** | | | | | |
| | 12.1 PURCHASE | | | | | |
| | (a) Channel | 37 | ACRES | $16,000.00 | $592,000 | Total land acquisition area is 37 acres - leased from State Land Department. |
| | (b) Happy Valley Road Basin | 32 | ACRES | $32,000.00 | $1,024,000 | Total detention area is 32 acres from State Land; unit cost is from Greiner (1996) |
| | (c) Deer Valley Road Basin | 33.5 | ACRES | $32,000.00 | $1,072,000 | Total detention area is 33.5 acres from State Land; unit cost is from Greiner (1996) |
| | (d) Union Hills Drive Basin | 43.5 | ACRES | $32,000.00 | $1,392,000 | Total detention area is 43.5 acres from State Land; unit cost is from Greiner (1996) |
| | 12.2 DRAINAGE EASEMENT (TO CAP BASIN) | 10.6 | ACRES | $21,300.00 | $225,780 | Total easement for underground conduit from Union Hills DB to CAP Basin is 17.2 acres but only about 10.6 acres will be purchased ; |
| | Sub-Total Cost | | | | **$4,305,780** | |
| 13 | **ENGINEERING** | 10 | PERCENT | $26,718,809.00 | **$2,671,881** | 10% of estimated cost (excluding land acquisition and easement); |
| 14 | **CONTINGENCY** | 15 | PERCENT | $26,718,809.00 | **$4,007,821** | 15% of estimated cost (excluded land acquisition and easement); |
| | **TOTAL ESTIMATED COST** | | | | **$37,704,291** | |


REFERENCES:

(1) Greiner, Inc. (1995), "City of Scottsdale Desert Greenbelt Project", Final Report, Volume 1 - Project Overview Specific Options, June 1995.
(2) Greiner, Inc. (1996), " Pima Road Cost Comparisons", a memorandum submitted to the City of Scottsdale dated June 18, 1996.
(3) PACE (1996), " Pima Road Cost Comparison- With and Without Detention", submitted to the City of Scottsdale date August 14, 1996.
(4) ADOT (1995), "Construction Costs 1995", prepared by the Contracts and Specification Section of the Highways Division, Arizona Dept. of Transportation.
(5) FCDMC (1996), " Bid Estimates for Tenth Street Detention Facility and Cactus Road Drain", dated February 28, 1996 and March 19, 1996.
(6) SFC (1996), "Unit Costs for the Gila River Indian Communities Alternative Alignment Studies", dated March 1, 1996.
(7) GVSCE (1996), "Fountain Hills ADMP", Interim Report dated November 1996.

## TABLE 5
### Cost Comparison for the Two Options Considered for the Pima Road Channel

| Item NO. | DESCRIPTION | Total Cost OPTION No. 1 | Total Cost OPTION No. 2 | Cost Difference |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (3)-(4) |
| 1 | PROJECT SIGNAGE | $75,000 | $75,000 | $0 |
| 2 | HAPPY VALLEY ROAD BASIN | $3,268,350 | $3,268,350 | $0 |
| 3 | DEER VALLEY ROAD BASIN | $4,377,320 | $3,201,650 | $1,175,670 |
| 4 | UNION HILLS DRIVE BASIN | $5,355,200 | $5,668,600 | -$313,400 |
| 5 | BRIDGE/CULVERT CROSSINGS | $1,010,100 | $1,010,100 | $0 |
| 6 | GRADE-SEPARATED CROSSINGS | $951,750 | $951,750 | $0 |
| 7 | CHANNEL | $10,336,420 | $10,719,004 | -$382,584 |
| 8 | MULTI-USE CONCRETE PATH | $450,000 | $450,000 | $0 |
| 9 | HORSE TRAIL | $7,500 | $7,500 | $0 |
| 10 | UTILITY RELOCATION | $705,855 | $705,855 | $0 |
| 11 | BYPASS CHANNEL (DEER VALLEY) | - | $661,000 | -$661,000 |
| | SUB-TOTAL | $26,537,495 | $26,718,809 | -$181,314 |
| 12 | LAND ACQUISITION | | | |
| | 12.1 PURCHASE | $4,080,000 | $4,080,000 | $0 |
| | 12.2 DRAINAGE EASEMENT (TO CAP BASIN) | $225,780 | $225,780 | $0 |
| 13 | ENGINEERING (10% of SUB-TOTAL COST) | $2,653,750 | $2,671,881 | -$18,131 |
| 14 | CONTINGENCY (15% of SUB-TOTAL COST) | $3,980,624 | $4,007,821 | -$27,197 |
| | TOTAL ESTIMATED COST | $37,477,649 | $37,704,291 | -$226,643 |

## TABLE 6

## Cost estimate for land acquisition for the Pima Road Channel

| Section (1) | Ownership (2) | Parcel Description (3) | Area (Acres) (4) | Unit Cost ($/acre) (5) | Cost ($) (6) | Basis of Unit Costs for Land Acquisition or Easement (7) |
|---|---|---|---|---|---|---|
| A | State Land Department | Area: 200' x 5160' | 23.70 | $16,000 | $379,200 | Lease at 50% of present purchase value ($32,000/acre) = $ 16,000/acre. |
| B | State Land Department | Happy Valley Det. Basin | 32.00 | $32,000 | $1,024,000 | Present purchase value = $ 32,000/acre. |
| C | Private | Area: 200' x 9150' | 41.90 | $0 | $0 | Drainage easement is stipulated in purchase of land parcel from State Land Dept. |
| D | State Land Department | Deer Valley Det. Basin | 33.50 | $32,000 | $1,072,000 | Present purchase value = $ 32,000/acre. |
| E | Grayhawk | Area: 250' x 2640' | 15.20 | $0 | $0 | Land to be contibuted to project. |
| F | State Land Department | Area: 250' x 1850' | 10.60 | $16,000 | $169,600 | Lease at 50% of present purchase value ($32,000/acre) = $ 16,000/acre. |
| G | Grayhawk | Area: 250' x 2900' | 16.60 | $0 | $0 | Land to be contibuted to project. |
| H | State Land Department | Area: 250' x 480' | 2.75 | $16,000 | $44,000 | Lease at 50% of present purchase value ($32,000/acre) = $ 16,000/acre. |
| I | City of Scottsdale | Area: 250' x 3600' | 20.70 | $0 | $0 | Land owned by City of Scottsdale (Water Campus). |
| J | State Land Department | Union Hills Det. Basin | 43.50 | $32,000 | $1,392,000 | Present purchase value = $ 32,000/acre. |
| K | State Land Department | Area: 100' x 3150' | 7.20 | $16,000 | $115,200 | Drainage easement @ $16,000/acre. |
| L | ADOT | Area: 100' x 750' | 1.75 | $0 | $0 | Drainage easement across Pima Freeway right-of-way; to be contributed to project. |
| M | Perimeter Center | Area: 100' x 1080' | 2.50 | $35,000 | $87,500 | Drainage easement at 10% of present purchase value ($ 350,000/acre) = $ 35,000/acre. |
| N | Private | Area: 100' x 360' | 0.85 | $25,000 | $21,250 | Drainage easement @ $ 25,000/acre. |
| O | TPC Golf Course | Area: 100' x 2210' | 5.10 | $0 | $0 | Drainage easement to be contributed to project. |
| | **TOTAL COST** | | | | **$4,304,750** | |

## APPENDIX A

**Hydraulic calculations for the concept design of the Pima Road Channel**

**Depth of flow and flow velocities upstream of drop structures for a range of channel slopes; for unit discharges (q) of 100, 50, 40, 30 and 20 cfs per foot; and resistance coefficients (n) of 0.015, 0.025 and 0.40**

Table ~~#####~~ 1

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=100cfs/ft; n=0.015)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.15% | S=0.20% | S=0.2138% | S=0.10% | S=0.15% | S=0.20% | S=0.2138% |
| 0 | 6.77 | 6.77 | 6.77 | 6.77 | 14.77 | 14.77 | 14.77 | 14.77 |
| 25 | 7.12 | 7.02 | 6.87 | 6.78 | 14.05 | 14.24 | 14.55 | 14.77 |
| 50 | 7.24 | 7.10 | 6.89 | 6.78 | 13.81 | 14.08 | 14.51 | 14.76 |
| 100 | 7.40 | 7.20 | 6.90 | 6.78 | 13.51 | 13.88 | 14.48 | 14.76 |
| 150 | 7.52 | 7.27 | 6.91 | 6.78 | 13.30 | 13.76 | 14.47 | 14.76 |
| 200 | 7.61 | 7.32 | 6.91 | 6.78 | 13.14 | 13.67 | 14.47 | 14.75 |
| 300 | 7.75 | 7.39 | 6.92 | 6.78 | 12.90 | 13.54 | 14.46 | 14.75 |
| 500 | 7.95 | 7.47 | 6.92 | 6.78 | 12.59 | 13.39 | 14.46 | 14.75 |
| 1000 | 8.23 | 7.55 | 6.92 | 6.78 | 12.16 | 13.24 | 14.46 | 14.75 |
| 2000 | 8.47 | 7.58 | 6.92 | 6.78 | 11.81 | 13.19 | 14.46 | 14.75 |
| N. Depth (ft) | 8.64 | 7.58 | 6.92 | 6.78 | | | | |

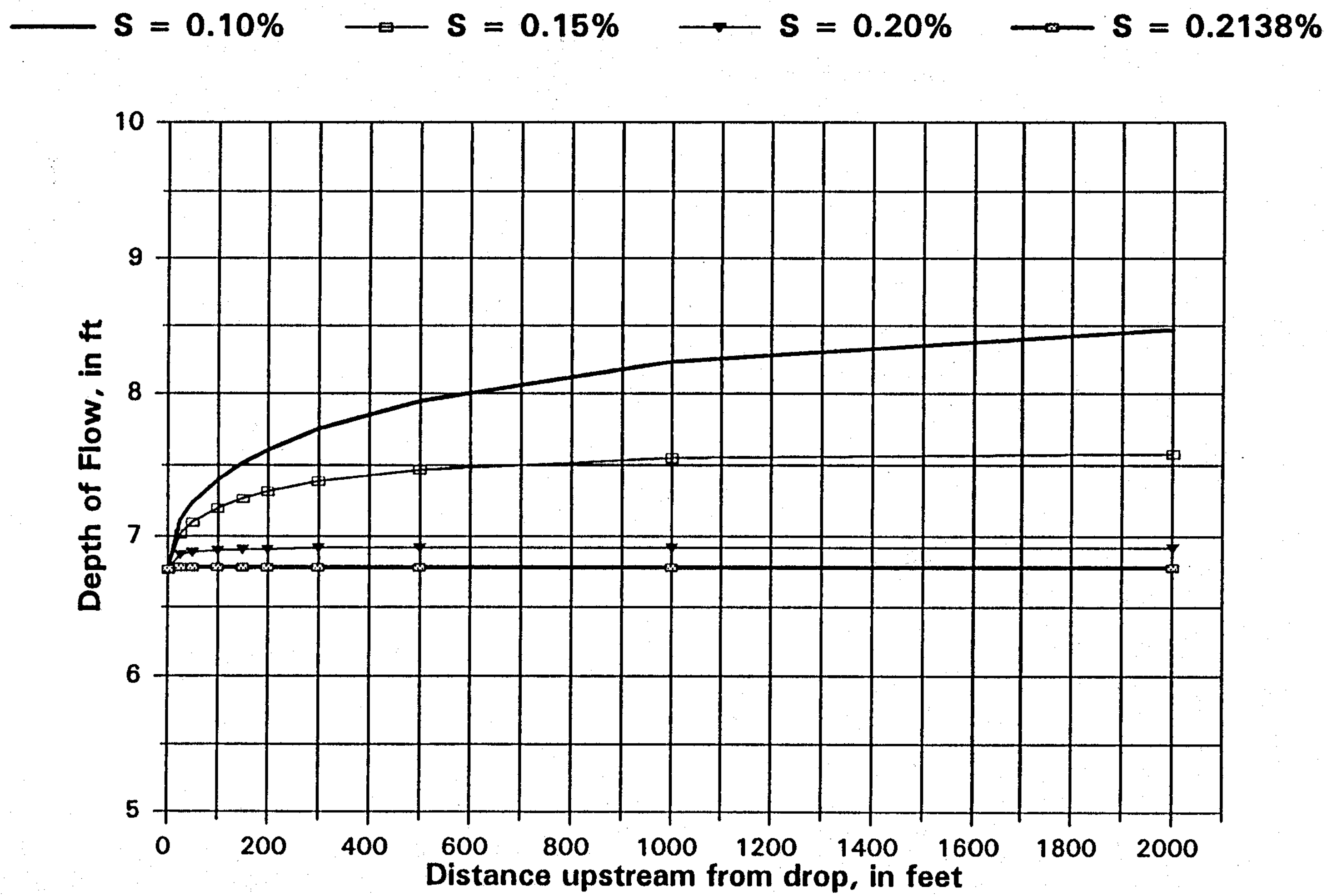



Figure 1-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 100 cfs/ft and n = 0.015

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11-Jul-96

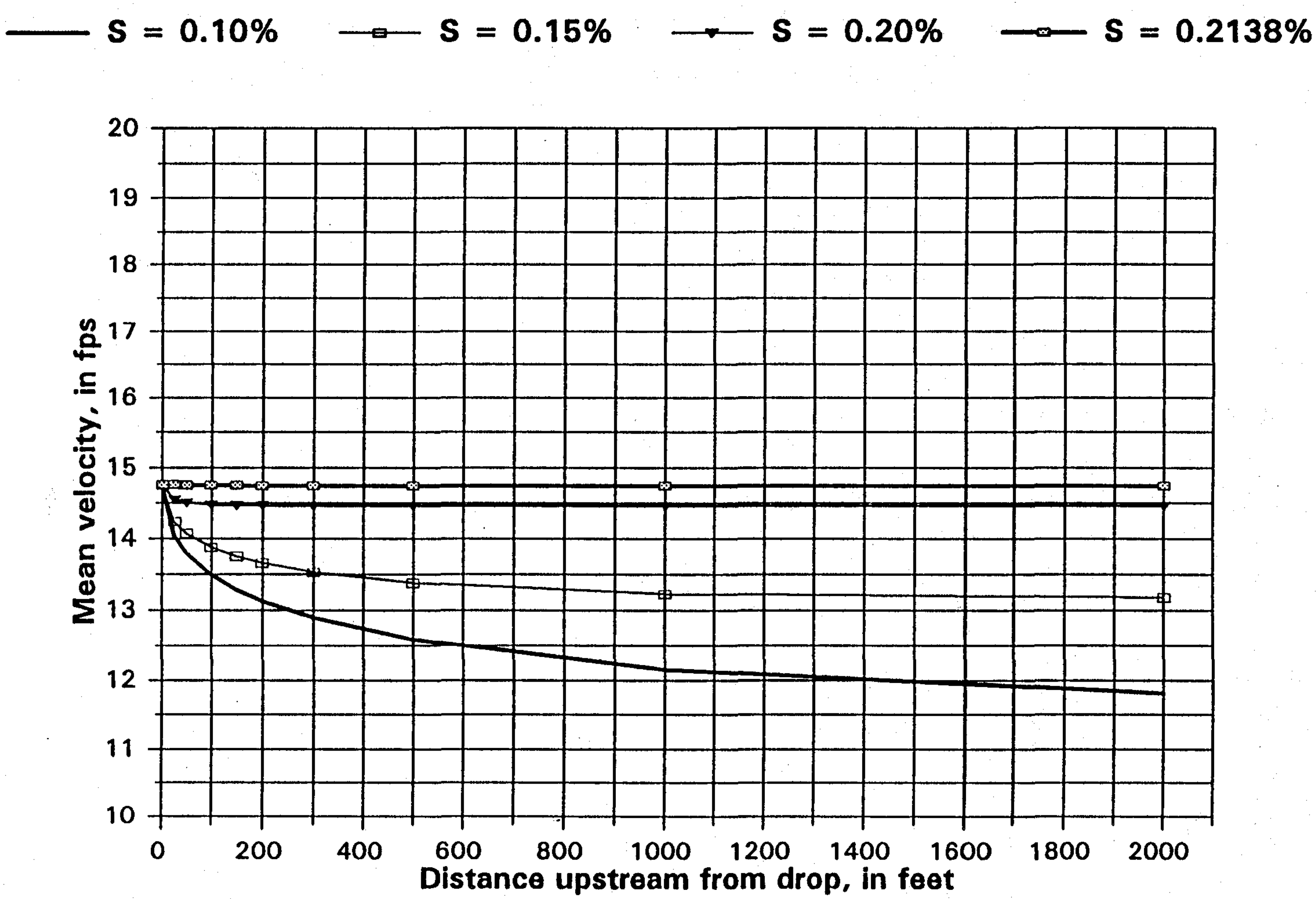



Figure 2-A
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 100 cfs/ft and n = 0.015

Table ~~#####~~ 2

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=100cfs/ft; n=0.025)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=0.59% | S=0.10% | S=0.25% | S=0.50% | S=0.59% |
| 0 | 6.77 | 6.77 | 6.77 | 6.77 | 14.77 | 14.77 | 14.77 | 14.77 |
| 25 | 7.51 | 7.36 | 7.04 | 6.78 | 13.32 | 13.58 | 14.20 | 14.76 |
| 50 | 7.76 | 7.55 | 7.08 | 6.79 | 12.88 | 13.24 | 14.12 | 14.75 |
| 100 | 8.11 | 7.80 | 7.12 | 6.79 | 12.33 | 12.83 | 14.04 | 14.75 |
| 150 | 8.36 | 7.96 | 7.14 | 6.79 | 11.96 | 12.56 | 14.00 | 14.75 |
| 200 | 8.56 | 8.09 | 7.15 | 6.79 | 11.68 | 12.37 | 13.99 | 14.75 |
| 300 | 8.88 | 8.27 | 7.15 | 6.79 | 11.26 | 12.09 | 13.98 | 14.75 |
| 500 | 9.35 | 8.50 | 7.15 | 6.79 | 10.70 | 11.76 | 13.98 | 14.75 |
| 1000 | 10.07 | 8.78 | 7.15 | 6.79 | 9.93 | 11.40 | 13.98 | 14.75 |
| 2000 | 10.84 | 8.92 | 7.15 | 6.79 | 9.23 | 11.21 | 13.98 | 14.75 |
| N. Depth (ft) | 12.06 | 8.94 | 7.15 | 6.79 | | | | |

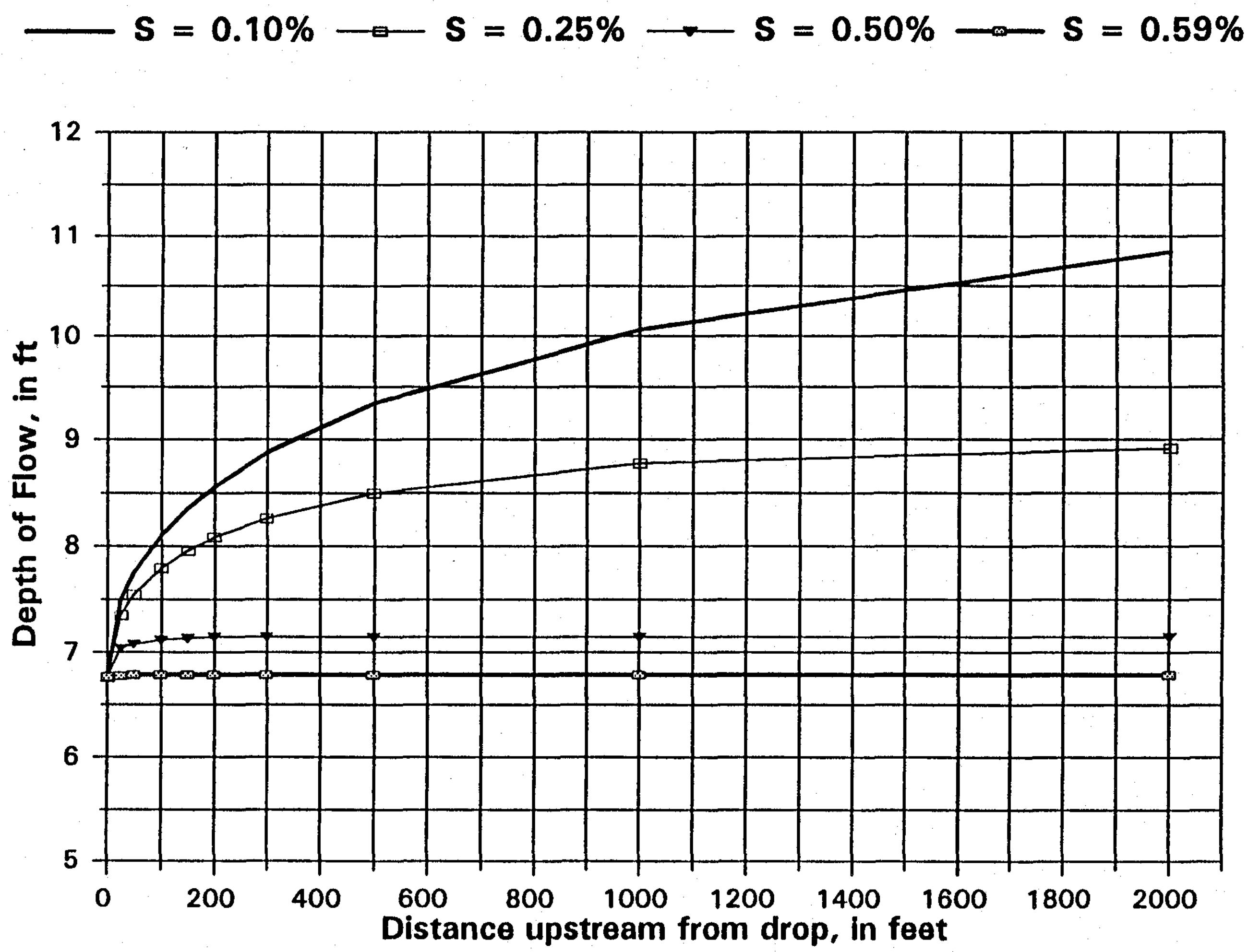



Figure ~~1-B~~ 2 A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 100 cfs/ft and n = 0.025

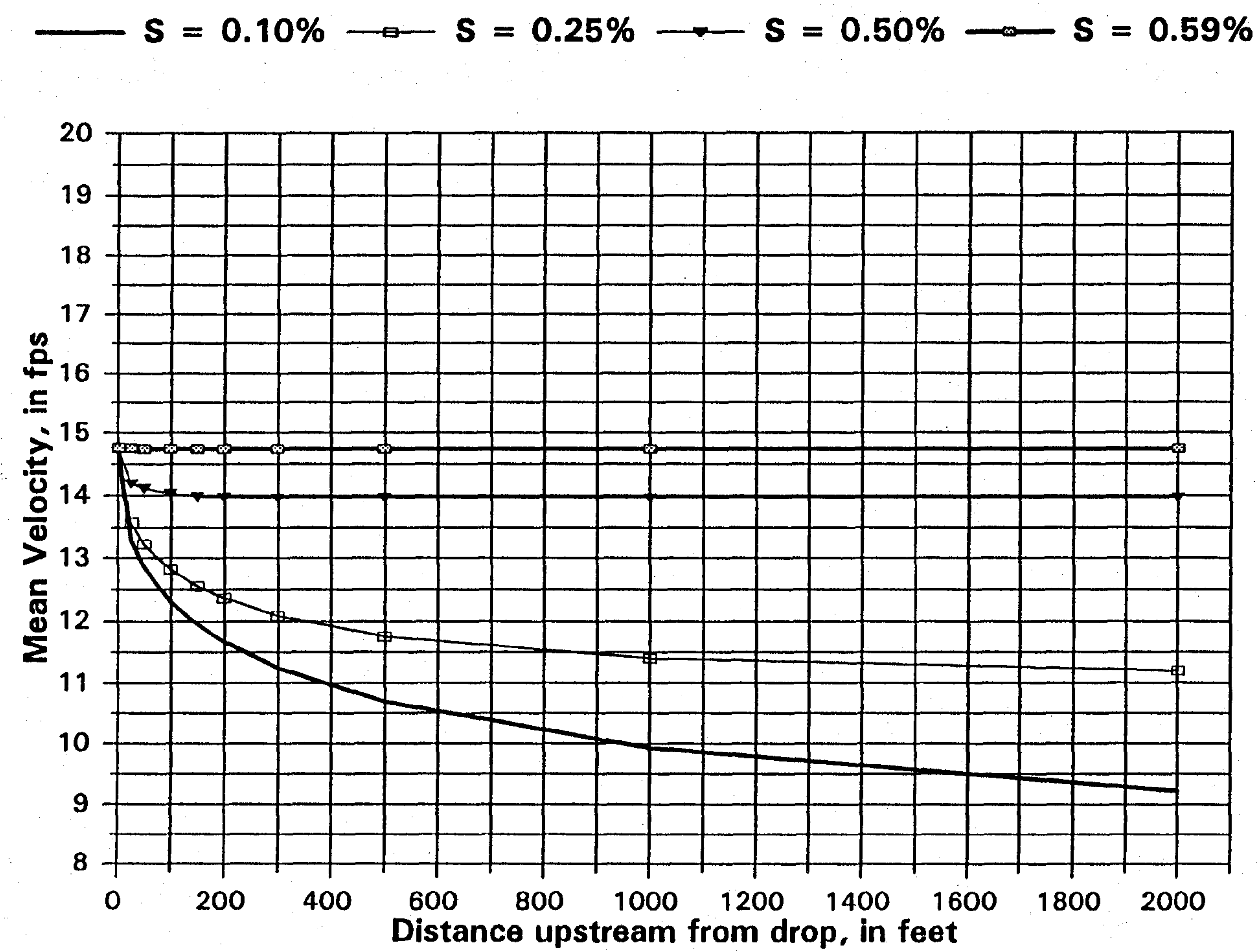



Figure 2-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 100 cfs/ft and n = 0.025

Table ~~#####~~ 3

Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure
(q=100cfs/ft; n=0.040)

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | | Flow Velocity (in fps) Slope (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.52% | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.52% |
| | | | | | | | | | | |
| 0 | 6.77 | 6.77 | 6.77 | 6.77 | 6.77 | 14.77 | 14.77 | 14.77 | 14.77 | 14.77 |
| 25 | 8.02 | 7.94 | 7.78 | 7.42 | 6.77 | 12.46 | 12.60 | 12.85 | 13.47 | 14.77 |
| 50 | 8.44 | 8.30 | 8.07 | 7.53 | 6.77 | 11.85 | 12.04 | 12.39 | 13.27 | 14.77 |
| 100 | 9.00 | 8.79 | 8.43 | 7.65 | 6.77 | 11.11 | 11.37 | 11.86 | 13.08 | 14.77 |
| 150 | 9.41 | 9.13 | 8.67 | 7.69 | 6.77 | 10.63 | 10.95 | 11.54 | 13.00 | 14.77 |
| 200 | 9.73 | 9.40 | 8.84 | 7.72 | 6.77 | 10.28 | 10.64 | 11.32 | 12.96 | 14.77 |
| 300 | 10.25 | 9.81 | 9.08 | 7.74 | 6.77 | 9.76 | 10.20 | 11.02 | 12.93 | 14.77 |
| 500 | 11.00 | 10.36 | 9.35 | 7.74 | 6.77 | 9.09 | 9.65 | 10.69 | 12.92 | 14.77 |
| 1000 | 12.21 | 11.14 | 9.62 | 7.74 | 6.77 | 8.19 | 8.98 | 10.40 | 12.92 | 14.77 |
| 2000 | 13.54 | 11.78 | 9.68 | 7.74 | 6.77 | 7.39 | 8.49 | 10.32 | 12.92 | 14.77 |
| | | | | | | | | | | |
| N. Depth (ft) | 16.52 | 12.15 | 9.68 | 7.74 | 6.77 | | | | | |

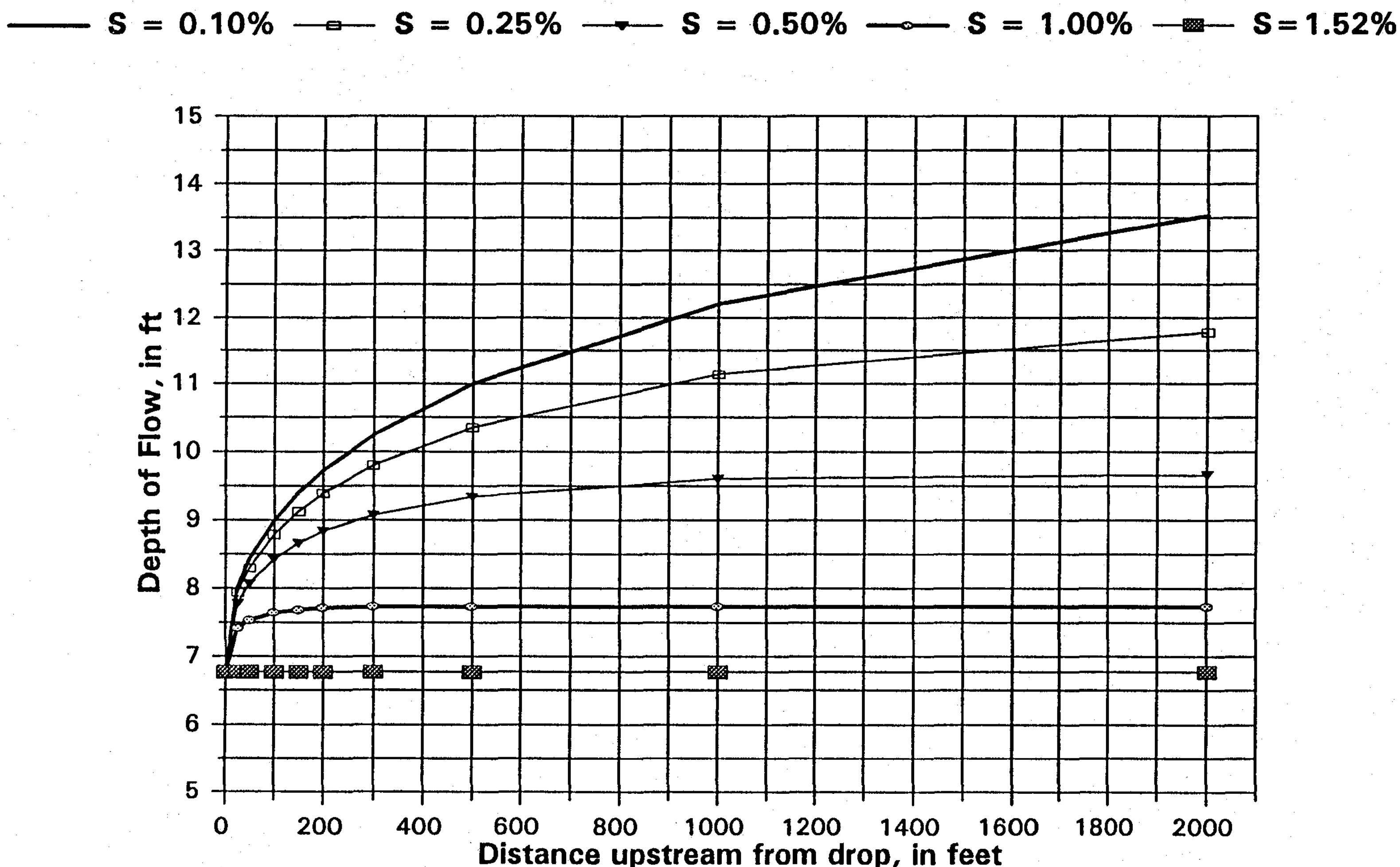



Figure ~~1-C~~ 3A
Flow Depths from Backwater Analysis from Rectangular Channel
for q = 100 cfs/ft and n = 0.040

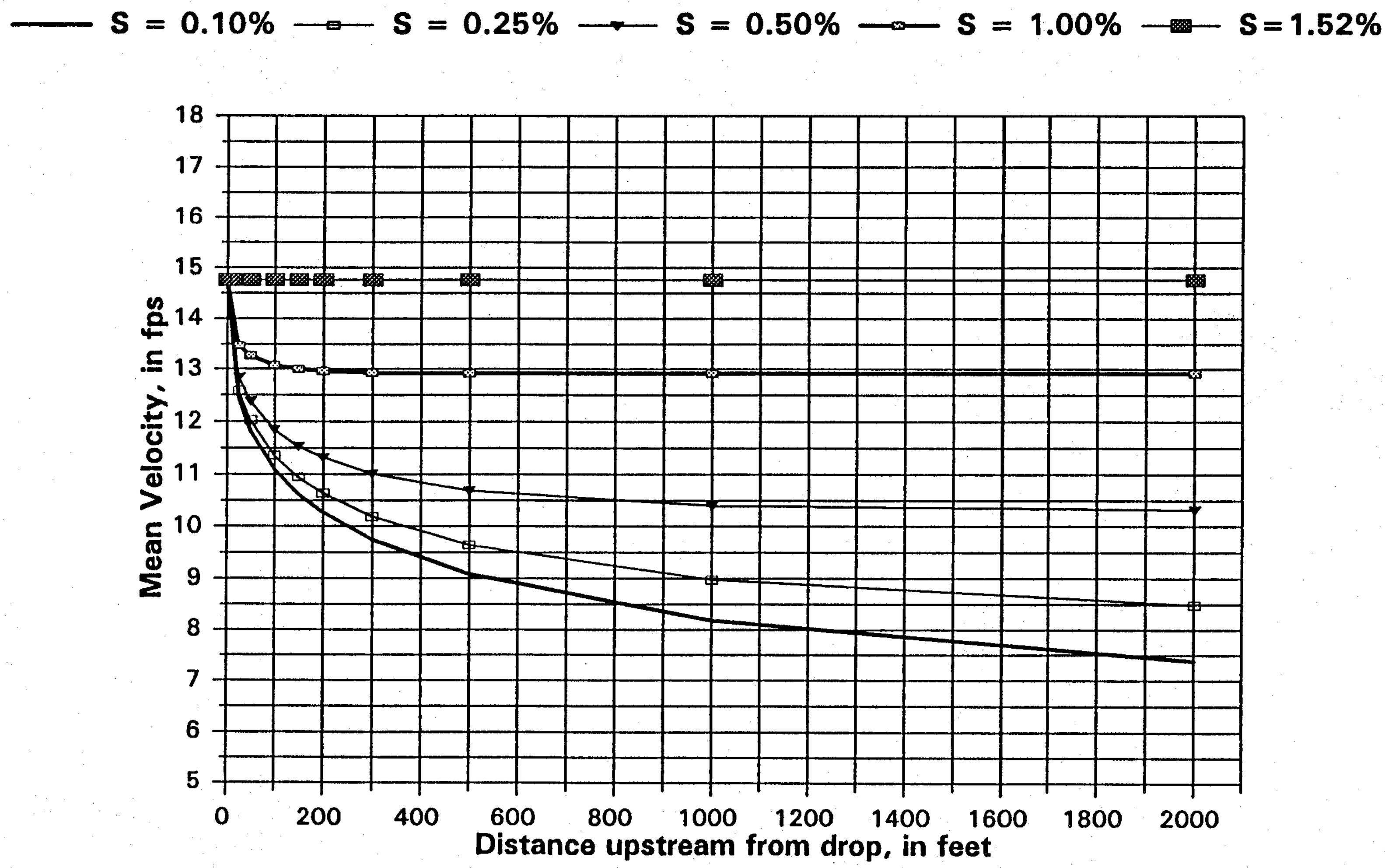



Figure ~~2-C~~ 3 B
Flow Velocities from Backwater Analysis of Rectangular Channel for q = 100 cfs/ft and n = 0.040

Table ~~#####~~ 4

Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure
(q= 50cfs/ft; n=0.015)

| Distance (feet) | Flow Depth (in Feet) | | | | Flow Velocity (in fps) | | | |
|---|---|---|---|---|---|---|---|---|
| | Slope (%) | | | | Slope (%) | | | |
| | S=0.10% | S=0.15% | S=0.20% | S=0.23% | S=0.10% | S=0.15% | S=0.20% | S=0.23% |
| | | | | | | | | |
| 0 | 4.27 | 4.27 | 4.27 | 4.27 | 11.71 | 11.71 | 11.71 | 11.71 |
| 25 | 4.56 | 4.49 | 4.39 | 4.27 | 10.97 | 11.14 | 11.38 | 11.71 |
| 50 | 4.66 | 4.55 | 4.42 | 4.27 | 10.73 | 10.98 | 11.32 | 11.71 |
| 100 | 4.79 | 4.64 | 4.44 | 4.27 | 10.44 | 10.78 | 11.26 | 11.71 |
| 150 | 4.88 | 4.69 | 4.45 | 4.27 | 10.25 | 10.66 | 11.23 | 11.71 |
| 200 | 4.95 | 4.73 | 4.46 | 4.27 | 10.11 | 10.58 | 11.22 | 11.71 |
| 300 | 5.05 | 4.78 | 4.46 | 4.27 | 9.90 | 10.47 | 11.20 | 11.71 |
| 500 | 5.19 | 4.83 | 4.46 | 4.27 | 9.63 | 10.35 | 11.19 | 11.71 |
| 1000 | 5.37 | 4.88 | 4.47 | 4.27 | 9.30 | 10.25 | 11.19 | 11.71 |
| 2000 | 5.51 | 4.89 | 4.47 | 4.27 | 9.08 | 10.23 | 11.19 | 11.71 |
| | | | | | | | | |
| N. Depth (ft) | 5.55 | 4.89 | 4.47 | 4.27 | | | | |

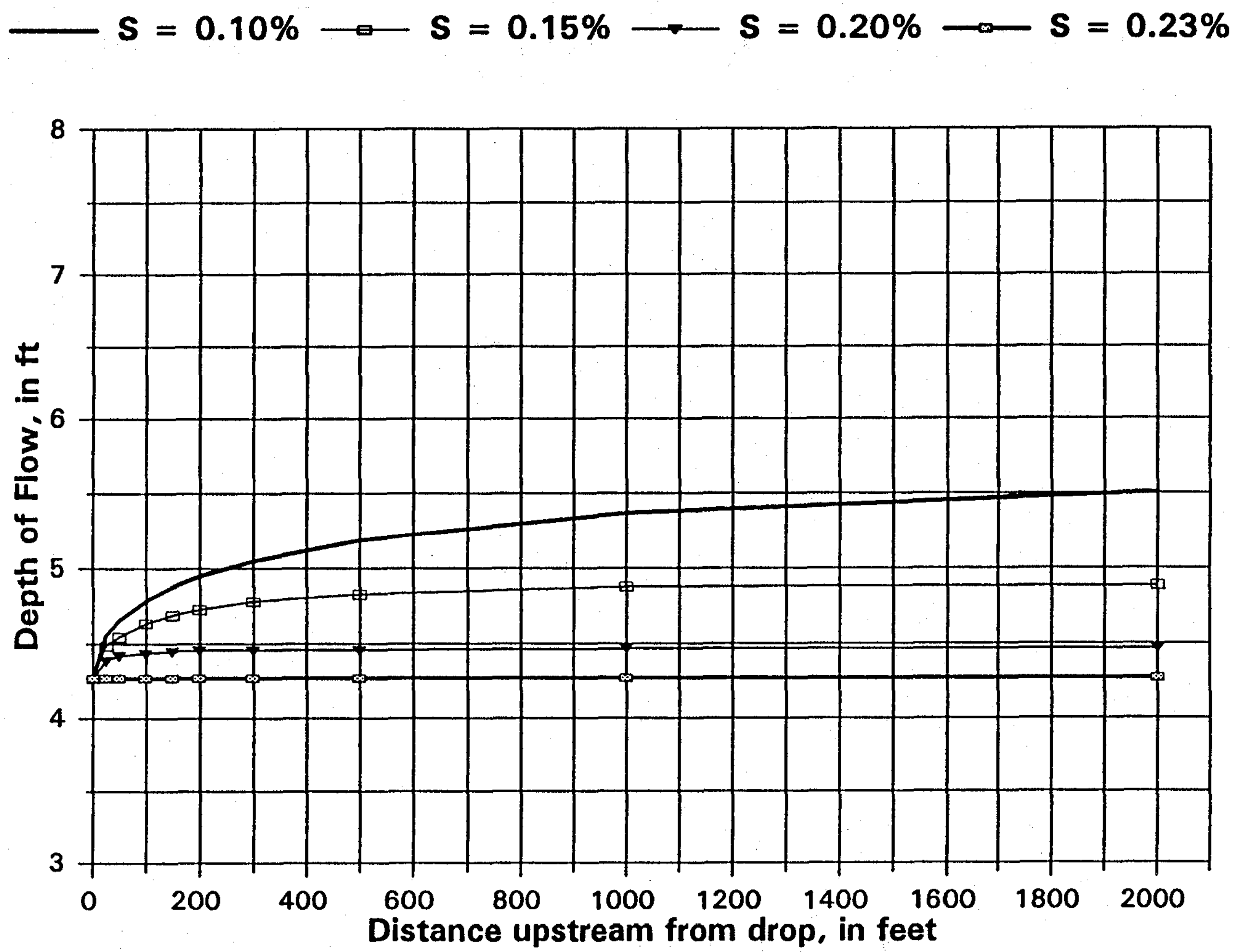



Figure 4-A

Flow Depths from Backwater Analysis for Rectangular Channel for q = 50 cfs/ft and n = 0.015

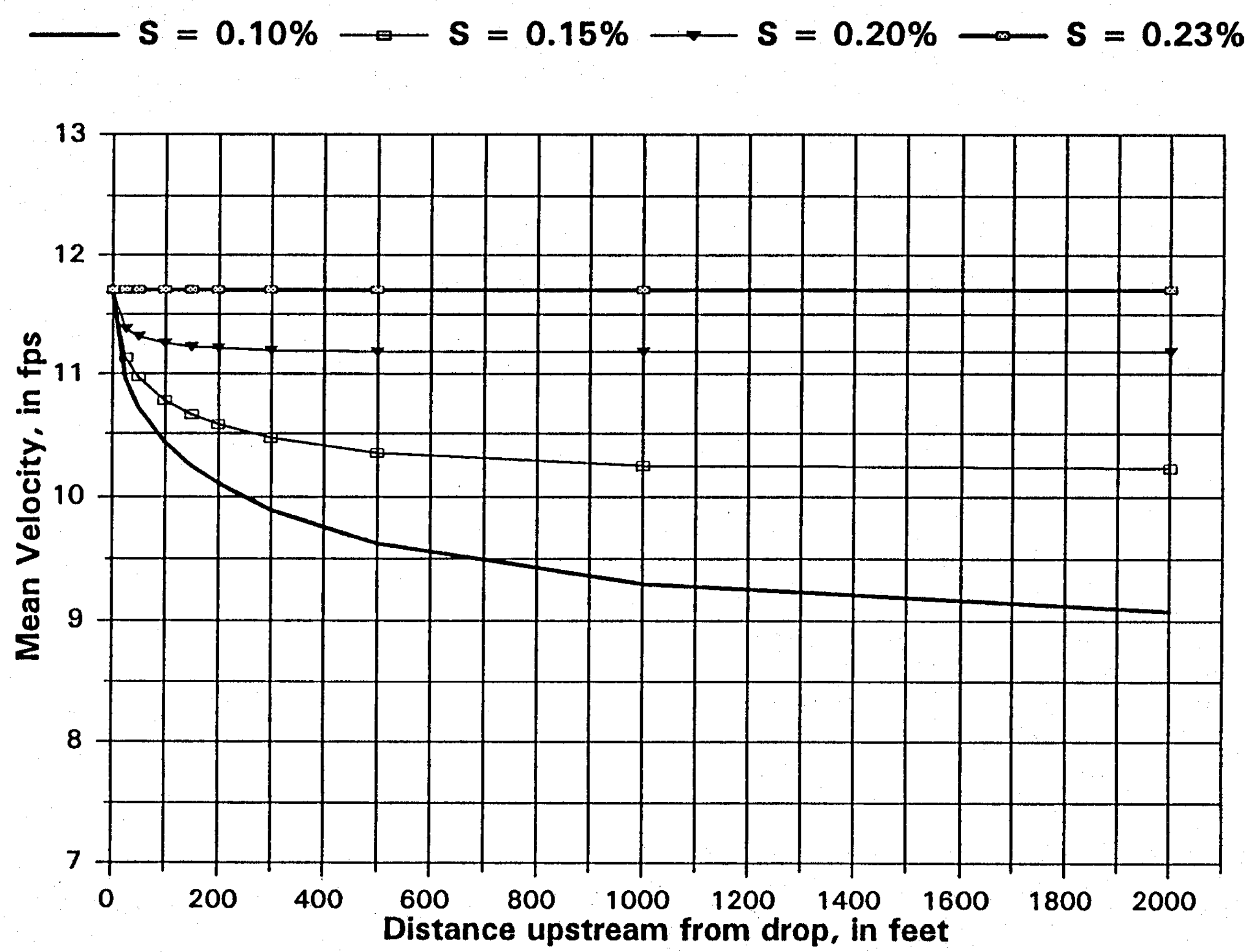



Figure 4-B
Flow Velocities from Backwater Aanalysis for Rectangular Channel
for $q$ = 50 cfs/ft and $n$ = 0.015

Table ~~#####~~ 5

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=50 cfs/ft; n=0.025)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=0.64% | S=0.10% | S=0.25% | S=0.50% | S=0.64% |
| | | | | | | | | |
| 0 | 4.27 | 4.27 | 4.27 | 4.27 | 11.71 | 11.71 | 11.71 | 11.71 |
| 25 | 4.87 | 4.76 | 4.53 | 4.27 | 10.26 | 10.50 | 11.05 | 11.71 |
| 50 | 5.07 | 4.91 | 4.56 | 4.27 | 9.85 | 10.19 | 10.96 | 11.71 |
| 100 | 5.34 | 5.09 | 4.60 | 4.27 | 9.36 | 9.82 | 10.88 | 11.71 |
| 150 | 5.53 | 5.21 | 4.61 | 4.27 | 9.04 | 9.60 | 10.85 | 11.71 |
| 200 | 5.68 | 5.30 | 4.61 | 4.27 | 8.80 | 9.44 | 10.84 | 11.71 |
| 300 | 5.92 | 5.42 | 4.62 | 4.27 | 8.44 | 9.22 | 10.83 | 11.71 |
| 500 | 6.25 | 5.56 | 4.62 | 4.27 | 8.00 | 8.99 | 10.83 | 11.71 |
| 1000 | 6.75 | 5.70 | 4.62 | 4.27 | 7.41 | 8.77 | 10.83 | 11.71 |
| 2000 | 7.21 | 5.74 | 4.62 | 4.27 | 6.93 | 8.71 | 10.83 | 11.71 |
| | | | | | | | | |
| N. Depth (ft) | 7.68 | 5.74 | 4.62 | 4.27 | | | | |

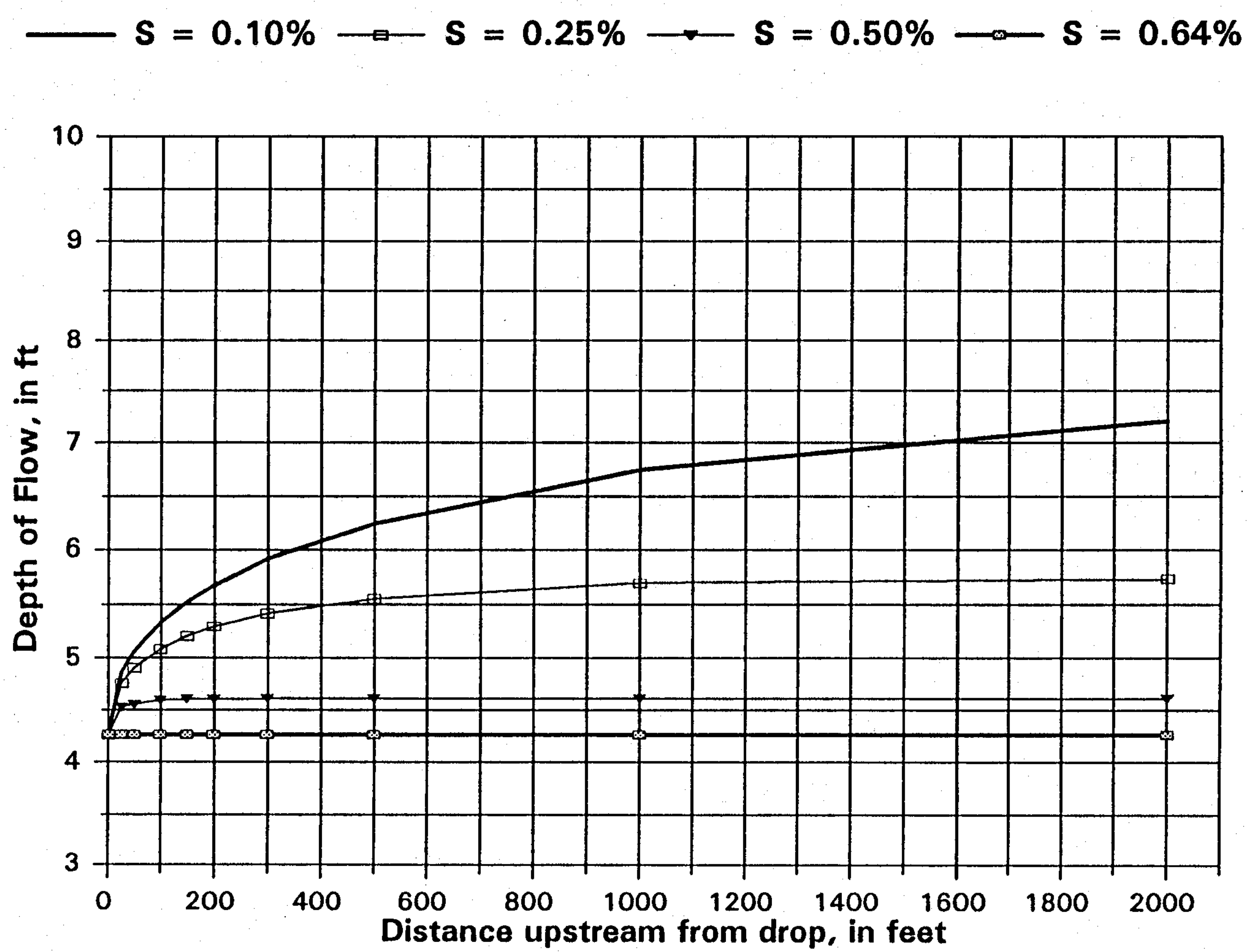



Figure 5-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 50 cfs/ft and n = 0.025

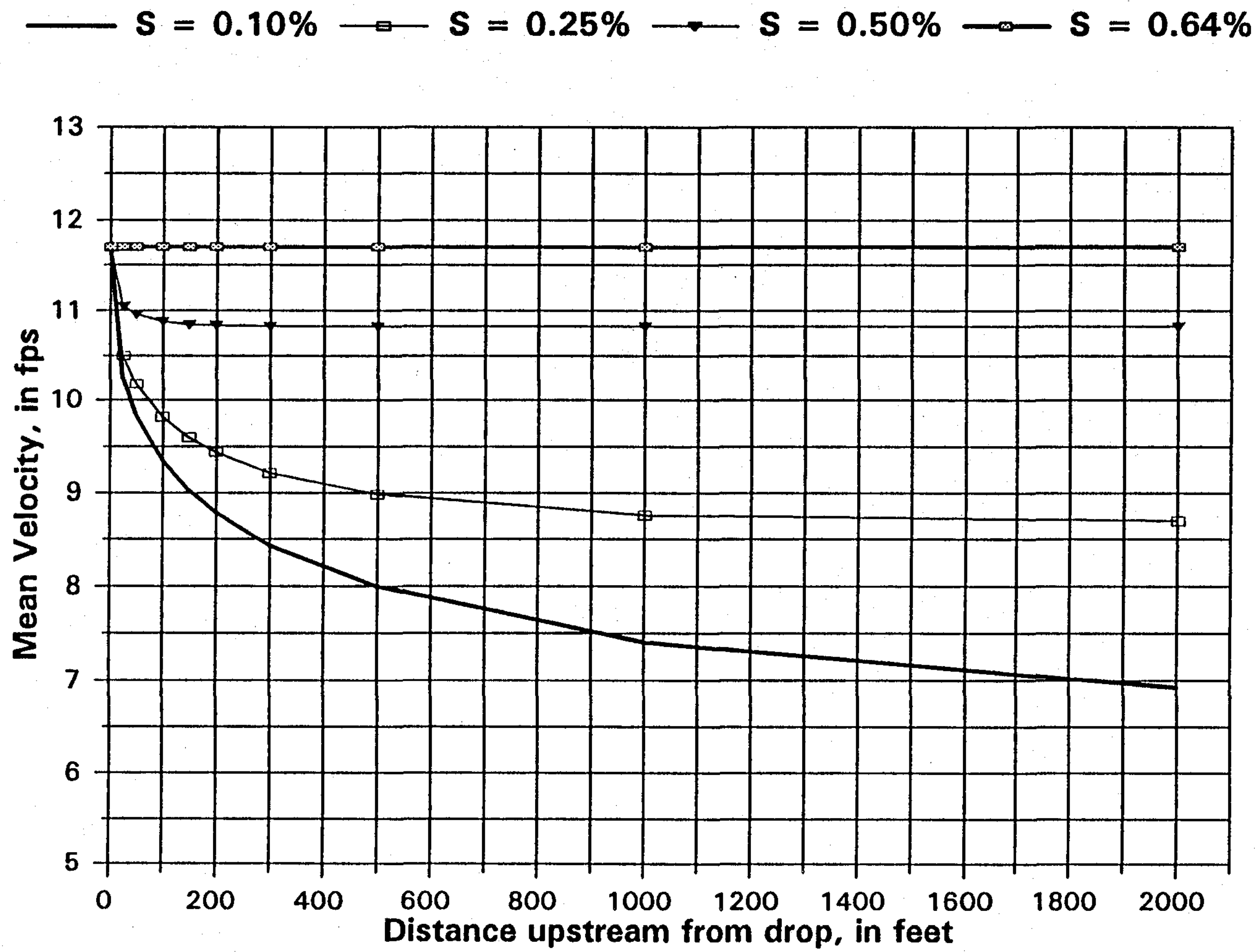



Figure 5-B
Flow Velocities from Backwater Aanalysis for Rectangular Channel
for q = 50 cfs/ft and n = 0.025

6

Table ~~#####~~

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=50 cfs/ft; n=0.040)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | | Flow Velocity (in fps) Slope (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.64% | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.64% |
| 0 | 4.27 | 4.27 | 4.27 | 4.27 | 4.27 | 11.71 | 11.71 | 11.71 | 11.71 | 11.71 |
| 25 | 5.30 | 5.23 | 5.11 | 4.83 | 4.27 | 9.43 | 9.56 | 9.79 | 10.36 | 11.71 |
| 50 | 5.62 | 5.51 | 5.31 | 4.89 | 4.27 | 8.90 | 9.08 | 9.41 | 10.22 | 11.71 |
| 100 | 6.04 | 5.86 | 5.57 | 4.95 | 4.27 | 8.28 | 8.53 | 8.98 | 10.09 | 11.71 |
| 150 | 6.34 | 6.11 | 5.72 | 4.97 | 4.27 | 7.88 | 8.18 | 8.74 | 10.05 | 11.71 |
| 200 | 6.58 | 6.30 | 5.83 | 4.98 | 4.27 | 7.60 | 7.94 | 8.58 | 10.04 | 11.71 |
| 300 | 6.96 | 6.57 | 5.97 | 4.99 | 4.27 | 7.19 | 7.60 | 8.38 | 10.03 | 11.71 |
| 500 | 7.49 | 6.94 | 6.11 | 4.99 | 4.27 | 6.67 | 7.21 | 8.18 | 10.03 | 11.71 |
| 1000 | 8.32 | 7.39 | 6.21 | 4.99 | 4.27 | 6.01 | 6.77 | 8.06 | 10.03 | 11.71 |
| 2000 | 9.16 | 7.67 | 6.21 | 4.99 | 4.27 | 5.46 | 6.52 | 8.06 | 10.03 | 11.71 |
| N. Depth (ft) | 10.41 | 7.74 | 6.21 | 4.99 | 4.27 | | | | | |

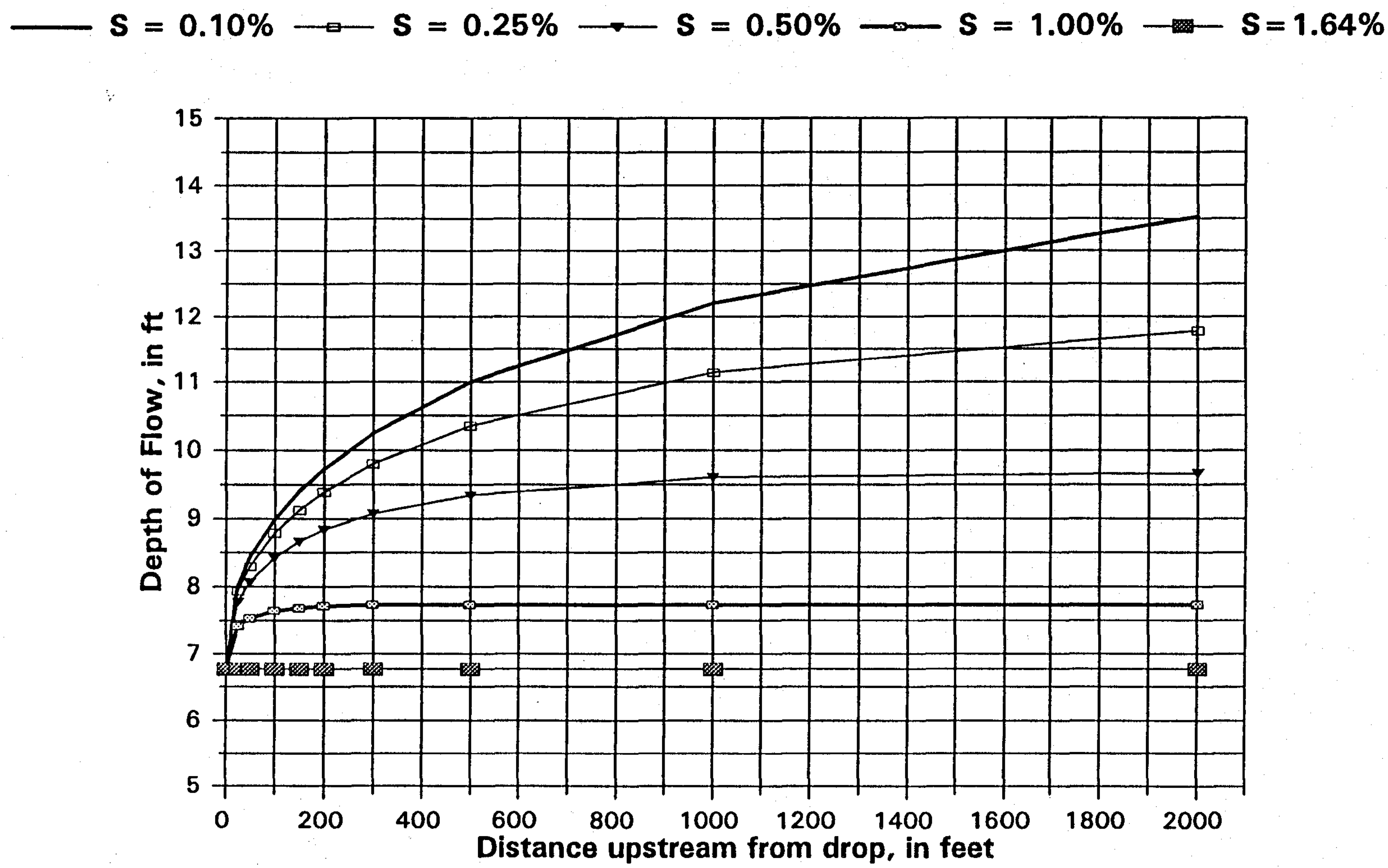



Figure 6-A
Flow Depths from Backwater Aanalysis for Rectangular Channel
for q = 50 cfs/ft and n = 0.040

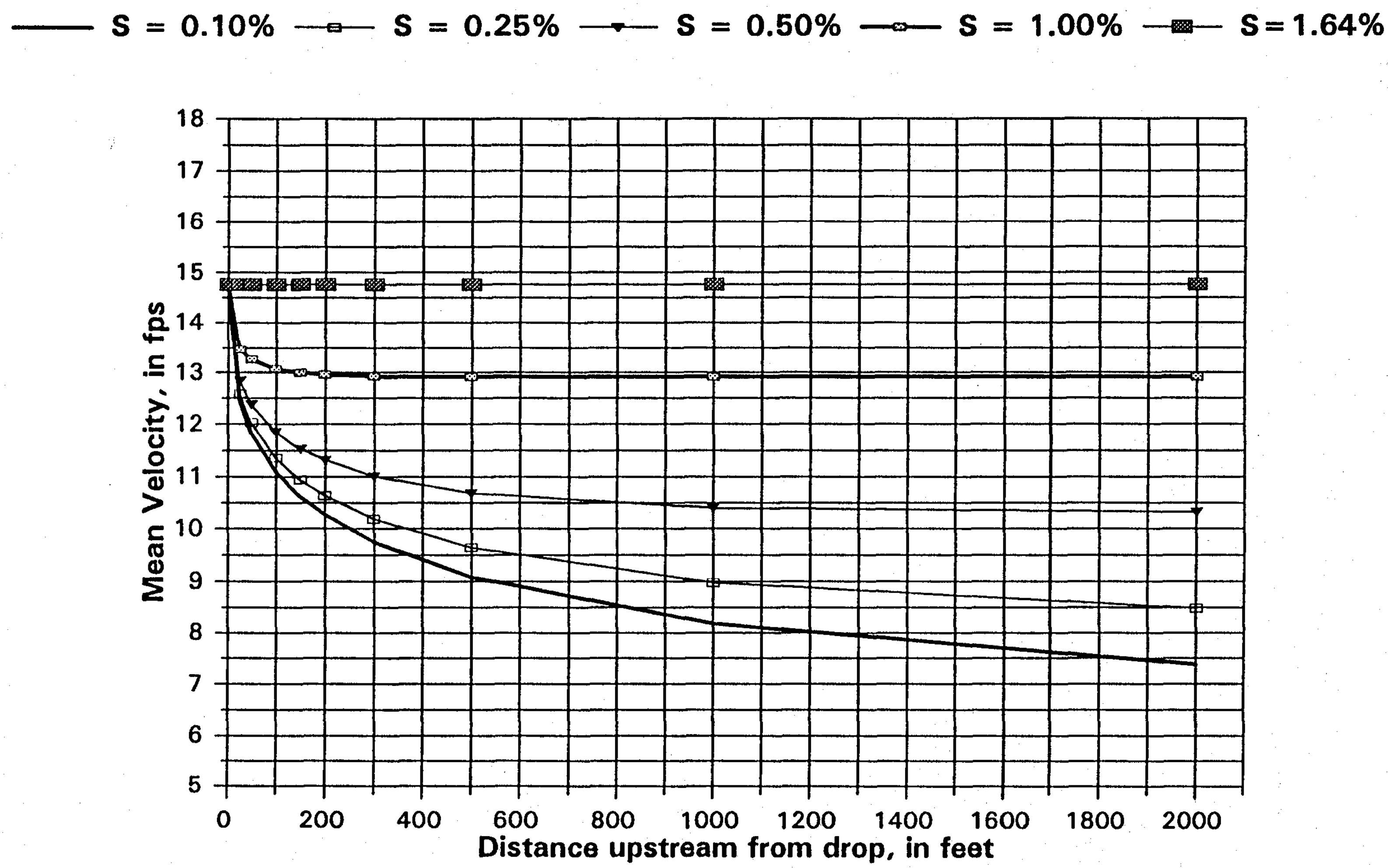



Figure 6-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 50 cfs/ft and n = 0.040

Table 7

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=40cfs/ft; n=0.015)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.15% | S=0.20% | S=0.238% | S=0.10% | S=0.15% | S=0.20% | S=0.238% |
| | | | | | | | | |
| 0 | 3.68 | 3.68 | 3.68 | 3.68 | 10.87 | 10.87 | 10.87 | 10.87 |
| 25 | 3.96 | 3.89 | 3.81 | 3.68 | 10.11 | 10.28 | 10.51 | 10.87 |
| 50 | 4.05 | 3.95 | 3.83 | 3.68 | 9.88 | 10.12 | 10.44 | 10.87 |
| 100 | 4.17 | 4.03 | 3.86 | 3.68 | 9.60 | 9.92 | 10.37 | 10.87 |
| 150 | 4.25 | 4.08 | 3.87 | 3.68 | 9.41 | 9.81 | 10.33 | 10.87 |
| 200 | 4.31 | 4.11 | 3.88 | 3.68 | 9.27 | 9.72 | 10.32 | 10.87 |
| 300 | 4.41 | 4.16 | 3.88 | 3.68 | 9.07 | 9.62 | 10.30 | 10.87 |
| 500 | 4.53 | 4.21 | 3.89 | 3.68 | 8.82 | 9.51 | 10.29 | 10.87 |
| 1000 | 4.69 | 4.25 | 3.89 | 3.68 | 8.52 | 9.42 | 10.29 | 10.87 |
| 2000 | 4.80 | 4.25 | 3.89 | 3.68 | 8.34 | 9.41 | 10.29 | 10.87 |
| | | | | | | | | |
| N. Depth (ft) | 4.82 | 4.25 | 3.89 | 3.68 | | | | |

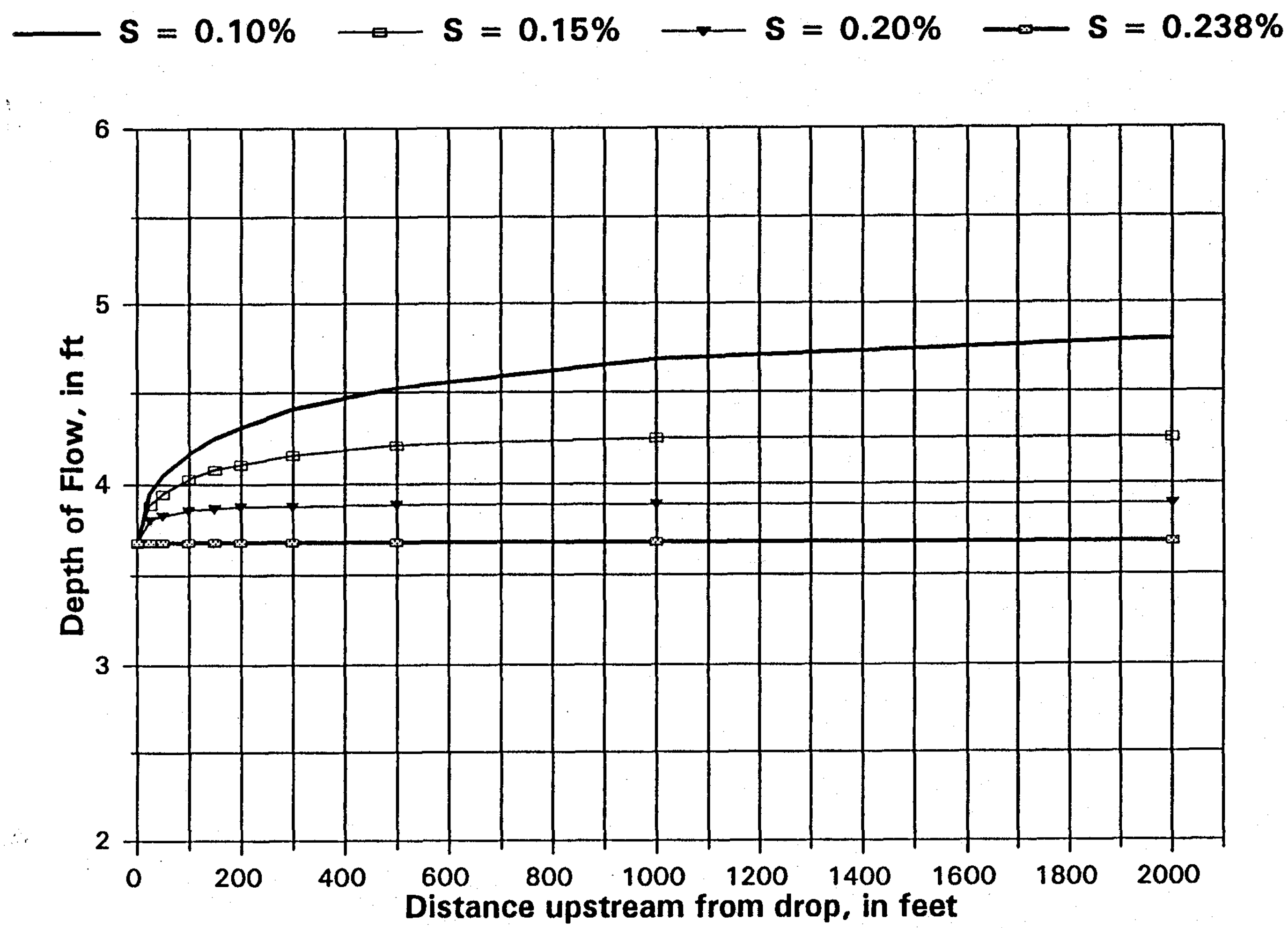



Figure 7-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.015

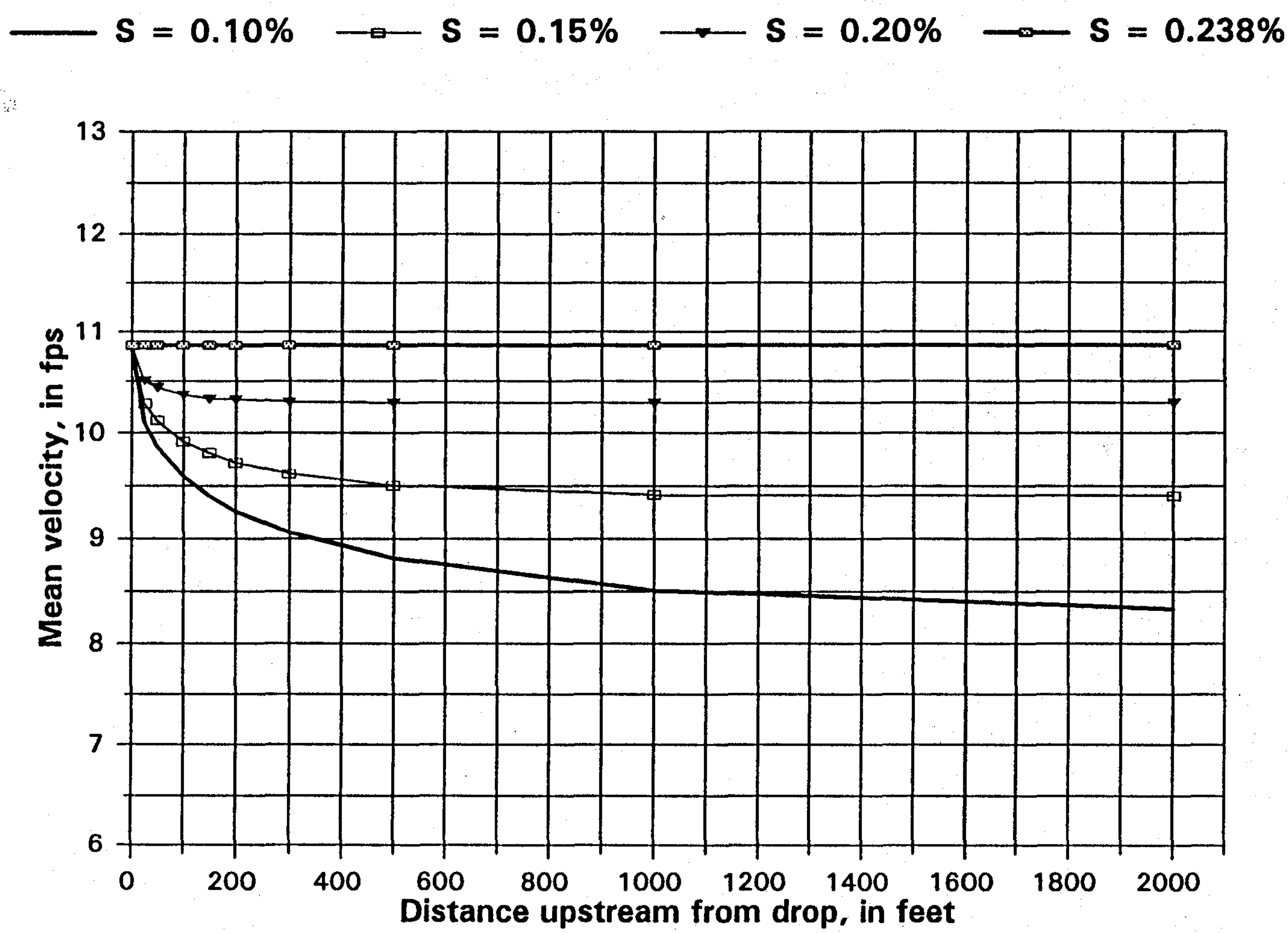



Figure 7-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.015

## Table ~~#####~~ 8

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=40cfs/ft; n=0.025)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=0.66% | S=0.10% | S=0.25% | S=0.50% | S=0.66% |
| | | | | | | | | |
| 0 | 3.68 | 3.68 | 3.68 | 3.68 | 10.87 | 10.87 | 10.87 | 10.87 |
| 25 | 4.25 | 4.15 | 3.93 | 3.68 | 9.41 | 9.65 | 10.17 | 10.87 |
| 50 | 4.43 | 4.28 | 3.97 | 3.68 | 9.02 | 9.34 | 10.08 | 10.87 |
| 100 | 4.68 | 4.45 | 4.00 | 3.68 | 8.54 | 8.99 | 10.00 | 10.87 |
| 150 | 4.86 | 4.55 | 4.01 | 3.68 | 8.24 | 8.78 | 9.98 | 10.87 |
| 200 | 4.99 | 4.63 | 4.01 | 3.68 | 8.01 | 8.64 | 9.97 | 10.87 |
| 300 | 5.21 | 4.74 | 4.02 | 3.68 | 7.68 | 8.44 | 9.96 | 10.87 |
| 500 | 5.50 | 4.86 | 4.02 | 3.68 | 7.27 | 8.23 | 9.96 | 10.87 |
| 1000 | 5.94 | 4.97 | 4.02 | 3.68 | 6.74 | 8.05 | 9.96 | 10.87 |
| 2000 | 6.33 | 4.99 | 4.02 | 3.68 | 6.32 | 8.02 | 9.96 | 10.87 |
| | | | | | | | | |
| N. Depth | 6.66 | 4.99 | 4.02 | 3.68 | | | | |

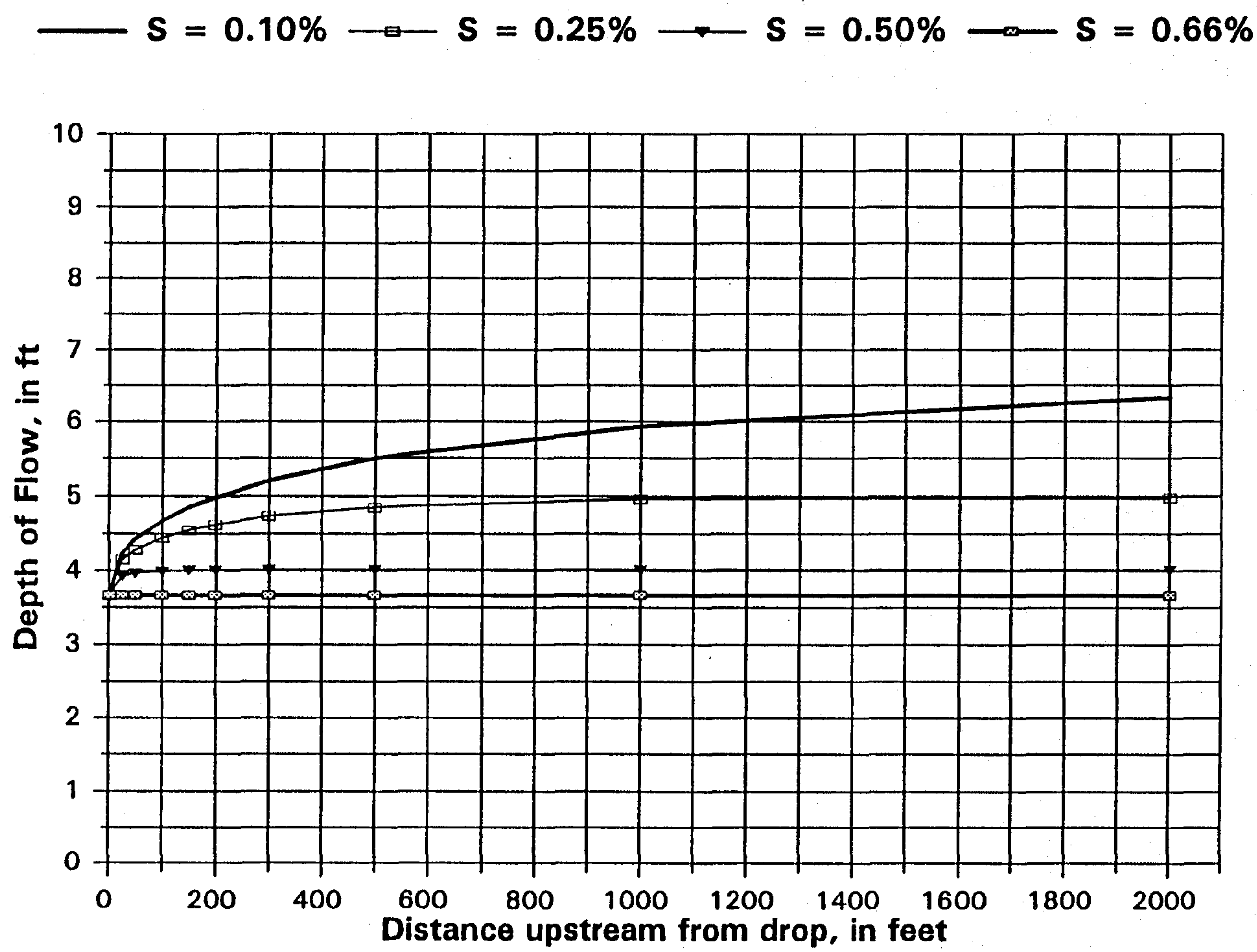



Figure 8-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.025

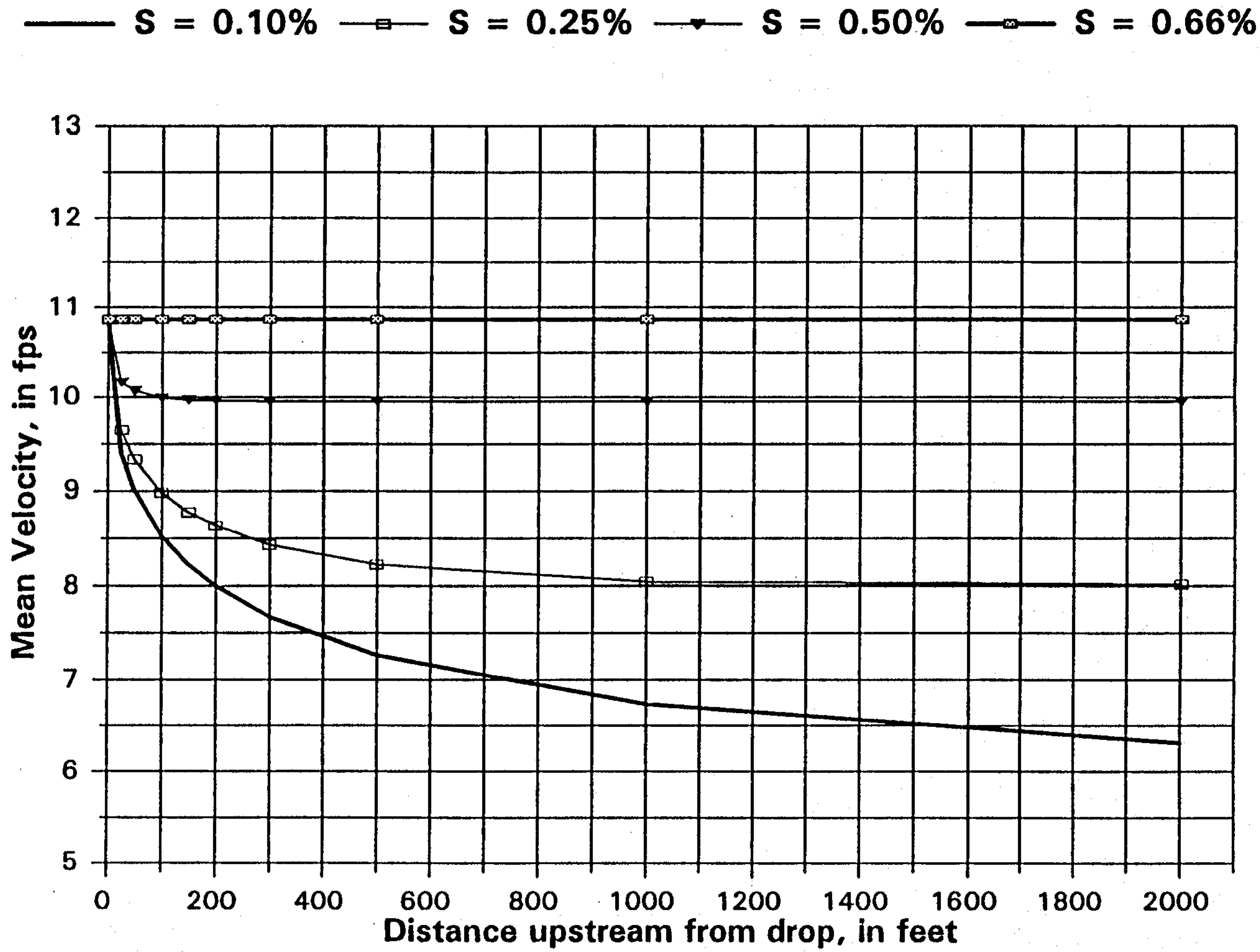



Figure 8-B
Flow Velocities from Backwater Aanalysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.025

Table 9

Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure
(q=30 cfs/ft; n=0.015)

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.15% | S=0.20% | S=0.25% | S=0.10% | S=0.15% | S=0.20% | S=0.25% |
| | | | | | | | | |
| 0 | 3.03 | 3.03 | 3.03 | 3.03 | 9.90 | 9.90 | 9.90 | 9.90 |
| 25 | 3.30 | 3.24 | 3.17 | 3.07 | 9.10 | 9.26 | 9.46 | 9.77 |
| 50 | 3.38 | 3.30 | 3.20 | 3.07 | 8.87 | 9.09 | 9.38 | 9.77 |
| 100 | 3.49 | 3.37 | 3.22 | 3.07 | 8.59 | 8.90 | 9.31 | 9.76 |
| 150 | 3.56 | 3.41 | 3.24 | 3.07 | 8.42 | 8.79 | 9.27 | 9.76 |
| 200 | 3.62 | 3.44 | 3.24 | 3.07 | 8.28 | 8.71 | 9.25 | 9.76 |
| 300 | 3.71 | 3.48 | 3.25 | 3.07 | 8.10 | 8.61 | 9.24 | 9.76 |
| 500 | 3.81 | 3.52 | 3.25 | 3.07 | 7.87 | 8.51 | 9.23 | 9.76 |
| 1000 | 3.94 | 3.55 | 3.25 | 3.07 | 7.61 | 8.44 | 9.23 | 9.76 |
| 2000 | 4.02 | 3.55 | 3.25 | 3.07 | 7.47 | 8.44 | 9.23 | 9.76 |
| | | | | | | | | |
| N. Depth (ft) | 4.03 | 3.55 | 3.25 | 3.07 | | | | |

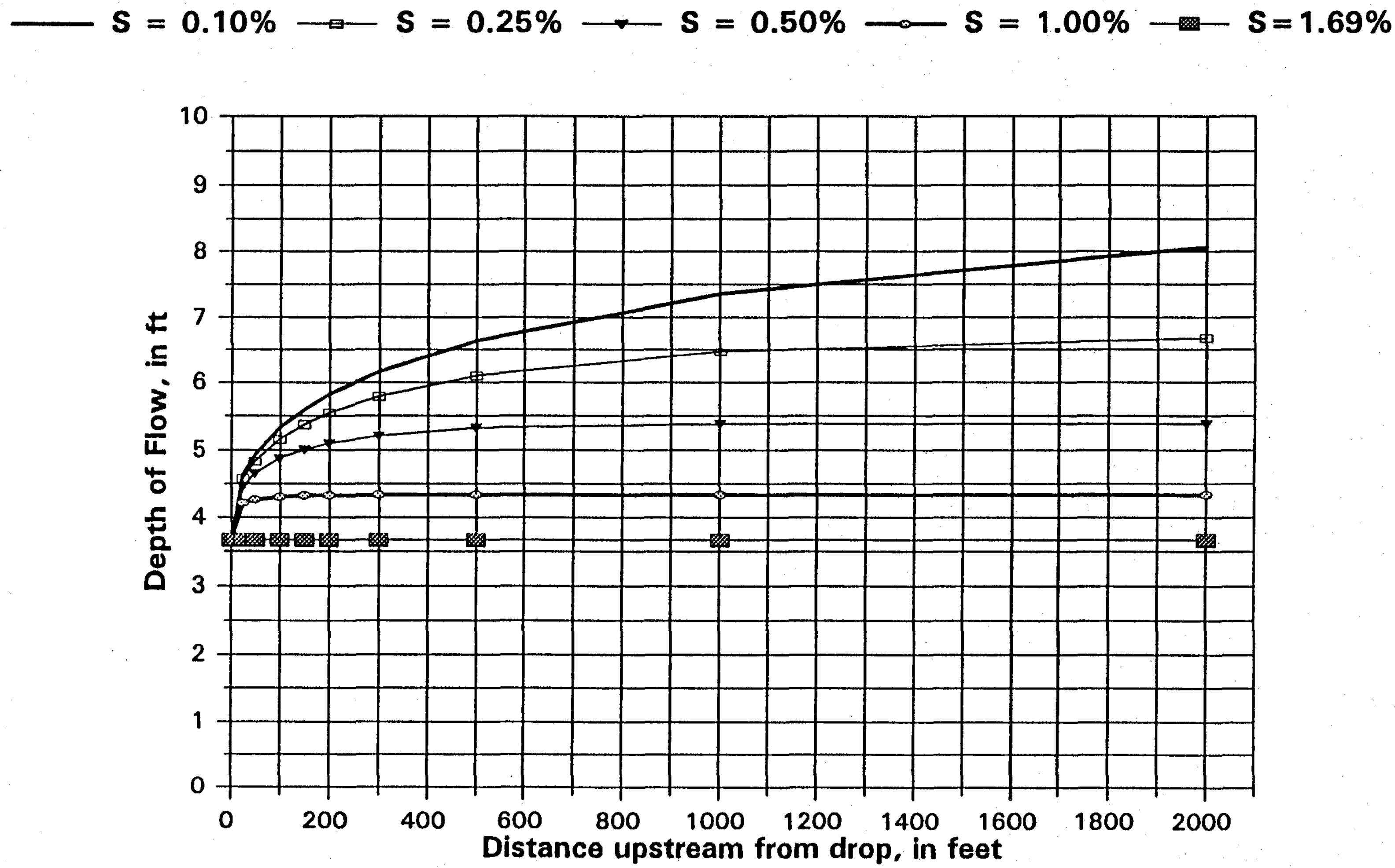



Figure 9-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.040

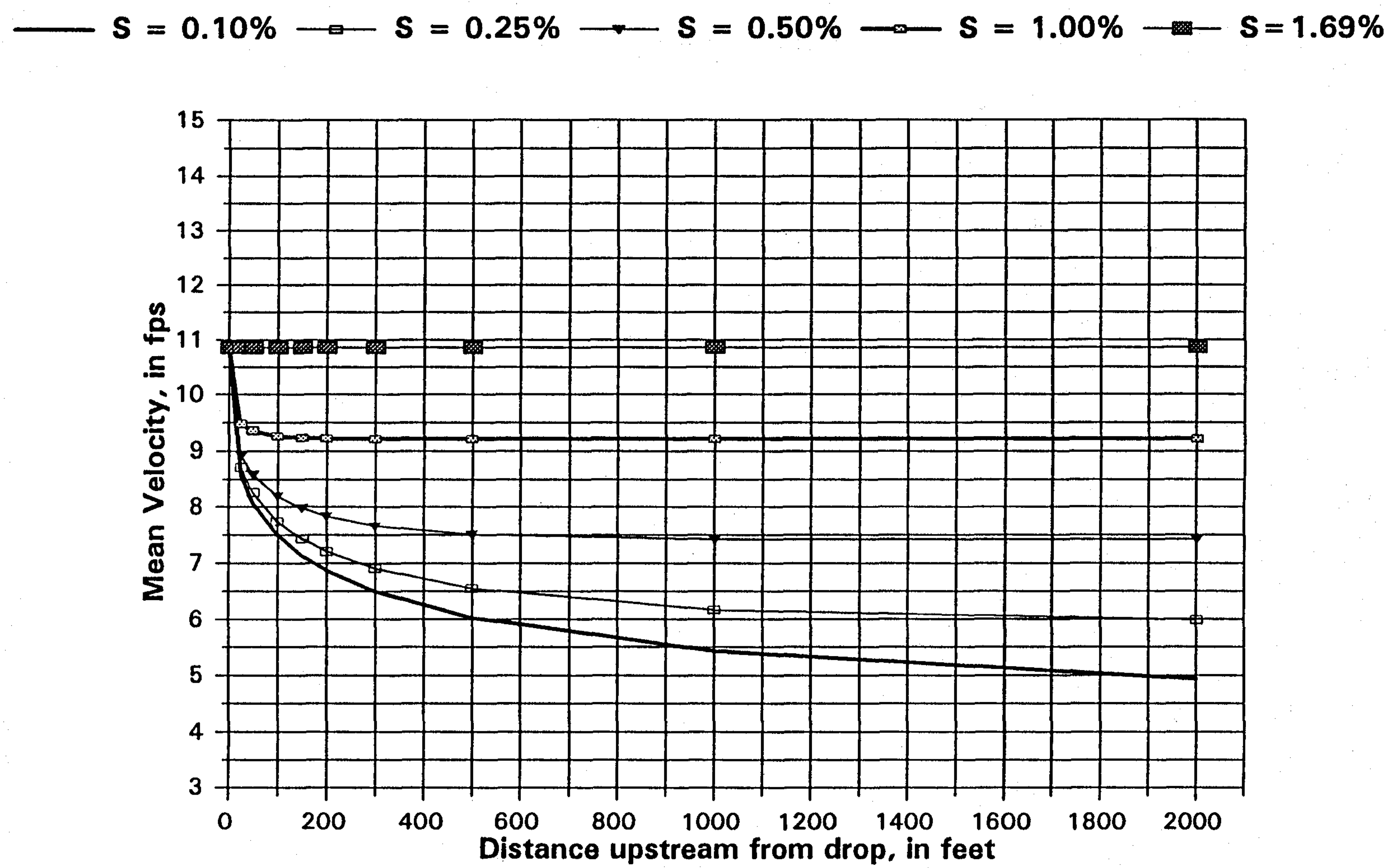



Figure 9-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 40 cfs/ft and n = 0.040

Table ~~9~~ 10

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q=30 cfs/ft; n=0.015)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.15% | S=0.20% | S=0.25% | S=0.10% | S=0.15% | S=0.20% | S=0.25% |
| | | | | | | | | |
| 0 | 3.03 | 3.03 | 3.03 | 3.03 | 9.90 | 9.90 | 9.90 | 9.90 |
| 25 | 3.30 | 3.24 | 3.17 | 3.07 | 9.10 | 9.26 | 9.46 | 9.77 |
| 50 | 3.38 | 3.30 | 3.20 | 3.07 | 8.87 | 9.09 | 9.38 | 9.77 |
| 100 | 3.49 | 3.37 | 3.22 | 3.07 | 8.59 | 8.90 | 9.31 | 9.76 |
| 150 | 3.56 | 3.41 | 3.24 | 3.07 | 8.42 | 8.79 | 9.27 | 9.76 |
| 200 | 3.62 | 3.44 | 3.24 | 3.07 | 8.28 | 8.71 | 9.25 | 9.76 |
| 300 | 3.71 | 3.48 | 3.25 | 3.07 | 8.10 | 8.61 | 9.24 | 9.76 |
| 500 | 3.81 | 3.52 | 3.25 | 3.07 | 7.87 | 8.51 | 9.23 | 9.76 |
| 1000 | 3.94 | 3.55 | 3.25 | 3.07 | 7.61 | 8.44 | 9.23 | 9.76 |
| 2000 | 4.02 | 3.55 | 3.25 | 3.07 | 7.47 | 8.44 | 9.23 | 9.76 |
| | | | | | | | | |
| N. Depth (ft) | 4.03 | 3.55 | 3.25 | 3.07 | | | | |

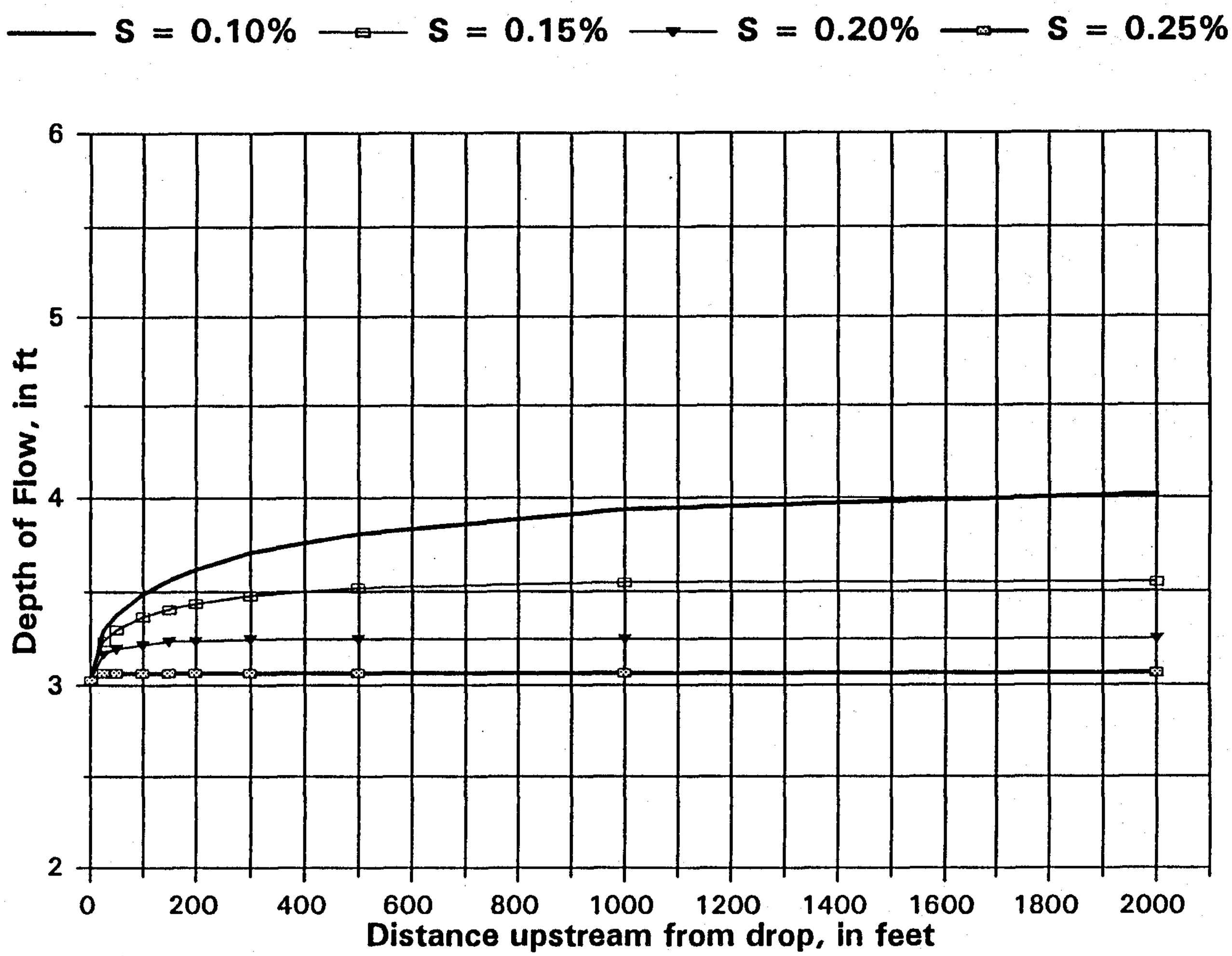



Figure 10-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.015

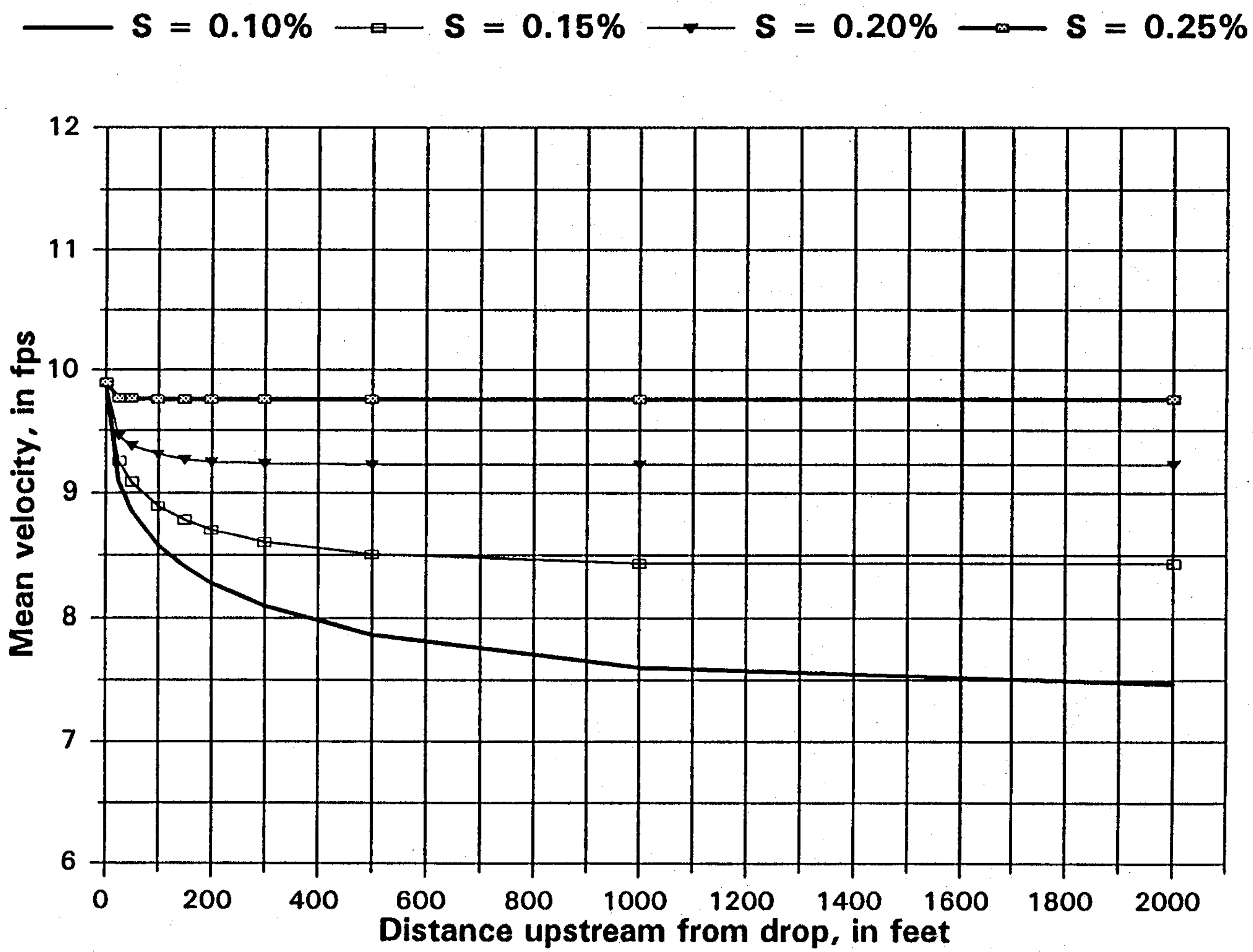



Figure 10-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.015

Table 11

Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure
(q=30 cfs/ft; n=0.025)

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | Flow Velocity (in fps) Slope (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=0.69% | S=0.10% | S=0.25% | S=0.50% | S=0.69% |
| | | | | | | | | |
| 0 | 3.04 | 3.04 | 3.04 | 3.04 | 9.87 | 9.87 | 9.87 | 9.87 |
| 25 | 3.57 | 3.48 | 3.29 | 3.04 | 8.41 | 8.63 | 9.12 | 9.87 |
| 50 | 3.73 | 3.59 | 3.32 | 3.04 | 8.03 | 8.35 | 9.04 | 9.87 |
| 100 | 3.96 | 3.74 | 3.35 | 3.04 | 7.58 | 8.02 | 8.97 | 9.87 |
| 150 | 4.11 | 3.83 | 3.35 | 3.04 | 7.30 | 7.82 | 8.94 | 9.87 |
| 200 | 4.23 | 3.90 | 3.36 | 3.04 | 7.09 | 7.69 | 8.94 | 9.87 |
| 300 | 4.42 | 3.99 | 3.36 | 3.04 | 6.79 | 7.52 | 8.93 | 9.87 |
| 500 | 4.68 | 4.08 | 3.36 | 3.04 | 6.42 | 7.35 | 8.93 | 9.87 |
| 1000 | 5.04 | 4.16 | 3.36 | 3.04 | 5.96 | 7.21 | 8.93 | 9.87 |
| 2000 | 5.34 | 4.17 | 3.36 | 3.04 | 5.61 | 7.20 | 8.93 | 9.87 |
| | | | | | | | | |
| N. Depth (ft) | 5.35 | 4.17 | 3.36 | 3.04 | | | | |

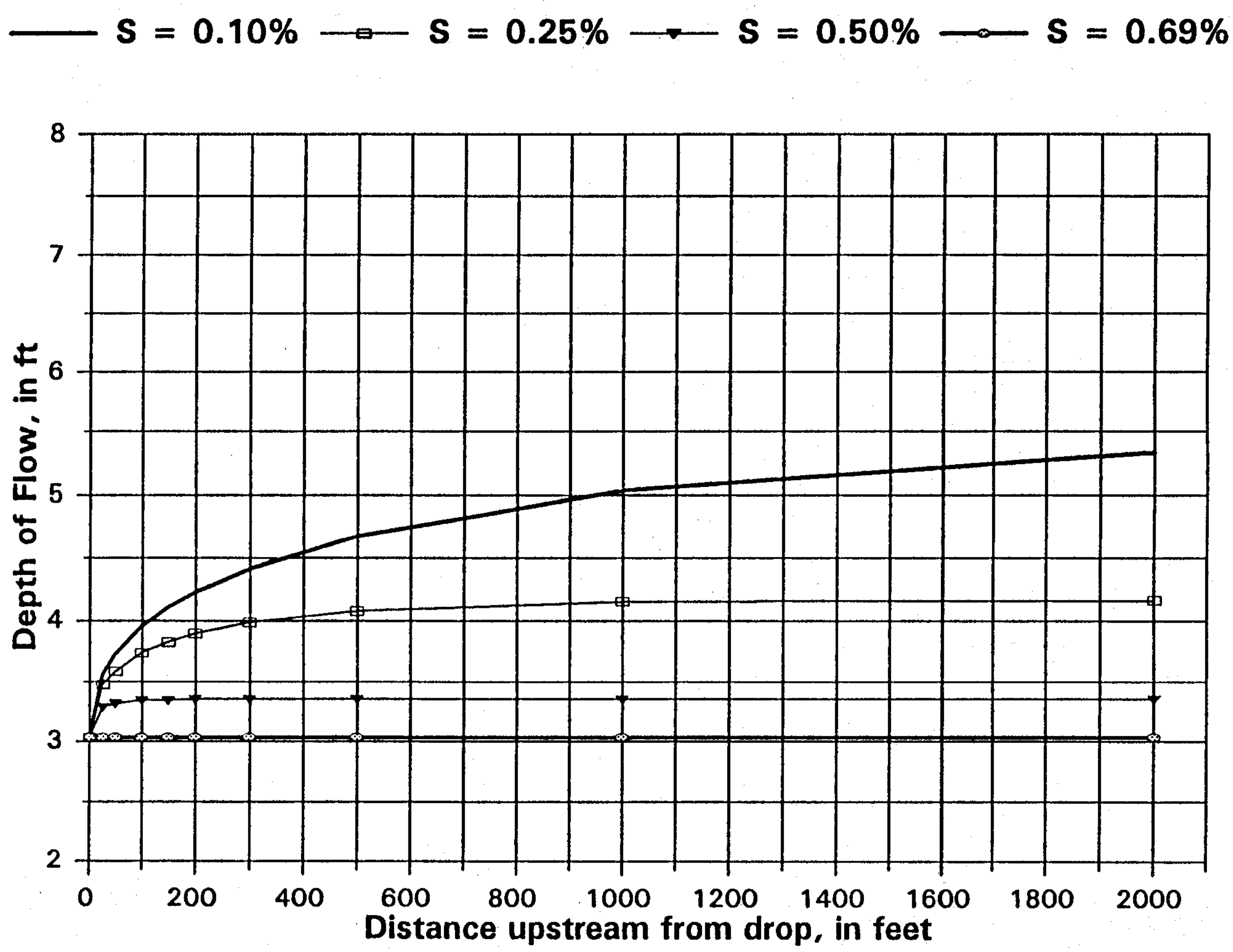



Figure 1Ø-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.025

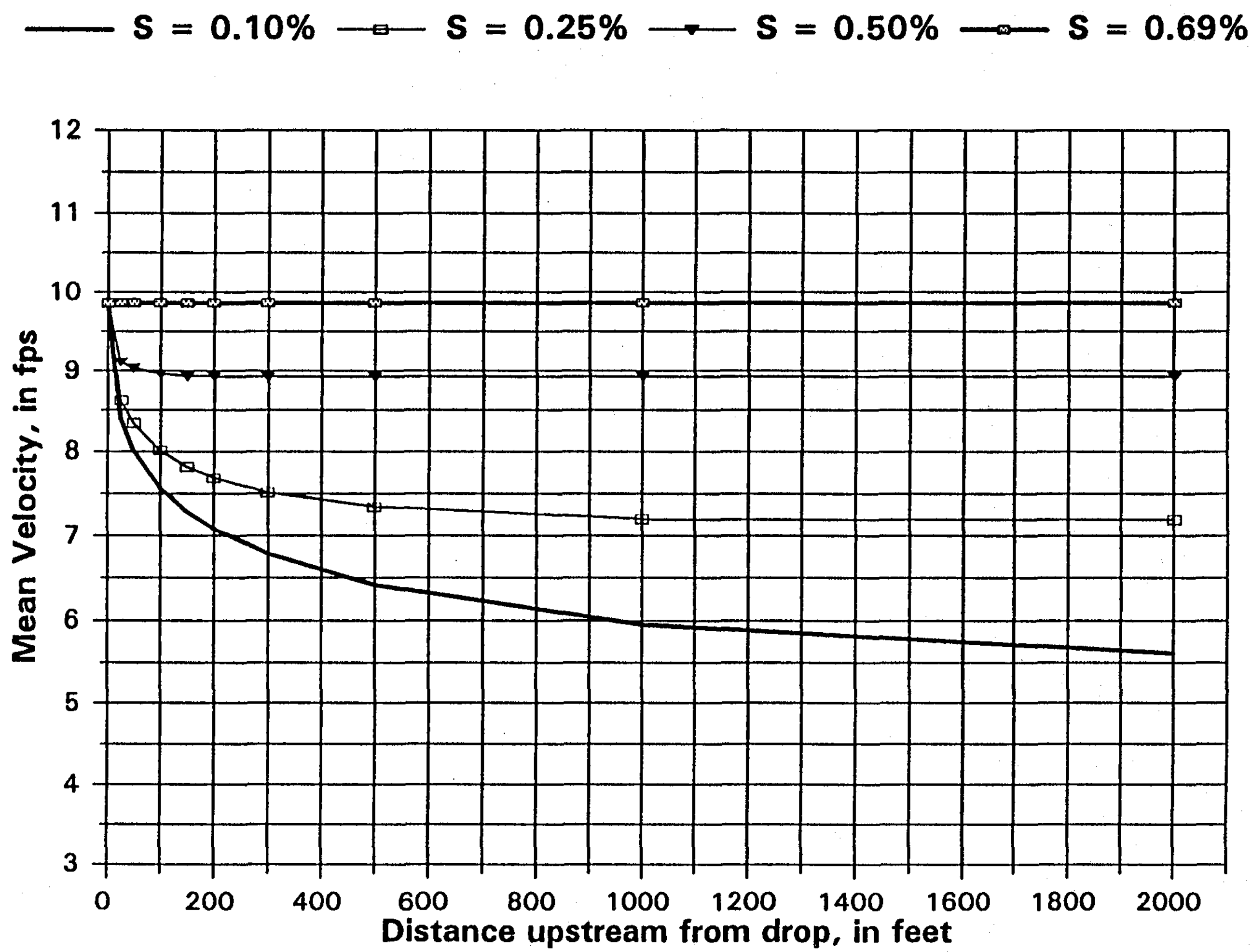



Figure 11-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.025

## Table 12

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q= 30 cfs/ft; n=0.040)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | | Flow Velocity (in fps) Slope (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.77% | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.77% |
| | | | | | | | | | | |
| 0 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 9.87 | 9.87 | 9.87 | 9.87 | 9.87 |
| 25 | 3.95 | 3.89 | 3.78 | 3.55 | 3.04 | 7.60 | 7.72 | 7.94 | 8.46 | 9.87 |
| 50 | 4.20 | 4.10 | 3.94 | 3.58 | 3.04 | 7.14 | 7.31 | 7.62 | 8.37 | 9.87 |
| 100 | 4.54 | 4.39 | 4.12 | 3.61 | 3.04 | 6.60 | 6.84 | 7.27 | 8.30 | 9.87 |
| 150 | 4.78 | 4.57 | 4.23 | 3.62 | 3.04 | 6.27 | 6.56 | 7.09 | 8.28 | 9.87 |
| 200 | 4.97 | 4.71 | 4.30 | 3.62 | 3.04 | 6.03 | 6.36 | 6.97 | 8.28 | 9.87 |
| 300 | 5.27 | 4.92 | 4.39 | 3.63 | 3.04 | 5.70 | 6.10 | 6.83 | 8.27 | 9.87 |
| 500 | 5.6[illegible] | 5.17 | 4.47 | 3.63 | 3.04 | 5.28 | 5.80 | 6.71 | 8.27 | 9.87 |
| 1000 | 6.2[illegible] | 5.45 | 4.50 | 3.63 | 3.04 | 4.77 | 5.50 | 6.66 | 8.27 | 9.87 |
| 2000 | 6.8[illegible] | 5.59 | 4.50 | 3.63 | 3.04 | 4.37 | 5.37 | 6.67 | 8.27 | 9.87 |
| | | | | | | | | | | |
| N. Depth (ft) | 7.43 | 5.59 | 4.5 | 3.63 | 3.04 | | | | | |

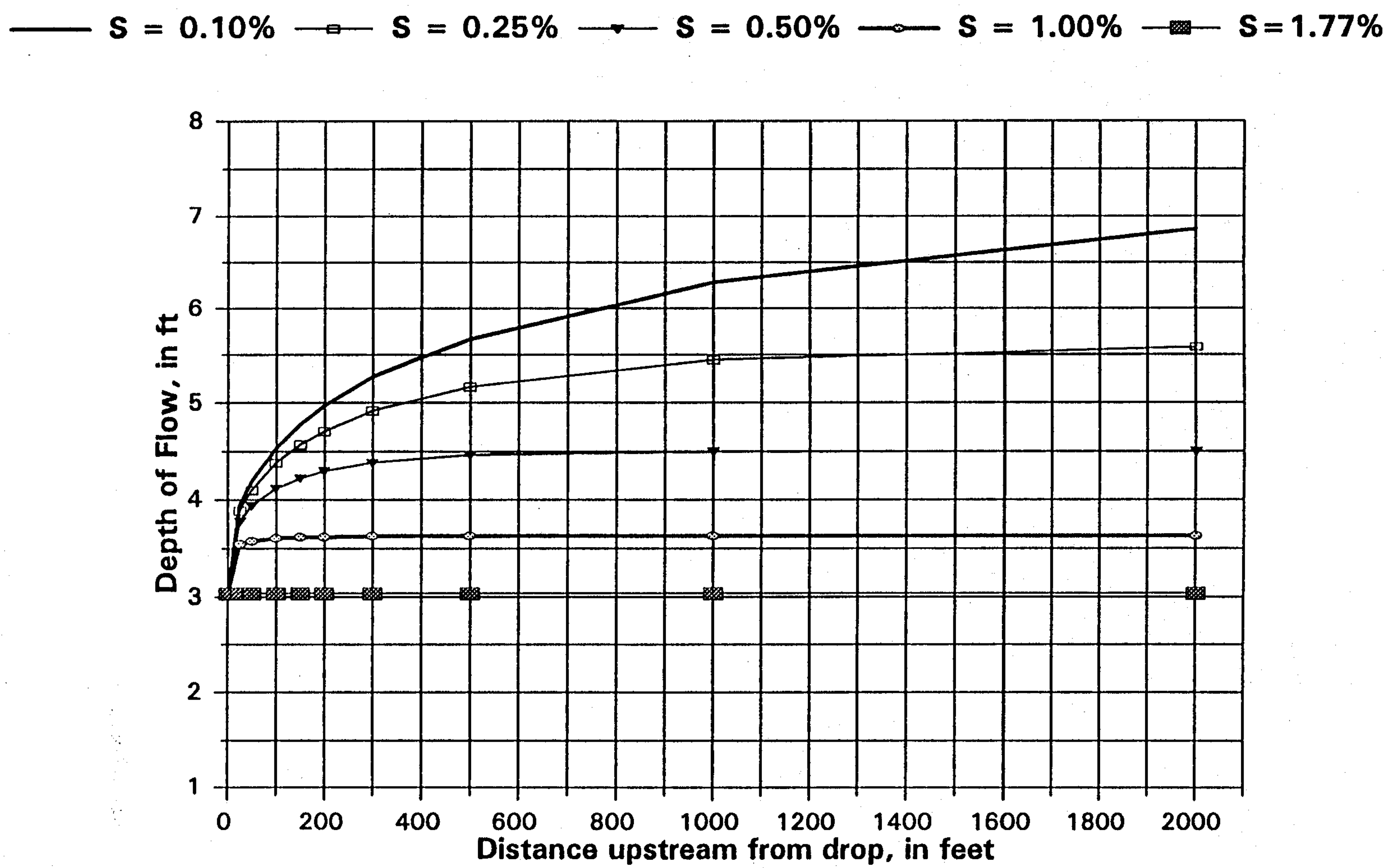



Figure 12-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.040

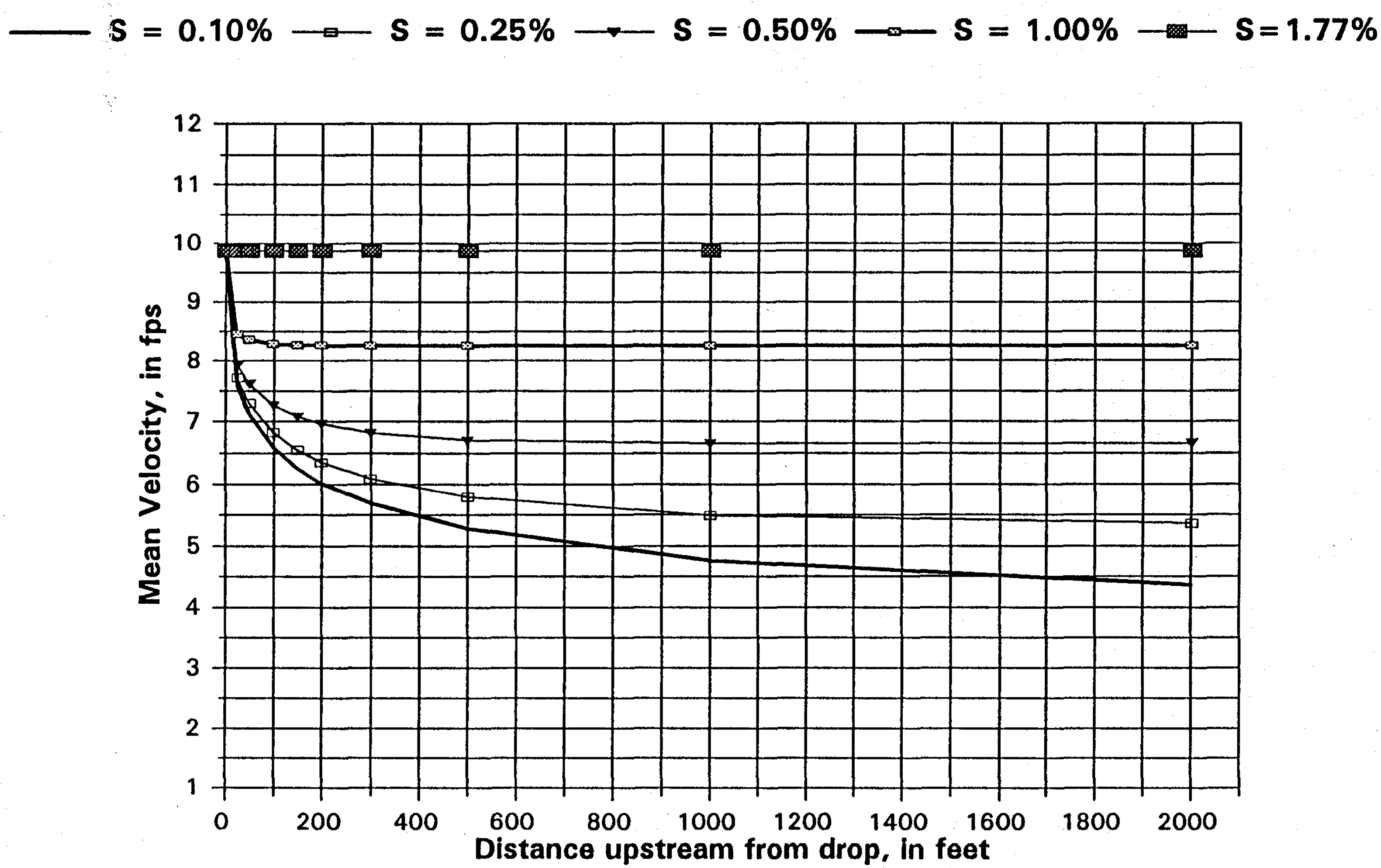



Figure12-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 30 cfs/ft and n = 0.040

Table 13

Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure
(q= 20 cfs/ft; n=0.015)

| Distance (feet) | Flow Depth (in Feet) | | | | Flow Velocity (in fps) | | | |
|---|---|---|---|---|---|---|---|---|
| | Slope (%) | | | | Slope (%) | | | |
| | S=0.10% | S=0.15% | S=0.20% | S=0.267% | S=0.10% | S=0.15% | S=0.20% | S=0.267% |
| | | | | | | | | |
| 0 | 2.32 | 2.32 | 2.32 | 2.32 | 8.62 | 8.62 | 8.62 | 8.62 |
| 25 | 2.56 | 2.51 | 2.45 | 2.34 | 7.82 | 7.97 | 8.16 | 8.57 |
| 50 | 2.63 | 2.56 | 2.48 | 2.34 | 7.60 | 7.81 | 8.07 | 8.57 |
| 100 | 2.73 | 2.62 | 2.51 | 2.34 | 7.34 | 7.62 | 7.98 | 8.56 |
| 150 | 2.79 | 2.66 | 2.52 | 2.34 | 7.17 | 7.52 | 7.95 | 8.56 |
| 200 | 2.84 | 2.69 | 2.52 | 2.34 | 7.05 | 7.45 | 7.93 | 8.56 |
| 300 | 2.91 | 2.72 | 2.53 | 2.34 | 6.88 | 7.36 | 7.91 | 8.56 |
| 500 | 2.99 | 2.75 | 2.53 | 2.34 | 6.68 | 7.28 | 7.90 | 8.56 |
| 1000 | 3.09 | 2.77 | 2.53 | 2.34 | 6.48 | 7.23 | 7.90 | 8.56 |
| 2000 | 3.13 | 2.77 | 2.53 | 2.34 | 6.38 | 7.23 | 7.90 | 8.56 |
| | | | | | | | | |
| N. Depth (ft) | 3.13 | 2.77 | 2.53 | 2.34 | | | | |

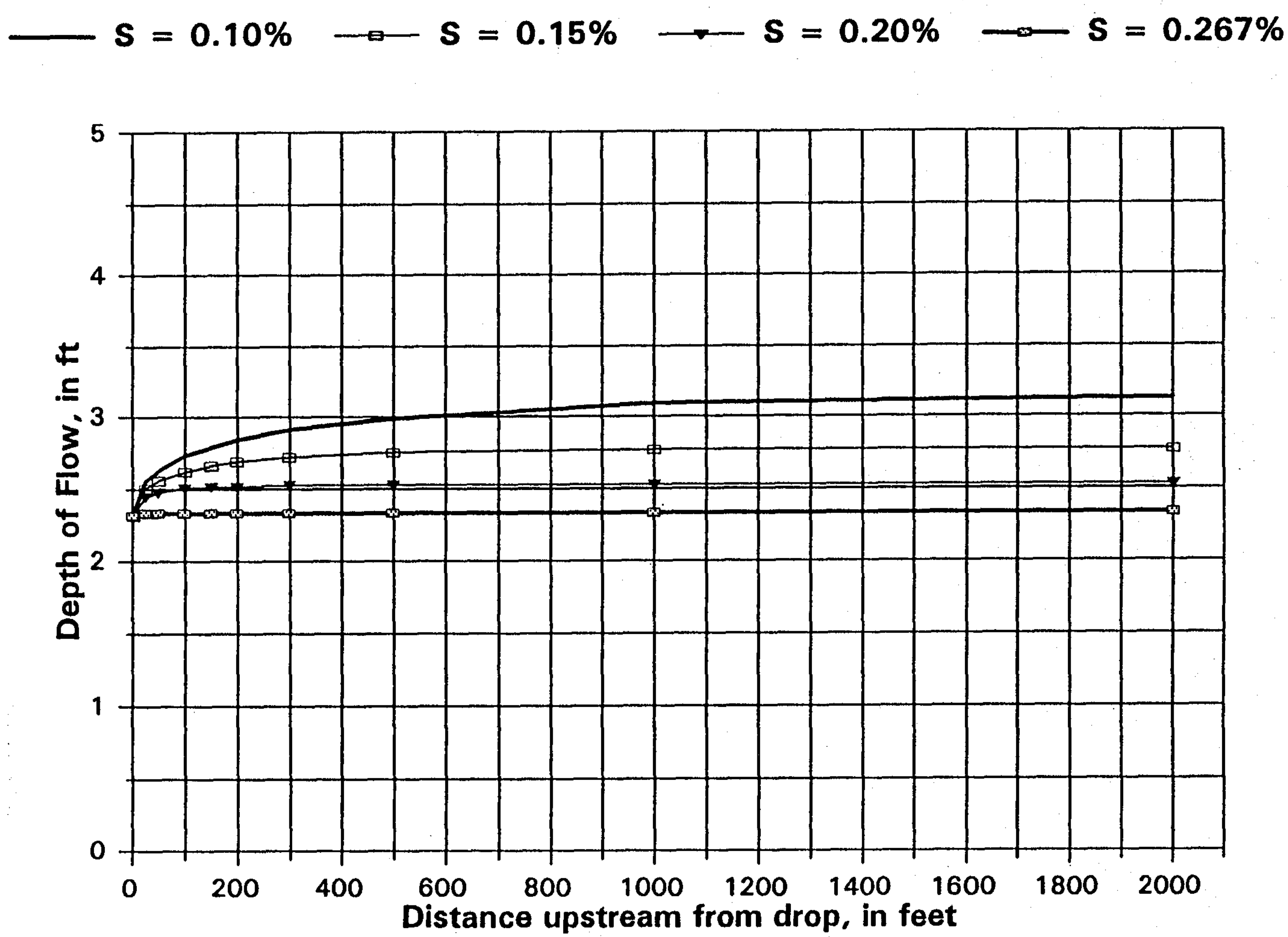



Figure 13-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.015

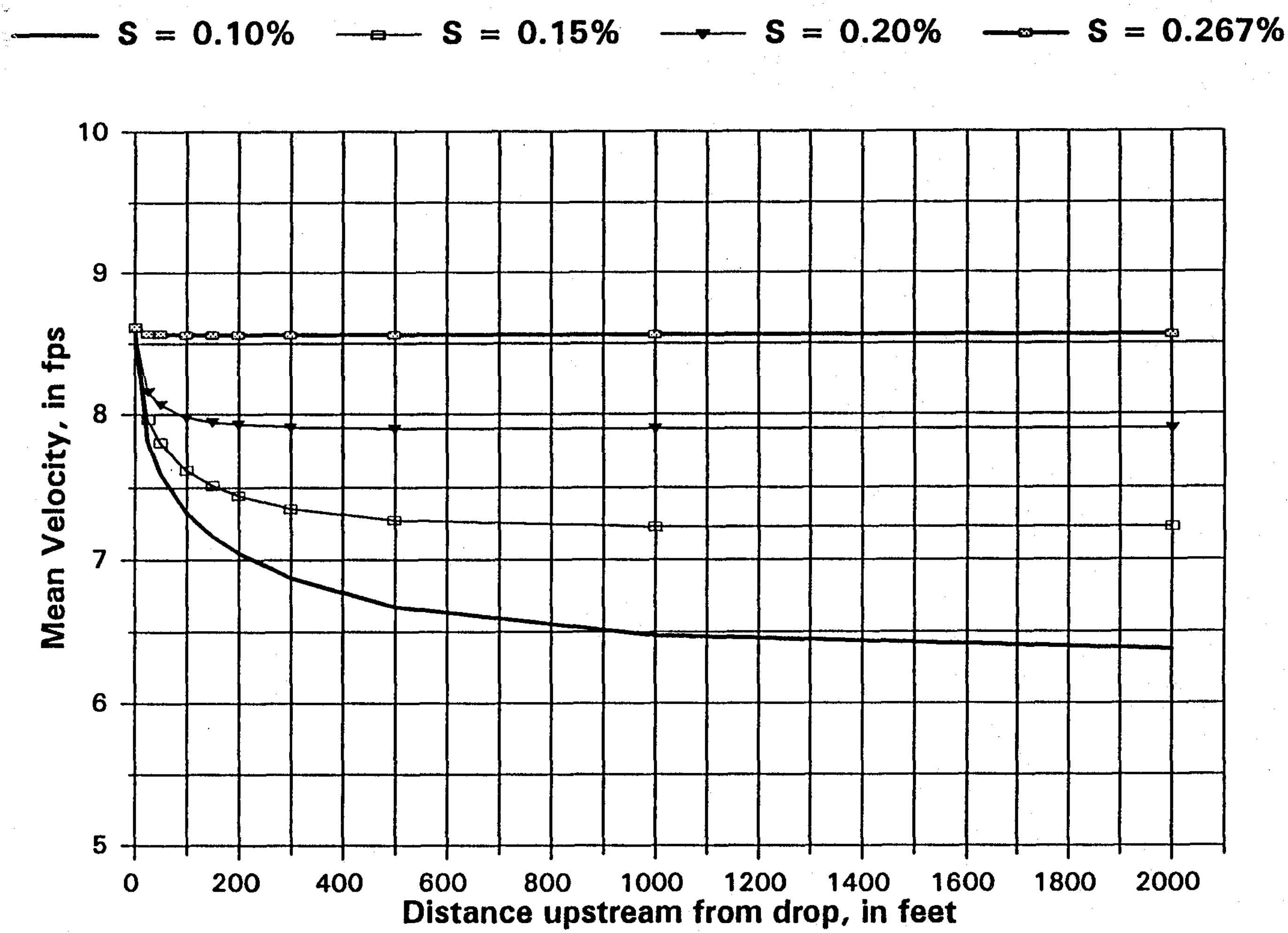



Figure 13-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.015

Table 14

Depth of Flow and Flow Velocities In Backwater Zone Upstream of a Drop Structure
(q=20 cfs/ft; n=0.025)

| Distance (feet) | Flow Depth (in Feet) | | | | Flow Velocity (in fps) | | | |
|---|---|---|---|---|---|---|---|---|
| | Slope (%) | | | | Slope (%) | | | |
| | S=0.10% | S=0.25% | S=0.50% | S=0.73% | S=0.10% | S=0.25% | S=0.50% | S=0.73% |
| | | | | | | | | |
| 0 | 2.32 | 2.32 | 2.32 | 2.32 | 8.62 | 8.62 | 8.62 | 8.62 |
| 25 | 2.80 | 2.72 | 2.56 | 2.33 | 7.14 | 7.36 | 7.81 | 8.61 |
| 50 | 2.94 | 2.82 | 2.59 | 2.33 | 6.80 | 7.09 | 7.73 | 8.61 |
| 100 | 3.13 | 2.94 | 2.61 | 2.33 | 6.39 | 6.80 | 7.67 | 8.61 |
| 150 | 3.26 | 3.02 | 2.61 | 2.33 | 6.13 | 6.63 | 7.66 | 8.60 |
| 200 | 3.36 | 3.07 | 2.61 | 2.33 | 5.95 | 6.52 | 7.65 | 8.60 |
| 300 | 3.52 | 3.13 | 2.62 | 2.33 | 5.69 | 6.39 | 7.65 | 8.59 |
| 500 | 3.72 | 3.20 | 2.62 | 2.33 | 5.37 | 6.26 | 7.65 | 8.59 |
| 1000 | 4.00 | 3.24 | 2.62 | 2.33 | 5.00 | 6.17 | 7.65 | 8.58 |
| 2000 | 4.21 | 3.24 | 2.62 | 2.33 | 4.75 | 6.18 | 7.65 | 8.58 |
| | | | | | | | | |
| N. Depth (ft) | 4.3 | 3.24 | 2.62 | 2.33 | | | | |

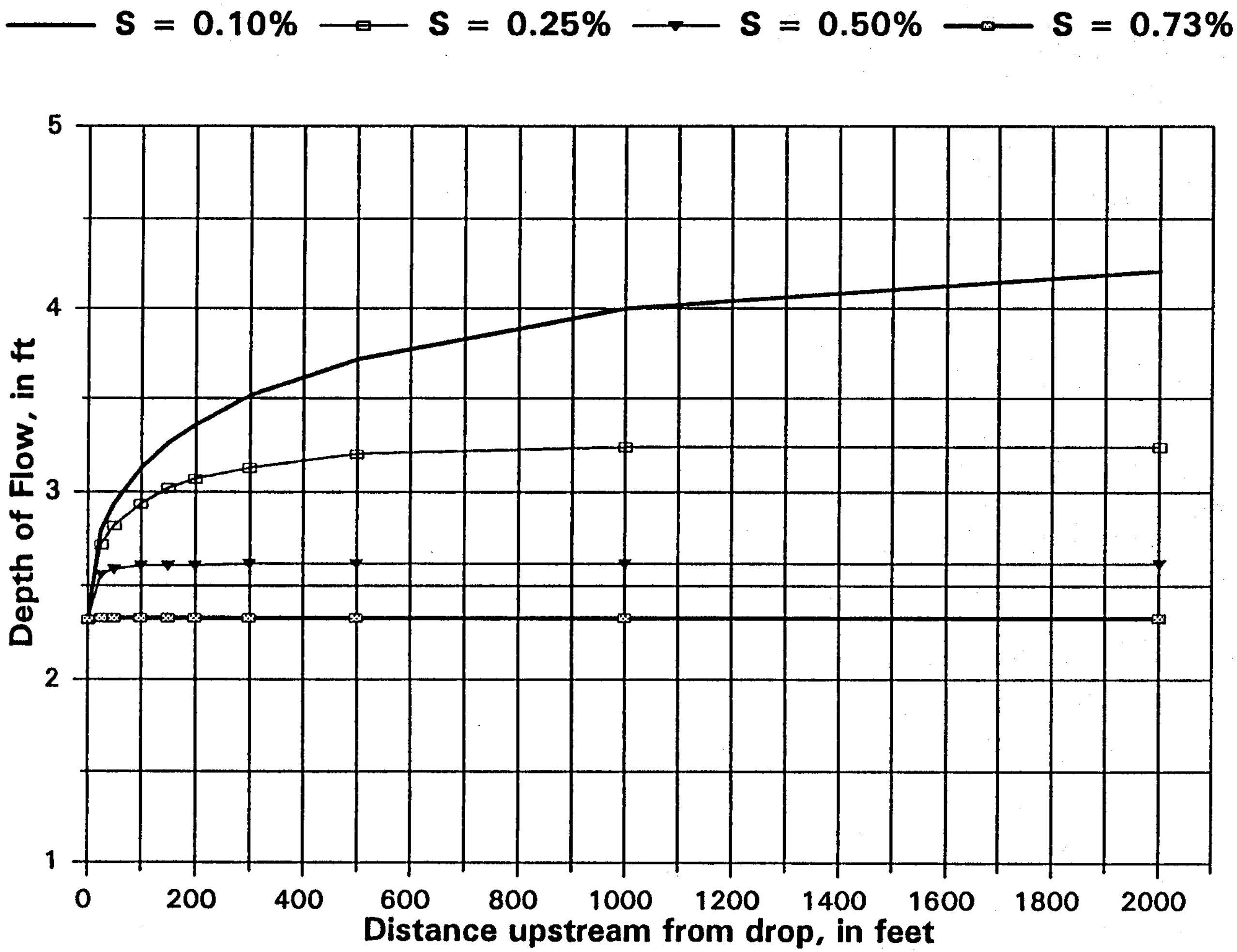



Figure 14-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.025

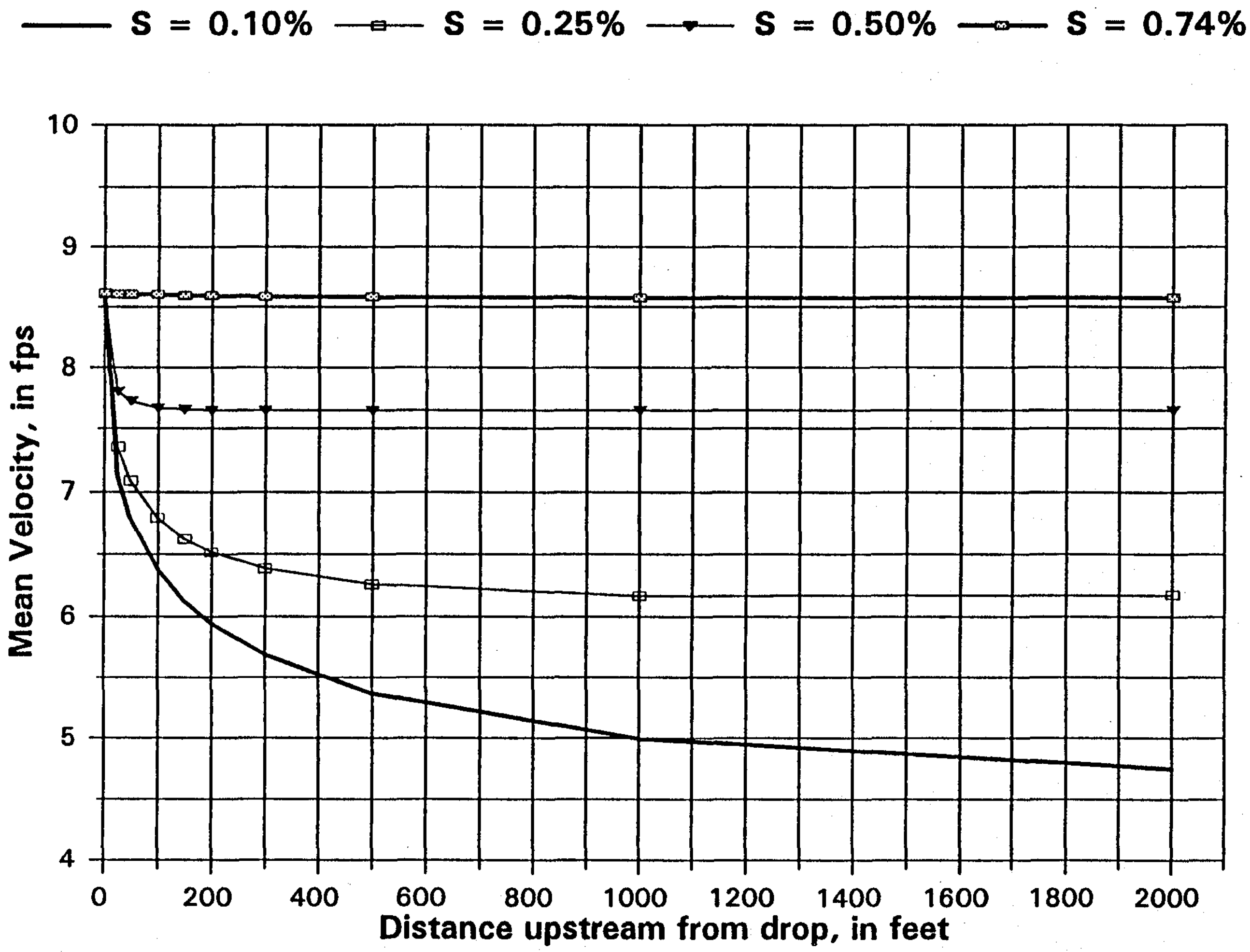



Figure 14-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.025

Table 15

**Depth of Flow and Flow Velocities in Backwater Zone Upstream of a Drop Structure**
**(q = 20 cfs/ft; n=0.040)**

| Distance (feet) | Flow Depth (in Feet) Slope (%) | | | | | Flow Velocity (in fps) Slope (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.89% | S=0.10% | S=0.25% | S=0.50% | S=1.00% | S=1.89% |
| | | | | | | | | | | |
| 0 | 2.32 | 2.32 | 2.32 | 2.32 | 2.32 | 8.62 | 8.62 | 8.62 | 8.62 | 8.62 |
| 25 | 3.15 | 3.09 | 3.00 | 2.79 | 2.32 | 6.36 | 6.47 | 6.67 | 7.16 | 8.62 |
| 50 | 3.36 | 3.27 | 3.12 | 2.81 | 2.32 | 5.96 | 6.12 | 6.41 | 7.12 | 8.62 |
| 100 | 3.64 | 3.50 | 3.26 | 2.82 | 2.32 | 5.49 | 5.72 | 6.13 | 7.10 | 8.62 |
| 150 | 3.84 | 3.65 | 3.34 | 2.82 | 2.32 | 5.21 | 5.48 | 5.99 | 7.09 | 8.62 |
| 200 | 4.00 | 3.76 | 3.39 | 2.82 | 2.32 | 5.00 | 5.32 | 5.90 | 7.09 | 8.62 |
| 300 | 4.24 | 3.91 | 3.44 | 2.82 | 2.32 | 4.72 | 5.11 | 5.81 | 7.09 | 8.62 |
| 500 | 4.57 | 4.10 | 3.49 | 2.82 | 2.32 | 4.38 | 4.88 | 5.74 | 7.09 | 8.62 |
| 1000 | 5.04 | 4.28 | 3.50 | 2.82 | 2.32 | 3.97 | 4.67 | 5.72 | 7.09 | 8.62 |
| 2000 | 5.45 | 4.34 | 3.50 | 2.82 | 2.32 | 3.67 | 4.61 | 5.72 | 7.09 | 8.62 |
| | | | | | | | | | | |
| N. Depth (ft) | 5.78 | 4.34 | 3.5 | 2.82 | 2.32 | | | | | |

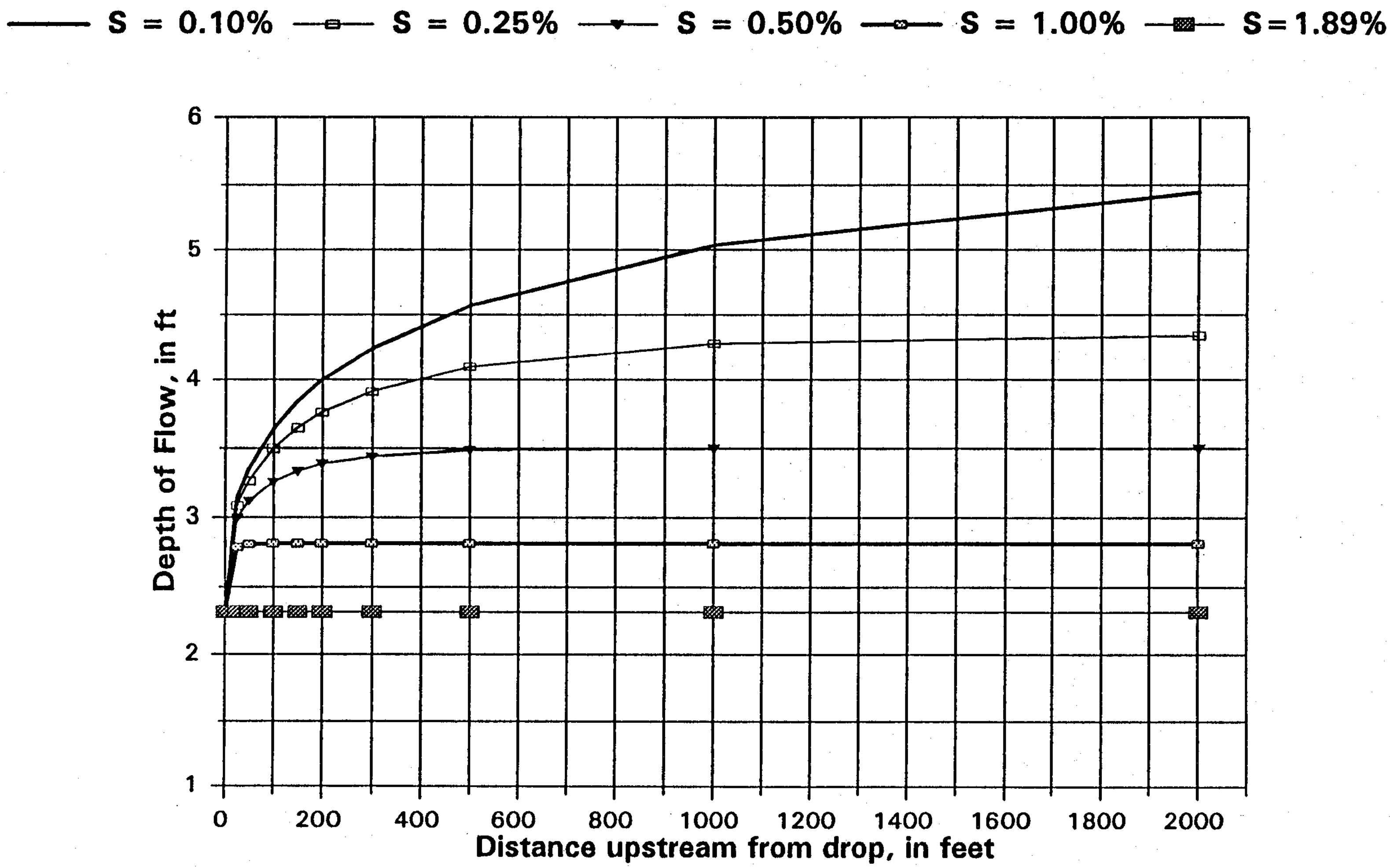



Figure 15-A
Flow Depths from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.040

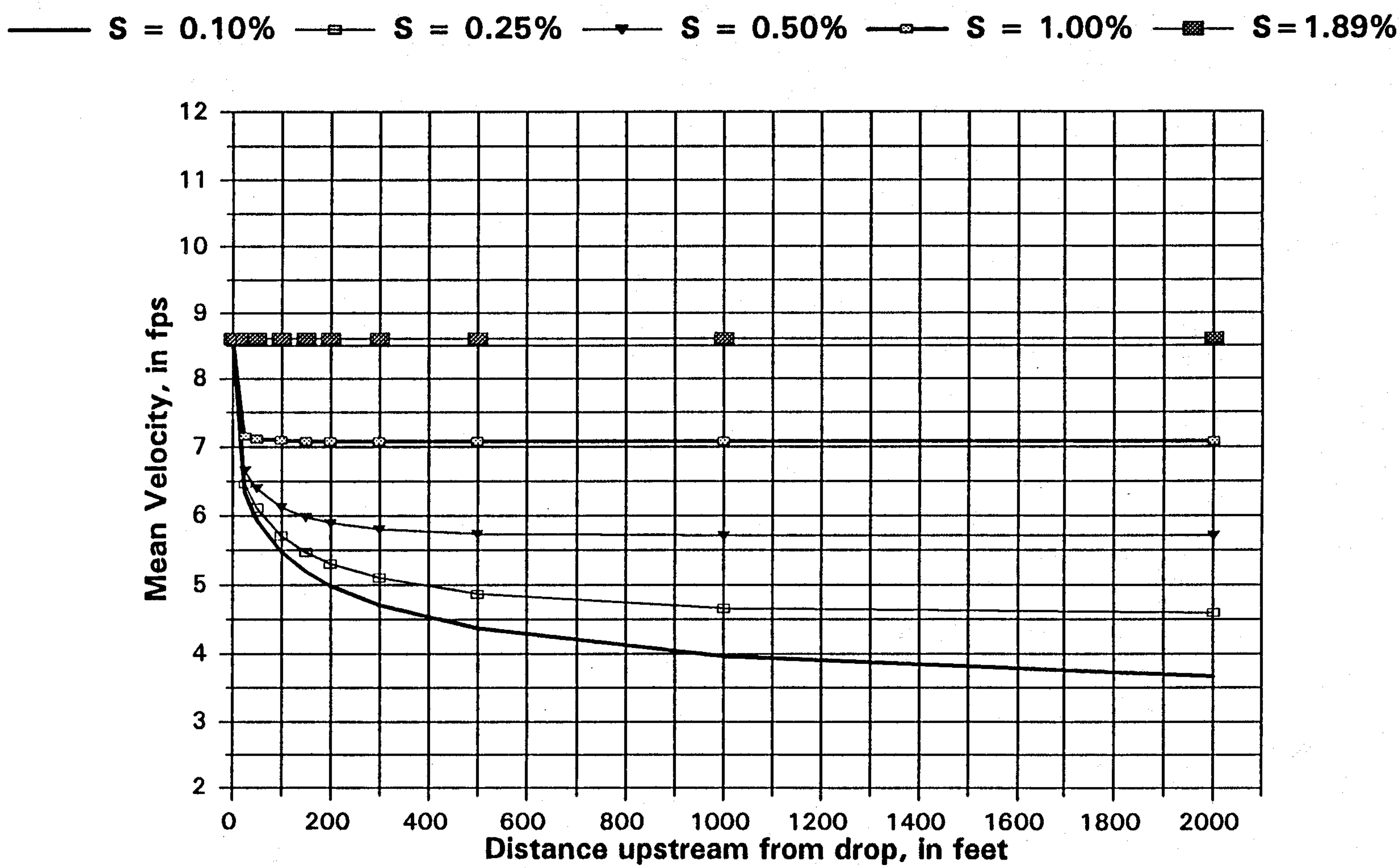



Figure 15-B
Flow Velocities from Backwater Analysis for Rectangular Channel
for q = 20 cfs/ft and n = 0.040

## Channel width rating table

### Trapezoidal Channel

n = 0.025

S = 1%

normal depth = 3 feet

side slope = 1V:2H

## Appendix A: Pima Rd Channel Q vs Bottom Width
## Rating Table for Trapezoidal Channel

| Project Description | |
|---|---|
| Project File | k:\p\1204104\flowmstr\pimachnl.fm2 |
| Worksheet | Pima Road Channel Rating Curve |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Bottom Width |

| Constant Data | | |
|---|---|---|
| Mannings Coefficient | 0.025 | |
| Channel Slope | 0.010000 | ft/ft |
| Depth | 3.00 | ft |
| Left Side Slope | 2.000000 | H : V |
| Right Side Slope | 2.000000 | H : V |

| Input Data | Minimum | Maximum | Increment |
|---|---|---|---|
| Discharge | 300.00 | 3,200.00 | 20.00 cfs |

Notes:

Assumptions:
- channel slope = 1.0%
- normal depth = 3.0 feet
- Manning's n = 0.025 (soil cement w/ rough surface
- bottom width varies with Q to maintain assumptions

Rating Table

| Discharge (cfs) | Bottom Width (ft) | Velocity (ft/s) |
|---|---|---|
| 300.00 | 5.32 | 8.84 |
| 320.00 | 5.91 | 8.95 |
| 340.00 | 6.50 | 9.06 |
| 360.00 | 7.09 | 9.17 |
| 380.00 | 7.68 | 9.26 |
| 400.00 | 8.26 | 9.35 |
| 420.00 | 8.84 | 9.44 |
| 440.00 | 9.41 | 9.51 |
| 460.00 | 9.99 | 9.59 |
| 480.00 | 10.56 | 9.66 |
| 500.00 | 11.13 | 9.73 |
| 520.00 | 11.70 | 9.79 |
| 540.00 | 12.27 | 9.85 |
| 560.00 | 12.84 | 9.91 |

## Appendix A: Pima Rd Channel Q vs Bottom Width
## Rating Table for Trapezoidal Channel

Rating Table

| Discharge (cfs) | Bottom Width (ft) | Velocity (ft/s) |
|---|---|---|
| 580.00 | 13.40 | 9.96 |
| 600.00 | 13.97 | 10.02 |
| 620.00 | 14.53 | 10.07 |
| 640.00 | 15.09 | 10.11 |
| 660.00 | 15.66 | 10.16 |
| 680.00 | 16.22 | 10.20 |
| 700.00 | 16.77 | 10.25 |
| 720.00 | 17.33 | 10.29 |
| 740.00 | 17.89 | 10.32 |
| 760.00 | 18.45 | 10.36 |
| 780.00 | 19.01 | 10.40 |
| 800.00 | 19.56 | 10.43 |
| 820.00 | 20.12 | 10.47 |
| 840.00 | 20.67 | 10.50 |
| 860.00 | 21.23 | 10.53 |
| 880.00 | 21.78 | 10.56 |
| 900.00 | 22.33 | 10.59 |
| 920.00 | 22.89 | 10.62 |
| 940.00 | 23.44 | 10.64 |
| 960.00 | 23.99 | 10.67 |
| 980.00 | 24.54 | 10.70 |
| 1,000.00 | 25.09 | 10.72 |
| 1,020.00 | 25.64 | 10.74 |
| 1,040.00 | 26.20 | 10.77 |
| 1,060.00 | 26.75 | 10.79 |
| 1,080.00 | 27.30 | 10.81 |
| 1,100.00 | 27.85 | 10.83 |
| 1,120.00 | 28.39 | 10.85 |
| 1,140.00 | 28.94 | 10.87 |
| 1,160.00 | 29.49 | 10.89 |
| 1,180.00 | 30.04 | 10.91 |
| 1,200.00 | 30.59 | 10.93 |
| 1,220.00 | 31.14 | 10.95 |
| 1,240.00 | 31.69 | 10.97 |
| 1,260.00 | 32.23 | 10.99 |
| 1,280.00 | 32.78 | 11.00 |
| 1,300.00 | 33.33 | 11.02 |
| 1,320.00 | 33.88 | 11.03 |
| 1,340.00 | 34.42 | 11.05 |
| 1,360.00 | 34.97 | 11.07 |
| 1,380.00 | 35.52 | 11.08 |
| 1,400.00 | 36.06 | 11.09 |
| 1,420.00 | 36.61 | 11.11 |
| 1,440.00 | 37.15 | 11.12 |
| 1,460.00 | 37.70 | 11.14 |

## Appendix A: Pima Rd Channel Q vs Bottom Width
## Rating Table for Trapezoidal Channel

Rating Table

| Discharge (cfs) | Bottom Width (ft) | Velocity (ft/s) |
|---|---|---|
| 1,480.00 | 38.25 | 11.15 |
| 1,500.00 | 38.79 | 11.16 |
| 1,520.00 | 39.34 | 11.18 |
| 1,540.00 | 39.88 | 11.19 |
| 1,560.00 | 40.43 | 11.20 |
| 1,580.00 | 40.97 | 11.21 |
| 1,600.00 | 41.52 | 11.22 |
| 1,620.00 | 42.06 | 11.24 |
| 1,640.00 | 42.61 | 11.25 |
| 1,660.00 | 43.15 | 11.26 |
| 1,680.00 | 43.70 | 11.27 |
| 1,700.00 | 44.24 | 11.28 |
| 1,720.00 | 44.79 | 11.29 |
| 1,740.00 | 45.33 | 11.30 |
| 1,760.00 | 45.87 | 11.31 |
| 1,780.00 | 46.42 | 11.32 |
| 1,800.00 | 46.96 | 11.33 |
| 1,820.00 | 47.51 | 11.34 |
| 1,840.00 | 48.05 | 11.35 |
| 1,860.00 | 48.59 | 11.36 |
| 1,880.00 | 49.14 | 11.37 |
| 1,900.00 | 49.68 | 11.37 |
| 1,920.00 | 50.22 | 11.38 |
| 1,940.00 | 50.77 | 11.39 |
| 1,960.00 | 51.31 | 11.40 |
| 1,980.00 | 51.85 | 11.41 |
| 2,000.00 | 52.40 | 11.42 |
| 2,020.00 | 52.94 | 11.42 |
| 2,040.00 | 53.48 | 11.43 |
| 2,060.00 | 54.03 | 11.44 |
| 2,080.00 | 54.57 | 11.45 |
| 2,100.00 | 55.11 | 11.45 |
| 2,120.00 | 55.65 | 11.46 |
| 2,140.00 | 56.20 | 11.47 |
| 2,160.00 | 56.74 | 11.48 |
| 2,180.00 | 57.28 | 11.48 |
| 2,200.00 | 57.83 | 11.49 |
| 2,220.00 | 58.37 | 11.50 |
| 2,240.00 | 58.91 | 11.50 |
| 2,260.00 | 59.45 | 11.51 |
| 2,280.00 | 60.00 | 11.52 |
| 2,300.00 | 60.54 | 11.52 |
| 2,320.00 | 61.08 | 11.53 |
| 2,340.00 | 61.62 | 11.53 |
| 2,360.00 | 62.16 | 11.54 |

## Appendix A: Pima Rd Channel Q vs Bottom Width
## Rating Table for Trapezoidal Channel

Rating Table

| Discharge (cfs) | Bottom Width (ft) | Velocity (ft/s) |
|---|---|---|
| 2,380.00 | 62.71 | 11.55 |
| 2,400.00 | 63.25 | 11.55 |
| 2,420.00 | 63.79 | 11.56 |
| 2,440.00 | 64.33 | 11.56 |
| 2,460.00 | 64.87 | 11.57 |
| 2,480.00 | 65.42 | 11.58 |
| 2,500.00 | 65.96 | 11.58 |
| 2,520.00 | 66.50 | 11.59 |
| 2,540.00 | 67.04 | 11.59 |
| 2,560.00 | 67.58 | 11.60 |
| 2,580.00 | 68.13 | 11.60 |
| 2,600.00 | 68.67 | 11.61 |
| 2,620.00 | 69.21 | 11.61 |
| 2,640.00 | 69.75 | 11.62 |
| 2,660.00 | 70.29 | 11.62 |
| 2,680.00 | 70.83 | 11.63 |
| 2,700.00 | 71.38 | 11.63 |
| 2,720.00 | 71.92 | 11.64 |
| 2,740.00 | 72.46 | 11.64 |
| 2,760.00 | 73.00 | 11.65 |
| 2,780.00 | 73.54 | 11.65 |
| 2,800.00 | 74.08 | 11.65 |
| 2,820.00 | 74.63 | 11.66 |
| 2,840.00 | 75.17 | 11.66 |
| 2,860.00 | 75.71 | 11.67 |
| 2,880.00 | 76.25 | 11.67 |
| 2,900.00 | 76.79 | 11.68 |
| 2,920.00 | 77.33 | 11.68 |
| 2,940.00 | 77.87 | 11.68 |
| 2,960.00 | 78.41 | 11.69 |
| 2,980.00 | 78.96 | 11.69 |
| 3,000.00 | 79.50 | 11.70 |
| 3,020.00 | 80.04 | 11.70 |
| 3,040.00 | 80.58 | 11.70 |
| 3,060.00 | 81.12 | 11.71 |
| 3,080.00 | 81.66 | 11.71 |
| 3,100.00 | 82.20 | 11.72 |
| 3,120.00 | 82.74 | 11.72 |
| 3,140.00 | 83.28 | 11.72 |
| 3,160.00 | 83.83 | 11.73 |
| 3,180.00 | 84.37 | 11.73 |
| 3,200.00 | 84.91 | 11.73 |

## Freeboard Calculation

### Trapezoidal Channel

$n = 0.025$

$S = 1\%$

normal depth = 3 feet

side slope = 1V:2H

Q = 1,000 to 3,000 cfs

George V. Sabol Consulting Engineers, Inc.

SHEET ____ OF ____

CLIENT ____

DATE 12/4/96

PROJECT Pima Road Channel

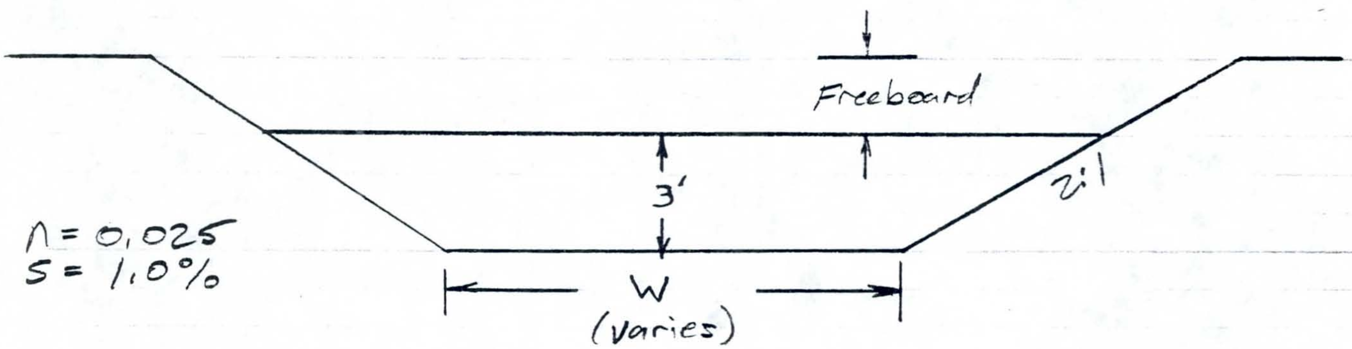
BY WSO

SUBJECT Freeboard Calculations

PROJECT NO. 1204104

Estimate of freeboard requirement:

$$FB = 0.25 \left( \text{Normal depth} + \frac{V^2}{2g} \right)$$




| Q cfs (1) | W ft (2) | V fps (3) | FB ft (4) | Minimum FB required per the FCDMC Hydraulics Manual ft (5) |
|---|---|---|---|---|
| 1,000 | 25.1 | 10.7 | 1.19 | 2 |
| 1,500 | 38.8 | 11.2 | 1.24 | 2 |
| 2,000 | 52.4 | 11.4 | 1.25 | 2 |
| 2,500 | 66.0 | 11.6 | 1.27 | 2 |
| 3,000 | 79.5 | 11.7 | 1.28 | 2 |

Appendix A

**HEC-RAS model of Pima Road Channel**

**Supercritical model to check velocities and depths for assumed design condition**

HEC-RAS Version 1.2 April 1996
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X  XXXXXX   XXXX         XXXX      XX      XXXX
X     X  X       X    X        X   X    X  X    X
X     X  X       X             X   X   X    X   X
XXXXXXX  XXXX    X       XXX   XXXX    XXXXXX    XXXX
X     X  X       X             X  X    X    X        X
X     X  X       X    X        X   X   X    X        X
X     X  XXXXXX   XXXX         X    X  X    X   XXXXX
```

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

PROJECT DATA
Project Title: Pima Rd Chnnl; Ck Bakwtr for typ reach
Project File : prc_ck.prj
Run Date and Time: 12/13/96 10:11:10 AM

Project in English units

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

PLAN DATA

Plan Title: Pima Rd Chnnl; Ck reach 1
Plan File : k:\p\1204104\hecras\prc_ck.p01

Geometry Title: Pima Rd Chnnl; Ck reach 1
Geometry File : k:\p\1204104\hecras\prc_ck.p01

Flow Title : Pima Rd Chnnl; Ck reach 1
Flow File : k:\p\1204104\hecras\prc_ck.p01

Plan Summary Information:

| | | | | | |
|---|---|---|---|---|---|
| Number of: | Cross Sections | = 17 | Mulitple Openings | = | 0 |
| | Culverts | = 0 | Inline Weirs | = | 0 |
| | Bridges | = 0 | | | |

Computational Information
Water surface calculation tolerance = .01
Critical depth calculaton tolerance = .01
Maximum number of interations = 20
Maximum difference tolerance = .3
Flow tolerance factor = .001

Computational Flow Regime: Supercritical Flow

Encroachment Data: None

Flow Distribution Locations: None

```
*********************************************************************************
```

FLOW DATA

Flow Title: Pima Rd Chnnl; Ck reach 1 Q's (50'bottom)
Flow File : k:\p\1204104\hecras\prc_ck.f01

Flow Data (cfs)

| Reach | Riv Sta | PF#1 | PF#2 | PF#3 | PF#4 | PF#5 |
|---|---|---|---|---|---|---|
| PRC_ck_1 | 800 | 1800 | 1900 | 2000 | 2100 | 2200 |
| PRC_ck_1 | 0 | 1800 | 1900 | 2000 | 2100 | 2200 |

Boundary Conditions

| Reach | Profile | Upstream | Downstream |
|---|---|---|---|
| PRC_ck_1 | 1 | Critical | |
| PRC_ck_1 | 2 | Critical | |
| PRC_ck_1 | 3 | Critical | |
| PRC_ck_1 | 4 | Critical | |
| PRC_ck_1 | 5 | Critical | |

```
*********************************************************************************
```

GEOMETRY DATA

Geometry Title: Pima Rd Chnnl; Ck reach 1 (50'bottom)
Geometry File : k:\p\1204104\hecras\prc_ck.g01

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 800
Description: upstream end

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 108 | 1010 | 103 | 1060 | 103 | 1070 | 108 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | .025 | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 750.*
Description:

Station Elevation Data, num = 4

Sta. Elev. Sta. Elev. Sta. Elev. Sta. Elev.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1000 | 107.5 | 1010 | 102.5 | 1060 | 102.5 | 1070 | 107.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT    Reach: PRC_ck_1    River Station: 700.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 107 | 1010 | 102 | 1060 | 102 | 1070 | 107 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT    Reach: PRC_ck_1    River Station: 650.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 106.5 | 1010 | 101.5 | 1060 | 101.5 | 1070 | 106.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT    Reach: PRC_ck_1    River Station: 600.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 106 | 1010 | 101 | 1060 | 101 | 1070 | 106 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT    Reach: PRC_ck_1    River Station: 550.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 105.5 | 1010 | 100.5 | 1060 | 100.5 | 1070 | 105.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 500.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 105 | 1010 | 100 | 1060 | 100 | 1070 | 105 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 450.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 104.5 | 1010 | 99.5 | 1060 | 99.5 | 1070 | 104.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 400.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 104 | 1010 | 99 | 1060 | 99 | 1070 | 104 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 350.*

Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 103.5 | 1010 | 98.5 | 1060 | 98.5 | 1070 | 103.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 300.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 103 | 1010 | 98 | 1060 | 98 | 1070 | 103 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 250.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 102.5 | 1010 | 97.5 | 1060 | 97.5 | 1070 | 102.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 200.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 102 | 1010 | 97 | 1060 | 97 | 1070 | 102 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 150.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 101.5 | 1010 | 96.5 | 1060 | 96.5 | 1070 | 101.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 100.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 101 | 1010 | 96 | 1060 | 96 | 1070 | 101 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 50.*
Description:

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 100.5 | 1010 | 95.5 | 1060 | 95.5 | 1070 | 100.5 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | 50 | 50 | 50 | .1 | .3 |

CROSS SECTION INPUT Reach: PRC_ck_1 River Station: 0
Description: Downstream end

Station Elevation Data, num = 4

| Sta. | Elev. | Sta. | Elev. | Sta. | Elev. | Sta. | Elev. |
|---|---|---|---|---|---|---|---|
| 1000 | 100 | 1010 | 95 | 1060 | 95 | 1070 | 100 |

Manning's n Values, num = 3

| Sta. | Value | Sta. | Value | Sta. | Value |
|---|---|---|---|---|---|
| 1000 | .025 | 1000 | .025 | 1070 | .025 |

| Bank Sta: Left | Right | Lengths: Left | Channel | Right | Coeff Contr. | Expan. |
|---|---|---|---|---|---|---|
| 1000 | 1070 | | | | .1 | .3 |

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

SUMMARY OF MANNING'S N VALUES

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *PRC_ck_1 | * 800 | * .025* | .025* | .025* |
| *PRC_ck_1 | * 750.* | * * | .025* | .025* |
| *PRC_ck_1 | * 700.* | * * | .025* | .025* |
| *PRC_ck_1 | * 650.* | * * | .025* | .025* |
| *PRC_ck_1 | * 600.* | * * | .025* | .025* |
| *PRC_ck_1 | * 550.* | * * | .025* | .025* |
| *PRC_ck_1 | * 500.* | * * | .025* | .025* |
| *PRC_ck_1 | * 450.* | * * | .025* | .025* |
| *PRC_ck_1 | * 400.* | * * | .025* | .025* |
| *PRC_ck_1 | * 350.* | * * | .025* | .025* |
| *PRC_ck_1 | * 300.* | * * | .025* | .025* |
| *PRC_ck_1 | * 250.* | * * | .025* | .025* |
| *PRC_ck_1 | * 200.* | * * | .025* | .025* |
| *PRC_ck_1 | * 150.* | * * | .025* | .025* |
| *PRC_ck_1 | * 100.* | * * | .025* | .025* |
| *PRC_ck_1 | * 50.* | * * | .025* | .025* |
| *PRC_ck_1 | * 0 | * .025* | .025* | .025* |

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

SUMMARY OF REACH LENGTHS

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *PRC_ck_1 | * 800 | * 50* | 50* | 50* |
| *PRC_ck_1 | * 750.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 700.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 650.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 600.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 550.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 500.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 450.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 400.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 350.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 300.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 250.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 200.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 150.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 100.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 50.* | * 50* | 50* | 50* |
| *PRC_ck_1 | * 0 | * * | * | * |

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

| Reach | River Sta. | Contr. | Expan. |
|---|---|---|---|
| PRC_ck_1 | 800 | .1 | .3 |
| PRC_ck_1 | 750.* | .1 | .3 |
| PRC_ck_1 | 700.* | .1 | .3 |
| PRC_ck_1 | 650.* | .1 | .3 |
| PRC_ck_1 | 600.* | .1 | .3 |
| PRC_ck_1 | 550.* | .1 | .3 |
| PRC_ck_1 | 500.* | .1 | .3 |
| PRC_ck_1 | 450.* | .1 | .3 |
| PRC_ck_1 | 400.* | .1 | .3 |
| PRC_ck_1 | 350.* | .1 | .3 |
| PRC_ck_1 | 300.* | .1 | .3 |
| PRC_ck_1 | 250.* | .1 | .3 |
| PRC_ck_1 | 200.* | .1 | .3 |
| PRC_ck_1 | 150.* | .1 | .3 |
| PRC_ck_1 | 100.* | .1 | .3 |
| PRC_ck_1 | 50.* | .1 | .3 |
| PRC_ck_1 | 0 | .1 | .3 |

Profile Output Table - Standard Table 1

| River Sta. | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|
| 800 | 1800.00 | 103.00 | 106.27 | 106.27 | 107.74 | 0.006593 | 9.73 | 185.01 | 63.09 | 1.00 |
| 800 | 1900.00 | 103.00 | 106.39 | 106.39 | 107.90 | 0.006517 | 9.88 | 192.39 | 63.55 | 1.00 |
| 800 | 2000.00 | 103.00 | 106.50 | 106.50 | 108.06 | 0.006460 | 10.02 | 199.54 | 64.00 | 1.00 |
| 800 | 2100.00 | 103.00 | 106.61 | 106.61 | 108.21 | 0.006407 | 10.16 | 206.59 | 64.44 | 1.00 |
| 800 | 2200.00 | 103.00 | 106.72 | 106.72 | 108.37 | 0.006356 | 10.30 | 213.56 | 64.87 | 1.00 |
| | | | | | | | | | | |
| 750.* | 1800.00 | 102.50 | 105.44 | 105.76 | 107.30 | 0.009482 | 10.95 | 164.37 | 61.77 | 1.18 |
| 750.* | 1900.00 | 102.50 | 105.56 | 105.89 | 107.46 | 0.009277 | 11.08 | 171.46 | 62.22 | 1.18 |
| 750.* | 2000.00 | 102.50 | 105.66 | 106.00 | 107.62 | 0.009205 | 11.25 | 177.73 | 62.62 | 1.18 |
| 750.* | 2100.00 | 102.50 | 105.75 | 106.11 | 107.78 | 0.009137 | 11.42 | 183.92 | 63.02 | 1.18 |
| 750.* | 2200.00 | 102.50 | 105.85 | 106.21 | 107.93 | 0.009076 | 11.58 | 190.01 | 63.40 | 1.18 |
| | | | | | | | | | | |
| 700.* | 1800.00 | 102.00 | 104.91 | 105.27 | 106.82 | 0.009808 | 11.07 | 162.58 | 61.65 | 1.20 |
| 700.* | 1900.00 | 102.00 | 105.02 | 105.38 | 106.98 | 0.009698 | 11.24 | 169.00 | 62.06 | 1.20 |
| 700.* | 2000.00 | 102.00 | 105.11 | 105.49 | 107.14 | 0.009643 | 11.42 | 175.06 | 62.45 | 1.20 |
| 700.* | 2100.00 | 102.00 | 105.21 | 105.60 | 107.30 | 0.009588 | 11.60 | 181.05 | 62.84 | 1.20 |
| 700.* | 2200.00 | 102.00 | 105.30 | 105.71 | 107.45 | 0.009533 | 11.77 | 186.98 | 63.21 | 1.21 |
| | | | | | | | | | | |
| 650.* | 1800.00 | 101.50 | 104.42 | 104.77 | 106.31 | 0.009698 | 11.03 | 163.17 | 61.69 | 1.20 |
| 650.* | 1900.00 | 101.50 | 104.51 | 104.88 | 106.48 | 0.009773 | 11.27 | 168.58 | 62.04 | 1.20 |
| 650.* | 2000.00 | 101.50 | 104.61 | 104.99 | 106.64 | 0.009723 | 11.46 | 174.59 | 62.42 | 1.21 |
| 650.* | 2100.00 | 101.50 | 104.70 | 105.10 | 106.80 | 0.009671 | 11.63 | 180.54 | 62.80 | 1.21 |
| 650.* | 2200.00 | 101.50 | 104.79 | 105.21 | 106.96 | 0.009617 | 11.80 | 186.45 | 63.18 | 1.21 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 600. | 1800.00 | 101.00 | 103.91 | 104.27 | 105.81 | 0.009777 | 11.06 | 162.74 | 61.66 | 1.20 |
| 600. | 1900.00 | 101.00 | 104.00 | 104.38 | 105.98 | 0.009835 | 11.29 | 168.23 | 62.02 | 1.21 |
| 600. | 2000.00 | 101.00 | 104.10 | 104.49 | 106.15 | 0.009792 | 11.48 | 174.19 | 62.40 | 1.21 |
| 600. | 2100.00 | 101.00 | 104.19 | 104.60 | 106.31 | 0.009745 | 11.66 | 180.10 | 62.78 | 1.21 |
| 600. | 2200.00 | 101.00 | 104.29 | 104.71 | 106.46 | 0.009695 | 11.83 | 185.96 | 63.15 | 1.21 |
| 550. | 1800.00 | 100.50 | 103.41 | 103.77 | 105.32 | 0.009841 | 11.08 | 162.40 | 61.64 | 1.20 |
| 550. | 1900.00 | 100.50 | 103.51 | 103.88 | 105.48 | 0.009743 | 11.26 | 168.75 | 62.05 | 1.20 |
| 550. | 2000.00 | 100.50 | 103.59 | 103.99 | 105.65 | 0.009847 | 11.50 | 173.87 | 62.38 | 1.21 |
| 550. | 2100.00 | 100.50 | 103.69 | 104.10 | 105.81 | 0.009806 | 11.68 | 179.73 | 62.75 | 1.22 |
| 550. | 2200.00 | 100.50 | 103.78 | 104.21 | 105.96 | 0.009762 | 11.86 | 185.54 | 63.12 | 1.22 |
| 500. | 1800.00 | 100.00 | 102.92 | 103.27 | 104.81 | 0.009750 | 11.05 | 162.89 | 61.67 | 1.20 |
| 500. | 1900.00 | 100.00 | 103.01 | 103.38 | 104.98 | 0.009811 | 11.28 | 168.37 | 62.02 | 1.21 |
| 500. | 2000.00 | 100.00 | 103.10 | 103.49 | 105.15 | 0.009764 | 11.47 | 174.35 | 62.41 | 1.21 |
| 500. | 2100.00 | 100.00 | 103.20 | 103.60 | 105.30 | 0.009705 | 11.64 | 180.34 | 62.79 | 1.21 |
| 500. | 2200.00 | 100.00 | 103.27 | 103.71 | 105.47 | 0.009818 | 11.88 | 185.19 | 63.10 | 1.22 |
| 450. | 1800.00 | 99.50 | 102.41 | 102.77 | 104.32 | 0.009820 | 11.08 | 162.51 | 61.65 | 1.20 |
| 450. | 1900.00 | 99.50 | 102.52 | 102.88 | 104.48 | 0.009707 | 11.25 | 168.95 | 62.06 | 1.20 |
| 450. | 2000.00 | 99.50 | 102.60 | 102.99 | 104.65 | 0.009825 | 11.49 | 174.00 | 62.39 | 1.21 |
| 450. | 2100.00 | 99.50 | 102.69 | 103.10 | 104.81 | 0.009774 | 11.67 | 179.92 | 62.76 | 1.21 |
| 450. | 2200.00 | 99.50 | 102.78 | 103.21 | 104.96 | 0.009726 | 11.84 | 185.77 | 63.14 | 1.22 |
| 400. | 1800.00 | 99.00 | 101.92 | 102.27 | 103.81 | 0.009717 | 11.04 | 163.07 | 61.68 | 1.20 |
| 400. | 1900.00 | 99.00 | 102.01 | 102.38 | 103.98 | 0.009781 | 11.27 | 168.54 | 62.03 | 1.21 |
| 400. | 2000.00 | 99.00 | 102.11 | 102.49 | 104.14 | 0.009730 | 11.46 | 174.55 | 62.42 | 1.21 |
| 400. | 2100.00 | 99.00 | 102.19 | 102.60 | 104.31 | 0.009830 | 11.69 | 179.58 | 62.74 | 1.22 |
| 400. | 2200.00 | 99.00 | 102.28 | 102.71 | 104.46 | 0.009788 | 11.87 | 185.38 | 63.11 | 1.22 |
| 350. | 1800.00 | 98.50 | 101.41 | 101.77 | 103.32 | 0.009793 | 11.07 | 162.66 | 61.65 | 1.20 |
| 350. | 1900.00 | 98.50 | 101.50 | 101.88 | 103.48 | 0.009841 | 11.30 | 168.20 | 62.01 | 1.21 |
| 350. | 2000.00 | 98.50 | 101.60 | 101.99 | 103.65 | 0.009797 | 11.48 | 174.16 | 62.40 | 1.21 |
| 350. | 2100.00 | 98.50 | 101.69 | 102.10 | 103.81 | 0.009741 | 11.66 | 180.12 | 62.78 | 1.21 |
| 350. | 2200.00 | 98.50 | 101.77 | 102.21 | 103.97 | 0.009840 | 11.89 | 185.06 | 63.09 | 1.22 |
| 300. | 1800.00 | 98.00 | 100.91 | 101.27 | 102.82 | 0.009853 | 11.09 | 162.34 | 61.63 | 1.20 |
| 300. | 1900.00 | 98.00 | 101.01 | 101.38 | 102.98 | 0.009753 | 11.26 | 168.69 | 62.04 | 1.20 |
| 300. | 2000.00 | 98.00 | 101.09 | 101.49 | 103.15 | 0.009851 | 11.50 | 173.85 | 62.38 | 1.21 |
| 300. | 2100.00 | 98.00 | 101.19 | 101.60 | 103.31 | 0.009804 | 11.68 | 179.74 | 62.75 | 1.22 |
| 300. | 2200.00 | 98.00 | 101.28 | 101.71 | 103.46 | 0.009758 | 11.86 | 185.57 | 63.12 | 1.22 |
| 250. | 1800.00 | 97.50 | 100.42 | 100.77 | 102.31 | 0.009769 | 11.06 | 162.79 | 61.66 | 1.20 |
| 250. | 1900.00 | 97.50 | 100.51 | 100.88 | 102.48 | 0.009818 | 11.29 | 168.33 | 62.02 | 1.21 |
| 250. | 2000.00 | 97.50 | 100.60 | 100.99 | 102.65 | 0.009771 | 11.47 | 174.31 | 62.41 | 1.21 |
| 250. | 2100.00 | 97.50 | 100.70 | 101.10 | 102.80 | 0.009702 | 11.64 | 180.36 | 62.79 | 1.21 |
| 250. | 2200.00 | 97.50 | 100.78 | 101.21 | 102.97 | 0.009815 | 11.88 | 185.22 | 63.10 | 1.22 |
| 200. | 1800.00 | 97.00 | 99.91 | 100.27 | 101.82 | 0.009834 | 11.08 | 162.44 | 61.64 | 1.20 |
| 200. | 1900.00 | 97.00 | 100.01 | 100.38 | 101.98 | 0.009718 | 11.25 | 168.89 | 62.06 | 1.20 |
| 200. | 2000.00 | 97.00 | 100.10 | 100.49 | 102.15 | 0.009830 | 11.50 | 173.97 | 62.38 | 1.21 |
| 200. | 2100.00 | 97.00 | 100.19 | 100.60 | 102.31 | 0.009771 | 11.67 | 179.94 | 62.77 | 1.21 |
| 200. | 2200.00 | 97.00 | 100.28 | 100.71 | 102.46 | 0.009720 | 11.84 | 185.80 | 63.14 | 1.22 |

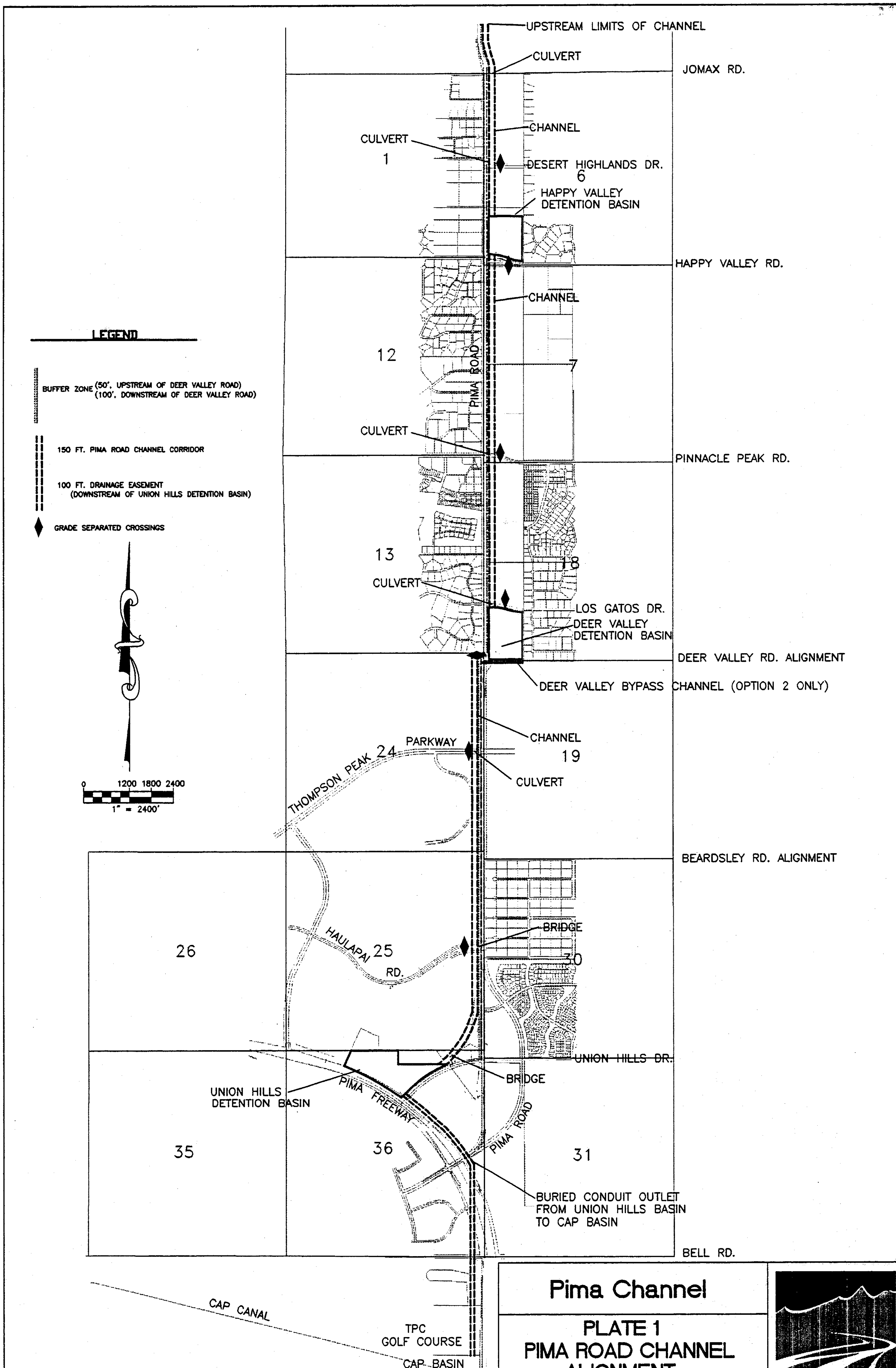
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 150. | 1800.00 | 96.50 | 99.42 | 99.77 | 101.31 | 0.009740 | 11.05 | 162.95 | 61.67 | 1.20 |
| 150. | 1900.00 | 96.50 | 99.51 | 99.88 | 101.48 | 0.009790 | 11.28 | 168.48 | 62.03 | 1.21 |
| 150. | 2000.00 | 96.50 | 99.60 | 99.99 | 101.64 | 0.009739 | 11.46 | 174.50 | 62.42 | 1.21 |
| 150. | 2100.00 | 96.50 | 99.69 | 100.10 | 101.81 | 0.009828 | 11.69 | 179.60 | 62.74 | 1.22 |
| 150. | 2200.00 | 96.50 | 99.78 | 100.21 | 101.96 | 0.009784 | 11.87 | 185.41 | 63.11 | 1.22 |
| | | | | | | | | | | |
| 100. | 1800.00 | 96.00 | 98.91 | 99.27 | 100.82 | 0.009811 | 11.07 | 162.56 | 61.65 | 1.20 |
| 100. | 1900.00 | 96.00 | 99.00 | 99.38 | 100.98 | 0.009848 | 11.30 | 168.16 | 62.01 | 1.21 |
| 100. | 2000.00 | 96.00 | 99.10 | 99.49 | 101.15 | 0.009805 | 11.49 | 174.12 | 62.39 | 1.21 |
| 100. | 2100.00 | 96.00 | 99.19 | 99.60 | 101.30 | 0.009738 | 11.66 | 180.14 | 62.78 | 1.21 |
| 100. | 2200.00 | 96.00 | 99.27 | 99.71 | 101.47 | 0.009836 | 11.89 | 185.08 | 63.09 | 1.22 |
| | | | | | | | | | | |
| 50. | 1800.00 | 95.50 | 98.42 | 98.77 | 100.31 | 0.009703 | 11.03 | 163.14 | 61.69 | 1.20 |
| 50. | 1900.00 | 95.50 | 98.51 | 98.88 | 100.48 | 0.009764 | 11.27 | 168.63 | 62.04 | 1.20 |
| 50. | 2000.00 | 95.50 | 98.61 | 98.99 | 100.64 | 0.009700 | 11.45 | 174.73 | 62.43 | 1.21 |
| 50. | 2100.00 | 95.50 | 98.69 | 99.10 | 100.81 | 0.009801 | 11.68 | 179.76 | 62.75 | 1.22 |
| 50. | 2200.00 | 95.50 | 98.78 | 99.21 | 100.96 | 0.009753 | 11.85 | 185.60 | 63.13 | 1.22 |
| | | | | | | | | | | |
| 0 | 1800.00 | 95.00 | 97.91 | 98.27 | 99.81 | 0.009782 | 11.06 | 162.72 | 61.66 | 1.20 |
| 0 | 1900.00 | 95.00 | 98.00 | 98.38 | 99.98 | 0.009827 | 11.29 | 168.28 | 62.02 | 1.21 |
| 0 | 2000.00 | 95.00 | 98.10 | 98.49 | 100.15 | 0.009772 | 11.47 | 174.30 | 62.41 | 1.21 |
| 0 | 2100.00 | 95.00 | 98.20 | 98.60 | 100.30 | 0.009697 | 11.64 | 180.38 | 62.79 | 1.21 |
| 0 | 2200.00 | 95.00 | 98.28 | 98.71 | 100.47 | 0.009811 | 11.88 | 185.24 | 63.10 | 1.22 |

ERRORS WARNINGS AND NOTES

Errors Warnings and Notes for Plan : ck reach 1

Summary for Profiles:1,2,3,4,5

No Errors, Warnings or Notes in Computations




**Pima Channel**

**PLATE 1**
**PIMA ROAD CHANNEL ALIGNMENT AND MAJOR FEATURES**

*George V. Sabol Consulting Engineers, Inc.*

The Desert Greenbelt
SCOTTSDALE ARIZONA


# Pima Road Channel

PLATE 2
HAPPY VALLEY
DETENTION BASIN
Sheet 1 of 1

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# Pima Road Channel

PLATE 3

DEER VALLEY DETENTION BASIN

OPTION 1

Sheet 1 of 1

The Desert Greenbelt


# Pima Road Channel

PLATE 4
DEER VALLEY DETENTION BASIN
OPTION 2

Sheet 1 of 1

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# Pima Road Channel

PLATE 5
UNION HILLS DETENTION BASIN
OPTION 1

Sheet 1 of 1

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# Pima Road Channel

PLATE 6
UNION HILLS DETENTION BASIN
OPTION 2

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# Pima Road Channel

## Plate 7

## Pima Road Channel Profile

Sheet 1 of 3

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# Pima Road Channel

Plate 7

Pima Road Channel Profile

Sheet 3 of 3

The Desert Greenbelt


LEGEND

Pima Channel Invert

Natural Ground

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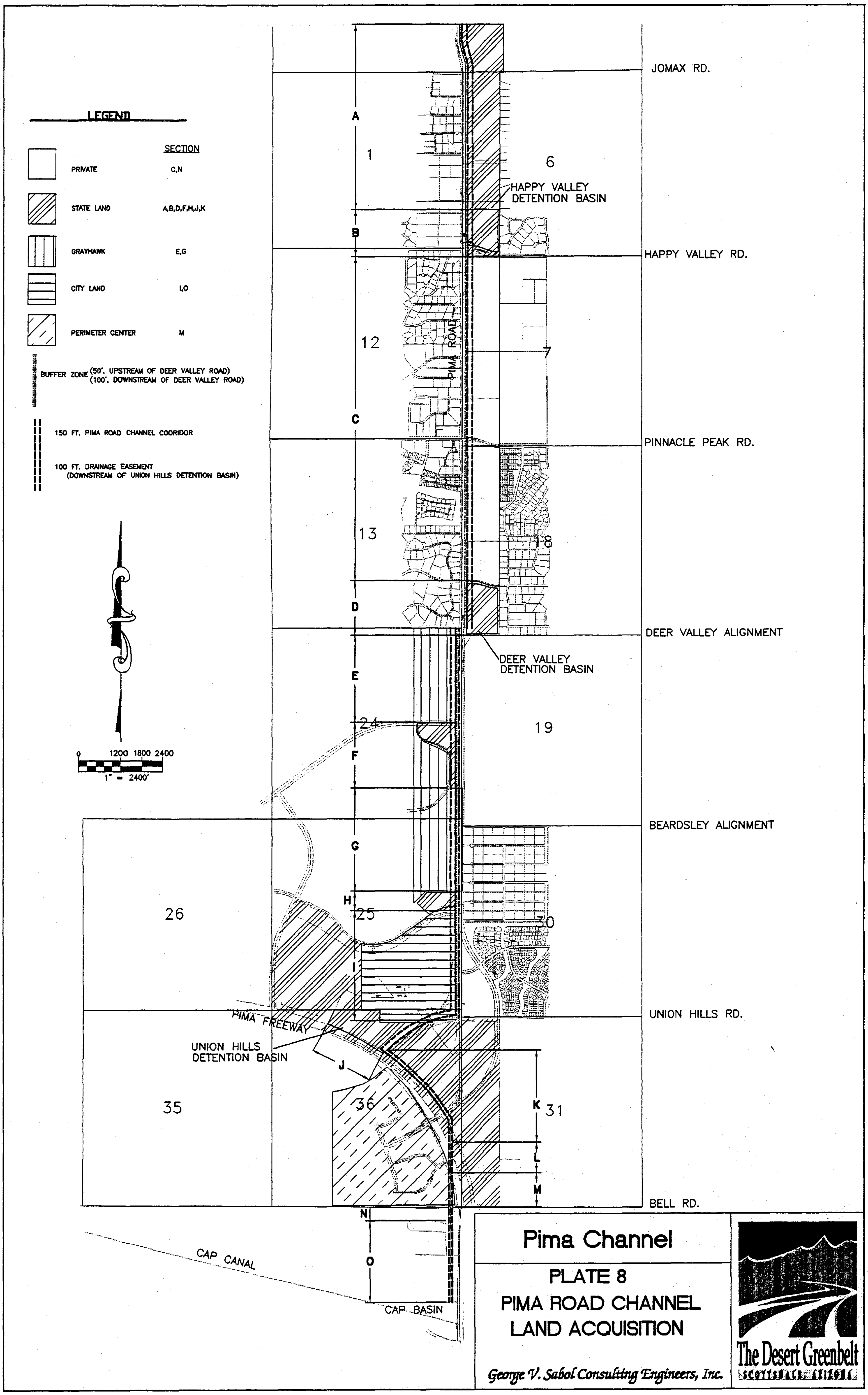
# Pima Road Channel

## Plate 7

## Pima Road Channel Profile

Sheet 2 of 3

The Desert Greenbelt




# Pima Channel

## PLATE 8
## PIMA ROAD CHANNEL LAND ACQUISITION

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