BULLARD WASH
CHANNEL IMPROVEMENTS
INTERSTATE 10 TO
LOWER BUCKEYE ROAD
DESIGN REPORT

Contract FCD 2001 C023

WOOD/PATEL

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WP #011489

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1.0 INTRODUCTION

1.1 Purpose of Report

The purpose of this report is to provide a description and technical back-up to fulfill the requirements for the final design submittal, as outlined in the scope of work for the Bullard Wash Channel Improvements, Interstate 10 to Lower Buckeye Road. The purpose of the final design report is to provide adequate details for the channel, bridge crossing, landscape, irrigation and right-of-way needs.

1.2 Submittal List

Items to be included with the final submittal include:

- Design plans including civil, landscape, irrigation, telemetry, and soil boring logs;
- Special Provisions and General Conditions;
- Bid quantity calculations and opinion of probable costs;
- Correspondence report;
- Design Calculations and Design Data Report (included in this report); and
- Flood Response Plan.

1.3 Consultant Team

The consultant team includes the following firms:

Wood, Patel & Associates, Inc.	Civil Design
Logan Simpson Design	Landscape Architecture
LTM Engineering	Flood Response
Structural Grace	Structural Design
ATL, Inc.	Geotechnical Investigations
Bolduc, Smiley & Associates	Traffic Control
Geotrack	Utility Locating
Kenney Aerial Mapping	Aerial Mapping
Wright Engineering Corporation	Safety Lighting and Telemetry
EPG	Environmental Studies

2.0 PROJECT DESCRIPTION

2.1 Agencies

The Flood Control District of Maricopa County (District), in partnership with the City of Goodyear (City), is developing design plans for the Bullard Wash Channel Improvements, Interstate 10 to Lower Buckeye Road project.

2.2 Location

The project includes the construction of a flood control channel along the Bullard Wash alignment between I-10 and the existing channelized portion of the wash near Lower Buckeye Road. The project limits are shown in Appendix D on the Floodplain and Affected Parcels Exhibit.

2.3 Features

The channel will be constructed as a greenbelt facility with irrigated landscaping, turf, trails, and other multi-use features. The basic project features will be constructed initially, with additional park and recreation amenities to be added in the future, as needs dictate and funding allows. Dry roadway crossings will be constructed at Van Buren Street and Yuma Road with adequate clearance for the pedestrian and equestrian trails. It is anticipated that construction funding will be spread out over several fiscal years. Therefore, the channel improvement plans have been broken out into the following projects:

- Yuma Road to Lower Buckeye Road
- Van Buren Street to Yuma Road
- Interstate 10 to Van Buren Street

It should be noted that the plan breakout uses hard break lines to separates the proposed channel improvements into three reaches. If the projects are constructed separately, additional plans will be required to transition construction at break lines to match interim conditions.

Due to FHWA and ADOT involvement on the proposed Van Buren Street and Yuma Road Bridges over Bullard Wash, the roadway and bridge plan design and construction will be performed independently.

2.4 Purpose

The primary purpose of the project is flood control; however, aesthetic and multi-use features are important project components. The facility will provide visitors with recreational opportunities in a relaxing, natural-feeling park.

3.0 STUDY OF AREA

3.1 Past Studies

The following reports and studies have also been reviewed for this project's design concept:

- *Loop 303 Corridor/White Tanks Area Drainage Master Plan Update: Draft Level II Phase I Technical Memorandum for the Bullard Wash – Thomas Road to Buckeye*
- *Loop 303 Corridor/White Tanks Area Drainage Master Plan Update: Draft Existing Condition Hydrology*
- *Loop 303 Corridor/White Tanks Area Drainage Master Plan Update: Draft Level II Phase I Alternatives Technical Memorandum*
- *Loop 303 Corridor/White Tanks Area Drainage Master Plan Update: Level II Draft Phase II Alternative Analysis Report*
- *Bullard Wash Channel Improvements (Phase I) – Contract FCD 95-39* (Geotechnical Investigations)
- *Bullard Wash Channel Improvements (Phase I) – Levees and Embankments, FCD Project No. 95-39* (Geotechnical Investigations)
- *Bullard Wash Channel Improvements (Phase I) – MC 85 Bridge and BID Canal Overchute* (Geotechnical Investigations)
- *Landscape Aesthetics & Multi-Use Plan*
- *Flood Control West Valley Existing Facilities Landscape Aesthetics and Multi-Use Opportunities Assessment Report*
- *Agua Fria River Watercourse Master Plan, Landscape Aesthetics and Multi-Use Opportunities Assessment Report*
- *City of Goodyear Parks, Trails, and Open Space Master Plan*

3.2 Existing Conditions

3.2.1 Topography

Interstate-10 crosses the wash at the north end of the project and the project ends just north of Lower Buckeye Road alignment. The existing Bullard Wash crosses the alignments of Van Buren Street, Yuma Road, and Lower Buckeye Parkway. Van Buren Street and Yuma Road are dip crossings with approximately 24 feet of pavement at each road. Lower Buckeye Parkway

improvements have only been constructed to each side of the existing wash corridor boundary.

Ground topography was obtained within the immediate vicinity of the project corridor at a one-foot contour interval. Areas outside of this area are identified with a two-foot contour interval from previous topographic data received from the District.

The area in the vicinity of the existing Bullard Wash is primarily irrigated farms, which are being replaced with residential and industrial developments. The adjacent land slopes gently to the southeast toward the wash from Estrella Parkway and to the southwest toward the wash from Bullard Avenue. An existing irrigation tailwater swale runs the length of the wash alignment.

3.2.2 Floodplain

Currently, per Federal Emergency Management Agency's (FEMA) regulatory Flood Insurance Rate Map (FIRM), Bullard Wash is zoned AE as shown on Map 04013C2060F and Map 04013C2070G, map revision date July 19, 2001. Zone AE is defined as base flooding elevations determined. A copy of the effective FIRM Map is included in Appendix E.

The Bullard Wash floodplain is rather wide and unconfined. The floodway width varies between 230 and 430 feet with an average width of about 350 feet. The floodplain varies in width between 500 and 1,200 feet. The average floodplain width is approximately 900 feet. A channel constructed for the Rancho Mirage subdivision, just north of Van Buren Street, confines the floodway and floodplain to 300 feet.

A Conditional Letter of Map Revision (CLOMR) Technical Data Notebook (TDN) has been prepared and approved by FEMA based on the 90% design. The CLOMR will recommend a revision of the floodplain as shown on the TDN study work maps. Once the channel is built, a set of as-built plans will be prepared for the Letter of Map Revision (LOMR) submittal.

3.2.3 Soil Properties

The soils along the wash alignment are primarily clay, silt, and sand mixtures with plasticities ranging from 5 to 15. In a very short segment of wash near Lower Buckeye Parkway, the soils exhibited no plasticity. Based on the soil evaluation work for this project and for the existing channelized reach immediately south of this project. It has been determined that the soil in the channel corridor is erosion resistant.

3.2.4 Utilities

There are several utility crossing locations along the project corridor. Sewer service laterals cross the wash from the Snyder's of Hanover plant and the Southwest Specialty Foods building on the east to a sewer interceptor line on the west. This sewer line then crosses the wash from west to east approximately 265 feet north of Van Buren Street. It is recommended that the 8" sewer line from Snyder's of Hanover be replaced at the wash crossing with 8" D.I.P. This will require the removal and replacement of approximately 334 LF of sewer line. This replacement will need to be coordinated with Snyder's of Hanover, as outlined in the Special Provisions for the Interstate 10 to Van Buren Street reach, to minimize disruption to their facility.

The 12" sewer line from Southwest Specialty Foods was constructed with D.I.P. and will not be replaced. However, one of the manholes for this line lies within the channel bank. This manhole frame and cover will be replaced with a watertight frame and cover. The 18" sewer crossing north of Van Buren Street has approximately 12' of cover. No modifications are proposed at this location.

In Van Buren Street, there is a 24-inch waterline, two buried telephone lines, a 12-inch sewer force main (abandoned) and a 27" sewer line at the wash crossing. The 27" sewer has been designed and constructed on the south side of Van Buren Street to accommodate the proposed channel improvements. The sewer force main has been abandoned at the proposed bridge crossing. The direct bury Qwest lines will be relocated by Qwest prior to the construction of the bridge project.

The 24" waterline is in conflict with the proposed Van Buren Street Bridge improvements and will be relocated as a part of the Van Buren Street Bridge plans for this project.

An overhead electrical 69 kV transmission line and a 12kV primary conductor line run along the north side of Van Buren Street. It is anticipated that the 69kV line will remain overhead, which will require the relocation of a power pole outside of the bride footprint. The 12kV line will be relocated by APS possibly within the bridge.

Utilities at the Yuma Road crossing include: a group of three buried telephone lines on the north side (one abandoned), a buried cable, a 16-inch ductile iron pipe (DIP) waterline, a 24-inch return effluent pipe, a common trench buried telephone duct bank (4-4" conduits with 2-2½" abandoned Cox conduits), a 4-inch gas line and a 3-inch high-pressure gas line. The 16-inch waterline, telephone duct bank and 24-inch return effluent line were constructed with dips to accommodate a future structure at the Bullard Wash crossing. The Qwest, Cox and Southwest gas lines will be relocated by their respective owners prior to construction of the Yuma Road Bridge.

An overhead 12kV electrical primary conductor line runs along the north side of Yuma Road. The 12kV line will be relocated by APS possibly within the bridge.

There is a 16-inch ACP waterline and a 12-inch sewer line in Lower Buckeye Parkway, which do not extend across the current gap in pavement that spans the entire Bullard Wash corridor.

Effected utilities including Qwest Communications, Southwest Gas, Cox Communications and Arizona Public Service have been provided with plans for utility conflict determination and relocation.

3.3 Site Analysis

3.3.1 Existing Land Use

The existing land use within the project area is predominantly agricultural. However, there are pockets of development located adjacent to Bullard Wash. Two industrial projects, Snyder's of Hanover and Southwest Specialty Foods, are located between I-10 and Van Buren Street on the east side of Bullard Wash. The residential community of Rancho Mirage is located on the west side of Bullard Wash, just north of Van Buren Street. This community extends approximately ¼ mile north of Van Buren Street. The Phoenix-Goodyear Municipal Airport is located at the south end of the project on the east side. A United States Postal Service facility is located at Yuma Road and Estrella Parkway.

3.3.2 Proposed Land Use

The proposed land use for the area consists predominantly of residential and industrial developments. The west side of the channel will be developed predominantly as residential north of Yuma Road. Between Van Buren Street and Yuma Road along the west side of the wash, Centerra, a residential community, is currently under development. This development will include a mix of single- and multi-family housing, along with various open spaces and a school facility. This development has provisions for access to Bullard Wash for its residents. Development plans are currently being prepared for the Centerra Corporate Center at the northeast corner of Yuma Road and Bullard Wash. While not directly adjacent to Bullard Wash, the City of Goodyear City Center is planned approximately ½ mile west of Bullard Wash north of Yuma Road.

The east side of Bullard Wash has been identified as industrial development. As previously stated, industrial developments are already located north of Van Buren Street. Industrial use has been identified south of Yuma Road on both sides of Bullard Wash through the Estrella Aerospace development. Also, north of Van Buren Street on the east side of Bullard Wash is the proposed Skyway Church of the West Valley.

3.3.3 Transportation Corridors

The following transportation corridors are found within the project area:

Vehicular – The main roadways that cross through and parallel the project area provide vehicular corridors. These corridors provide a means of access to the future amenities that will be provided at the park.

Multi-Use Path (Bicycle/Pedestrian) – Multi-use corridors, existing and proposed, are provided adjacent to the main roadways that cross through and parallel the project area. Multi-use corridors are also provided within Bullard Wash.

Equestrian Trail – An equestrian trail has been identified within Bullard Wash. It is to connect with the equestrian trial that is identified to parallel Lower Buckeye Road and ultimately extend north and south of the project limits. Possible connections to the Sun Circle Trail also exist, which will ultimately provide access to most areas of Maricopa County.

3.3.4 Design Opportunities

Through a combination of site visits, research, and site inventories, several conclusions were made regarding possible design solutions and concepts as related to this site. The following examples are a few of the major design influencing opportunities as related to this site:

- Views to both the White Tank and Estrella Mountains should be maintained and enhanced. Such views add a sense of place for visitors and can enhance the overall experience of the site.
- Views of utility lines and corridors should be screened when possible. This includes other forms of general infrastructure that are usually not very pleasing to the eye.
- Views to the adjacent Phoenix-Goodyear Municipal Airport can aid in the development of an aircraft-based theme. In addition, the viewing of aircraft traffic could be developed into an activity for this area, much like people watching or viewing of water based traffic in some port cities.

- Agriculture related structures could help in defining a theme for the park area and add a cultural and historic perspective to the park.
- Adjacent residential areas provide a population of people that are within walking distance to the park. This will provide a group of people with quick and easy access to the park and its amenities.
- Nearby businesses provide a weekday population to the area that can potentially add visitors to the park as well. The close proximity to businesses is a benefit in that there is potential for pedestrians visiting the park to also visit nearby shops and stores.
- Planned land uses and some existing land uses allow for unobstructed access into the park at several areas. Such access points can be developed according to its surrounding land use and characteristics. An example would be a pedestrian trailhead in a residential cul-de-sac; this access point would not provide for parking, thus eliminating it being a destination spot for vehicular visitors. This example would be focused on the pedestrian and not the driver. Other areas, however, will provide small to mid-size parking areas, allowing for larger group activities.
- The several planned trails in and around the area is an asset that should be utilized to the fullest extent possible.
- The close proximity to the Planned City Center along Yuma Road is a benefit to the park in that it allows for potential connection between the two along Yuma Road. This connection could be in the form of a pedestrian-oriented streetscape or "greenbelt."
- Bury electrical overhead lines or provide conduit in the bridges.

3.4 Survey

A field survey was conducted to supplement information on the aerial topographic mapping. This included shots on existing walls and sewer manholes, rims, and inverts. Detailed cross-sections were also taken along Van Buren Street and Yuma Road to assist with the structure and roadway designs.

3.5 Geotechnical Investigation

A geotechnical investigation was conducted by ATL, Inc. to identify soil properties along the project corridor and at the proposed structure locations. A Geotechnical Report was submitted as part of the Design Concept. The investigations determined that the soils along the proposed channel have plasticities from 5-15, with the exception of a very small segment near Lower Buckeye Parkway that exhibited no plasticity.

ATL, Inc. has performed detailed soil/geotechnical analysis for the project in a *Geotechnical Investigation Report*, dated July 26, 2002. ATL recommends that the *Uniform Standards Specifications for Public Works Construction by the Maricopa Association of Governments (MAG)* 1997 (including revisions through 2001) be generally used as a guideline. Areas not addressed by the MAG specifications and areas where the Engineer suggests a deviation is presented in the report for the following activity/elements:

- Structural Excavation and Backfill
- Borrow
- Aggregate Base Course
- Placement and Compaction
- Portland Cement Concrete
- Shotcrete
- Riprap

4.0 BASIS OF DESIGN

4.1 Project Needs Assessment

A Project Needs Assessment Meeting was held on July 1, 2002 at the City of Goodyear. Those in attendance included members of the design team and City of Goodyear staff. The purpose of this meeting was to explore the City of Goodyear's needs, in both channel design and recreational opportunities, for Bullard Wash Channel.

Elements and needs discussed included the following:

- Development of 'Urban Plazas'
- Incorporation of drinking fountains, benches, and restrooms
- Rest Areas
- Ramada Structures
- Large turf open space
- Exercise Stations
- Park Signage
- Vehicle Parking
- Security Lighting and Node Lighting
- Incorporation of low flow channel as an element
- Development of multi-use trails
- Separate bicyclists, pedestrians, and equestrians on trails
- Maintenance of low flow channel (silt/debris removal)
- Varying channel side slopes (6:1 to 12:1; 4:1 slope in very tight areas only)
- Horseshoe Pits
- Basketball and Tennis Courts, Ball Fields
- Connections to adjacent residential and commercial properties
- Skate Park
- Development of community/neighborhood park areas within channel
- Play structures

These elements were then individually ranked and placed in one or more classification levels. The development rankings are shown on Table I – Landscape Design Criteria in Appendix A.

4.2 Design Criteria

The criteria for the incorporated design elements are shown on Table II – Design Criteria in Appendix A. These criteria are the standards that have been used for the design up to this point and they may be updated as more detail becomes available as the project proceeds.

4.3 Public Participation

Public participation is an important part of the project. Much public input has been obtained through the development of the District's *Loop 303 Corridor/White Tanks Area Drainage Master Plan* and the City's *Parks, Trails, and Open Space Master Plan.* A Project Aesthetics Advisory Committee (PAAC) has been formed with adjacent landowners, local officials, and design team members to review and provide recommendations for the project. The PAAC has met twice and has given direction to the consultant team regarding the design. Two work sessions have been conducted with the Goodyear City Council, during which the project was presented and comments were received from the Council. Two newsletter mailings and public meetings have been held and comments were received from the public.

5.0 HYDROLOGY

The basis for the project hydrology is the *Loop 303 Corridor/White Tanks Area Drainage Master Plan Update*: *Draft Existing Condition Hydrology* HEC-1 model. Accordingly, the project corridor will be designed for the 100-year flood peak of 3,200 cfs. This value is predetermined per the contract scope of work.

The Rational method was used to determine flow quantities for the design of side inlets for the offsite side local contributing sub-areas. The design is based on existing land use within the watershed. The design assumed that retention has been provided for the existing developed parcels based on City development requirements. The analysis and results are shown in Appendix B. The Rational Method was chosen because of the size of side contributing area and the urban nature of current and future land use.

6.0 DESIGN ELEMENTS

6.1 Right-of-Way and Easements

The right-of-way limits are shown on the plan sheets. Right-of-way has already been dedicated adjacent to the Rancho Mirage subdivision and for a portion of the Centerra residential subdivision. A goal of the project is for the right-of-way to be dedicated by the adjacent property owners.

6.1.1 Alignment Comparison and Widths

In general, the alignment of the proposed channel follows the floodway. In two locations, the alignment has been moved away from the floodway to avoid bisecting existing parcels. This has been done through property owned by Snyder's of Hanover, Southwest Specialty Foods, Bruce Hilby, and Coit Hughes.

It is recommended that right-of-way be obtained according to the locations shown on the plans for the construction of this project. The right-of-way identified will provide sufficient area for the project hydraulic aesthetic and multi-use features identified in the Needs Assessment.

6.1.2 Easements

Drainage Easements have been identified on the plans for side inlets. Temporary Construction Easements (TCE) have been identified for the construction of farm roads adjacent to the channel and low areas along the channel corridor that will require earth fill to provide positive drainage to the channel from adjacent property. Easements will also be identified in the Yuma Road and Van Buren Street projects to accommodate the proposed interim paving design.

6.2 Channel Design

6.2.1 Hydraulic Design

The flood control channel will be designed with three hydraulic functions. The main channel facility will contain the 100-year storm flow. Within the main channel, a low-flow area will carry runoff from higher-frequency, lower-flow events to minimize frequent flood damage and related maintenance of the upper terraces within the main channel. These terraces might contain practice fields,

playgrounds, and picnic areas. The third hydraulic function is an irrigation tailwater swale, which will meander through the low-flow area.

6.2.1.1 Manning's n-value

Subsequent to the 30% submittal, a significant amount of effort was expended before the design team was able to arrive at a consensus for the channel's Manning's n-values. A sample plan (sheet L01) of the 30% submittal package was determined by the District to have a Manning's n-value of 0.032. The District concurred with the number of additional trees that would be required to increase the Manning's n-value to 0.036 and the tree density in the channel was increased accordingly. The following is a summary of the values used in the Hydraulic Analyses:

COMPONENT	LOCATION	MATERIAL	MANNING'S 'n'
Drop Structure	South of I-10	Gabions	0.035
Channel (greenbelt)	I-10 toVan Buren St. Van Buren to Yuma Rd.	Turf, trees	0.036
Channel Lining	Van Buren Street and Yuma Road Bridges	Roughened concrete	0.02
Channel (modified greenbelt)	Yuma Road to Phase I Channel	Turf, trees	0.033 (channel) 0.027 (overbank)
Box culvert (future)	Lower Buckeye Pkwy	Concrete	0.025
Drop Structure	Phase I connection	Gabions	0.03
Tailwater Swale	Entire Alignment	Concrete (heavy broom finish or impressed cobble texture)	0.025

During the establishment phase for the landscaping, after construction, when the trees and shrubs are not established, an "Initial condition" Manning's n-value of 0.029 will be used to determine the effect on the Velocity Distribution. In addition, the channel was analyzed using a "Neglected Condition" n-value of 0.055 to ensure the design flow would be contained even if channel maintenance were severely neglected. The

HEC-RAS calculations for the Ultimate, Initial and Neglected Conditions are shown in Section 2 of Appendix C.

Ongoing maintenance of the designed or recommended drainage systems is required to preserve the integrity and purpose of the drainage system. Failure to provide maintenance can prevent the drainage system from performing to its intended design purpose and can result in reduced performance. Maintenance within the public right-of-way is the responsibility of the City of Goodyear. A regular maintenance program is required to have drainage systems perform to the level of protection or services as presented in this report and projects' plans and specifications.

6.2.1.2 Allowable Velocity

The allowable velocity for the composite channel section will depend on the individual treatment components. The maximum allowable velocities for different channel linings are shown below:

Lining	Maximum Allowable Velocity
Turf	6.0 ft/s
Desert Landscaping	3.5 ft/s
Concrete	15.0 ft/s

The design velocities in the channel have been analyzed at different sections to ensure that the maximum allowable velocities are not violated for the different linings along the channel section.

It should be noted that the velocity of stormwater that is above turf, immediately adjacent to the concrete-lined tailwater swale, could be greater than 6.0 ft/s. Refer to Section 1 of Appendix C for further discussion on the maximum allowable velocity.

6.2.1.3 Minimum Hydraulic Sections

The channel between I-10 and Yuma road will be turf-lined for the entire flow area of the 100-year flood. Above the flood high water mark, the

channel will be either turf-lined or desert landscaped. The channel south of Yuma Road will have a 4.5-foot deep turf-lined channel that carries the majority of the 100-year flow with desert landscaping above this depth.

The minimum hydraulic sections developed in the design have been adjusted to incorporate a low-flow channel in the section north of Yuma Road and to reflect the use of a 4.5-foot deep turf-lined channel south of Yuma Road. The geometry of the low-flow channel, tailwater swale, and main channel for both treatments are identified in the Design Criteria Table in Appendix A and are shown on the plans.

The minimum hydraulic sections for each treatment will be adjusted to include aesthetic features, such as slope warping, top and toe of channel meandering, terracing, benching, and mounds. These features will give the channel a more natural appearance and will result in a more pleasing facility. A minimum 300 feet of right-of-way is needed for the hydraulic and aesthetic features needed for the channel. This width allows for slope warping, benching, terraces, and mounds. This width also considers the City's initial vision of the open space corridor.

6.2.1.4 HEC-RAS Analysis

A hydraulic model has been created based on the channel geometry shown on the 100% plans. The HEC-RAS hydraulic analysis of this model is shown in Section 2 of Appendix C. Three runs were made to determine hydraulics for the phase immediately following construction when only the turf is established "Initial Condition", for the established vegetation phase "Ultimate Condition" and for a neglected maintenance scenario "Neglected Condition". The models include bridge structures at Yuma Road and Van Buren Street and a future box culvert at Lower Buckeye Road. Printout and digital files from these three models are included in Appendix C, Section 2.

6.2.1.5 Channel Freeboard

The flow regime for the proposed channel with the design flow is sub critical. Channel freeboard requirements are based on FCDMC requirements of $0.25(Y+v^2/2g)$ or 1' minimum. Verification of freeboard requirements is shown in Appendix A, Table III – Freeboard Requirements.

6.2.2 Tailwater Swale

The tailwater swale will be constructed with a heavy broom finish or with an impressed cobble texture (allowance item) to increase the Manning's roughness value to 0.025, which will reduce velocities. With a minimum longitudinal slope of 0.2% in a 9-foot wide u-channel flowing at the full 9-inch depth, the channel has a capacity of 13cfs. Since the actual tailwater flow is unknown and will diminish as development occurs in the upstream watershed, the design team has agreed that this design is reasonable. Tailwater swale hydraulics is shown in Section 3 of Appendix C. The concrete tailwater swale is also structurally designed with a safety factor of 1.5 to prevent buoyancy.

6.2.3 Drop Structure Analysis and Design

A 7-foot grade differential is required to tie the proposed channel invert into the existing wash invert at the end of project just south of the I-10 crossing. For this purpose, a drop structure is proposed at this location. This structure will be an interim facility since Bullard Wash will ultimately be channelized to the north at which time this structure will be removed. The drop geometry is shown on the plans and details. Drop hydraulic analysis is shown in Section 4 of Appendix C.

A second one-foot drop occurs in the channel north of Lower Buckeye Road alignment. This will also be an interim facility since Lower Buckeye Parkway will ultimately be extended across the wash corridor at which time it is intended that the drop will be incorporated into the box culvert at the crossing.

6.2.4 Transitions

Concrete transitions will be located at both bridge crossings and at the tie-in to the existing downstream-channelized section at the downstream end of the

project. A layout of these transitions is shown on the plans. Transitions have been incorporated in the hydraulic model to ensure smooth hydraulic operation. Erosion protection including loose riprap upstream of the I-10 drop and concrete channel lining with cut-off walls at each bridge and at the transition to the existing channelized reach at the downstream end of the project has been provided as needed to resist local erosive forces created at transition areas.

6.2.5 Side Inlet Design

Local inflow will be accommodated using side inlets with a drop inlet and culverts and outlet headwalls into the channel. The locations of the side inlets are shown on the plans and require Temporary Construction Easements (TCE) and Drainage Easements (DE). The number of pipes required at each location is determined by normal depth calculations based on the local hydrology. The inlet requirements are summarized in Appendix B. Side inlet profiles are included in the design plans.

6.2.6 Roadway Drainage

The proposed interim roadway improvements are designed to provide the same level of service as currently exists, one lane in each direction. In the interim condition, roadway drainage will be directed to area drain inlets and conveyed by culverts into the channel. It is anticipated that in the ultimate condition a storm drain system will be incorporated into the roadway plans

6.3 Earthwork

The grading concept for Bullard Wash channel includes varying side slopes (4:1 to 12:1), terracing, varying channel width, earth contouring and mounds at the top of the channel, and a meandering low flow channel. The careful integration of these elements will insure a channel that does not have a linear or "engineered" look, thus creating a park-like, or natural character. These techniques will allow the channel to function hydraulically, and yet provide a space for park activities for people to visit and enjoy.

Additional earthwork will be performed to provide positive drainage from the area adjacent to the wash corridor, which will be filled to remove low areas which are now in the floodplain. These areas include property owned by Snyder's of Hanover, Southwest

Specialty Foods, Bruce Hilby, and Coit Hughes. Temporary construction easements are shown on the plans where fills will be placed in these areas.

As shown in the 100% Opinion of Probable Cost, there is a considerable amount of excavation required for the project. This material can be stockpiled north of I-10 in the District's detention ponds, for use on other projects. Adjacent landowners may also have interest in pre-excavating the channel to obtain material for their site grading. The City will need to monitor any pre-excavation allowed in order to ensure that fill requirements for the Yuma Road and Van Buren Street improvements can be met.

6.4 Structure Design

6.4.1 Structure Selection Report

A Structure Selection Report (SSR) was prepared as part of the design concept submittal. This report analyzed three types of bridge structures at the Van Buren Street and Yuma Road crossings of Bullard Wash. The following lists the analyzed options:

1. Pre-stressed Voided Slab Bridge
2. Type III AASHTO Girder Bridge
3. Cast-in-Place Concrete Slab Bridge

Based on the comparison of above options in the revisions to the Structure Selection Report, the cast-in-place, concrete slab bridge was the most efficient structure type for these crossings. This conclusion was based on several parameters, including cost, aesthetics and construction procedures, and their relative importance in determining the best possible structure type. This structure was recommended to the City and the recommendation was accepted.

The geometry of the bridge has been changed from the original SSR and is based on the SSR, Revision 2, dated December 2003, based on initial review comments from ADOT on the Preliminary Design Concept Report.

FHWA requires bridges that are receiving federal funding to be designed for the 500-year event. However, this channel has been designed with a stable bed based on allowable velocity approach, the flow is streamlined and is designed to stay in the channel, flow is coming from upstream of I-10 within the channel, the bridges are not skewed and concrete channel lining with cutoff walls upstream and downstream will be provided under the bridges. Wood/Patel has discussed this issue with ADOT (Dennis Crandall and Enamel Hoque) and they concur that, as far as scour is concerned, if there is lining under the bridge and upstream and downstream cutoff walls have been provided to meet long term degradation requirements, bridge abutment and pier scour, in this situation, is not an issue. Therefore, the bridge abutments will be constructed on spread footings.

The City currently has federal funding in place for the Yuma Road Bridge and will be submitting a Federal funding application to Maricopa Association of Governments (MAG) for the Van Buren Street Bridge by the September 2004 deadline. The Design Concept Reports for each of these bridges has been submitted to ADOT for review.

Since ADOT will be the review agency for the bridge and roadway improvements, the projects will follow their schedule. This design and review time does not correspond with the Channel Improvement's current schedule. Therefore, the bridges and roadway plans have been separated from the channel plans. Once the Design Concept Reports for the bridges have been approved, the bridge and roadway plans will be converted to ADOT format. Separate plan sets and construction documents will be prepared for each bridge.

6.5 Roadway Design

Due to the profile of the proposed bridges at Van Buren Street and Yuma Road, these roadways will require improvements to tie into the existing profile. The roadway design assumes a minimum longitudinal slope of 0.25%. This was chosen as the absolute minimum because the road will have asphalt pavement. The design also assumes positive drainage towards low points at the end of the bridge approach slabs. AASHTO guidelines were followed regarding sight distances, striping requirements, and travel lane tapers.

6.6 Traffic Control

Roadway closures will be permitted for construction of the bridges. However, closure of only one arterial roadway will be permitted at any given time. The contractor shall be responsible for providing bypass lanes if necessary in order to make the road available to local traffic.

6.7 Utility Design

Several utilities are crossed by the project, as discussed in Section 3.2.4. Preliminary analysis, using record drawings, electronically traced locations and pothole information, shows that no loops will be required for water or return effluent lines. The location of the utilities according to surveyed manholes and tracing information and potholing data is shown on the plans.

6.8 Landscaping/Irrigation

6.8.1 Landscape Concept

The landscape concept for Bullard Wash has been identified and consists of planting predominantly turf from I-10 to Yuma Road and a combination of turf and native plantings from Yuma Road to the south end of the project.

From I-10 to Yuma Road, turf is the dominant landscape material. Turf is located throughout the bottom of the channel, up the channel side slopes, and in places at the top of the channel. The multi-use concrete path and concrete headers define the meandering turf edges. Canopy trees are located within the turf areas and along the multi-use path. These trees provide valuable shade for the park users. A combination of trees and shrubs are planted within decomposed granite areas along the top of the channel.

Within the project, three neighborhood park areas will be created between I-10 and Yuma Road on the west side of the channel. Elements of these neighborhood parks will ultimately include parking for eight to twelve vehicles, play structures, basketball courts, sand volleyball courts, ramada structures, and turf open space areas.

The side slopes of the channel vary from 4:1 to 12:1 throughout this stretch. Terraces have been created within the channel providing open space opportunities for multi-use recreation.

South of Yuma Road, the channel is comprised of turf in the bottom four and one half feet of the channel and native plantings on the upper side slopes and top of channel. Turf extends a minimum of four and one half feet up the channel side slope from the channel bottom. Slopes vary in this stretch of the channel, but not to the same extent as those found from I-10 to Yuma Road.

Provisions for earth contouring/berming, a multi-use path, operations and maintenance paths, and various landscape amenities have been incorporated into the channel design.

Earth contouring/berming occurs at the top of the channel for the entire length of the channel. The berms vary in height from one foot to three feet and occur in both turf and decomposed granite areas.

A 10-foot concrete multi-use path meanders throughout the channel. It is primarily located in the bottom of the channel with provisions to connect at various access points at the top of the channel. The multi-use path crosses a meandering tailwater swale located at the bottom of the channel a number of times. A bridged crossing including handrails has been incorporated at those crossing locations.

A meandering 14-foot, all-weather surface, maintenance path is located at the top of the channel on both sides. The maintenance path is widened to 20 feet at approximately 300' intervals for emergency vehicles to pass. The operation and maintenance path located on the east side of the channel would double as an equestrian trail.

Access point/rest areas have been identified at various locations along each side of the channel but will not be constructed with this project. Access points allow

residents, as well as employees in the adjacent businesses, to access the channel. Elements of the access points/rest areas include seating and shade.

6.8.2 Irrigation

Irrigation for Bullard Wash would be a combination of spray and drip irrigation. At this time, it is anticipated that the existing Centerra well located ¼ mile west of the channel on the south side of Van Buren Street will provide irrigation water for the project.

The irrigation design includes a gravity supply line from the Centerra well to storage/distribution points within the project. For the Yuma Road to Lower Buckeye Road reach, the irrigation supply line will extend from the well site to the southwest corner of Yuma Road and Bullard Wash. Underground storage tanks will be constructed to at this point and will be utilized when the automatic irrigation system starts delivery. Radio telemetry will be provided at the storage tanks and at the well site to automatically turn the well on when watering begins and to turn the well off once watering ends and the storage tanks have refilled.

For the Van Buren Street to Yuma Road reach, the telemetry will be moved to the underground storage tanks at the southwest corner of Van Buren Street and Bullard Wash. Currently, there is not a pump located at the well site. The design for this system is based on direction from the City that a working well will be in place to provided water for irrigation at a rate of 2,000 gallons per minute. It is estimated that the irrigation requirements for this project, I-10 to Lower Buckeye Road, will be approximately 1,000,000 gallons per day. This would require the well to run approximately 8.3 hours per day. Watering would occur during nighttime hours.

There is a possibility that pressurized water line stub outs will be provided to the project at both Van Buren Street and Yuma Road. If this occurs, a redesign of the irrigation supply system would be required.

There is also a possibility that effluent water could be used in the future as a source of irrigation. Therefore, the system will be designed for a non-potable

water supply. Once constructed, all irrigation and landscaping will be maintained by the City of Goodyear.

6.8.3 Themes

Two themes will be incorporated into the wash: agricultural and aeronautical. The agricultural theme will be incorporated primarily through the use of plant material. Plantings will be arranged to mimic the surrounding orchards and fields by having the plantings in rows or blocks. This type of planting will occur throughout the entire length of the channel. The agricultural theme will also be integrated into the three neighborhood park areas. The various play structures, shade elements, etc. will reflect elements found on a farm.

The aeronautical theme will occur predominantly south of Yuma Road and will relate to the adjacent Phoenix-Goodyear Airport. Elements and materials that represent the airport will be incorporated into signage, ramada structures, seating elements, etc.

6.9 Flood Response Plan

Flood response and other public safety issues must be considered at all stages of design. It is important to avoid locating recreational facilities at points of concentrated flow for more frequent conditions, accommodate emergency management and response activities, and address specific hazards at individual locations along the channel corridor. Specific public safety elements for the park in Bullard Wash Channel are summarized below.

6.9.1 Public Recreational Facilities Design

- Include signage of flood hazards where park amenities are constructed within the corridor and at all access points.
- Use benched or terraced recreational areas and keep active recreation on the upper terraces. If access is encouraged within the low-flow drainage path, allow passive recreation only.
- Locate structures and parking lots above the regulatory (100-year) flood elevation. If structural components for recreational facilities are needed within the regulatory floodplain, require that they be secured.
- Disallow any recreation (active or passive) within the tailwater swale.

- Provide periodic/frequent structural access across the tailwater swale.
- Provide safety lighting at bridges.
- Review of anticipated traffic patterns within the channel corridor, particularly the park facility. Eliminate potential risks such as fast-moving bicycles or roller blades immediately adjacent to play or other active recreation areas.
- Evaluate water quality considerations of the tailwater swale.

6.9.2 Flood Control Facilities Design

Because of the meandering, non-uniform layout of the park, channel sideslopes will vary. If steep slopes or vertical walls are used in any locations, the opposite sideslope must allow egress from the channel.

The drop structure proposed at the north end of the project just south of Interstate 10 public access to this location will be prohibited. In addition, right-of-way fencing issues are addressed from hydraulic, safety, and access perspectives.

Safety lighting will be provided upstream and downstream of the Yuma Road and Van Buren Street Bridges.

6.9.3 Flood Threat Recognition

It is anticipated that the District will monitor storm conditions and notify the City of potential flood threat to the Bullard Wash Channel. Flood threat notification will be broken down into several levels of certainty/severity. Available lead-time for each level will vary accordingly.

No real-time precipitation or stage gages are currently located within the upstream drainage area contributing to the proposed Bullard Wash Channel. Lead-time needs are being evaluated with City staff. It is anticipated that a new precipitation/stage gage will be recommended near Indian School Road and Wigwam Boulevard. In addition, a new precipitation gage near Camelback Road and Cotton Lane is anticipated. Data from these new gages and surrounding existing gages will be used as thresholds for activating the Flood Response Plan.

The City's police dispatch coordinates all local emergencies; therefore, dispatch will be the District's point of contact for a flood emergency in the park.

6.9.4 Emergency Management and Response

The Flood Response Plan will be incorporated into the City's existing Emergency Action Plan. City police intend to monitor the channel corridor and park daily for broader public safety concerns and this monitoring will be incorporated into the Flood Response Plan.

It is important to include access points for routine monitoring and emergency response activities. The following needs have been discussed with the City:

- Access points must be large enough for emergency vehicles and related equipment to enter and exit the area. Parking lots envisioned near the existing arterial streets could provide access and would be located near areas of concentrated recreational activity.
- The park's maintenance road will be used for routine monitoring and emergency response. The roadway width and surface need to accommodate the City's fire trucks.
- The City's fire trucks cannot drive off-road. Therefore, access must be from the maintenance road or at periodic adjacent access locations. Additionally, the trucks need access to the park from the arterial streets and not through the equestrian routes under the bridges.
- The maintenance road needs to allow periodic passing lanes for response vehicles or periodic backing lanes.
- Access to both sides of the channel needs to be included to avoid delays in responding to an emergency.
- Access gates to the maintenance road are preferred over bollards.

6.9.5 Requirements for Adjacent Development

The development review process should be modified to include an itemized review of public safety. The review could include items such as the effects of local surface or underground conduit drainage on park functions, emergency vehicular access to the park, and lighting needs.

7.0 ENGINEER'S OPINION OF PROBABLE COSTS

Preliminary bid quantities and an engineer's opinion of probable costs are included under separate cover.

8.0 CONCLUSIONS & RECOMMENDATIONS

With the alignment and geometry of the channel established, right-of-way acquisition should be pursued in earnest.

The improvement plans and construction documents are prepared in FCDMC format from Interstate 10 to the existing channel improvements north of Lower Buckeye Road. Plans for Van Buren Street Bridge and Yuma Road Bridge will be performed per ADOT requirements.

Ongoing maintenance is required for all drainage systems in order to assure design performance.

The City will ultimately be responsible for maintenance and safety of the project. The City will need to closely monitor adjacent development to ensure that the theme and viability of this project is not compromised.

The city will need to monitor the pre-excavation allowable in order to ensure that fill requirements for the Yuma Road and Van Buren Street improvements can be met.

APPENDIX A

Design Criteria

Table I: Landscape Design Criteria

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

I-10 to Yuma Road

Flood Control / Superstructure Components	Dev. Ranking	Feature	Design Criteria
Grading Elements - Berm	1	Loosely shaped, designed as integral part of channel, occur at top of slope	Height dependant upon area (Min. 18", Max. 4', Length varies based on location
Terrace	1	Large open space designed as integral part of channel, potential locations for volleyball and basketball courts and other recreational activities	A terrace is required at top of low flow. Terraces may be located between this and the 100-year flow elevation and at 100-year flow elevation. The overall size is dependant upon area available.
Side Slope	1	warping effect	Varies throughout channel 6:1 to 12:1; 4:1 in select locations for transitions
Hard Elements - Walls, Drop Structures, Head Walls, Bridge Structure, Box Culvert,	1	Elements designed as integral components of the channel	Materials would be consistent with other features located within the channel; concrete would be stained or painted, form liners potentially used to provide texture
Low Flow Channel *	1	Meandering and varying width	Side slopes vary 4:1 to 8:1, width dependant on anticipated flow, lined with maintained turf.
Tailwater Swale **	1	Meanders through low flow channel	Stained and/or molded concrete with boulder features at path crossings
Fundamental Planting (Landscape material possible with $40,000/acre limit)	1	Predominantly turf throughout channel; higher density of trees and shrubs at top of channel and key locations such as park nodes, access points, rest areas; groupings of trees throughout channel; lesser density of trees and shrubs between key locations	Turf elevation within channel to be minimally to 100-year event; edge of turf to meander
Operations & Maintenance Road	1	Meanders along top of channel; located on both sides of channel; doubles as equestrian multi-use path on east bank and multi-use path on west bank	See Table II
Multi-Use Elements	**Dev. Ranking**	**Feature**	**Design Criteria**
Multi-Use paths	1	Located in top and throughout bottom with a continuous hard surfaced bottom path, a continuous hard surfaced west O&M road that doubles as a multi-use path and an all weather east O&M road that doubles as a path.	10' minimum width; 8' minimum height clearance; 2' edge of path clearance; low flow crossings; all weather surface, crosses under roadway bridges and connects to cross streets
Park Signage (Minimal)	1	located at entry points and select locations; directional and informational (park rules)	Entry signage materials consistent with theme and adjacent area; informational signage to be metal, signage would incorporate park logo and name
Connections to Adjacent Properties/Developments	1	Provided at residential and business developments; level of development varies from rest area/secondary access points to park node	Refer to rest area/secondary access point and park node descriptions
Staging Facility for Equestrians	4	Potentially on southend of project. A place to park and prepare to ride a horse.	Large parking area with minimal features and access to the equestrian trail. Will be planned at a later date.
Restrooms	2	Located at major entries Gerber feeder for equestrians off restroom	Plan location and provide conduit

Table I: Landscape Design Criteria

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

I-10 to Yuma Road			
Multi-Use Elements (Cont.)	**Dev. Ranking**	**Feature**	**Design Criteria**
Rest Areas/Secondary Access Points	2	Occur approximately every 1/3 mile along main multi-use path; provides shade and a place to rest	Approx. 1,400 ft. in size; contains a 12' x 12' ramada structure; 2 benches; 1 trash receptacle; 1 bike rack; shade trees, drinking fountain; not gated by project; ADA compliant; located adjacent to path; constructed of integrally-colored concrete
Primary Park Entry (Plaza at Yuma Road)	2	Outdoor plaza space, entry feature element, vehicle parking	See descriptions of individual elements (Urban Plaza, Park Signage, Parking)
(Areas near Centerra, Rancho Mirage and Van Buren Street)	1,2	Sport court, ramada structure, horseshoe pit, exercise station, play structure vehicle parking	See descriptions of individual elements
Drinking Fountains	1	located at entry points and rest areas	Catalogue item; ADA compliant; chilled water provided
Benches / Seat Walls	1 Entry Only 2 Elsewhere	Located at rest areas, entry points, park nodes, urban plaza	Varying lengths, 6' minimum; benches to be catalogue item, seat walls either CMU or cast-in-place concrete; colors and textures to blend with adjacent area
Ramada Structure	2	Located at entry points, park nodes, rest areas; provides shade and place to gather	Sizes will vary depending on area; style of ramadas to compliment adjacent developments and theme of area; Catalogue item
Urban Plaza Grading for Urban Plaza (Amphitheater)	2 1	Incorporated into main entry to channel at Yuma Road and Bullard Wash on both sides of channel, primarily within R/W utilizing paved areas and grass terraces; open space for festivals etc.; shade provided by a combination of structures and trees, various hardscape surfaces	Formal layout; ADA compliant; spaces for various civic and recreational functions such as art & craft fairs, councerts, farmer's markets, puppet shows, group picnics, scouting events, cultural festivals and school events. Approximate area = 60,000 sf. Turf area = approx. 50,000 sf.
Exercise Stations	2	Located adjacent to Multi-Use path throughout channel	Catalogue Item, leave flat area
Park Signage (Complete)	2	Located throughout channel; directional, informational, and interpretive	Materials would be consistent with theme and adjacent area
Vehicle Parking	2, 4	Located at Yuma Road, Van Buren Street, and within developments	Accommodate approximately 10 vehicles; ADA compliant; asphalt surface, leave flat DG area in the first phase of construction.
Security Lighting (change order item)	1	Conduit along multi-use path, access points, under bridges, and in parking lots	Catalogue items; bollards along multi-use path; pole mounted in parking lots, extend conduits under bridges
Project Lighting	3	Beyond basic security lighting located in parking lots, entry points, rest areas, paths, and park nodes.	Pedestrian Scale Lighting for path and amenities. Extra parking Lot lighting for parking areas.
Conduit System	1	Providing utility conduit for future restrooms, water fountains, lighting, etc.	Amenity sites will need to be pre-determined. Locate close to entry points to eliminate long runs
Horseshoe Pits	3	Located at park nodes	Regulation size and materials, leave flat area in the first phase of construction.
Sport Courts	2	Located at entry nodes and select park nodes; courts to be provided include basketball, tennis, and volleyball	Courts would be regulation size; surface would be concrete for basketball and tennis, sand for volleyball, Leave flat area in the first phase of construction.
Ball Fields (practice)	2	Large turf areas for soccer and softball practice	Designed to minimum regulation size
Park Node	2	Active area; access point to channel	Tot lot; shade provided by structures and vegetation; ball courts provided at some locations; size of node varies
Play Structures	2	Located at park nodes	Catalogue Item; ADA compliant
Skate Park	4		Located off-site

Table I: Landscape Design Criteria

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

Yuma Road to Existing Channel			
Flood Control / Superstructure Components	**Dev. Ranking**	**Feature**	**Design Criteria**
Grading Elements - Berm	1	Loosely shaped, designed as integral part of channel, occur at top of slope	Height dependant upon area (Min. 18", Max. 4', Length varies based on location
Side Slope	1	warping effect	Varies throughout channel 6:1 to 12:1; 4:1 in select locations
Hard Elements - Walls, Drop Structures, Head Walls, Bridge Structure, Box Culvert,	1	Elements designed as integral components of the channel; materials would be consistent with other features located within the channel	Materials would be consistent with other features located within the channel; concrete when used would be stained, painted, and/or formed
Low Flow Channel *	1	Meandering	4:1 side slopes, consistent width less frequent maintainence of turf.
Tailwater Swale **	1	Meanders through low flow channel	Stained and/or molded concrete with boulder features at path crossings
Fundamental Planting	1	Predominantly native plantings throughout channel with turf located in bottom and sides of low-flow channel; plantings used for erosion control on slopes and screening views	Higher density of trees and shrubs at at key locations such as park nodes, access points, rest areas; turf located in bottom and sides of low-flow channel
Operations & Maintenance Road	1	Meanders along top of channel; located on both sides of channel; doubles as equestrian multi-use path on east bank and multi-use path on west bank	See Table II
Multi-Use Elements	**Dev. Ranking**	**Feature**	**Design Criteria**
Multi-Use paths	1	Located in top and throughout bottom with a continuous hard surfaced bottom path, a continuous hard surfaced west O&M road that doubles as a multi-use path and an all weather east O&M road that doubles as a path.	10' minimum width; 8' minimum height clearance; 2' edge of path clearance; low flow crossings; all weather surface, crosses under roadway bridges and connects to cross streets
Park Signage (Minimal)	1	Located at entry points and select locations; Directional and informational (park rules)	Entry signage materials consistent with theme and adjacent area; informational signage to be metal
Connections to Adjacent Properties/Developments	1	Provided at business developments	Refer to rest areas/secondary access points description
Rest Areas/Secondary Access Points	1	Occur approximately every 1/3 mile along main multi-use path; provides shade and a place to rest	Approx. 1,400 ft. in size; contains a 12' x 12' ramada structure; 2 benches; 1 trash receptacle; 1 bike rack; shade trees; drinking fountain; not gated by project; ADA compliant; located adjacent to path; constructed of integrally-colored concrete
Drinking Fountains	1	Predominantly located at entry points and rest areas	Catalogue item; ADA compliant; chilled water provided
Benches / Seat Walls	1 Entry Only 2 Elsewhere	Located at rest areas, entry points	Varying lengths, 6' minimum; benches to be catalogue item, seat walls either CMU or cast-in-place concrete; colors and textures to blend with adjacent area
Ramada Structure	2	Located at entry points, rest areas	Sizes will vary depending on area; style of ramadas to compliment adjacent developments and theme of area; Catalogue item or modified catalogue item

Table I: Landscape Design Criteria

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

Yuma Road to Phase I Channel			
Multi-Use Elements (Cont.)	**Dev. Ranking**	**Feature**	**Design Criteria**
Exercise Stations	2	Located adjacent to Multi-Use path throughout channel	Catalogue Item; leave flat area in the first phase of construction.
Park Signage (Complete)	2	Located throughout channel; directional, informational, and interpretive	Materials would be consistent with theme and adjacent area
Vehicle Parking	4	Located at Lower Buckeye Road, west side of channel	ADA compliant; asphalt surface; leave flat DG area in the first phase of construction
Security Lighting (change order item)	1	Conduit along multi-use path, access points, under bridges, and in parking lot	Catalogue items; bollards along multi-use path; pole mounted in parking lots; combination at access points; extend conduit under bridges
Horseshoe Pits	3	Located at break area	Regulation size and materials, leave flat area in Phase I
Project Lighting	3	Beyond basic security lighting located in parking lots, entry points, rest areas, paths, and park nodes.	Pedestrian Scale Lighting for path and amenities. Extra parking Lot lighting for parking areas.
Conduit System	1	Providing utility conduit for future restrooms, water fountains, lighting, etc.	Amenity sites will need to be pre-determined. Locate close to entry points to eliminate long runs.
Staging Facility for Equestrians	4	Potentially on southend of project. A place to park and prepare to ride a horse.	Large parking area with minimal features and access to the equestrian trail. Will be planned at a later date.
Restrooms	2	Located at major entries Gerber feeder for equestrians off restroom	Plan location and provide water service lines in the first phase of construction.

NOTES:

Level 1 - Provide in Current Construction Documents
Level 2 - Make accommodations in the Construction Documents for this item
Level 3 - Do not include in Construction Documents
Level 4 - Off-Site item not to be included in Construction Documents

* See Table II for design criteria of Low Flow Channel
** See Table II for design criteria of tailwater swale

Table II: Design Criteria

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

Feature	Element	Criterion	Source/Notes
Tailwater Swale	Depth:	9 inches	
	Max allowable flow depth:	18 inches	City of Goodyear (Needs Assessment meeting)
	Manning's n	0.025	Heavy broom-finish or impressed cobble texture
	Max side slope	vertical	
	Bottom width	9 feet	Changed from 12' to 9' June 18, '03
	Capacity	13+ cfs	Observed operating capacity of existing tailwater ditch downstream of this project.
Low Flow Channel	Depth	2.0 feet	
North of Yuma	Manning's n	0.036	
	Top width	40 - 80 feet	
	Capacity	±200 cfs	
Main Channel	Design flow	3,200 cfs	Scope
North of Yuma	Long. slope	0.002 – 0.0033 ft/ft	generally match existing slope
	Min. bottom width	192' - ½ (low flow top + low flow bottom widths)	
	Flow depth	5.5 feet	
	Manning's n	composite	0.036 design for turf, 0.038 max. for turf
	Required freeboard	varies	Drainage Design Manual – Vol. II, Hydraulics
	Max side slope	4:1	Note: 6:1 to 12:1 generally desired
	Max velocity	6.0 ft/s	Drainage Design Manual – Vol. II, Hydraulics
	Min. top width	178 feet at 100-yr WSE	Necessary for hydraulic conveyance
Main Channel	Design flow	3,200 cfs	Scope
South of Yuma	Long. slope	0.0033 ft/ft	Existing ground
	Flow depth	4.5 feet	
	Manning's n	composite	0.033 design for turf, 0.037 max. for turf
	Required freeboard	varies	Drainage Design Manual – Vol. II, Hydraulics
	Max side slope	4.5:1	Note: 6:1 to 12:1 generally desired
	Max velocity	6.0 ft/s	Drainage Design Manual – Vol. II, Hydraulics
	Top width	156 feet	
Maintenance Road	Number	2	one on east side, one on west side
	Width	14'	with 20' width at pullouts
	Pullout lane spacing	300 feet	both sides
	Surface west	ABC	All weather
	Surface east	Stabilized DG	All weather
	Vertical clearance	14'-6"	8.2.5.C.5
	Maximum grade	5%	ADA requirement - (8% for emergency vehicles in 8.2.5.C.7)
	Access restriction	Landscaping Design	Hide access through 12' path @ entrance and landscaping
Multi-Use Path	Width	10 feet	AASHTO Guide for the Development of Bicycle Facilities
	Surface	6" concrete	Saw-cut transverse joints
	Clearance	2' on either side	for max. grade of 6:1; 5' for steeper sides
	Vertical clearance	8', 10' through tunnel	
	Design speed	20 mph	for bicycles; higher for grades at 5%
	Min. radius of curvature	100 feet	for design speed of 20 mph
	Stopping sight distance	140 feet	longer for higher speeds
	Min. length of crest curve	218 feet	longer for higher speeds
	Lat. Clearance on curve	18 feet min.	at height of 28"; greater clearance req'd for higher speeds
	Cross slope	2%	min. for drainage, max. for ADA
	Center stripe	4" dashed yellow	solid if needed to restrict passing; to separate travel directions
	Tunnel approach length	140 feet	500' min. radius (required stopping sight distance)
Crossing Structure	Max skew	20°	
Path / Swale	Design load	Loaded dump truck	
crossing	Handrail height	Minimum 54"	AASHTO Guide for the Development of Bicycle Facilities
	Structure width	14 feet	includes 2' shoulders
	Swale width openings	9 feet	
	Swale height opening	9 inches	
	Top slab thickness	±8 inches	reinforced concrete

Table II: Design Criteria

Bullard Wash Channel Improvements

Interstate 10 to Lower Buckeye Road

Feature	Element	Criterion	Source/Notes
Bridge Structure Yuma Road	Span	106 feet	
	Piers	One center	
	Vertical clearance	10 feet (min)	
	Abutment foreslope	1.5:1	
	Specifications & details	ADOT	
	Abutments	Spread Footings	
Bridge Structure Van Buren Street	Span	106 feet	
	Piers	One center	
	Vertical clearance	10 feet (min)	
	Abutment foreslope	1.5:1	
	Specifications & details	ADOT	
	Abutments	Spread Footings	
Erosion Protection under Bridges	Thickness	6"	
	Toe down depth	4' US, 6' DS	
	Reinforcement	#4 @ 12" O.C. Each way	
Van Buren Street Arterial w/ bike lane	Traffic lanes	2 each way ultimate, construct one each way now, and accommodate widening	
	Right of way width	110 feet	
	Existing pavement	25 feet	
	Design speed	65 mph	AASHTO design speed 55 mph, conservative 65 mph used
	Trans. to wider pvmnt	5*design speed	Section 4.1.10.A
	Trans. to narrower	read section	Section 4.1.10.B
	Min. longitudinal slope	0.25%	Section 4.1.3.H.1 says 0.15%, MAG says 0.25% for asphalt
Yuma Road Major arterial w/ bike lane	Traffic lanes	3 each way ultimate, construct one each way now, and accommodate widening	
	Right of way width	150 feet	
	Existing pavement	25 feet	
	Design speed	65 mph	AASHTO design speed 55 mph, conservative 65 mph used
	Trans. to wider pvmnt	5*design speed	Section 4.1.10.A
	Trans. to narrower	read section	Section 4.1.10.B
	Min. longitudinal slope	0.25%	Section 4.1.3.H.1 says 0.15%, MAG says 0.25% for asphalt
Lower Buckeye Pkwy.	Traffic lanes	3 each way, only hydraulic modeling of this crossing	
	Right of way width	130 feet	
	Existing pavement	none	
	Culvert	8 - 10' x 6' Box Culverts	Culvert modeled for hydraulics. Culvert Const. by others (Future)
Plans	Scale	40 scale	Plan and Profile
		100 scale	Fill Areas
Hydraulic Modeling	Expansion ratio	2	Downstream - App. B of HEC-RAS Hydraulic Reference Manual
	Contraction ratio	1.9	Upstream - App. B of HEC-RAS Hydraulic Reference Manual
	Expansion coefficient	0.3	HEC-RAS defaults
	Contraction coefficient	0.1	HEC-RAS defaults

Table III: Freeboard Requirements

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

River Station	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Total (ft/s)	Froude # Channel	TOB Elev Provided	TOB Elev Required	Freeboard Required (ft)(a)	Freeboard Provided (ft)	Execss FB Provided (ft)
11100	3200	932.83	940.09	940.55	5.47	0.41	942.8	942.0	1.93	2.74	0.8
11200	3200	932.95	940.22	940.68	5.46	0.41	943.0	942.2	1.93	2.73	0.8
11300	3200	933.07	940.39	940.81	5.24	0.39	943.1	942.3	1.93	2.68	0.7
11425	3200	933.22	940.54	940.97	5.23	0.39	943.2	942.5	1.94	2.68	0.7
11550	3200	933.37	940.69	941.12	5.23	0.39	943.4	942.6	1.94	2.68	0.7
11735	3200	933.6	940.9	941.36	5.43	0.4	943.6	942.8	1.94	2.70	0.8
11883	3200	933.77	941.1	941.55	5.4	0.4	943.8	943.0	1.94	2.67	0.7
11932	3200	933.84	941.16	941.61	5.41	0.4	943.8	943.1	1.94	2.68	0.7
11943	3200	933.85	941.13	941.67	5.89	0.43	943.9	943.1	1.95	2.72	0.8
12195	3200	934.75	941.51	942.04	5.83	0.42	944.2	943.3	1.82	2.64	0.8
12197	3200	937.25	942.06	943.75	14	1.12	945.0	943.7	1.63	2.94	1.3
12209	3200	937.28	943.18	943.89	9.11	0.66	945.1	944.8	1.65	1.92	0.3
12220.5	3200	937.32	943.45	943.94	7.62	0.54	945.3	945.1	1.66	1.85	0.2
12315	3200	937.59	943.77	944.1	6.27	0.44	945.4	945.4	1.63	1.63	0.0
12508.7	3200	938.15	943.99	944.38	6.72	0.49	945.9	945.5	1.56	1.91	0.4
12708.5	3200	938.73	944.3	944.72	7.17	0.54	946.5	945.8	1.50	2.18	0.7
12908.8	3200	939.32	944.67	945.1	7.28	0.55	947.1	946.1	1.44	2.40	1.0
13095.9	3200	939.86	945	945.56	8.31	0.65	947.6	946.4	1.42	2.61	1.2
13294.6	3200	940.44	945.53	946.1	8.44	0.66	948.2	946.9	1.41	2.66	1.2
13494.6	3200	941.02	946.14	946.63	7.86	0.61	948.8	947.5	1.40	2.63	1.2
13694.6	3200	941.6	946.6	947.16	8.45	0.67	949.4	948.0	1.39	2.75	1.4
13894.6	3200	942.18	947.15	947.77	8.83	0.7	949.9	948.5	1.40	2.78	1.4
14096.5	3200	942.76	947.78	948.39	8.69	0.68	950.5	949.2	1.41	2.73	1.3
14298.9	3200	943.35	948.4	948.99	8.58	0.67	951.1	949.8	1.41	2.70	1.3
14391.42	3200	943.62	948.67	949.27	8.89	0.7	951.3	950.1	1.41	2.61	1.2
14461.42	Culvert										
14531.42	3200	944.02	950.42	950.68	5.38	0.37	952.1	952.1	1.66	1.68	0.0
14543	3200	944.06	950.41	950.7	6.06	0.42	952.1	952.1	1.66	1.69	0.0
14544	3200	945.06	950.23	950.78	8.28	0.64	952.8	951.7	1.43	2.58	1.1
14663.1	3200	945.4	950.65	951.08	7.31	0.56	953.2	952.1	1.42	2.50	1.1
14817.3	3200	945.85	950.93	951.51	8.43	0.66	953.6	952.3	1.41	2.67	1.3
14998	3200	946.37	951.49	952.06	8.45	0.66	954.1	952.9	1.42	2.63	1.2
15199.3	3200	946.96	952.06	952.63	8.4	0.66	954.7	953.5	1.42	2.65	1.2
15401.8	3200	947.54	952.62	953.2	8.59	0.67	955.3	954.0	1.42	2.67	1.3
15590.8	3200	948.09	953.15	953.74	8.54	0.67	955.8	954.6	1.41	2.69	1.3
15779.9	3200	948.64	953.7	954.28	8.53	0.67	956.4	955.1	1.41	2.69	1.3
15969	3200	949.19	954.26	954.85	8.54	0.67	956.9	955.7	1.41	2.68	1.3
16165.7	3200	949.76	954.85	955.43	8.5	0.66	957.5	956.3	1.42	2.66	1.2
16366.6	3200	950.45	955.42	956.04	8.84	0.7	958.2	956.8	1.40	2.78	1.4
16562.9	3200	950.91	956.1	956.58	7.85	0.61	958.7	957.5	1.42	2.56	1.1
16762.7	3200	951.49	956.55	957.14	8.57	0.67	959.2	958.0	1.41	2.69	1.3
16961.4	3200	952.06	957.18	957.65	7.53	0.59	959.8	958.6	1.40	2.63	1.2
17076.5	3200	952.39	957.37	957.99	8.79	0.69	960.1	958.8	1.40	2.77	1.4
17188	3200	952.72	957.73	958.33	8.71	0.69	960.5	959.1	1.40	2.74	1.3
17285	3200	953	957.92	958.71	9.45	0.75	960.8	959.3	1.43	2.83	1.4
17310	3200	953.07	957.42	959.23	10.85	1	962.8	959.0	1.54	5.40	3.9
17371.91	Bridge										
17434	3200	953.43	959.12	960.09	7.95	0.62	963.2	960.8	1.67	4.06	2.4
17459	3200	953.51	959.83	960.19	7.05	0.49	961.6	961.5	1.67	1.77	0.1
17545	3200	953.76	959.99	960.32	7.14	0.5	961.7	961.6	1.64	1.71	0.1
17644	3200	954.04	960.14	960.51	7.91	0.56	961.8	961.8	1.62	1.65	0.0
17826.9	3200	954.6	960.49	960.89	8.28	0.6	962.4	962.1	1.57	1.86	0.3
18029.7	3200	955.2	960.92	961.46	9.58	0.71	963.0	962.5	1.57	2.03	0.5
18226.7	3200	955.78	961.52	962.08	9.87	0.73	963.5	963.1	1.58	2.01	0.4
18424.2	3200	956.36	962.14	962.71	9.7	0.71	964.1	963.7	1.59	1.97	0.4

Table III: Freeboard Requirements

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

River Station	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Total (ft/s)	Froude # Channel	TOB Elev Provided	TOB Elev Required	Freeboard Required (ft)(a)	Freeboard Provided (ft)	Execss FB Provided (ft)
18623.3	3200	956.95	962.84	963.23	8.2	0.6	964.7	964.4	1.57	1.86	0.3
18821.3	3200	957.54	963.27	963.66	8.13	0.6	965.3	964.8	1.53	2.02	0.5
19017.6	3200	958.24	963.69	964.25	9.78	0.74	965.9	965.2	1.50	2.18	0.7
19205.1	3200	958.67	964.3	964.9	10.36	0.77	966.6	965.9	1.56	2.30	0.7
19400	3200	959.25	965.04	965.57	9.76	0.72	967.2	966.6	1.58	2.16	0.6
19602.6	3200	959.85	965.71	966.15	8.7	0.63	967.7	967.3	1.57	1.99	0.4
19790.8	3200	960.4	966.19	966.57	8.07	0.59	968.2	967.7	1.54	1.96	0.4
19974.5	3200	961.07	966.61	966.98	8.41	0.63	968.8	968.1	1.48	2.21	0.7
20164.2	3200	961.51	967.09	967.43	8.16	0.61	969.3	968.6	1.48	2.17	0.7
20341.9	3200	962.03	967.47	967.9	8.68	0.66	969.8	968.9	1.47	2.31	0.8
20524.1	3200	962.57	967.89	968.64	11.42	0.87	970.3	969.4	1.52	2.43	0.9
20718	3200	963.14	968.84	969.49	10.76	0.79	970.9	970.4	1.59	2.05	0.5
20918.4	3200	963.74	969.63	970.19	9.7	0.7	971.5	971.2	1.61	1.86	0.2
21118.3	3200	964.33	970.29	970.73	8.61	0.62	972.1	971.9	1.60	1.79	0.2
21318.7	3200	964.92	970.8	971.17	7.86	0.57	972.7	972.4	1.56	1.87	0.3
21517.7	3200	965.51	971.2	971.66	9.02	0.67	973.3	972.7	1.54	2.06	0.5
21718.5	3200	966.1	971.71	972.37	10.66	0.79	973.9	973.3	1.57	2.14	0.6
21911	3200	966.67	972.54	973.03	9.44	0.69	974.4	974.1	1.59	1.88	0.3
22102	3200	967.24	973.13	973.54	8.57	0.62	975.0	974.7	1.57	1.86	0.3
22300.9	3200	967.82	973.61	974.01	8.41	0.62	975.6	975.2	1.55	1.96	0.4
22496.6	3200	968.4	974.05	974.49	8.51	0.63	976.2	975.6	1.52	2.10	0.6
22611	3200	968.72	974.28	974.83	9.2	0.69	976.5	975.8	1.53	2.19	0.7
22705	3200	969	974.55	975.09	8.66	0.65	976.8	976.1	1.52	2.20	0.7
22728.93	3200	969.07	973.95	975.46	9.92	0.85	977.8	975.5	1.60	3.87	2.3
22774.93	Bridge										
22820.93	3200	969.39	975.3	976.27	7.95	0.61	978.1	977.0	1.72	2.84	1.1
22845.6	3200	969.46	976.03	976.37	6.85	0.47	977.8	977.8	1.73	1.77	0.0
22946.3	3200	969.78	976.18	976.52	7.26	0.51	977.9	977.9	1.69	1.72	0.0
23054.4	3200	970.12	976.36	976.69	7.35	0.52	978.0	978.0	1.64	1.64	0.0
23203.98	3200	970.58	976.57	977	8.38	0.6	978.3	978.2	1.60	1.76	0.2
23390.8	3200	971.15	976.98	977.44	8.85	0.65	978.9	978.6	1.57	1.92	0.3
23566.1	3200	971.7	977.43	977.94	9.36	0.69	979.5	979.0	1.56	2.02	0.5
23762.2	3200	972.31	978.02	978.49	8.84	0.65	980.1	979.6	1.55	2.04	0.5
23962.1	3200	972.94	978.59	978.97	7.92	0.59	980.7	980.1	1.51	2.10	0.6
24152.7	3200	973.53	978.95	979.5	9.5	0.72	981.3	980.4	1.49	2.33	0.8
24300.2	3200	973.99	979.38	980.05	10.62	0.81	981.7	980.9	1.51	2.36	0.8
24462.45	3200	974.5	980.17	980.61	8.83	0.65	982.3	981.7	1.53	2.08	0.6
24611	3200	974.81	980.56	981	8.63	0.63	982.6	982.1	1.55	2.00	0.5
24802.1	3200	975.2	981.08	981.43	8.02	0.58	983.0	982.6	1.56	1.87	0.3
24978.4	3200	975.57	981.44	981.94	9.33	0.68	983.3	983.0	1.59	1.88	0.3
25182.2	3200	975.99	982.03	982.5	8.98	0.64	983.8	983.7	1.63	1.77	0.1
25379.3	3200	976.4	982.56	982.93	7.77	0.55	984.2	984.2	1.63	1.64	0.0
25558.8	3200	976.77	982.94	983.26	7.65	0.54	984.6	984.6	1.62	1.66	0.0
25701.5	3200	977.06	983.18	983.53	7.96	0.57	984.8	984.8	1.62	1.63	0.0
25901.7	3200	977.48	983.54	983.9	7.65	0.55	985.2	985.1	1.60	1.69	0.1
26101.6	3200	977.89	983.9	984.29	8.18	0.59	985.6	985.5	1.60	1.74	0.1
26300.4	3200	978.3	984.3	984.73	8.5	0.61	986.1	985.9	1.61	1.75	0.1
26495.2	3200	978.5	984.75	985.17	8.35	0.59	986.5	986.4	1.67	1.71	0.0
26677.6	3200	978.5	985.15	985.56	7.93	0.54	987.0	986.9	1.76	1.85	0.1
26806.44	3200	978.5	985.39	985.78	7.07	0.47	987.5	987.2	1.82	2.11	0.3
26821	3200	978.5	985.33	985.84	7.74	0.52	987.5	987.2	1.84	2.17	0.3
26822	3200	978.5	985.59	985.87	4.54	0.3	987.5	987.4	1.84	1.91	0.1
26862	3200	978.5	985.63	985.9	4.52	0.3	987.5	987.5	1.85	1.87	0.0
26871	3200	981	990.02	991.64	12.8	0.85	996.0	992.7	2.66	5.98	3.3
26883.44	3200	981.03	990.54	991.73	11.15	0.71	996.0	993.2	2.68	5.46	2.8

Table III: Freeboard Requirements

Bullard Wash Channel Improvements
Interstate 10 to Lower Buckeye Road

River Station	*Q Total (cfs)*	*Min Ch El (ft)*	*W.S. Elev (ft)*	*E.G. Elev (ft)*	*Vel Total (ft/s)*	*Froude # Channel*	*TOB Elev Provided*	*TOB Elev Required*	*Freeboard Required (ft)(a)*	*Freeboard Provided (ft)*	*Execss FB Provided (ft)*
26936	3200	981.3	991.56	991.92	5.61	0.4	996.0	994.2	2.66	4.44	1.8
27011	3200	983.4	991.71	992.03	5.97	0.41	995.0	993.9	2.16	3.29	1.1
27034	Bridge										
27057	5319	983.9	991.8	992.54	9.09	0.62	995.0	N/A	N/A	3.20	
27127	5319	984.3	991.95	992.8	9.8	0.68	995.0	N/A	N/A	3.05	
27150	Bridge										
27173	5319	984.5	992.04	992.88	9.71	0.67	995.0	N/A	N/A	2.96	

Note:

(a) Freeboard requirement is based on FCDMC Drainage Design Manual, Volume II, Hydraulics for subcritical Flow: FB = 0.25 (Y+V^2/2g) (or 1' minimum).

(b) Project limit is from Station 12197 to Station 26871.

APPENDIX B

Offsite Hydrology and Hydraulics

Rational Method - 5-Year Storm

Reference: FCDMC, Jan. 1995. Drainage Design Manual for Maricopa County, AZ, Vol. I Hydrology

Project Name: Bullard Wash Channel Improvement **Project Number: 011489**

Drainage Basin No.	Comment	Inlet Station	Drainage Area (acre)	Drainage Area (mile²)	Drainage Length L (mile)	Drainage Slope S (ft/mile)	Drainage Average Height(ft)	Resistance Coefficient Kb	Design I (in/hr)	Concentration Time Tc (hr)	Design Runoff Coeff. C	Design Q (cfs)	Required(L) Pipe(s)
1A		264+60	38.0	0.0594	0.530	24.51	995	0.058	2.07	0.533	0.15	12	1-24"
1		255+20	44.0	0.0688	0.606	21.45	995	0.057	1.85	0.615	0.15	12	1-24"
2		255+20	60.3	0.0942	0.360	33.35	992	0.034	3.22	0.255	0.47	91	3-36"
3		240+90	98.0	0.1531	0.530	22.63	992	0.053	2.13	0.512	0.15	31	1-36"
4		240+90	63.2	0.0988	0.341	41.07	989	0.055	2.92	0.311	0.25	46	2-30"
5A	(d)	N/A	172.5	0.2695	0.852	18.77	998	0.049	1.59	0.743	0.15	41	N/A
5B		N/A	37.3	0.0583	0.246	24.37	991	0.058	2.86	0.322	0.15	16	N/A
5C	(a)	229+70											1-18"
5	(e)(m)	228+50										22	1-30"
6		228+90	53.5	0.0836	0.341	32.27	986	0.034	3.24	0.252	0.50	87	3-30"
7	(b)	N/A											N/A
7A	(o)	227+00											1-36"
8	(j)	N/A	61.2	0.0956	0.350	34.25	982	0.055	2.78	0.340	0.15	25	N/A
9A	(f)	N/A	85.2	0.1331	0.502	19.92	989	0.053	2.08	0.527	0.15	27	N/A
9B	(a)	N/A										0	N/A
9	(g)	N/A										0	N/A
10	(j)	197+00	121.5	0.1898	0.672	23.80	980	0.051	1.93	0.582	0.15	35	2-24"
11	(c)	186+50	46.5	0.0727	0.568	24.64	975	0.034	2.59	0.382	0.50	60	3-24"
12		190+10	46.6	0.0728	0.331	54.31	977	0.057	3.08	0.280	0.15	22	1-30"
13A	(f)	N/A	40.3	0.0630	0.511	23.47	978	0.058	2.08	0.527	0.15	13	N/A
13B		N/A	96.1	0.1502	0.587	23.85	971	0.053	2.05	0.539	0.15	30	N/A
13	(h)(n)	175+30										30	1-36"
14		174+80	63.6	0.0994	0.350	45.66	972	0.055	2.96	0.303	0.15	28	1-30"
15		160+90	99.2	0.1550	0.606	18.15	965	0.053	1.84	0.620	0.15	27	1-30"
16		160+00	50.6	0.0791	0.436	27.55	970	0.057	2.39	0.434	0.15	18	1-24"
17	(k)	N/A	93.0	0.1453	0.530	22.63	960	0.053	2.12	0.514	0.15	30	N/A
18		146+00	71.3	0.1114	0.436	32.14	965	0.055	2.53	0.397	0.15	27	1-30"
19	(k)	143+60	134.8	0.2106	0.625	22.40	959	0.051	1.98	0.562	0.15	40	2-24"
20		132+40	25.7	0.0402	0.303	26.40	954	0.061	2.66	0.365	0.15	10	1-24"
21		132+50	54.2	0.0847	0.379	47.52	959	0.056	2.88	0.319	0.15	23	1-30"
22		123+00	18.6	0.0291	0.284	49.28	953	0.063	3.08	0.280	0.15	9	1-24"

Notes:

1. C = 0.15 for agricultural field, 0.50 for residential land, and 0.65 for industrial area.
   Revised 11/12/02. The drainage areas have been revised based on the results of a field visit.
2. An area drain will be provided on the south side of Van Buren Street on the west side of the channel to convey irrigation tailwater and interim condition street runoff into the channel.

Comments:

(a) - 100 year, 6 hour on site retention has been provided. Basin 5C has an 18" bleed off pipe into the wash that will be extended to match the new channel design.

(b) - Retention provided based on drainage report for Centerra by Premier Engineering. There will be no 5 year flow from area 7 contributing to the channel.

(c) - Eastern 1/2 has 100yr, 6hr retention (93 AC total / 2 = 46.5 AC contributing)

(d) - There is an 18" pipe at Van Buren and Estrella Parkway that will allow flow to the east. The capacity of this culvert was estimated using pipe full flow with inlet control. Six cfs will flow to the east and the remainder will continue to the south.

(e) - This flow is the combination of the flow to the east from 5A (6 cfs) and the flow from 5B (16cfs).

(f) - This flow will continue to the south and will remain on the west of Estrella Parkway.

(g) - There will be no 5 year flow from areas 9A and 9B contributing to the channel.

(h) -All flow is from drainage area 13B.

(i) - Assuming pipe full flow depth with inlet control.

(j) - Combine Area 8 with Area 10

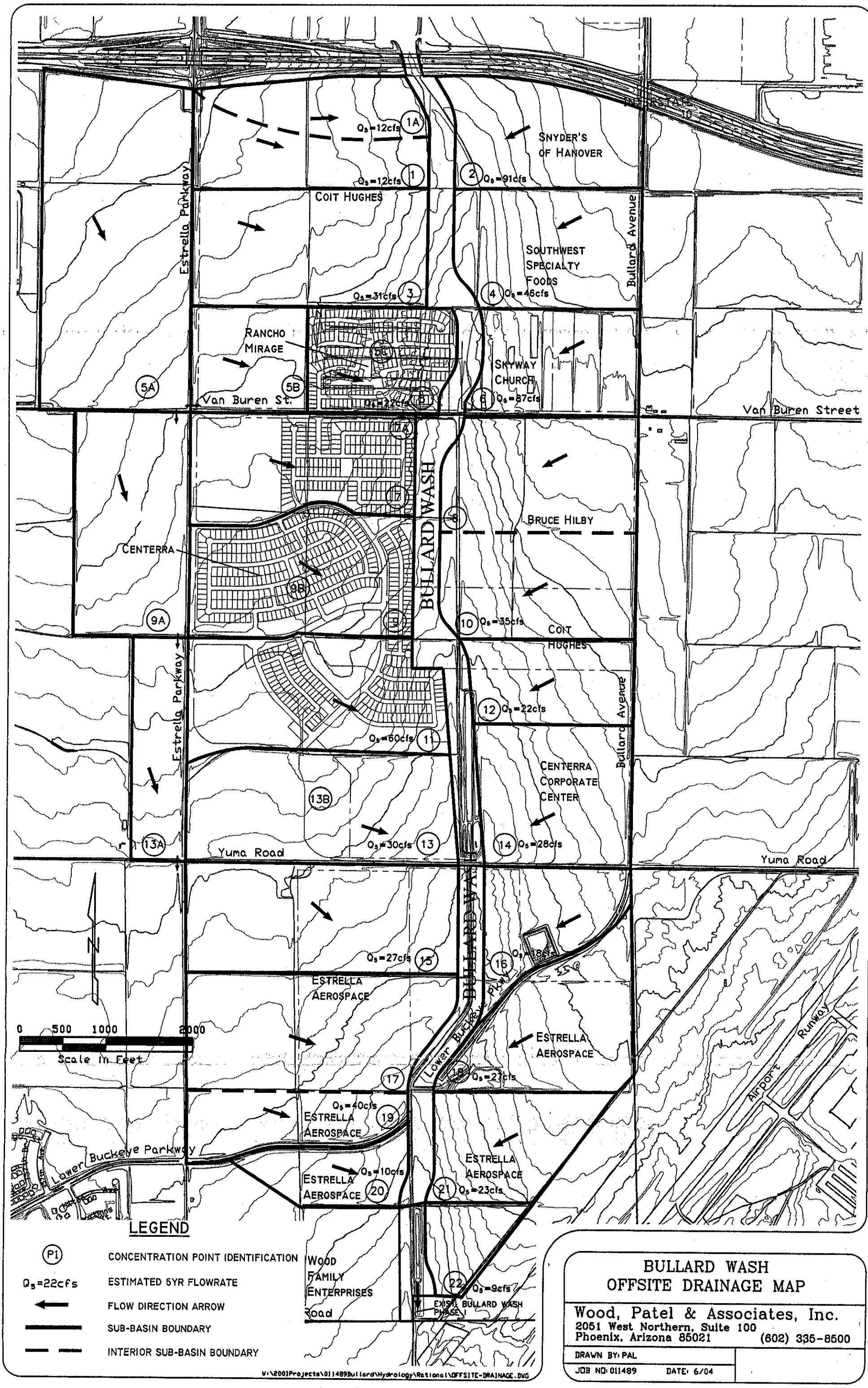
(k) - Combine Area 17 with Area 19

(L) - Pipes were sized by inlet control, assuming three feet of head.

(m) - Inlet will be ADOT C-1580 Double Grate Area Drain.

(n) - Inlet will be ADOT C-1580 Triple Grate Area Drain.

(o) - Inlet is for irrigation water and is sized to match preliminary design by Stantech for RID irrigation line.

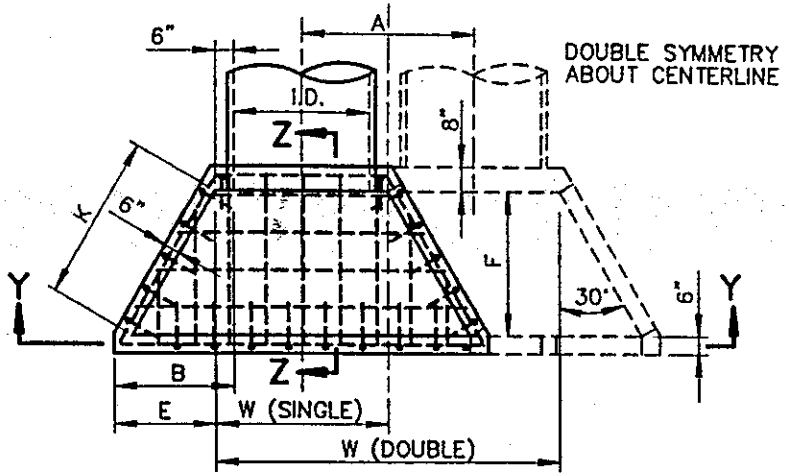


BULLARD WASH OFFSITE DRAINAGE MAP

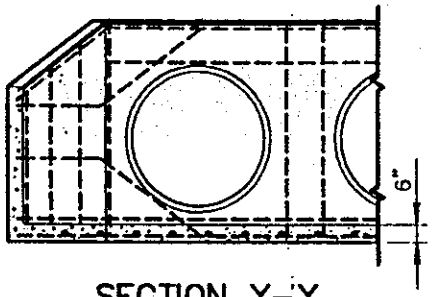
Wood, Patel & Associates, Inc.
2051 West Northern, Suite 100
Phoenix, Arizona 85021 (602) 335-8500

DRAWN BY: PAL

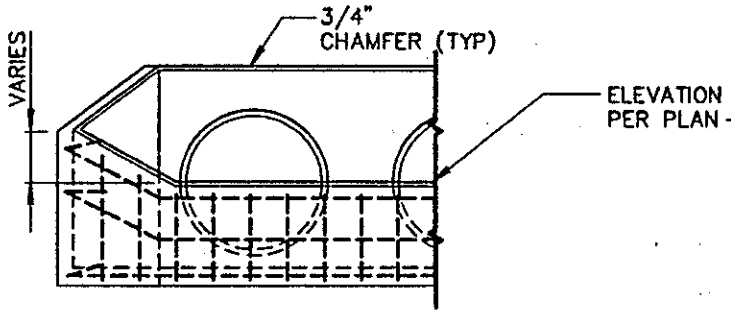
JOB NO: 011489 DATE: 6/04



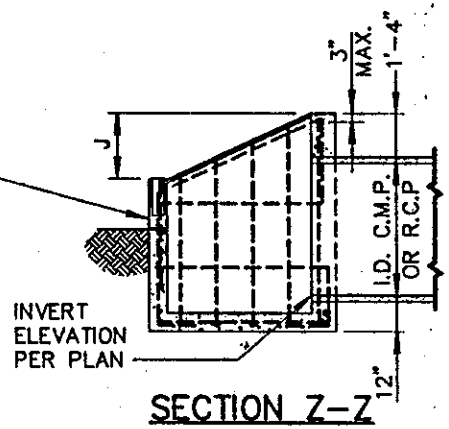
PLAN



SECTION Y–Y



ELEVATION



SECTION Z–Z

PIPE	DIMENSIONS							
I.D.	W		A	B	E	F	J	K
	SINGLE	DOUBLE						
18"	2'-6"	5'-2"	2'-8"	1'-3"	0'-9"	1'-3·5/8"	9"	1'-6"
24"	3'-0"	6'-6"	3'-6"	1'-7·1/2"	1'-1·1/2"	1'-11·3/8"	11"	2'-3"
30"	3'-6"	7'-10"	4'-4"	2'-0"	1'-6"	2'-7·1/4"	1'-1"	3'-0"
36"	4'-0"	9'-2"	5'-2"	2'-4·1/2"	1'-10·1/2"	3'-3"	1'-4"	3'-9"
42"	4'-6"	10-6"	6'-0"	2'-9"	2'-3"	3'-10·3/4"	1'-6"	4'-6"

NOTES:

1. HIGH POINT OF HEADWALL SHALL NOT PROJECT MORE THAN 3" ABOVE SLOPE.
2. ALL CONCRETE SHALL BE CLASS 'A' PER SECT. 725.
3. ALL REINFORCING BARS SHALL BE NO. 4, 12" C TO C AND 3" CLEAR TO INSIDE OF FLOOR AND WALLS.

DETAIL NO.		STANDARD DETAIL		REVISED	DETAIL NO.
501–5	MARICOPA ASSOCIATION of GOVERNMENTS	ENGLISH	HEADWALL DROP INLET		501–5

Weir EQ. $Q_i = C_w P d^{1.5} Cf$ **Orifice EQ.** $Q_i = C_o A (2gd)^{0.5} Cf$

Where: $C_w = 3.0$ **and** $C_o = 0.67$ **and Cf = clogging factor = 0.5**

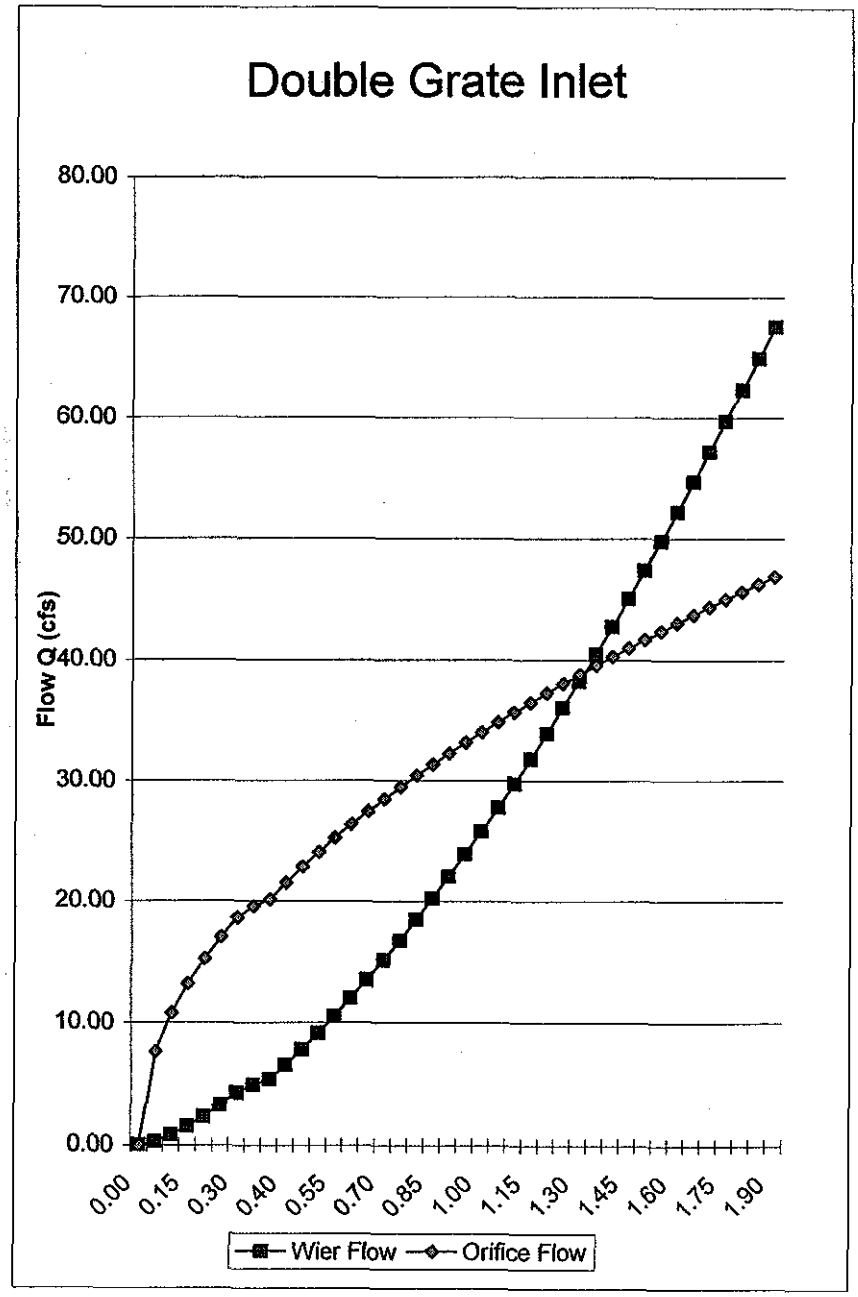
Triple Grate

P = 13.20 ft

A = 8.44 ft^2

ADOT, C-15.80 Double catch basin
Grate Opening

Depth (ft)	Weir Qi (cfs)	Orifice Qi (cfs)
0.00	0.00	0.00
0.05	0.22	5.07
0.10	0.63	7.18
0.15	1.15	8.79
0.20	1.77	10.15
0.25	2.48	11.34
0.30	3.25	12.43
0.33	3.75	13.03
0.35	4.10	13.42
0.40	5.01	14.35
0.45	5.98	15.22
0.50	7.00	16.04
0.55	8.08	16.83
0.60	9.20	17.58
0.65	10.38	18.29
0.70	11.60	18.98
0.75	12.86	19.65
0.80	14.17	20.29
0.85	15.52	20.92
0.90	16.91	21.53
0.95	18.33	22.12
1.00	19.80	22.69
1.05	21.30	23.25
1.10	22.84	23.80
1.15	24.42	24.33
1.20	26.03	24.86
1.25	27.67	25.37
1.30	29.35	25.87
1.35	31.06	26.36
1.40	32.80	26.85
1.45	34.57	27.32
1.50	36.37	27.79
1.55	38.21	28.25
1.60	40.07	28.70
1.65	41.97	29.15
1.70	43.89	29.58
1.75	45.84	30.02
1.80	47.82	30.44
1.85	49.82	30.86
1.90	51.86	31.28



Weir EQ. $Q_i = C_w P d^{1.5} Cf$ **Orifice EQ.** $Q_i = C_o A (2gd)^{0.5} Cf$

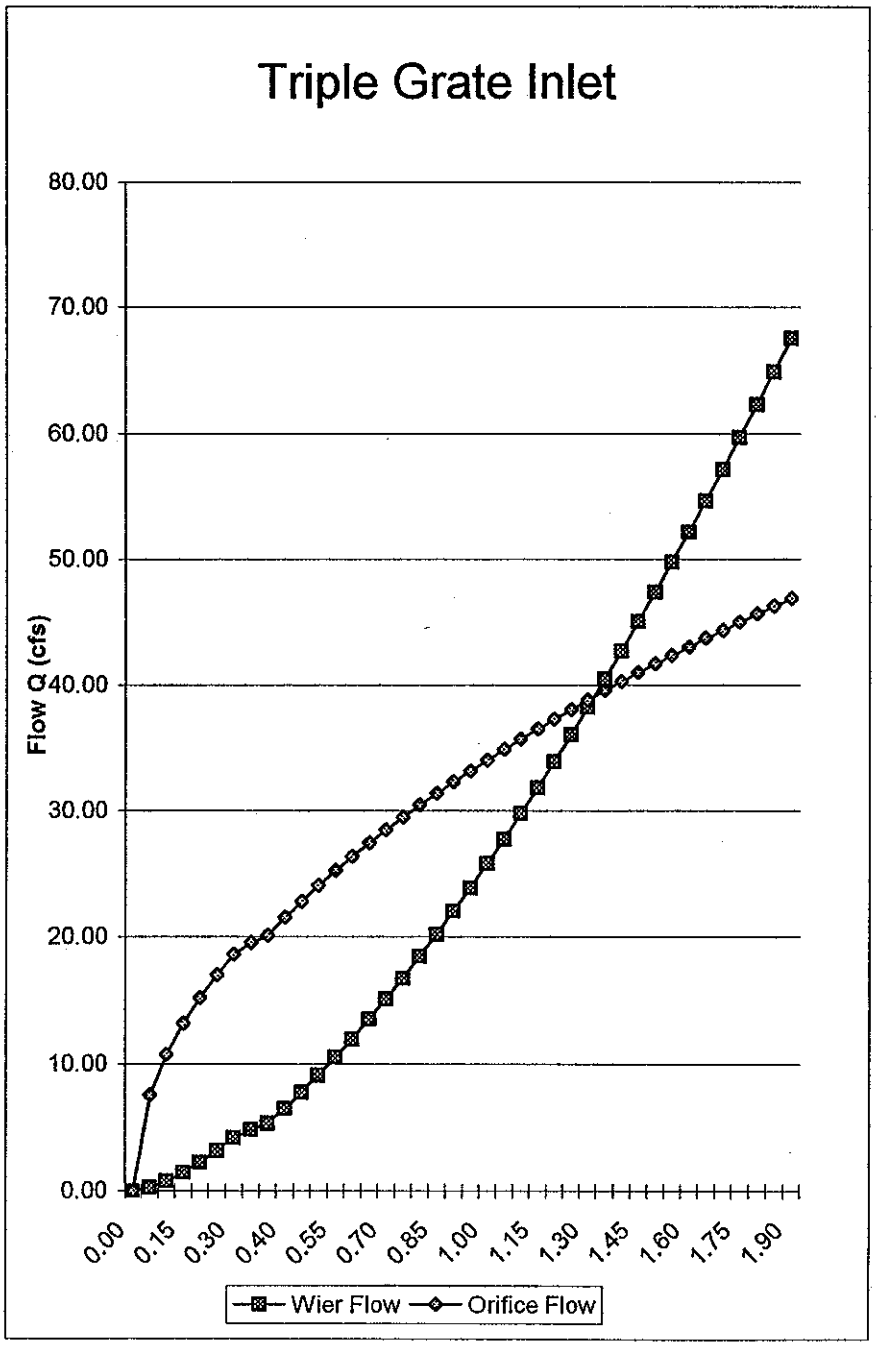
Where: $C_w = 3.0$ **and** $C_o = 0.67$ **and Cf = clogging factor = 0.5**

Triple Grate

ADOT, C-15.80 triple catch basin
Grate Opening

P =	**17.20**	**ft**
A =	**12.66**	**ft^2**

Depth (ft)	Weir Qi (cfs)	Orifice Qi (cfs)
0.00	0.00	0.00
0.05	0.29	7.61
0.10	0.82	10.76
0.15	1.50	13.18
0.20	2.31	15.22
0.25	3.23	17.02
0.30	4.24	18.64
0.33	4.89	19.55
0.35	5.34	20.14
0.40	6.53	21.53
0.45	7.79	22.83
0.50	9.12	24.07
0.55	10.52	25.24
0.60	11.99	26.36
0.65	13.52	27.44
0.70	15.11	28.48
0.75	16.76	29.47
0.80	18.46	30.44
0.85	20.22	31.38
0.90	22.03	32.29
0.95	23.89	33.17
1.00	25.80	34.03
1.05	27.76	34.88
1.10	29.77	35.70
1.15	31.82	36.50
1.20	33.91	37.28
1.25	36.06	38.05
1.30	38.24	38.81
1.35	40.47	39.54
1.40	42.74	40.27
1.45	45.05	40.98
1.50	47.40	41.68
1.55	49.79	42.37
1.60	52.22	43.05
1.65	54.68	43.72
1.70	57.19	44.38
1.75	59.73	45.02
1.80	62.31	45.66
1.85	64.92	46.29
1.90	67.57	46.91



APPENDIX C

Hydraulics

Section 1 **Allowable Velocity (Soil Evaluation)**

Section 2 **HEC-RAS Analysis**

Section 3 **Tailwater Swale**

Section 4 **Drop Structure Analysis (Interim Drop South of I-10)**

APPENDIX C

Hydraulics

Section 1 – Allowable Velocity (Soil Evaluation)

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard channel, ph. II

PROJECT NO. _____ SHEET NO. 1 OF 10

CALCULATED BY ttf DATE 9/02 CHECKED BY [illegible] DATE 9/02

Stable channel Design Using Allowable Velocity Approach:

Based on the soil analysis by ATL Inc (July 2002 - phase II, Sept 1997 - phase I),

It can be concluded that for the design alignment, the soil consists of CL-ML classifications.

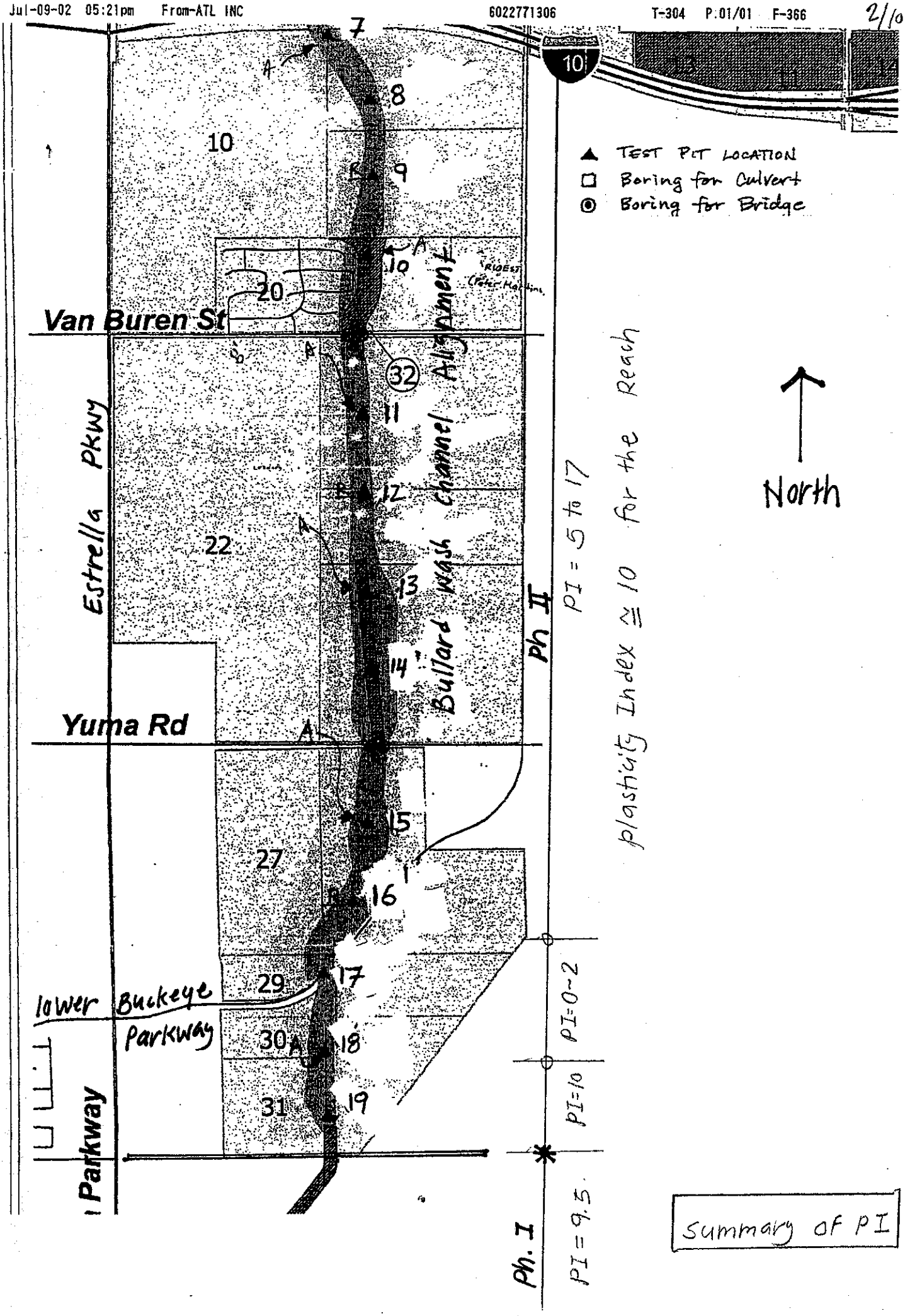
The plasticity index for the entire reach is about 10, with the exception at one location near Lower Buckeye Parkway. This location produced no plasticity. Perhaps, this may be a result of disturbance to the natural section caused by the roadway/utility improvement activity.

Since essentially all boring logs at about 5'~10' depth suggest a plasticity, the alignment in general can be classified to have an erosion resistant soil. The proposed channel section is anticipated to be about 5' to 7' in depth.

Table 6.2, Hydraulics vol. II recommends a channel permissible velocity = 6 fps for Erosion Resistant soil with Bermuda Grass Cover (slope 0 to 5%).

Note that the SCS "Handbook of channel Design for soil and water conservation" as well as the US Army Corps suggest that permissible velocity of 8 fps could be used for the channel with similar soil/turf/slope characteristics. (attached. Page 10/10)

Recommendation: Use 6 fps velocity for the channel design. Based on the SCS & Corps data up to 8 fps may be acceptable with proper maintenance


TEST PIT LOCATION
Boring for Culvert
Boring for Bridge
North
Van Buren St
Yuma Rd
Estrella Pkwy
Bullard Wash channel Alignment
Ph II
Ph. I
lower Buckeye Parkway
Parkway
PI = 5 to 17
plasticity Index ≅ 10 for the Reach
PI=0~2
PI=10
PI=9.5
Summary of PI

ATL, INC.
Excellence In Quality

SUMMARY OF LABORATORY ANALYSIS

CLIENT: WOOD, PATEL AND ASSOCIATES DATE: 07/03/02

PROJECT: BULLARD WASH CHANNEL IMPROVEMENTS, PHASE II

LOCATION: GOODYEAR, AZ

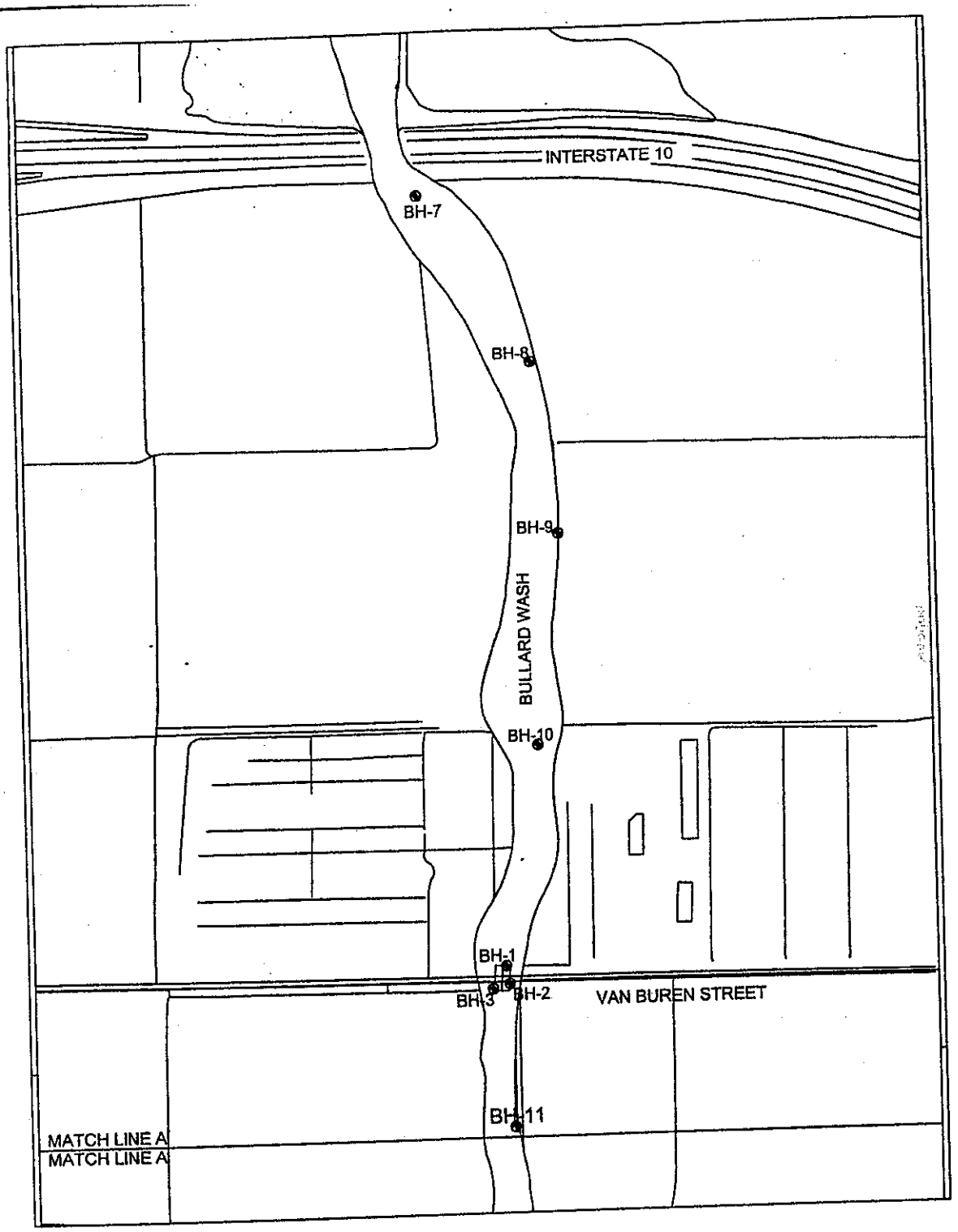
MATERIAL: SEE BELOW SAMPLING DATE: 06/14, 15, 24, 25/02

REQUESTED BY: AMMI OSORIO ATL JOB NO.: 101015

BOREHOLE No.	DEPTH (Feet)	IN-SITU Moist %	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING												pH	Res ohm/cm
						200	100	50	40	30	16	10	4	3/8	3/4	1.5	3.0		
*B - 1	0 - 5	-	-	-	-	36.1	41	50	55	64	80	86	92	98	100	-	-	-	-
B - 1	5 - 10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	1141
B - 1	10 - 15	7.3	SC	22	14	31.6	39	51	59	66	79	87	93	98	100	-	-	-	-
B - 1	32 - 33	29.6	CL	45	19	68.8	76	82	85	86	88	90	95	97	100	-	-	-	-
B - 1	60 - 61	28.7	CL	35	8	87.4	95	98	98	99	100	-	-	-	-	-	-	-	-
B - 2	36 - 37	25.1	CL	35	12	75.7	89	97	99	99	100	-	-	-	-	-	-	-	-
B - 3	5 - 10	10.2	CL - ML	21	5	52.7	66	81	89	92	95	96	98	99	100	-	-	-	-
B - 3	25 - 26	8.5	SM	-	NP	15.7	20	25	30	35	51	62	78	88	95	100	-	-	-
B - 4	5 - 10	18.4	CL	34	17	82.3	89	93	95	97	98	99	100			-	-	8.1	597
B - 4	40 - 41	5.8	SW - SM	-	NP	9.6	13	18	21	24	30	36	50	62	82	100	-	-	-
*B - 5	7 - 12	-	-	-	-	63.4	74	83	87	90	93	94	96	98	100	-	-	-	-
B - 5	31 - 32	7.7	SW - SM	-	NP	11.0	15	30	44	53	65	70	78	84	89	100	-	-	-
*B - 8	5 - 10	-	-	-	-	58.3	69	80	85	89	94	96	99	100	-	-	-	-	-
B - 8	5 - 10	7.4	CL	28	13	54.5	65	77	82	87	92	95	98	99	100	-	-	-	-
B - 12	5 - 10	10.3	CL - ML	19	5	60.0	68	80	87	91	96	98	99	100	-	-	-	-	-
*B - 12	8 - 10	-	-	-	-	72.9	82	92	95	97	99	100	-	-	-	-	-	-	-
B - 15	8-10	-	-	28	10	-	-	-	-	-	-	-	-	-	-	-	-	8.0	671
B - 16	4 - 6	-	-	26	10	63.4	77	94	98	99	100	-	-	-	-	-	-	-	-
B - 16	5 - 10	12.5	ML	24	1	63.4	77	94	98	99	100	-	-	-	-	-	-	-	-
B - 17	5 - 10	5.0	SM	-	NP	24.9	33	50	67	79	91	95	98	99	100	-	-	-	-
*B - 17	8 - 10	-	-	-	-	36.8	47	65	76	86	93	96	98	100	-	-	-	-	-
B - 18	8 - 10	-	-	19	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B - 19	8 - 10	-	-	27	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Hydrometer Analysis

Note: Ave depth of channel is 5' to 7', therefore borings with those depths are evaluated [marked O].



Not to Scale

BORE HOLE LOCATION MAP

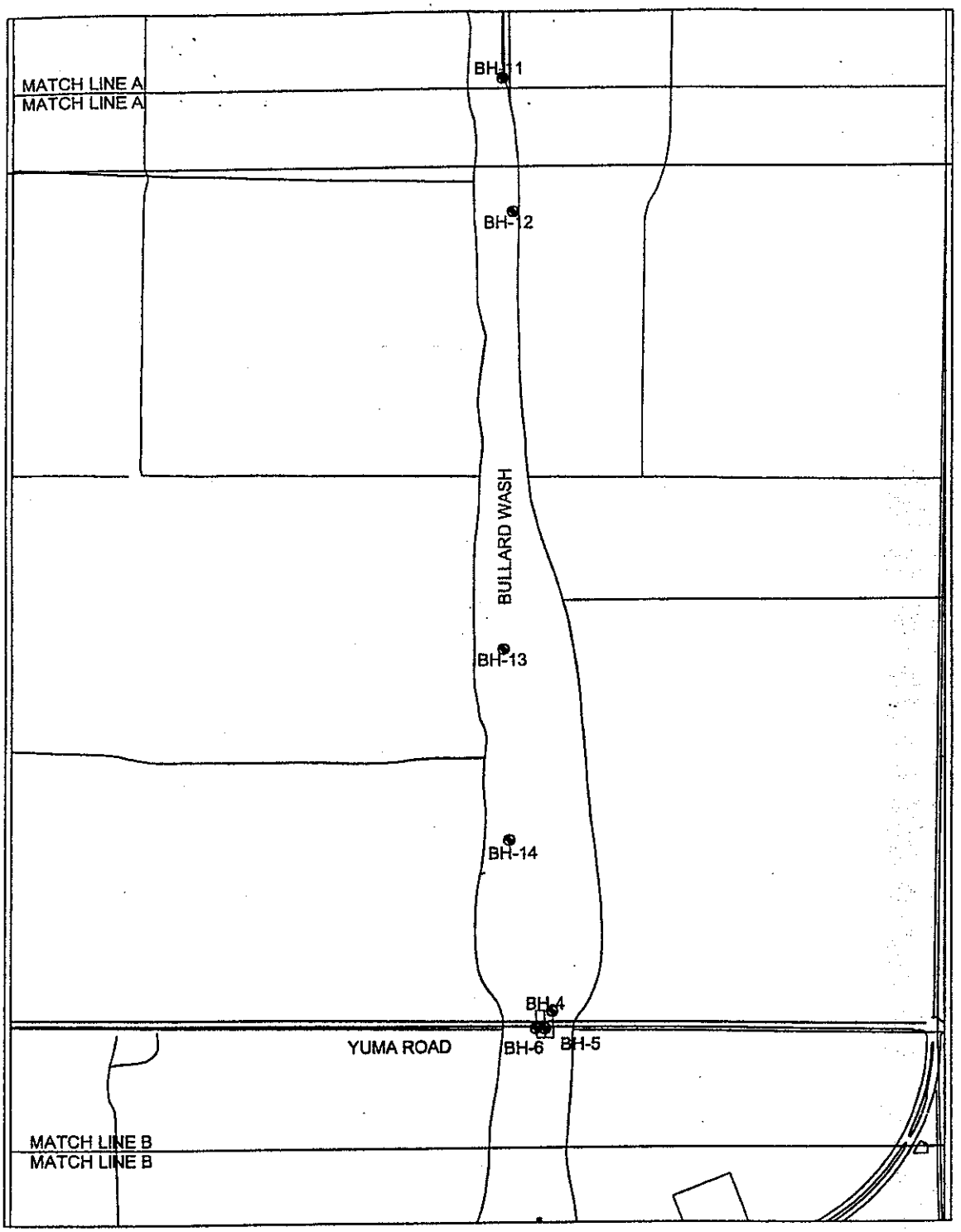
BULLARD WASH PHASE II

PHOENIX, ARIZONA

BORE HOLE

PLATE NO. 4a

ATL JOB NO. 101015



Not to Scale

BORE HOLE LOCATION MAP

BULLARD WASH PHASE II

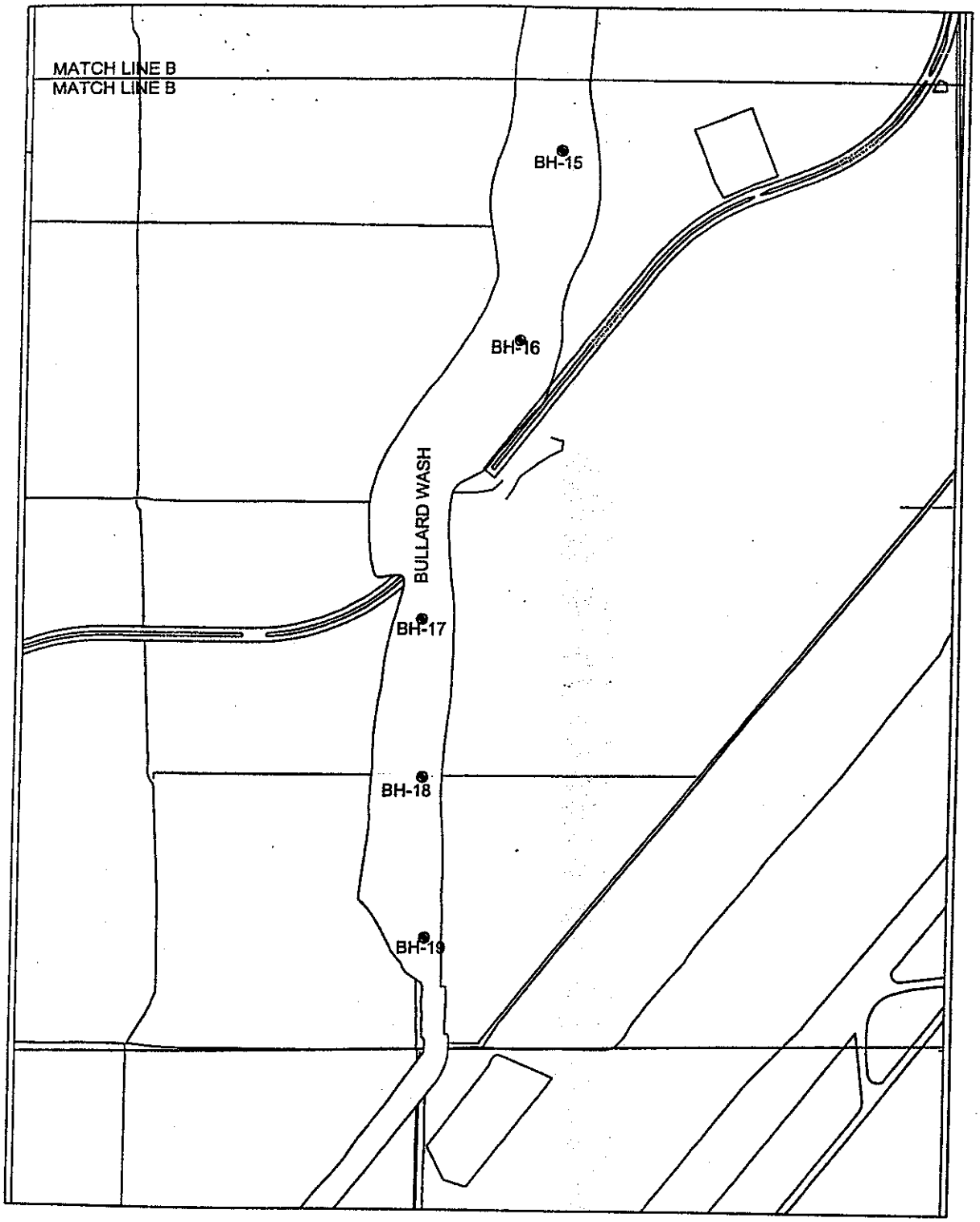
PHOENIX, ARIZONA

BORE HOLE

ATL JOB NO. 101015

PLATE NO. 4b

6/10



N
Not to Scale

BORE HOLE LOCATION MAP

BULLARD WASH PHASE II

PHOENIX, ARIZONA

BORE HOLE

ATL JOB NO. 101015

PLATE NO. 4c

ATL Job No. 196020-3

November 22, 1997

GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

PHASE I

BULLARD WASH - CHANNEL
CONTRACT FCD 95-39
GOODYEAR, ARIZONA
ATL JOB NO. 196020-3

Reviewed by:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
22719
David Preston
Hayes
Date Signed 11/25/97
ARIZONA, U.S.A.

David P. Hayes, P.E.
Executive Vice President

Prepared by:

Ammi Osorio
Project Engineer

SUMMARY OF LABORATORY ANALYSIS

CLIENT: SVERDRUP CIVIL, INC. DATE: 11/18/97

PROJECT: BULLARD WASH - CHANNEL Phase I

LOCATION: GOODYEAR, ARIZONA

MATERIAL: See Below SAMPLING DATE: 09/25/97

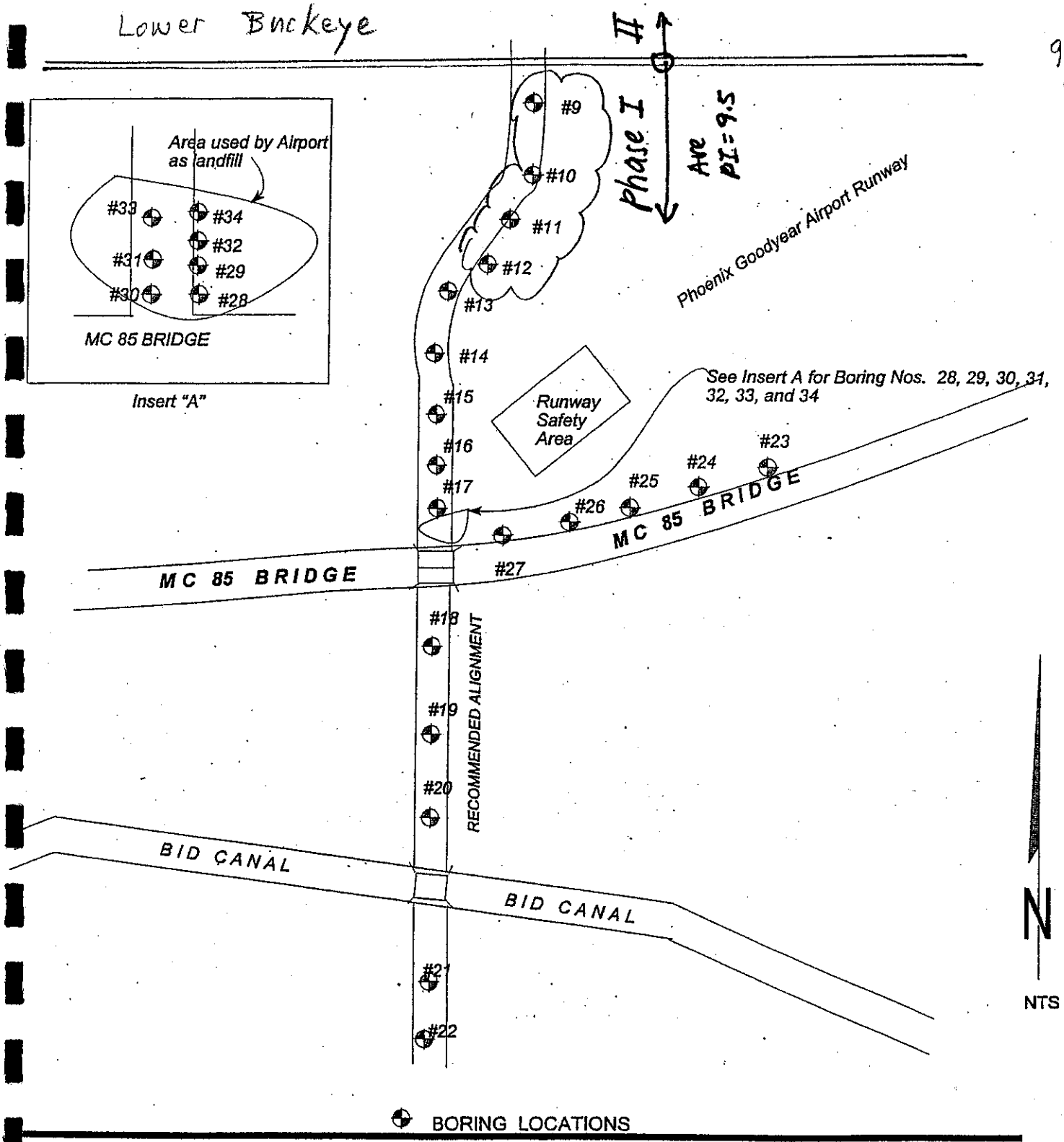
REQUESTED BY: David Hayes ATL JOB NO: 196020-3

BORING No.	DEPTH (Ft)	MOIST (%)	USCS	LL	PI	SIEVE ANALYSIS PERCENT PASSING 200	100	60	40	30	16	10	4	3/8	3/4	1.5	2
9	3 - 9	6.3	CL - ML	28	7	78.3	88	93	95	96	98	98	99	100	-	-	-
10	0 - 11	12.2	CL - ML	24	5	74.6	88	95	96	97	98	99	99	100	-	-	-
11	5 - 10	2.2	CL	30	11	94.2	98	100	-	-	-	-	-	-	-	-	-
12	2 - 10	19.7	SC	40	15	41.9	49	54	56	59	65	72	81	89	96	100	-
13	2 ½ - 11	19.9	CL	38	15	52.2	61	66	69	71	76	82	87	94	98	100	-
14	0 - 8	7.2	CL	32	12	77.0	84	89	91	93	95	96	98	99	100	-	-
15	2 - 15	4.9	SM	-	NP	33.1	43	63	73	79	84	88	92	96	99	99	100
16	4 - 10	7.1	ML	31	7	63.6	77	85	88	91	93	95	98	100	-	-	-
17	0 - 8	10.2	CL - ML	26	5	71.8	80	85	88	90	92	93	95	97	99	100	-
18	0 - 6	10.0	ML	22	3	74.1	89	96	98	99	100	-	-	-	-	-	-
19	0 - 11	13.6	ML	25	3	79.7	94	98	99	99	100	-	-	-	-	-	-
20	8 - 15	24.4	ML	32	6	83.0	92	93	94	95	96	97	100	-	-	-	-
21	0 - 11 ½	10.5	ML	29	5	86.9	98	99	99	100	-	-	-	-	-	-	-
22	4 - 6	1.5	SP - SM	-	NP	6.6	11	38	62	76	84	88	90	92	96	100	-
23	3 - 11 ½	12.8	CL - ML	25	4	68.7	87	97	99	99	100	-	-	-	-	-	-
24	0 - 8	7.4	CL	29	9	54.4	66	77	82	86	90	92	95	99	100	-	-
25	6 - 15	3.1	ML	-	NP	10.0	12	16	19	24	32	40	52	63	71	94	100
26	0 - 10	5.7	SM	26	3	43.7	54	64	70	74	79	82	85	91	97	100	-
27	0 - 12 ½	4.9	ML	22	1	54.0	71	87	91	94	97	98	99	99	100	-	-

Ave. PI = 9.5

Lower Buckeye

9/10



BORING LOCATIONS

BULLARD WASH - CHANNEL

Goodyear, Arizona

Phase I

ATL JOB NO. 196020-3

PLATE 4

10/10

TABLE C-1.--Permissible velocities for channels lined with vegetation
The values apply to average, uniform stands of each type of cover.

Cover	Slope range[2]	Permissible velocity[1]	
		Erosion resistant soils	Easily eroded soils
	Percent	Ft. per sec.	Ft. per sec.
Bermudagrass	0-5	8	6
	5-10	7	5
	over 10	6	4
Buffalograss Kentucky bluegrass Smooth brome Blue grama	0-5	7	5
	5-10	6	4
	over 10	5	3
Grass mixture	0-5	5	4
	5-10	4	3
Lespedeza sericea Weeping lovegrass Yellow bluestem Kudzu Alfalfa Crabgrass	[3]0-5	3.5	2.5
Common lespedeza[4] Sudangrass[4]	[5]0-5	3.5	2.5

From SCS "Handbook of Channel Design for Soil and Water Conservation"(5)

[1] Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.

[2] Do not use on slopes steeper than 10 percent except for side slopes in a combination channel.

[3] Do not use on slopes steeper than 5 percent except for side slopes in a combination channel.

[4] Annuals--used on mild slopes or as temporary protection until permanent covers are established.

[5] Use on slopes steeper than 5 percent is not recommended.

APPENDIX C

Hydraulics

Section 2 – HEC-RAS Analysis

2.1 - Ultimate Condition (Channel n=0.036 and 0.033)
2.2 - Initial Condition (Channel n=0.029)
2.3 - Neglected Condition (Channel n=0.055)

Hydraulics –HEC-RAS Analyses

Three HEC-RAS Models were run for the proposed channel.

1. The first model simulates the ultimate condition, which includes established vegetation including turf, shrubs and trees. The Manning's n-value used for this condition has been established at 0.036 Yuma Road to Van Buren Street and 0.033 Yuma Road to Lower Buckeye Road. The design flow rate is 3200 cfs.

2. The second model simulates the initial condition immediately following construction during the establishment phase of the vegetation. The Manning's n-value used for turf areas before trees and shrubs become established is 0.029. The design flow rate of 3200 cfs was used.

3. The third model simulates a condition after the establishment of vegetation and assumes that maintenance of the channel is severely neglected. The Manning's n-value assumed for this model is 0.055. The design flow rate of 3200 cfs was used. The purpose of this model is to ensure that the design flow would be contained in the proposed channel.

Subsequent to the 30% submittal, a significant amount of effort was expended before the design team was able to arrive at a consensus for the channel's Manning's n-values. A sample plan sheet (LOI) of the 30% submittal package was determined by the District to have a Manning's n-value of 0.032. The District concurred with the number of additional trees that would be required to increase the Manning's n-value to 0.036 and the tree density in the channel was increased accordingly.

It should be noted that the HEC-RAS summary tables for these models list a channel velocity that should not be considered to reflect velocities at every point in the cross section. Rather, this value is an average velocity for the channel section that includes a 9' wide concrete lined tailwater swale. The higher velocities in the tailwater swale will cause the average channel velocities to be much higher than an all turf section. For this reason, we have included shaded velocity distributions on the channel cross sections.

In addition, the models with higher Manning's n-values generate higher water surface elevations. In turn, this places more water within the tailwater swale section (with a lower Manning's n-value) thereby increasing the channel velocity.

HEC-RAS

2.1 - Ultimate Condition
(Channel n = 0.036 and 0.033)

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	27173	100-Year	5319.00	984.50	992.04	990.85	992.88	0.003511	9.71	756.65	169.63	0.67
Main Channel	27173	Low Flow	200.00	984.50	987.33	987.02	987.91	0.007500	6.08	32.87	18.22	0.80
Main Channel	27150		Bridge									
Main Channel	27127	100-Year	5319.00	984.30	991.95		992.80	0.003586	9.80	753.86	170.93	0.68
Main Channel	27127	Low Flow	200.00	984.30	987.33	986.86	987.83	0.006020	5.67	35.27	18.26	0.72
Main Channel	27057	100-Year	5319.00	983.90	991.80	990.35	992.54	0.002898	9.09	805.15	171.30	0.62
Main Channel	27057	Low Flow	200.00	983.90	987.26	986.44	987.48	0.002596	4.09	73.95	143.88	0.48
Main Channel	27034		Bridge									
Main Channel	27011	100-Year	3200.00	983.40	991.71		992.03	0.001276	5.97	743.29	165.01	0.41
Main Channel	27011	Low Flow	200.00	983.40	986.30	986.30	987.15	0.012419	7.37	27.14	16.33	1.01
Main Channel	26936	100-Year	3200.00	981.30	991.56		991.92	0.001253	5.61	710.98	156.35	0.40
Main Channel	26936	Low Flow	200.00	981.30	984.44		985.03	0.006311	6.13	32.63	14.80	0.73
Main Channel	26883.44	100-Year	3200.00	981.03	990.54		991.73	0.003189	11.15	443.94	107.08	0.71
Main Channel	26883.44	Low Flow	200.00	981.03	984.01	983.60	984.71	0.005341	6.72	29.74	12.98	0.78
Main Channel	26871	100-Year	3200.00	981.00	990.02	990.02	991.64	0.004613	12.80	389.26	106.04	0.85
Main Channel	26871	Low Flow	200.00	981.00	983.57	983.57	984.60	0.009056	8.13	24.60	12.14	1.01
Main Channel	26862	100-Year	3200.00	978.50	985.63		985.90	0.000826	4.52	763.78	114.26	0.30
Main Channel	26862	Low Flow	200.00	978.50	981.36		981.37	0.000067	0.70	294.49	105.73	0.07
Main Channel	26822	100-Year	3200.00	978.50	985.59		985.87	0.000840	4.54	759.56	114.19	0.30
Main Channel	26822	Low Flow	200.00	978.50	981.36		981.37	0.000067	0.70	294.20	105.72	0.07
Main Channel	26821	100-Year	3200.00	978.50	985.33		985.84	0.001903	7.74	575.28	110.67	0.52
Main Channel	26821	Low Flow	200.00	978.50	981.33		981.36	0.000533	2.27	147.79	102.65	0.24
Main Channel	26806.44	100-Year	3200.00	978.50	985.39		985.78	0.001568	7.07	662.68	140.81	0.47
Main Channel	26806.44	Low Flow	200.00	978.50	981.32		981.36	0.000525	2.25	151.93	109.98	0.24
Main Channel	26677.6	100-Year	3200.00	978.50	985.15		985.56	0.001995	7.93	680.48	176.93	0.54
Main Channel	26677.6	Low Flow	200.00	978.50	981.16		981.25	0.001203	3.34	100.00	74.41	0.36
Main Channel	26495.2	100-Year	3200.00	978.50	984.75		985.17	0.002190	8.35	671.37	184.97	0.59
Main Channel	26495.2	Low Flow	200.00	978.50	980.85		980.98	0.001821	3.96	84.26	68.98	0.46
Main Channel	26300.4	100-Year	3200.00	978.30	984.30		984.73	0.002267	8.50	662.75	184.02	0.61
Main Channel	26300.4	Low Flow	200.00	978.30	980.41		980.57	0.002388	4.34	77.62	69.06	0.53

HEC-RAS Plan: Design River: Bullard Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	26101.6	100-Year	3200.00	977.89	983.90		984.29	0.002085	8.18	690.72	191.78	0.59
Main Channel	26101.6	Low Flow	200.00	977.89	979.97		980.11	0.002149	4.09	81.43	70.18	0.50
Main Channel	25901.7	100-Year	3200.00	977.48	983.54		983.90	0.001744	7.65	726.97	193.01	0.55
Main Channel	25901.7	Low Flow	200.00	977.48	979.79		979.84	0.000785	2.69	121.63	87.29	0.31
Main Channel	25701.5	100-Year	3200.00	977.06	983.18		983.53	0.001939	7.96	735.39	212.37	0.57
Main Channel	25701.5	Low Flow	200.00	977.06	979.47		979.62	0.001653	3.95	78.99	53.36	0.45
Main Channel	25558.8	100-Year	3200.00	976.77	982.94		983.26	0.001777	7.65	773.59	224.95	0.54
Main Channel	25558.8	Low Flow	200.00	976.77	978.75		979.18	0.005765	6.45	45.51	37.54	0.81
Main Channel	25379.3	100-Year	3200.00	976.40	982.56		982.93	0.001817	7.77	715.53	187.91	0.55
Main Channel	25379.3	Low Flow	200.00	976.40	978.55		978.64	0.001362	3.32	95.63	69.91	0.40
Main Channel	25182.2	100-Year	3200.00	975.99	982.03		982.50	0.002511	8.98	656.31	199.45	0.64
Main Channel	25182.2	Low Flow	200.00	975.99	978.15		978.30	0.002103	4.14	74.86	54.98	0.50
Main Channel	24978.4	100-Year	3200.00	975.57	981.44		981.94	0.002826	9.33	622.66	187.01	0.68
Main Channel	24978.4	Low Flow	200.00	975.57	977.68		977.84	0.002323	4.27	74.31	58.76	0.52
Main Channel	24802.1	100-Year	3200.00	975.20	981.08		981.43	0.002071	8.02	734.86	223.45	0.58
Main Channel	24802.1	Low Flow	200.00	975.20	977.31		977.44	0.001945	3.92	81.14	62.59	0.48
Main Channel	24611.0	100-Year	3200.00	974.81	980.56		981.00	0.002441	8.63	677.12	208.58	0.63
Main Channel	24611.0	Low Flow	200.00	974.81	976.88		977.03	0.002240	4.18	77.94	65.94	0.51
Main Channel	24462.45	100-Year	3200.00	974.50	980.17		980.61	0.002653	8.83	658.73	204.12	0.65
Main Channel	24462.45	Low Flow	200.00	974.50	976.48		976.66	0.002848	4.54	72.68	65.41	0.57
Main Channel	24300.2	100-Year	3200.00	973.99	979.38		980.05	0.004049	10.62	548.93	181.19	0.81
Main Channel	24300.2	Low Flow	200.00	973.99	975.90		976.13	0.003655	5.04	63.03	56.89	0.64
Main Channel	24152.7	100-Year	3200.00	973.53	978.95		979.50	0.003094	9.50	618.01	203.84	0.72
Main Channel	24152.7	Low Flow	200.00	973.53	975.19		975.50	0.004956	5.46	55.49	56.37	0.75
Main Channel	23962.1	100-Year	3200.00	972.94	978.59		978.97	0.002126	7.92	692.79	194.33	0.59
Main Channel	23962.1	Low Flow	200.00	972.94	974.81		974.90	0.001781	3.47	97.66	90.17	0.45
Main Channel	23762.2	100-Year	3200.00	972.31	978.02		978.49	0.002628	8.84	638.16	187.46	0.65
Main Channel	23762.2	Low Flow	200.00	972.31	974.31		974.47	0.002588	4.36	76.10	67.84	0.54
Main Channel	23566.1	100-Year	3200.00	971.70	977.43		977.94	0.002938	9.36	614.18	185.60	0.69
Main Channel	23566.1	Low Flow	200.00	971.70	973.65		973.87	0.003592	5.04	65.01	60.02	0.64

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	23390.8	100-Year	3200.00	971.15	976.98		977.44	0.002532	8.85	649.94	191.91	0.65
Main Channel	23390.8	Low Flow	200.00	971.15	973.14		973.31	0.002700	4.46	73.32	64.73	0.56
Main Channel	23203.98	100-Year	3200.00	970.58	976.57		977.00	0.002181	8.38	678.07	191.26	0.60
Main Channel	23203.98	Low Flow	200.00	970.58	972.52		972.75	0.003452	4.97	65.55	62.63	0.63
Main Channel	23054.4	100-Year	3200.00	970.12	976.36		976.69	0.001615	7.35	757.19	196.90	0.52
Main Channel	23054.4	Low Flow	200.00	970.12	971.86		972.12	0.005008	5.52	60.23	64.00	0.74
Main Channel	22946.3	100-Year	3200.00	969.78	976.18		976.52	0.001522	7.26	740.82	178.74	0.51
Main Channel	22946.3	Low Flow	200.00	969.78	971.43		971.62	0.004034	4.79	69.48	73.03	0.66
Main Channel	22845.6	100-Year	3200.00	969.46	976.03		976.37	0.001309	6.85	713.36	142.74	0.47
Main Channel	22845.6	Low Flow	200.00	969.46	971.33		971.38	0.001103	2.72	124.15	108.93	0.35
Main Channel	22820.93	100-Year	3200.00	969.39	975.30	973.84	976.27	0.002013	7.95	408.50	79.87	0.61
Main Channel	22820.93	Low Flow	200.00	969.39	971.29	970.64	971.36	0.000991	2.13	94.32	76.86	0.34
Main Channel	22774.93		Bridge									
Main Channel	22728.93	100-Year	3200.00	969.07	973.95		975.46	0.004191	9.92	326.59	79.09	0.85
Main Channel	22728.93	Low Flow	200.00	969.07	970.82		970.91	0.001533	2.42	82.71	76.75	0.41
Main Channel	22705.0	100-Year	3200.00	969.00	974.55		975.09	0.002660	8.66	565.04	135.61	0.65
Main Channel	22705.0	Low Flow	200.00	969.00	970.80		970.86	0.001396	2.96	115.10	107.06	0.39
Main Channel	22611.0	100-Year	3200.00	968.72	974.28		974.83	0.002950	9.20	589.86	169.49	0.69
Main Channel	22611.0	Low Flow	200.00	968.72	970.58		970.69	0.002189	3.81	85.51	75.44	0.49
Main Channel	22496.6	100-Year	3200.00	968.40	974.05		974.49	0.002469	8.51	650.07	185.79	0.63
Main Channel	22496.6	Low Flow	200.00	968.40	970.32		970.44	0.002276	3.97	85.32	79.14	0.51
Main Channel	22300.9	100-Year	3200.00	967.82	973.61		974.01	0.002337	8.41	692.75	210.17	0.62
Main Channel	22300.9	Low Flow	200.00	967.82	969.92		970.03	0.001911	3.86	88.33	77.20	0.47
Main Channel	22102.0	100-Year	3200.00	967.24	973.13		973.54	0.002364	8.57	691.98	213.20	0.62
Main Channel	22102.0	Low Flow	200.00	967.24	969.37		969.57	0.002782	4.71	65.49	49.94	0.57
Main Channel	21911.0	100-Year	3200.00	966.67	972.54		973.03	0.002870	9.44	649.26	216.28	0.69
Main Channel	21911.0	Low Flow	200.00	966.67	968.88		969.07	0.002463	4.56	68.54	52.19	0.54
Main Channel	21718.5	100-Year	3200.00	966.10	971.71		972.37	0.003896	10.66	552.21	178.34	0.79
Main Channel	21718.5	Low Flow	200.00	966.10	968.20		968.49	0.003731	5.42	56.18	44.88	0.66

HEC-RAS Plan: Design River: Bullard Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	21517.7	100-Year	3200.00	965.51	971.20		971.66	0.002753	9.02	647.31	200.95	0.67
Main Channel	21517.7	Low Flow	200.00	965.51	967.51		967.74	0.003593	5.12	63.10	56.22	0.64
Main Channel	21318.7	100-Year	3200.00	964.92	970.80		971.17	0.001961	7.86	718.34	202.52	0.57
Main Channel	21318.7	Low Flow	200.00	964.92	966.91		967.09	0.002829	4.58	75.44	76.80	0.57
Main Channel	21118.3	100-Year	3200.00	964.33	970.29		970.73	0.002358	8.61	661.44	189.79	0.62
Main Channel	21118.3	Low Flow	200.00	964.33	966.46		966.60	0.002018	4.01	77.80	58.36	0.48
Main Channel	20918.4	100-Year	3200.00	963.74	969.63		970.19	0.003033	9.70	600.11	180.80	0.70
Main Channel	20918.4	Low Flow	200.00	963.74	965.92		966.13	0.002751	4.75	64.97	49.45	0.57
Main Channel	20718.0	100-Year	3200.00	963.14	968.84		969.49	0.003901	10.76	570.10	194.43	0.79
Main Channel	20718.0	Low Flow	200.00	963.14	965.29		965.53	0.003170	5.05	59.36	43.38	0.61
Main Channel	20524.1	100-Year	3200.00	962.57	967.89		968.64	0.004774	11.42	526.68	186.19	0.87
Main Channel	20524.1	Low Flow	200.00	962.57	964.35		964.71	0.005914	6.11	49.45	45.42	0.81
Main Channel	20341.9	100-Year	3200.00	962.03	967.47		967.90	0.002709	8.68	671.25	217.52	0.66
Main Channel	20341.9	Low Flow	200.00	962.03	963.96		964.07	0.001940	3.68	88.58	75.03	0.47
Main Channel	20164.2	100-Year	3200.00	961.51	967.09		967.43	0.002296	8.16	786.36	290.18	0.61
Main Channel	20164.2	Low Flow	200.00	961.51	963.66		963.76	0.001495	3.49	95.54	76.35	0.42
Main Channel	19974.5	100-Year	3200.00	961.07	966.61		966.98	0.002473	8.41	729.36	250.58	0.63
Main Channel	19974.5	Low Flow	200.00	961.07	963.04		963.31	0.004051	5.40	61.88	62.17	0.68
Main Channel	19790.8	100-Year	3200.00	960.40	966.19		966.57	0.002127	8.07	707.64	206.63	0.59
Main Channel	19790.8	Low Flow	200.00	960.40	962.53		962.70	0.002499	4.49	78.60	77.89	0.54
Main Channel	19602.6	100-Year	3200.00	959.85	965.71		966.15	0.002407	8.70	676.97	206.78	0.63
Main Channel	19602.6	Low Flow	200.00	959.85	962.11		962.28	0.002088	4.29	77.23	65.75	0.50
Main Channel	19400.0	100-Year	3200.00	959.25	965.04		965.57	0.003120	9.76	625.19	206.40	0.72
Main Channel	19400.0	Low Flow	200.00	959.25	961.44		961.73	0.003443	5.35	55.74	41.84	0.64
Main Channel	19205.1	100-Year	3200.00	958.67	964.30		964.90	0.003687	10.36	580.35	193.62	0.77
Main Channel	19205.1	Low Flow	200.00	958.67	960.79		961.05	0.003404	5.20	60.08	48.66	0.63
Main Channel	19017.6	100-Year	3200.00	958.24	963.69		964.25	0.003418	9.78	591.27	187.74	0.74
Main Channel	19017.6	Low Flow	200.00	958.24	960.17		960.39	0.003565	5.00	67.52	66.87	0.63
Main Channel	18821.3	100-Year	3200.00	957.54	963.27		963.66	0.002180	8.13	694.75	201.34	0.60
Main Channel	18821.3	Low Flow	200.00	957.54	959.56		959.75	0.002927	4.69	75.83	81.00	0.58

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	18623.3	100-Year	3200.00	956.95	962.84		963.23	0.002170	8.20	692.10	198.57	0.60
Main Channel	18623.3	Low Flow	200.00	956.95	959.05		959.21	0.002503	4.42	78.77	74.53	0.54
Main Channel	18424.2	100-Year	3200.00	956.36	962.14		962.71	0.003078	9.70	591.69	177.03	0.71
Main Channel	18424.2	Low Flow	200.00	956.36	958.55		958.73	0.002316	4.41	73.75	60.60	0.52
Main Channel	18226.7	100-Year	3200.00	955.78	961.52		962.08	0.003228	9.87	603.96	193.39	0.73
Main Channel	18226.7	Low Flow	200.00	955.78	957.83		958.13	0.003932	5.47	54.54	42.61	0.67
Main Channel	18029.7	100-Year	3200.00	955.20	960.92		961.46	0.003059	9.58	605.29	186.13	0.71
Main Channel	18029.7	Low Flow	200.00	955.20	957.30		957.47	0.002534	4.47	74.02	64.52	0.54
Main Channel	17826.9	100-Year	3200.00	954.60	960.49		960.89	0.002207	8.28	688.30	198.03	0.60
Main Channel	17826.9	Low Flow	200.00	954.60	956.46		956.76	0.005024	5.78	58.32	62.39	0.75
Main Channel	17644	100-Year	3200.00	954.04	960.14		960.51	0.001927	7.91	716.42	197.95	0.56
Main Channel	17644	Low Flow	200.00	954.04	955.72		955.91	0.004001	4.82	69.12	72.13	0.66
Main Channel	17545	100-Year	3200.00	953.76	959.99		960.32	0.001524	7.14	736.41	174.56	0.50
Main Channel	17545	Low Flow	200.00	953.76	955.47		955.58	0.002408	3.79	89.06	88.56	0.51
Main Channel	17459	100-Year	3200.00	953.51	959.83		960.19	0.001465	7.05	691.00	143.45	0.49
Main Channel	17459	Low Flow	200.00	953.51	955.38		955.43	0.001036	2.64	128.06	111.61	0.34
Main Channel	17434	100-Year	3200.00	953.43	959.12	957.78	960.09	0.001436	7.95	410.30	84.18	0.62
Main Channel	17434	Low Flow	200.00	953.43	955.35	954.67	955.41	0.000589	2.01	99.91	80.30	0.32
Main Channel	17371.91		Bridge									
Main Channel	17310	100-Year	3200.00	953.07	957.42	957.42	959.23	0.004053	10.85	299.56	83.68	1.00
Main Channel	17310	Low Flow	200.00	953.07	954.88		954.96	0.000798	2.20	91.36	80.45	0.36
Main Channel	17285	100-Year	3200.00	953.00	957.92		958.71	0.003662	9.45	460.05	127.03	0.75
Main Channel	17285	Low Flow	200.00	953.00	954.87		954.93	0.001275	2.92	110.01	102.06	0.38
Main Channel	17188	100-Year	3200.00	952.72	957.73		958.33	0.003037	8.71	527.96	154.28	0.69
Main Channel	17188	Low Flow	200.00	952.72	954.65		954.77	0.002212	3.94	96.95	126.37	0.50
Main Channel	17076.5	100-Year	3200.00	952.39	957.37		957.99	0.003120	8.79	523.12	153.61	0.69
Main Channel	17076.5	Low Flow	200.00	952.39	954.10		954.37	0.005769	5.85	68.27	120.25	0.79
Main Channel	16961.4	100-Year	3200.00	952.06	957.18		957.65	0.002208	7.53	596.49	163.99	0.59
Main Channel	16961.4	Low Flow	200.00	952.06	953.88		953.96	0.001877	3.48	105.79	133.65	0.46
Main Channel	16762.7	100-Year	3200.00	951.49	956.55		957.14	0.002888	8.57	535.80	154.26	0.67

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	16762.7	Low Flow	200.00	951.49	953.33		953.48	0.003075	4.50	86.34	125.33	0.59
Main Channel	16562.9	100-Year	3200.00	950.91	956.10		956.58	0.002344	7.85	590.96	172.56	0.61
Main Channel	16562.9	Low Flow	200.00	950.91	952.86		952.97	0.002036	3.81	99.57	126.04	0.48
Main Channel	16366.6	100-Year	3200.00	950.45	955.42		956.04	0.003147	8.84	521.00	153.37	0.70
Main Channel	16366.6	Low Flow	200.00	950.45	952.26		952.44	0.003666	4.86	80.88	125.00	0.64
Main Channel	16165.7	100-Year	3200.00	949.76	954.85		955.43	0.002840	8.50	539.28	154.58	0.66
Main Channel	16165.7	Low Flow	200.00	949.76	951.63		951.77	0.002907	4.41	88.34	125.63	0.57
Main Channel	15969.0	100-Year	3200.00	949.19	954.26		954.85	0.002865	8.54	537.59	154.50	0.67
Main Channel	15969.0	Low Flow	200.00	949.19	951.07		951.20	0.002767	4.32	89.68	125.84	0.56
Main Channel	15779.9	100-Year	3200.00	948.64	953.70		954.28	0.002870	8.53	538.13	155.10	0.67
Main Channel	15779.9	Low Flow	200.00	948.64	950.49		950.64	0.003049	4.50	86.81	126.12	0.58
Main Channel	15590.8	100-Year	3200.00	948.09	953.15		953.74	0.002850	8.54	537.60	154.41	0.67
Main Channel	15590.8	Low Flow	200.00	948.09	949.96		950.09	0.002688	4.26	90.08	125.54	0.55
Main Channel	15401.8	100-Year	3200.00	947.54	952.62		953.20	0.002858	8.59	537.47	154.83	0.67
Main Channel	15401.8	Low Flow	200.00	947.54	949.40		949.56	0.003031	4.52	85.78	125.76	0.59
Main Channel	15199.3	100-Year	3200.00	946.96	952.06		952.63	0.002763	8.40	544.30	154.95	0.66
Main Channel	15199.3	Low Flow	200.00	946.96	948.83		948.96	0.002729	4.27	90.55	125.87	0.55
Main Channel	14998	100-Year	3200.00	946.37	951.49		952.06	0.002782	8.45	542.83	154.89	0.66
Main Channel	14998	Low Flow	200.00	946.37	948.24		948.39	0.002907	4.42	88.12	125.61	0.57
Main Channel	14817.3	100-Year	3200.00	945.85	950.93		951.51	0.002794	8.43	541.83	154.49	0.66
Main Channel	14817.3	Low Flow	200.00	945.85	947.70		947.84	0.002784	4.29	89.96	125.43	0.56
Main Channel	14663.1	100-Year	3200.00	945.40	950.65		951.08	0.002012	7.31	623.64	172.18	0.56
Main Channel	14663.1	Low Flow	200.00	945.40	947.34		947.44	0.002050	3.80	102.53	143.30	0.48
Main Channel	14544	100-Year	3200.00	945.06	950.23		950.78	0.002635	8.28	552.63	155.49	0.64
Main Channel	14544	Low Flow	200.00	945.06	946.78	946.78	947.04	0.005421	5.70	70.07	121.36	0.77
Main Channel	14543	100-Year	3200.00	944.06	950.41		950.70	0.001072	6.06	747.11	176.18	0.42
Main Channel	14543	Low Flow	200.00	944.06	945.78	945.78	946.04	0.005509	5.74	69.41	120.67	0.77
Main Channel	14531.42	100-Year	3200.00	944.02	950.42	947.64	950.68	0.000864	5.38	797.68	176.35	0.37
Main Channel	14531.42	Low Flow	200.00	944.02	945.60	945.34	945.69	0.002708	3.73	92.49	118.55	0.52
Main Channel	14461.42		Culvert									

HEC-RAS Plan: Design River: Bullard Wash Reach: Main Channel (Continued)

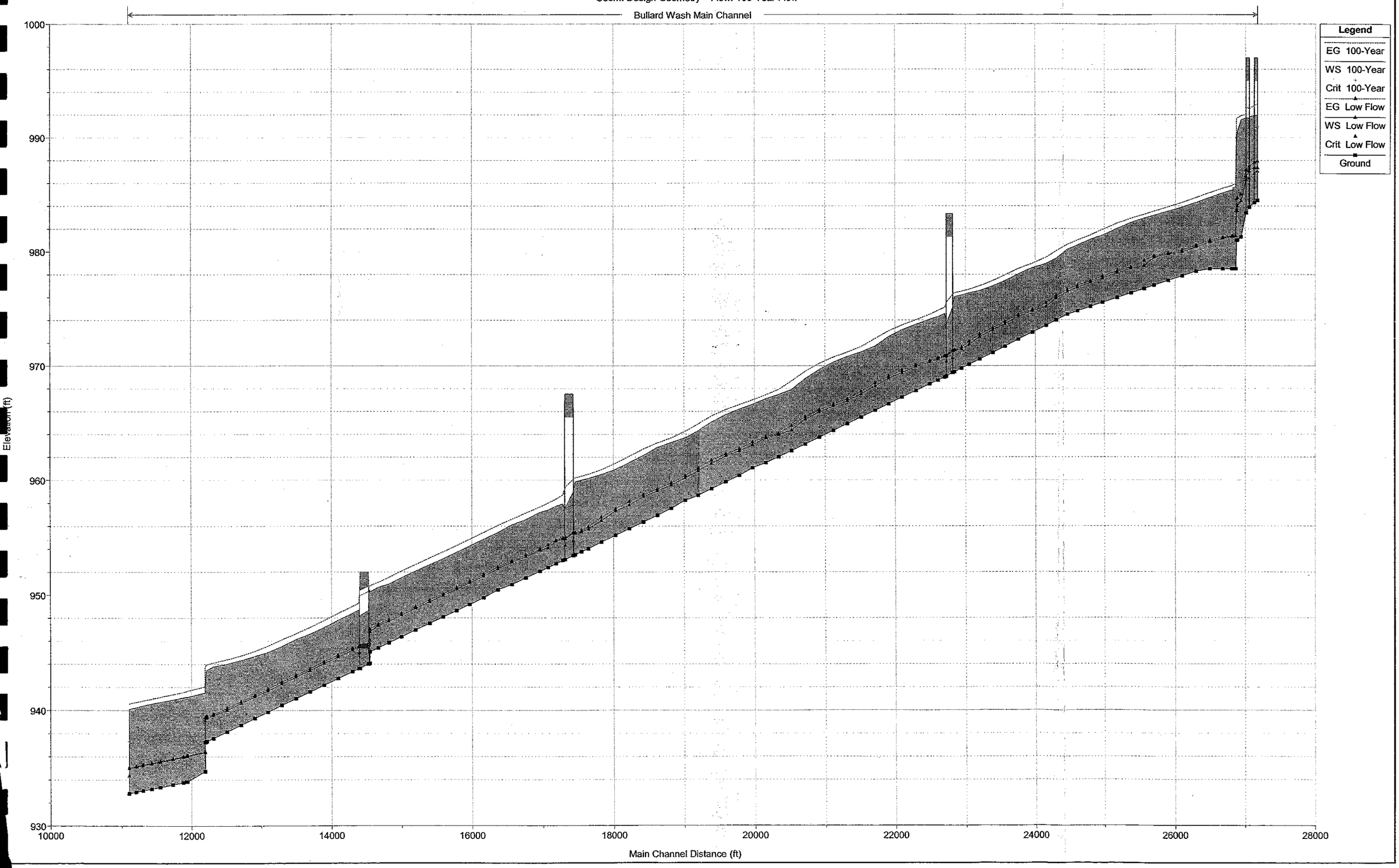
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	14391.42	100-Year	3200.00	943.62	948.67		949.27	0.003095	8.89	532.38	154.66	0.70
Main Channel	14391.42	Low Flow	200.00	943.62	945.47		945.53	0.001195	2.83	114.61	106.71	0.37
Main Channel	14298.9	100-Year	3200.00	943.35	948.40		948.99	0.002915	8.58	535.18	154.70	0.67
Main Channel	14298.9	Low Flow	200.00	943.35	945.20		945.35	0.003066	4.51	86.68	125.83	0.58
Main Channel	14096.5	100-Year	3200.00	942.76	947.78		948.39	0.002950	8.69	531.06	154.16	0.68
Main Channel	14096.5	Low Flow	200.00	942.76	944.62		944.77	0.002750	4.32	88.52	125.59	0.56
Main Channel	13894.6	100-Year	3200.00	942.18	947.15		947.77	0.003159	8.83	521.03	153.48	0.70
Main Channel	13894.6	Low Flow	200.00	942.18	944.05		944.19	0.002882	4.39	88.59	125.59	0.57
Main Channel	13694.6	100-Year	3200.00	941.60	946.60		947.16	0.002782	8.45	550.70	161.40	0.67
Main Channel	13694.6	Low Flow	200.00	941.60	943.44		943.61	0.002992	4.50	86.34	132.71	0.59
Main Channel	13494.6	100-Year	3200.00	941.02	946.14		946.63	0.002384	7.86	587.41	167.00	0.61
Main Channel	13494.6	Low Flow	200.00	941.02	942.89		943.03	0.002723	4.29	92.75	137.79	0.55
Main Channel	13294.6	100-Year	3200.00	940.44	945.53		946.10	0.002792	8.44	544.80	157.27	0.66
Main Channel	13294.6	Low Flow	200.00	940.44	942.29		942.44	0.003170	4.57	85.75	125.65	0.59
Main Channel	13095.9	100-Year	3200.00	939.86	945.00		945.56	0.002593	8.31	554.29	156.24	0.65
Main Channel	13095.9	Low Flow	200.00	939.86	941.71		941.86	0.002712	4.29	88.67	126.40	0.56
Main Channel	12908.8	100-Year	3200.00	939.32	944.67		945.10	0.001969	7.28	626.92	170.60	0.55
Main Channel	12908.8	Low Flow	200.00	939.32	941.19		941.32	0.002913	4.38	92.11	137.75	0.57
Main Channel	12708.5	100-Year	3200.00	938.73	944.30		944.72	0.001789	7.17	638.60	172.53	0.54
Main Channel	12708.5	Low Flow	200.00	938.73	940.60		940.74	0.002848	4.37	90.14	130.35	0.56
Main Channel	12508.7	100-Year	3200.00	938.15	943.99		944.38	0.001545	6.72	660.00	165.00	0.49
Main Channel	12508.7	Low Flow	200.00	938.15	940.01		940.15	0.003080	4.41	86.98	125.47	0.57
Main Channel	12315	100-Year	3200.00	937.59	943.77		944.10	0.001190	6.27	717.81	167.50	0.44
Main Channel	12315	Low Flow	200.00	937.59	939.56		939.66	0.001966	3.76	100.81	125.77	0.47
Main Channel	12220.5	100-Year	3200.00	937.32	943.45		943.94	0.001777	7.62	582.75	132.47	0.54
Main Channel	12220.5	Low Flow	200.00	937.32	939.37		939.48	0.001874	3.77	95.70	106.46	0.46
Main Channel	12209	100-Year	3200.00	937.28	943.18		943.89	0.002670	9.11	485.49	113.03	0.66
Main Channel	12209	Low Flow	200.00	937.28	939.32		939.46	0.002324	4.18	84.84	94.40	0.52
Main Channel	12197	100-Year	3200.00	937.25	942.06	942.06	943.75	0.008288	14.00	319.65	91.22	1.12
Main Channel	12197	Low Flow	200.00	937.25	939.11	939.11	939.40	0.005003	5.77	61.96	83.37	0.75

HE[redacted]S Pl[redacted]sign [redacted]: Bull[redacted]ash [redacted]: Ma[redacted]nnel ([redacted]nued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	12195	100-Year	3200.00	934.75	941.51		942.04	0.001391	5.83	549.03	92.70	0.42
Main Channel	12195	Low Flow	200.00	934.75	936.37		936.44	0.001304	2.01	99.47	82.42	0.32
Main Channel	11943	100-Year	3200.00	933.85	941.13		941.67	0.001482	5.89	543.45	92.44	0.43
Main Channel	11943	Low Flow	200.00	933.85	936.03		936.09	0.001391	2.03	98.53	82.00	0.33
Main Channel	11932	100-Year	3200.00	933.84	941.16		941.61	0.001277	5.41	591.25	105.27	0.40
Main Channel	11932	Low Flow	200.00	933.84	936.02		936.08	0.001238	1.94	103.01	84.71	0.31
Main Channel	11883	100-Year	3200.00	933.77	941.10		941.55	0.001272	5.40	592.06	105.30	0.40
Main Channel	11883	Low Flow	200.00	933.77	935.96		936.02	0.001202	1.92	103.94	84.76	0.31
Main Channel	11735	100-Year	3200.00	933.60	940.90		941.36	0.001287	5.43	589.70	105.21	0.40
Main Channel	11735	Low Flow	200.00	933.60	935.78		935.84	0.001241	1.94	102.94	84.71	0.31
Main Channel	11550	100-Year	3200.00	933.37	940.69		941.12	0.001221	5.23	611.86	111.62	0.39
Main Channel	11550	Low Flow	200.00	933.37	935.55		935.61	0.001219	1.92	104.00	85.91	0.31
Main Channel	11425	100-Year	3200.00	933.22	940.54		940.97	0.001223	5.23	611.50	111.60	0.39
Main Channel	11425	Low Flow	200.00	933.22	935.40		935.46	0.001230	1.93	103.72	85.89	0.31
Main Channel	11300	100-Year	3200.00	933.07	940.39		940.81	0.001226	5.24	611.01	111.58	0.39
Main Channel	11300	Low Flow	200.00	933.07	935.24		935.30	0.001246	1.94	103.29	85.87	0.31
Main Channel	11200	100-Year	3200.00	932.95	940.22		940.68	0.001311	5.46	586.07	105.07	0.41
Main Channel	11200	Low Flow	200.00	932.95	935.12		935.18	0.001281	1.96	101.93	84.66	0.32
Main Channel	11100	100-Year	3200.00	932.83	940.09	937.32	940.55	0.001321	5.47	584.67	105.02	0.41
Main Channel	11100	Low Flow	200.00	932.83	934.98	934.34	935.04	0.001320	1.98	100.98	84.62	0.32

Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

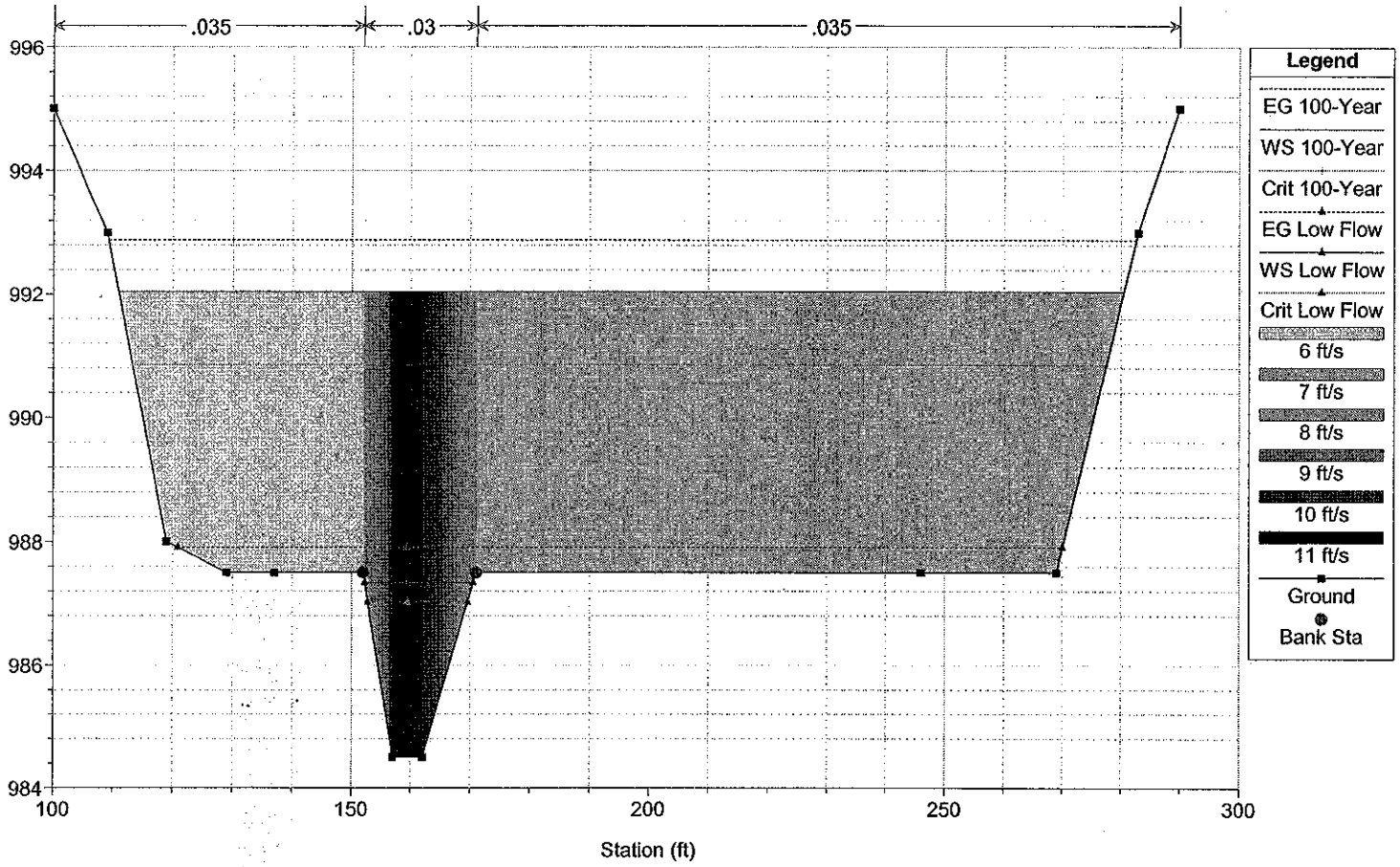
Geom: Design Geometry Flow: 100-Year Flow



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

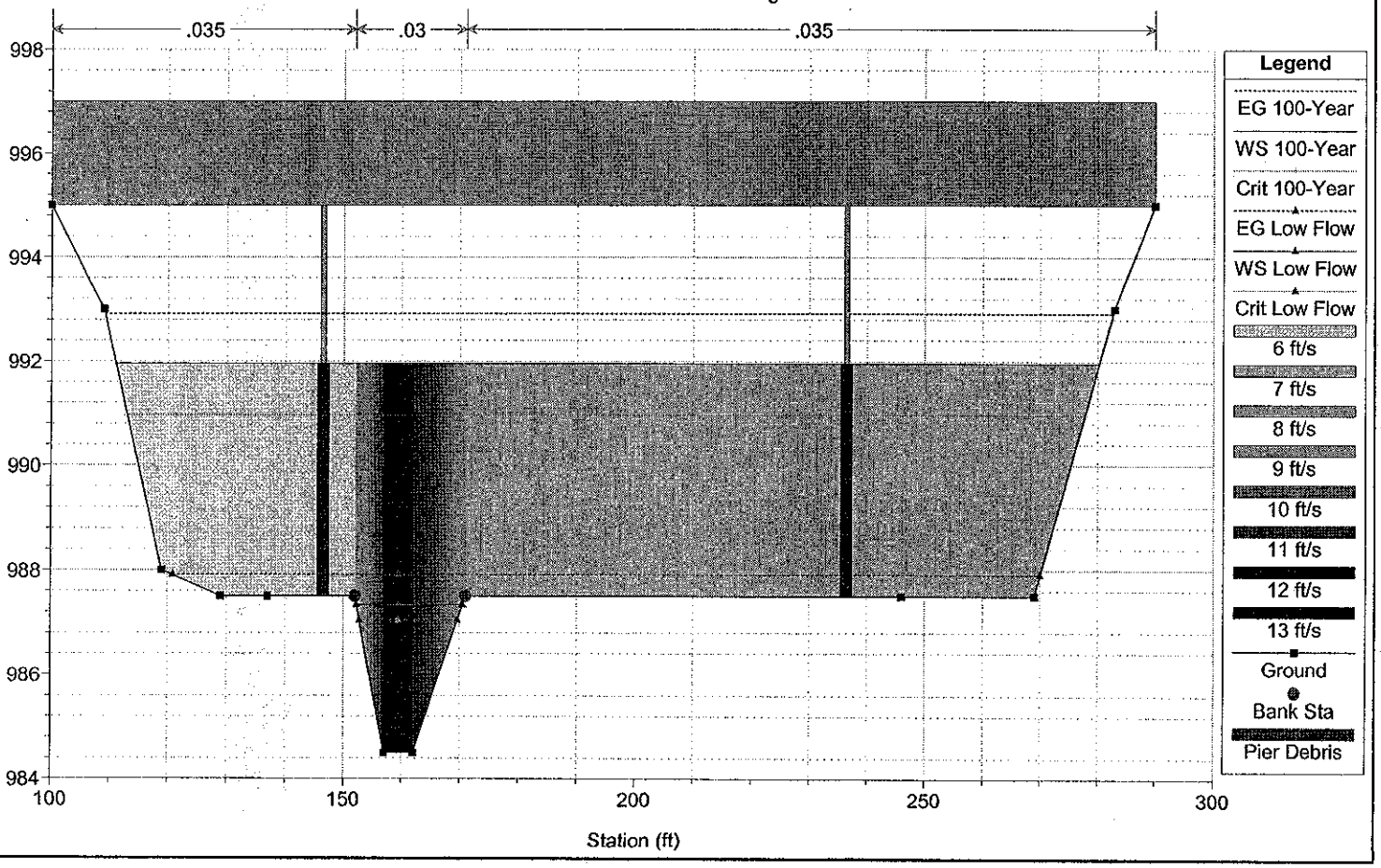
RS = 27173 U/S of I-10 West Bound Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

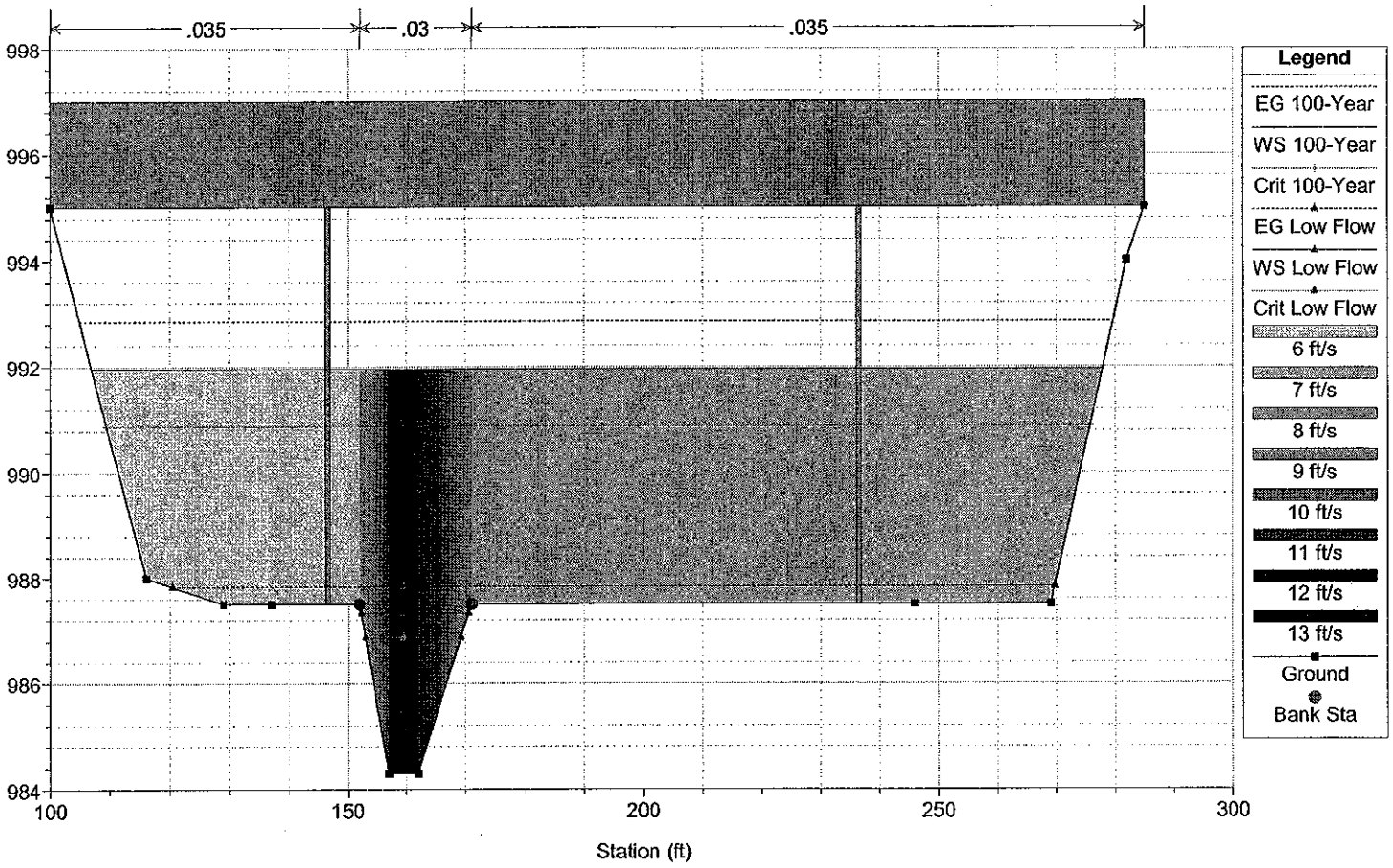
RS = 27150 BR I-10 Bridge WB



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

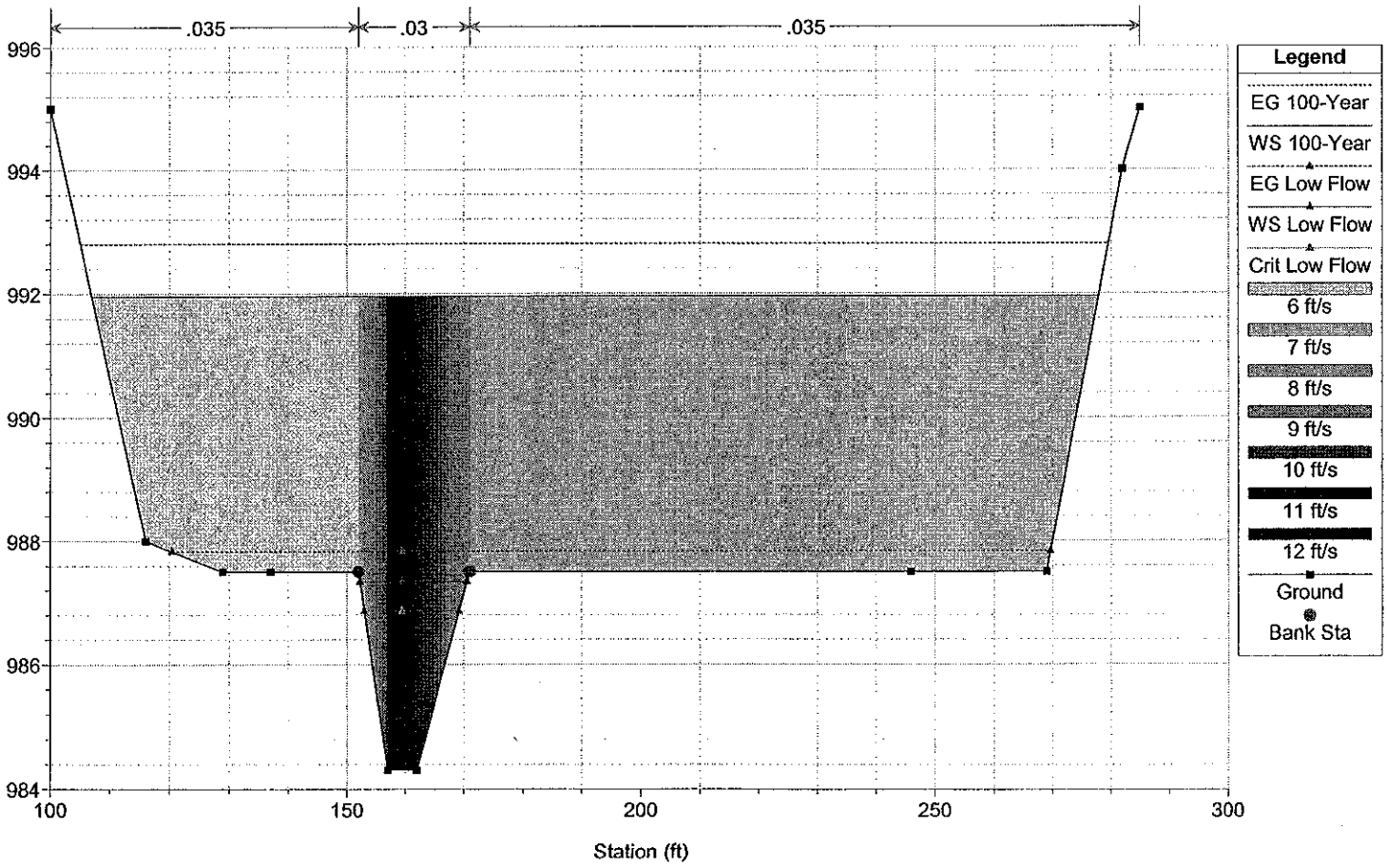
RS = 27150 BR I-10 Bridge WB



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

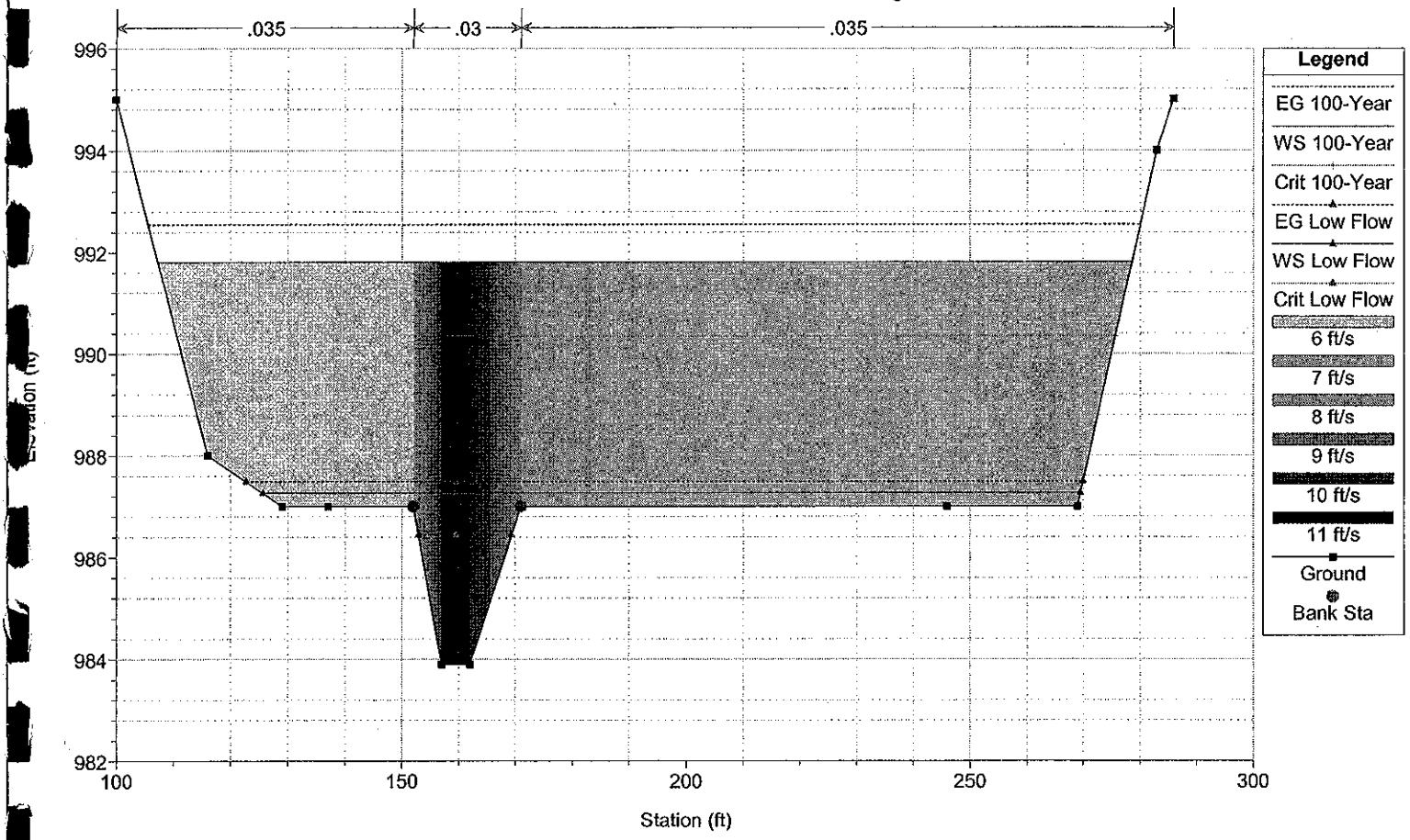
RS = 27127 D/S of I-10 West Bound Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

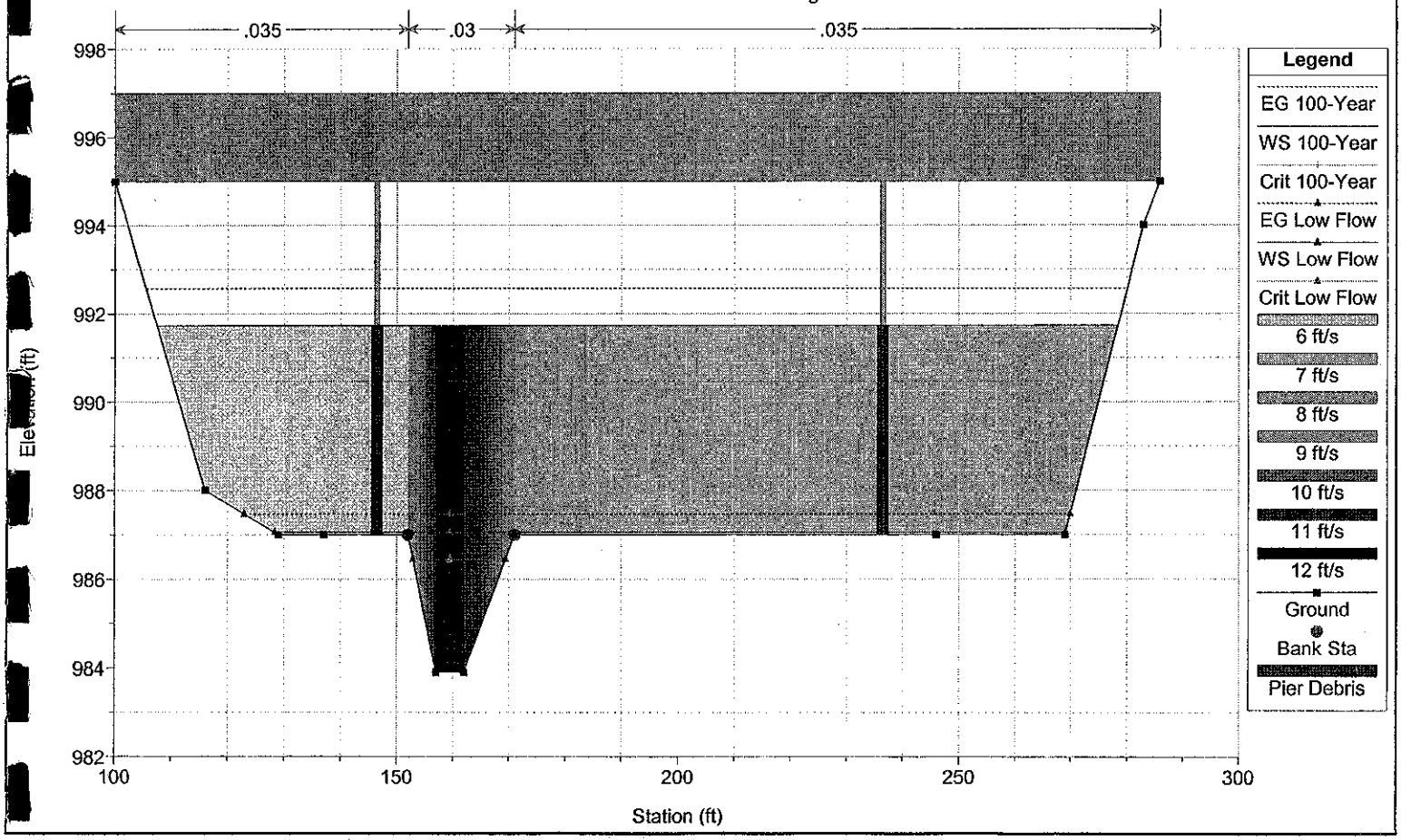
RS = 27057 U/S of I-10 East Bound Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

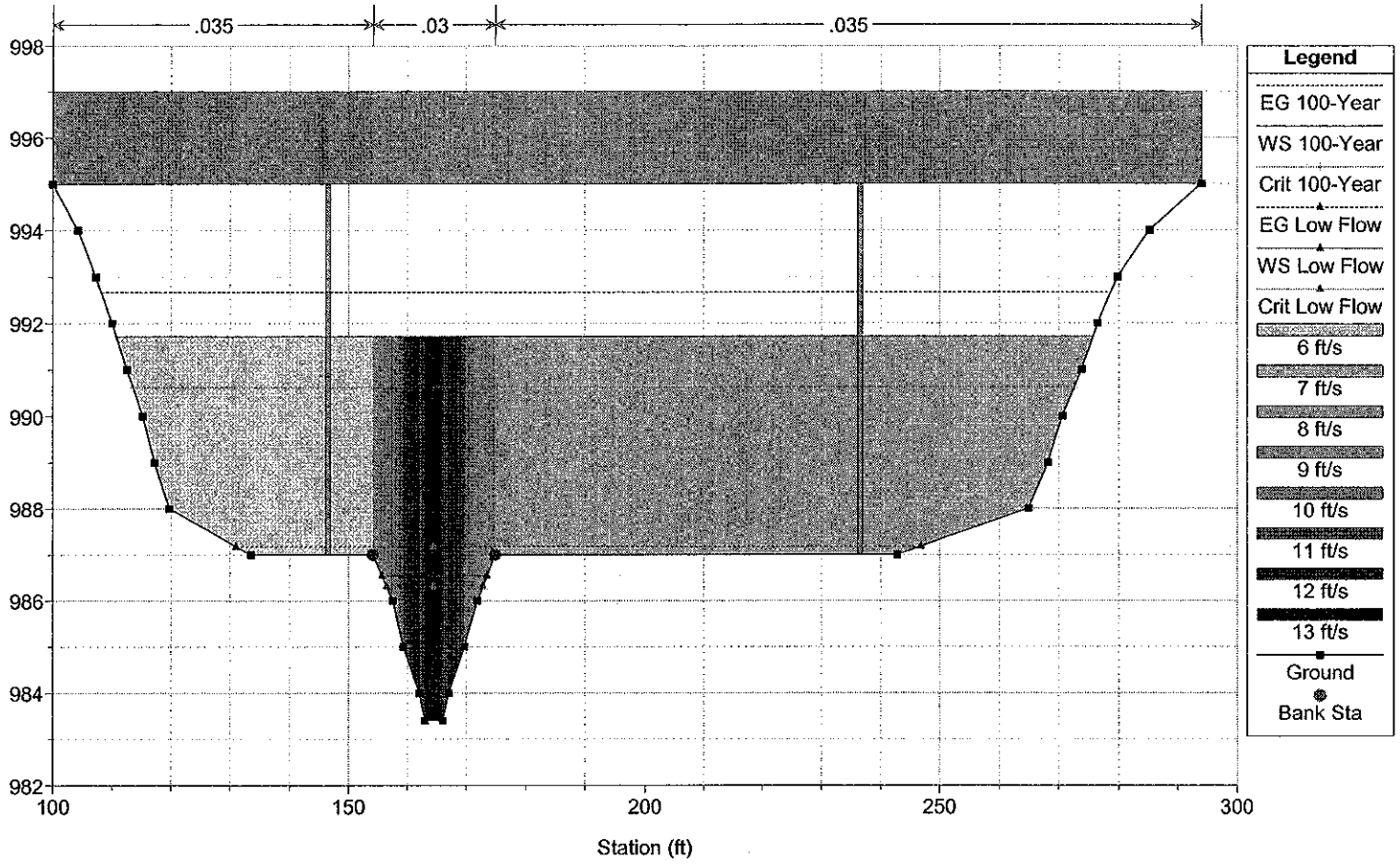
RS = 27034 BR I-10 Bridge EB



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

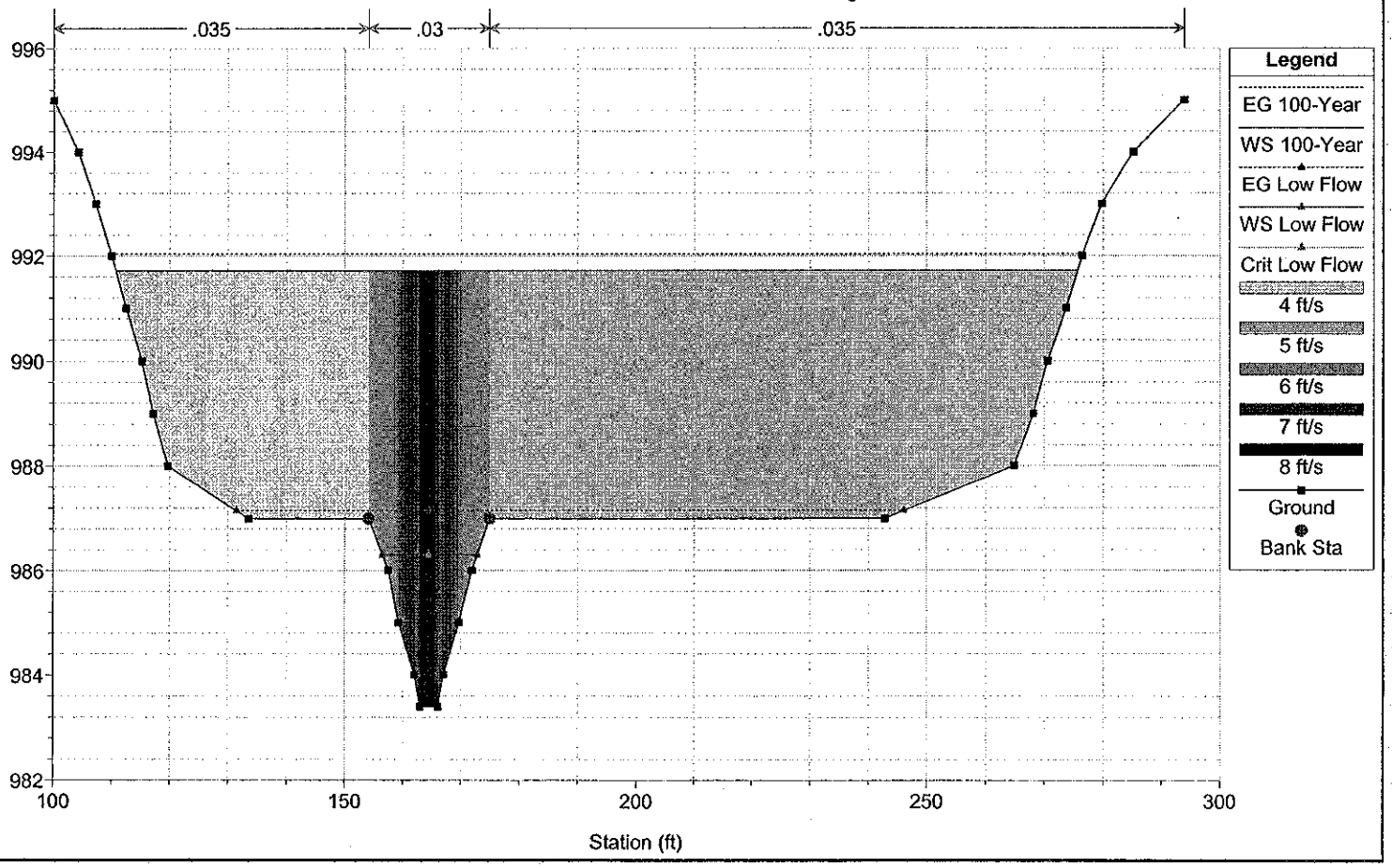
RS = 27034 BR I-10 Bridge EB



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

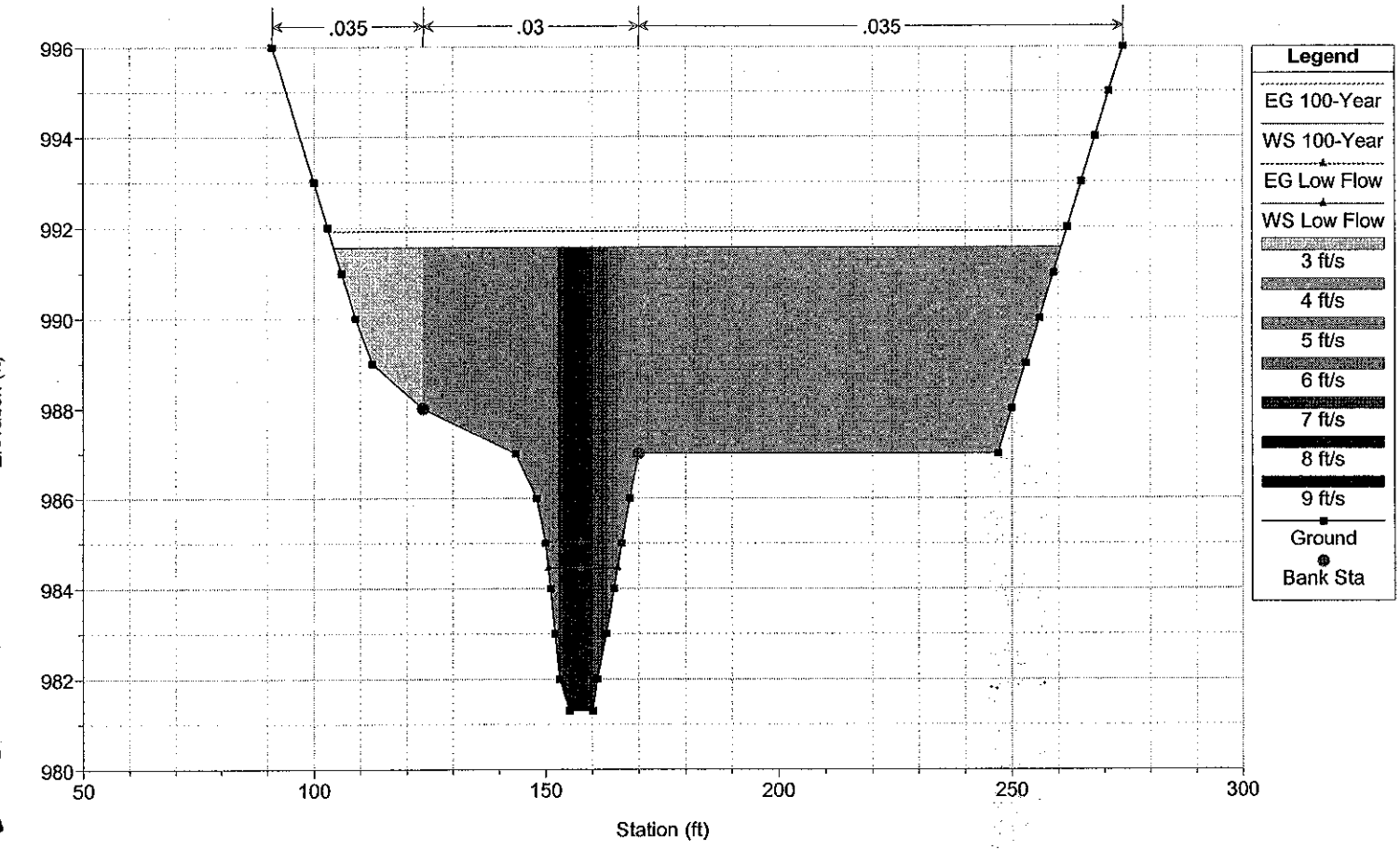
RS = 27011 D/S of I-10 East Bound Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

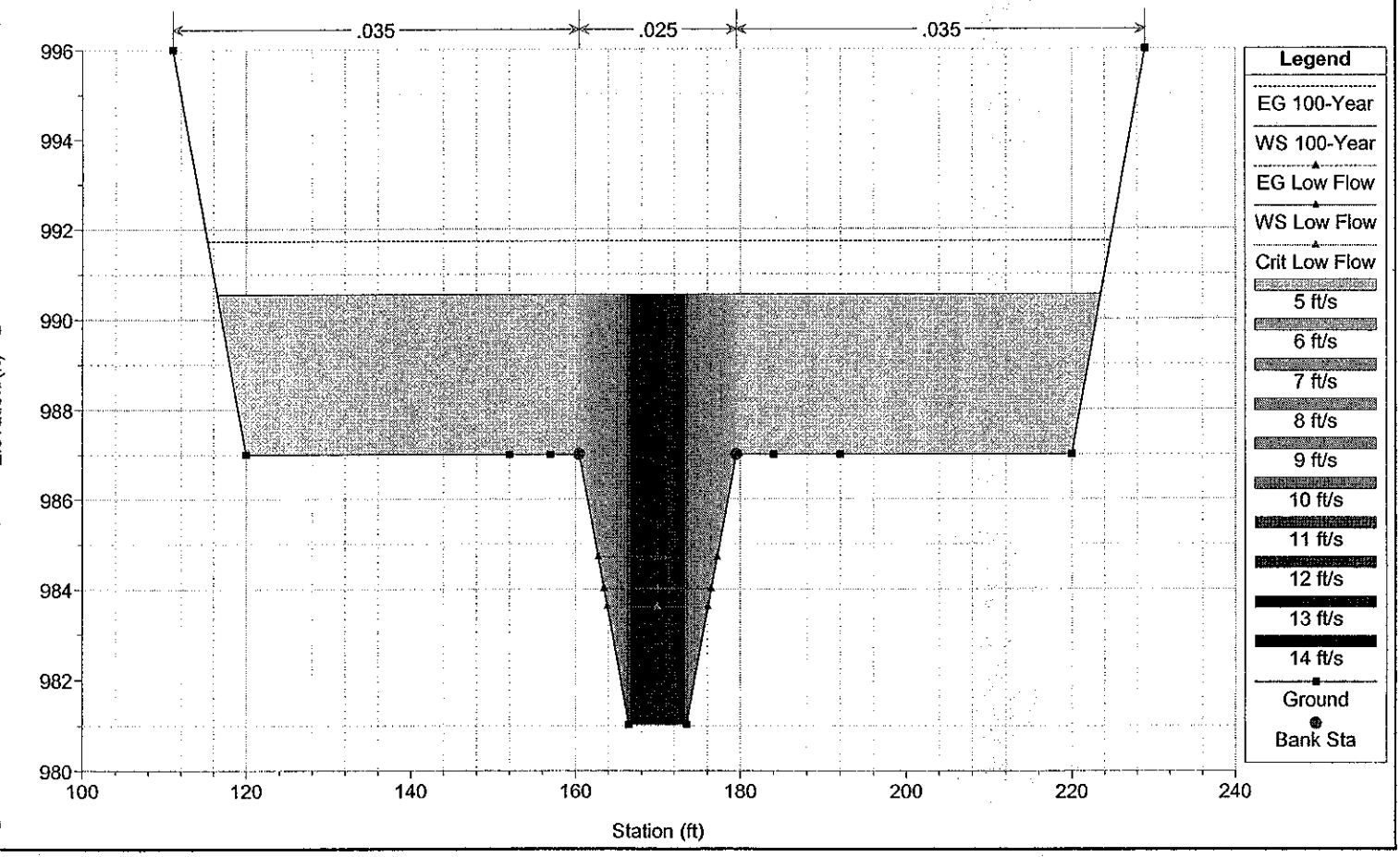
RS = 26936



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

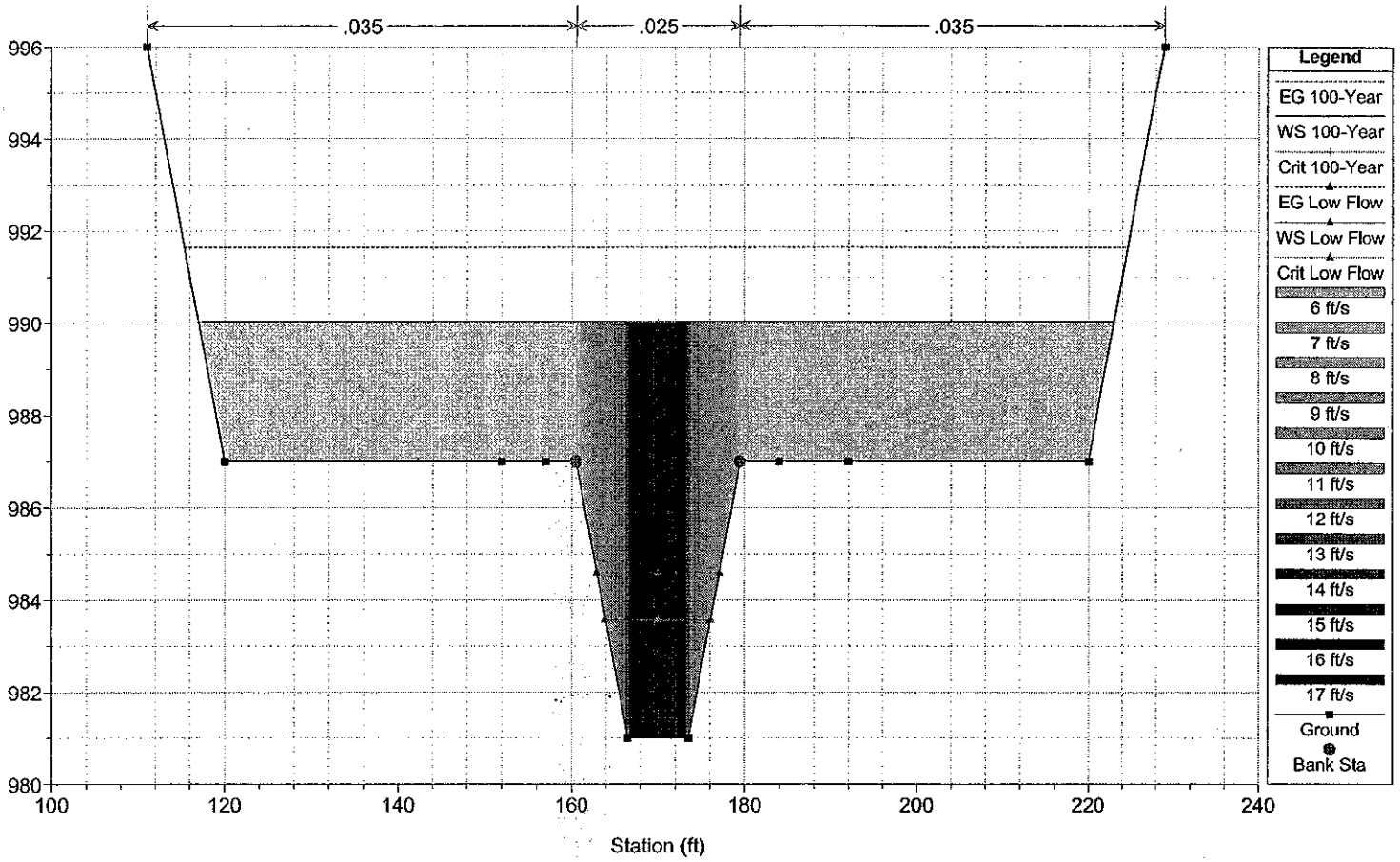
RS = 26883.44



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

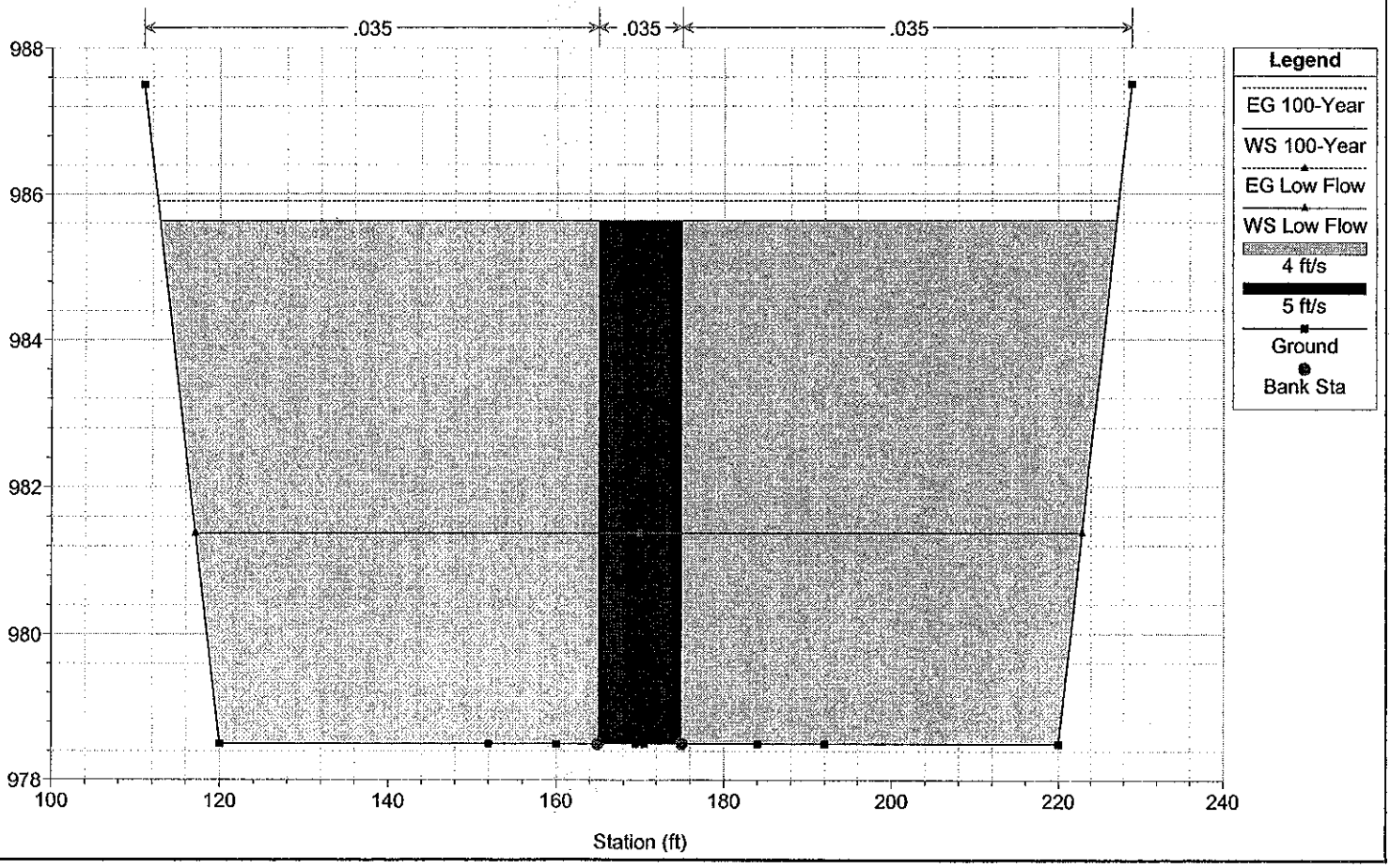
RS = 26871



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

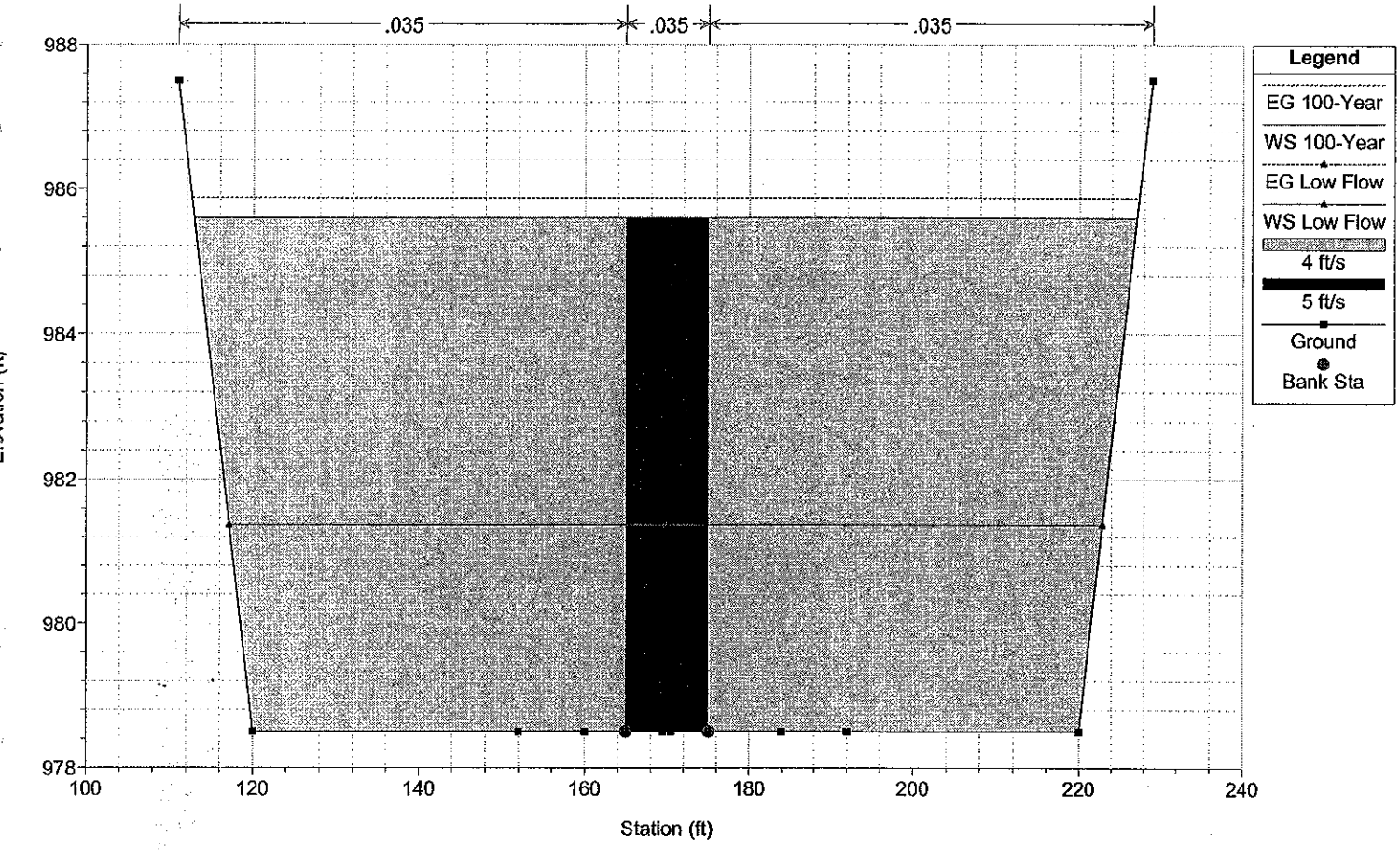
RS = 26862



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

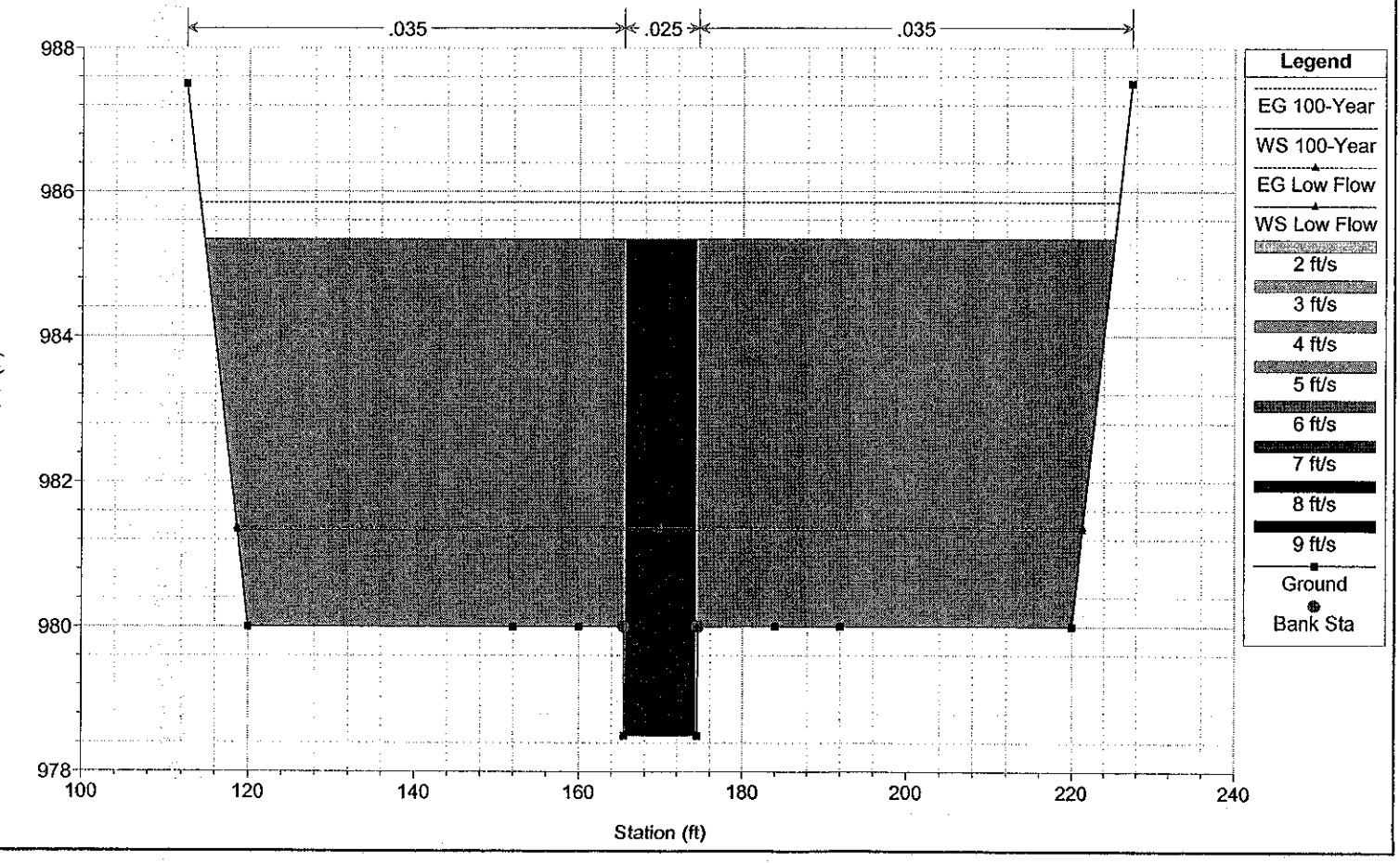
RS = 26822



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

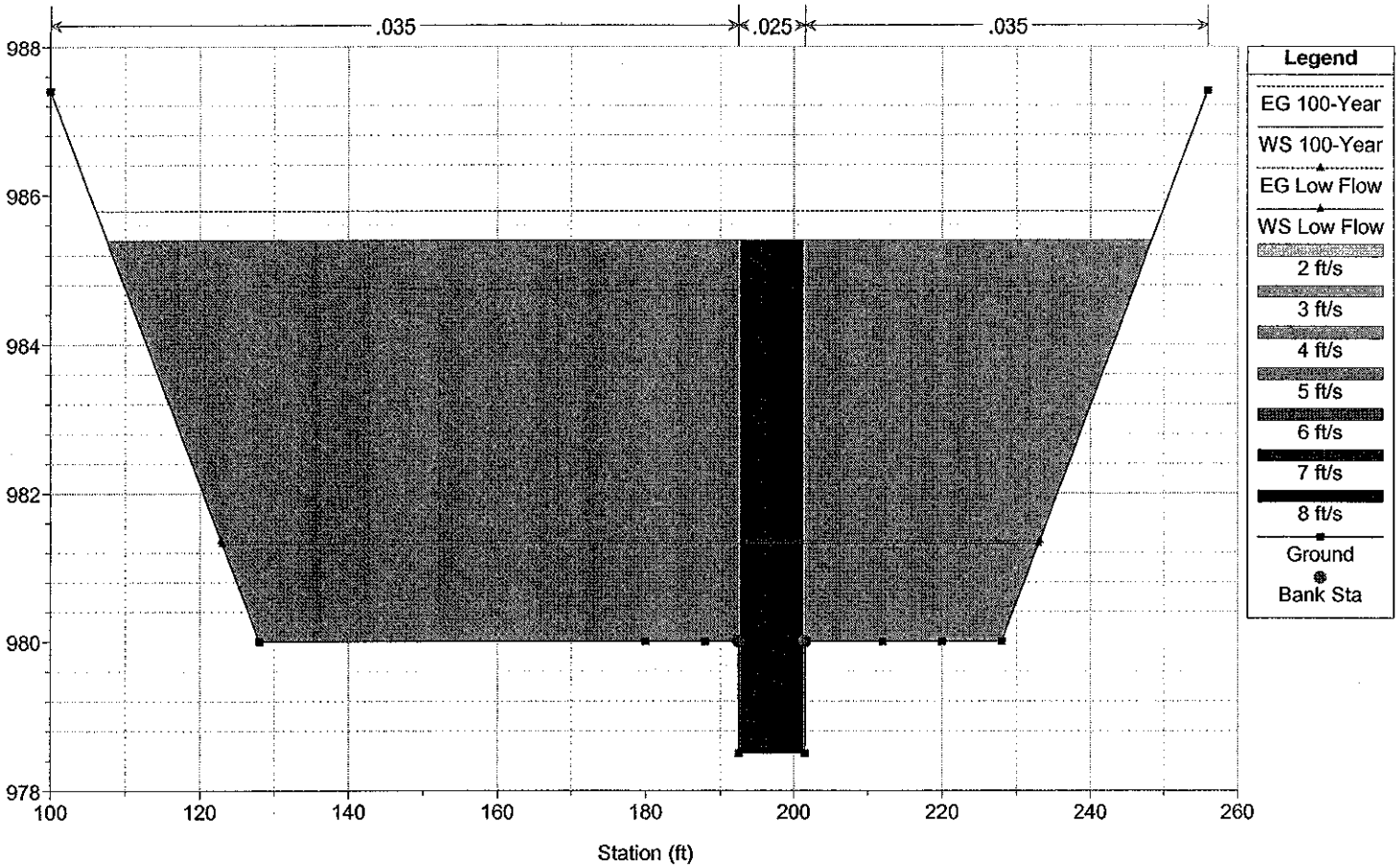
RS = 26821



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

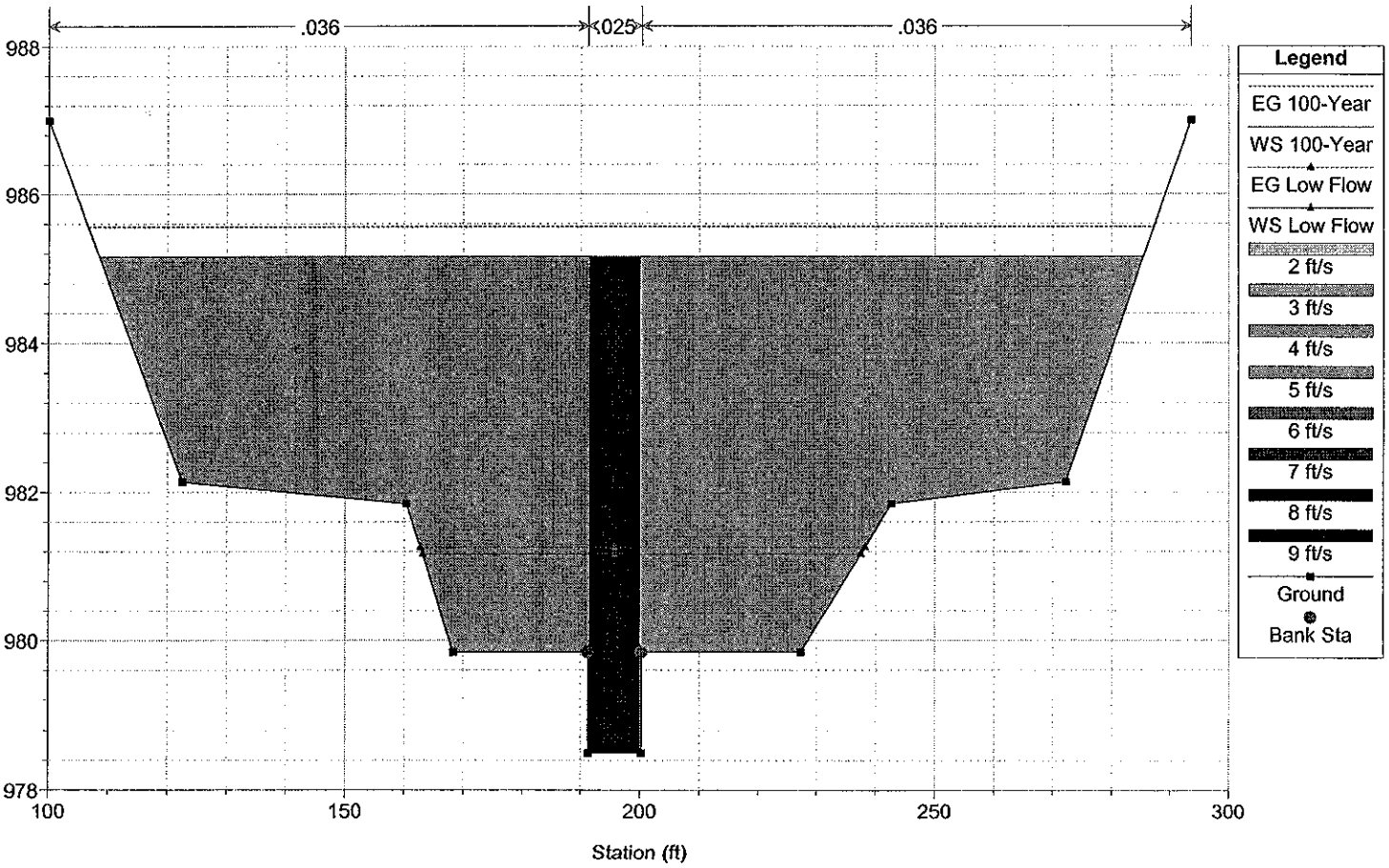
RS = 26806.44 End drop



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

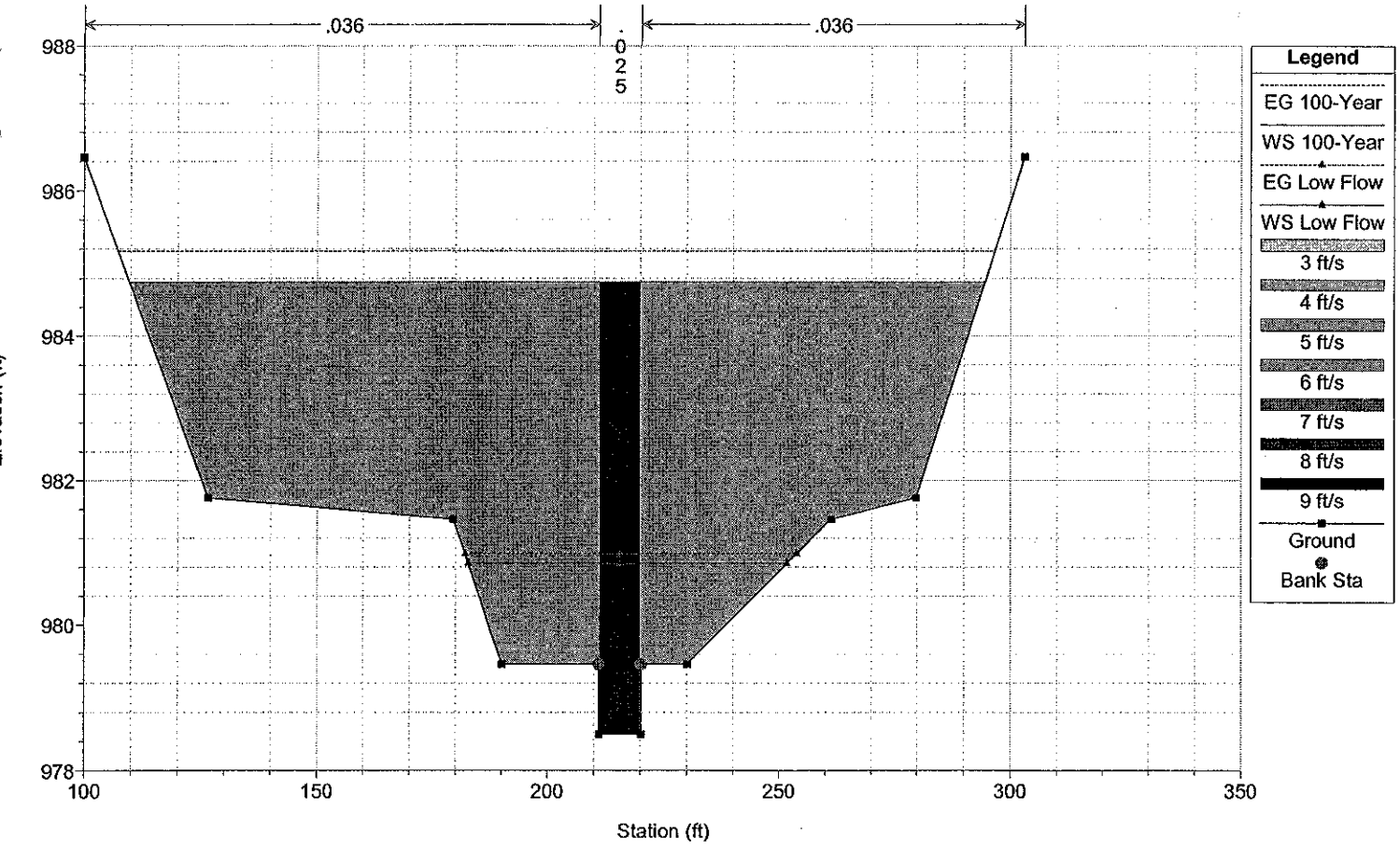
RS = 26677.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

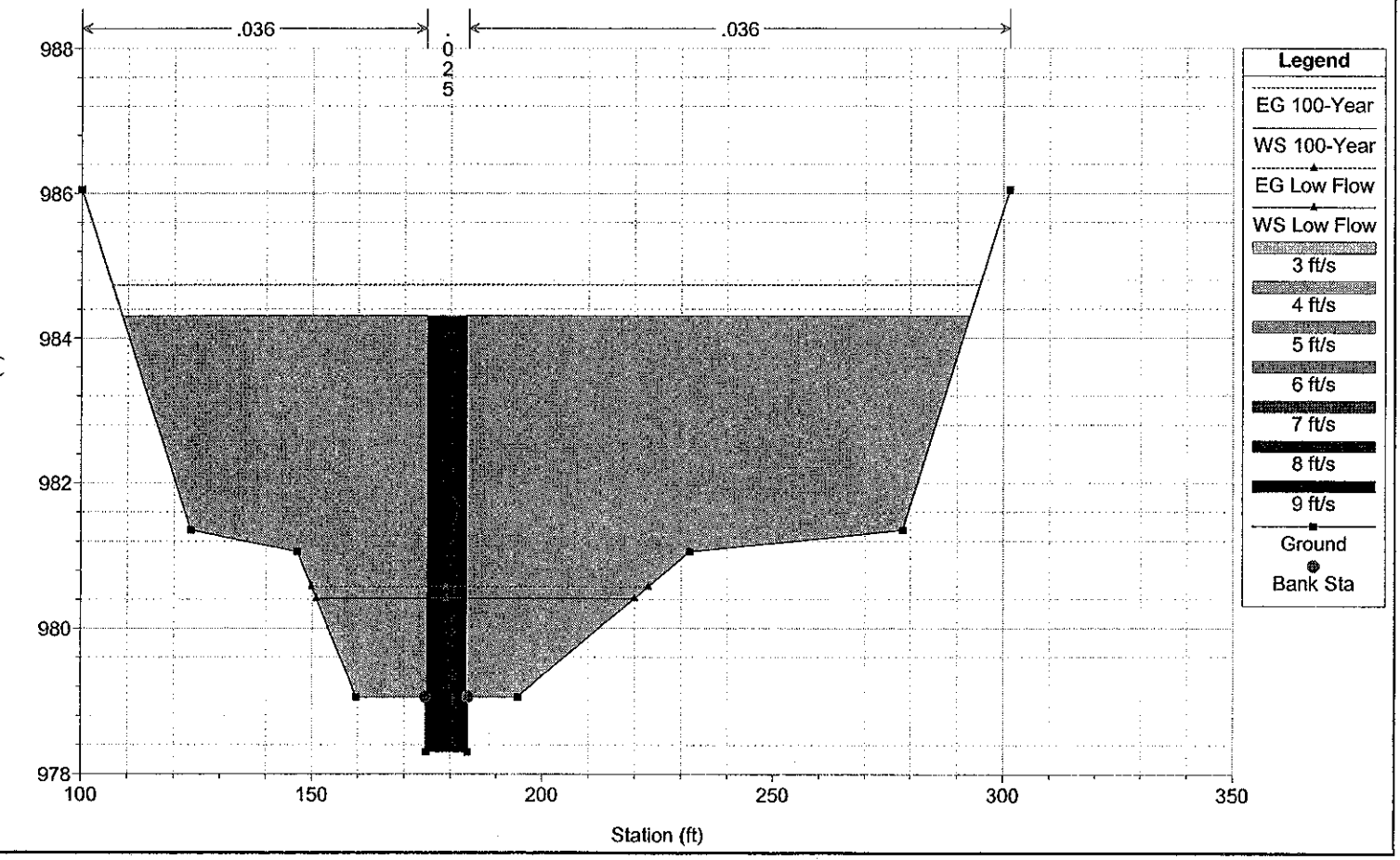
RS = 26495.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

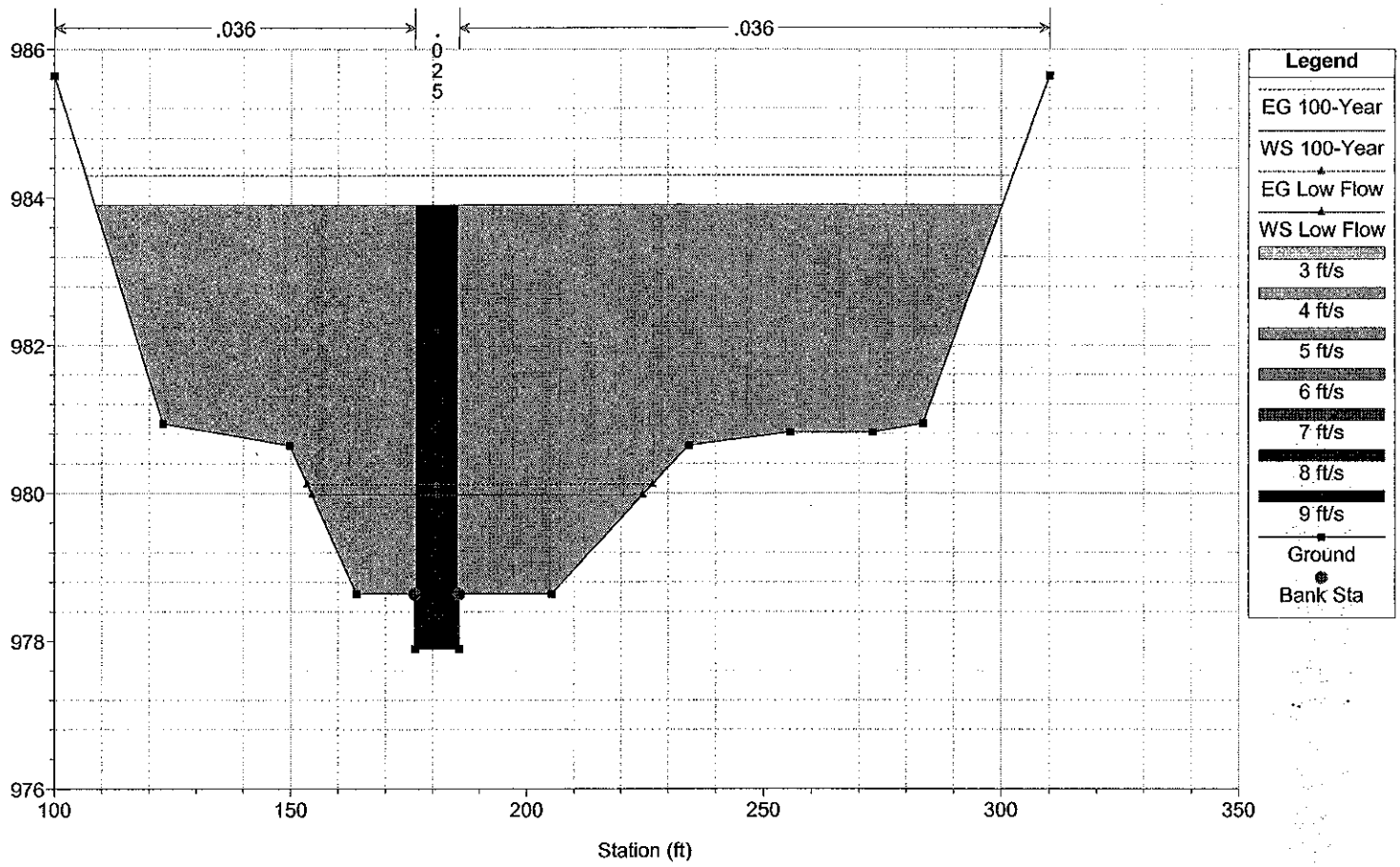
RS = 26300.4



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

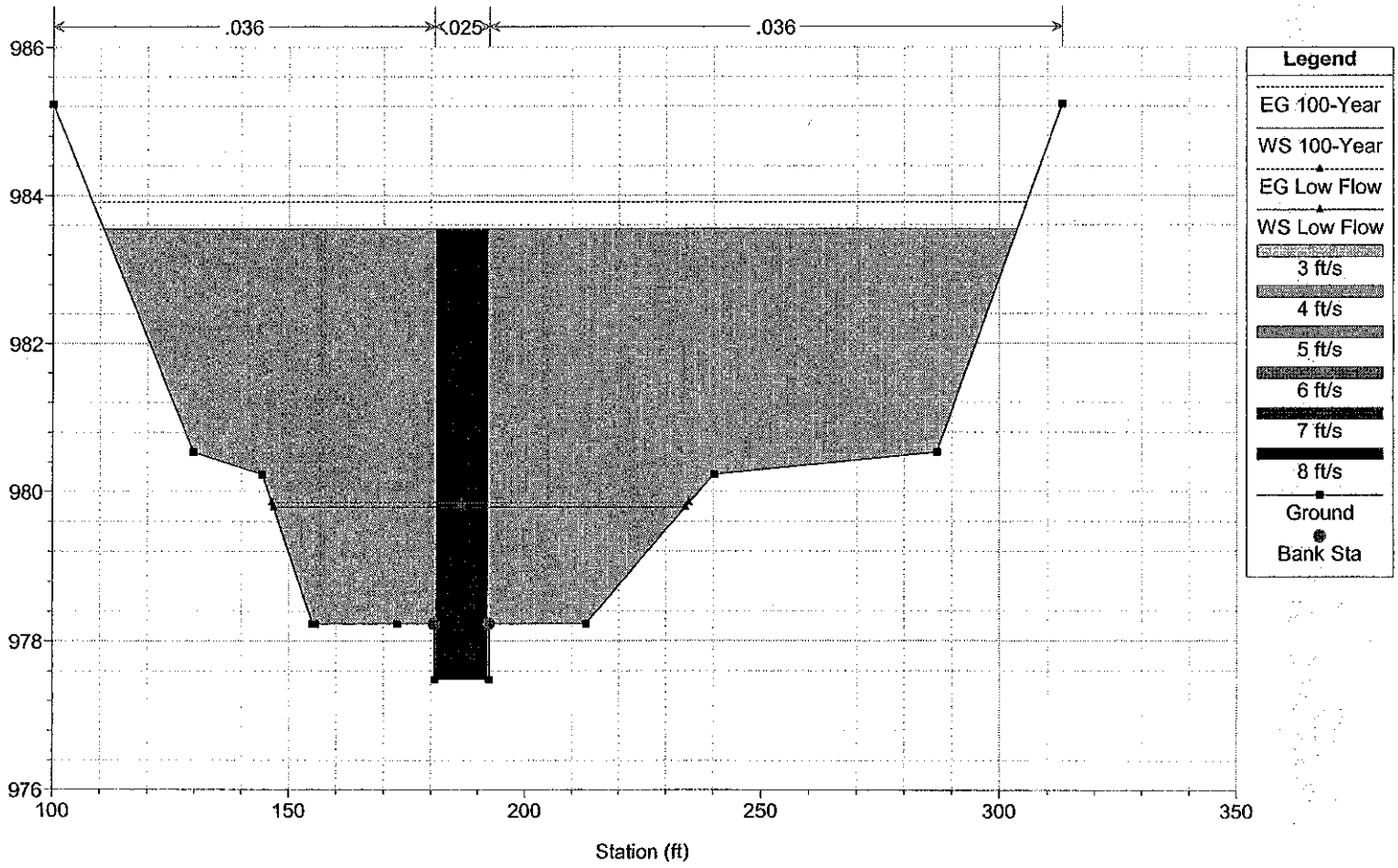
RS = 26101.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

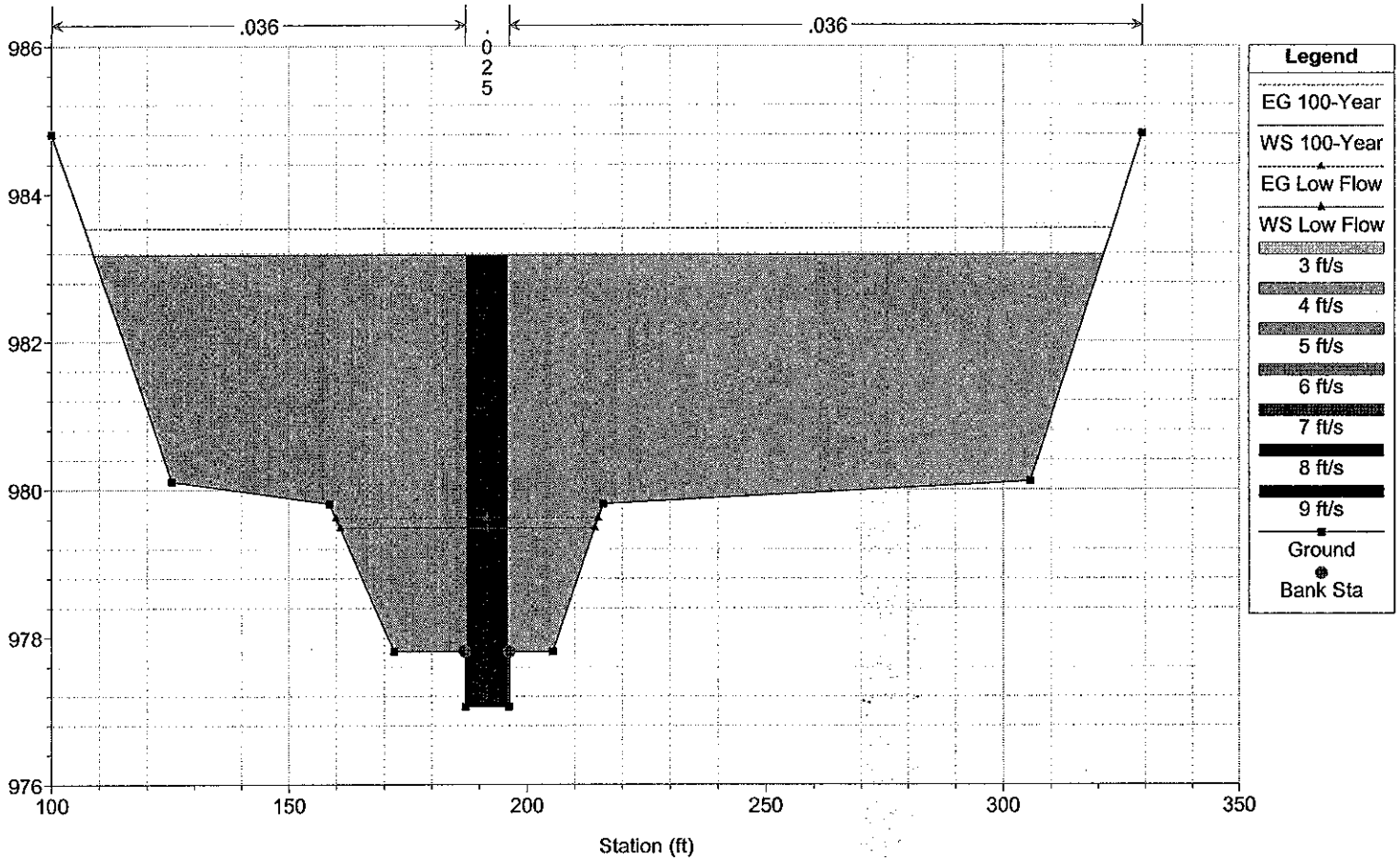
RS = 25901.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

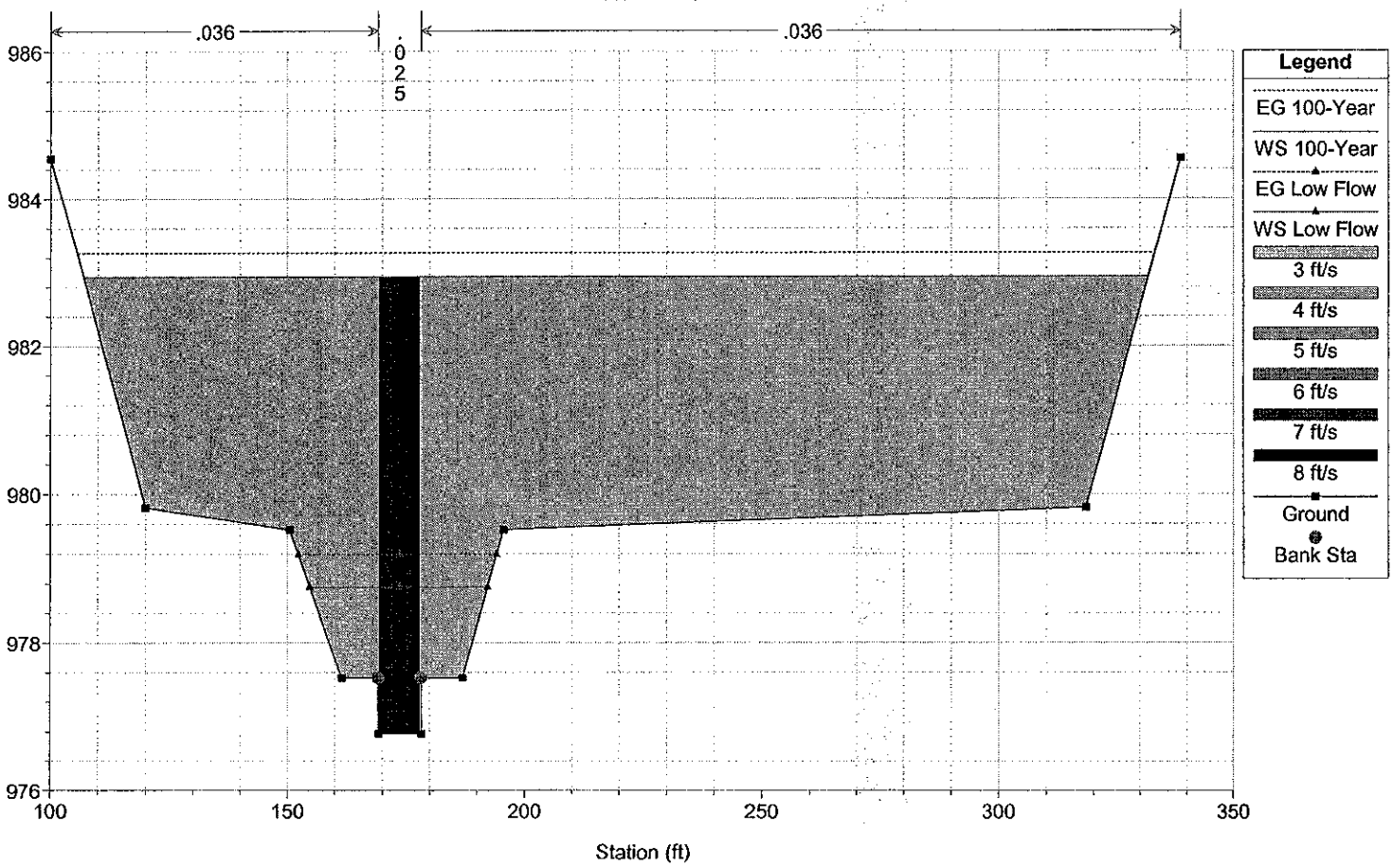
RS = 25701.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

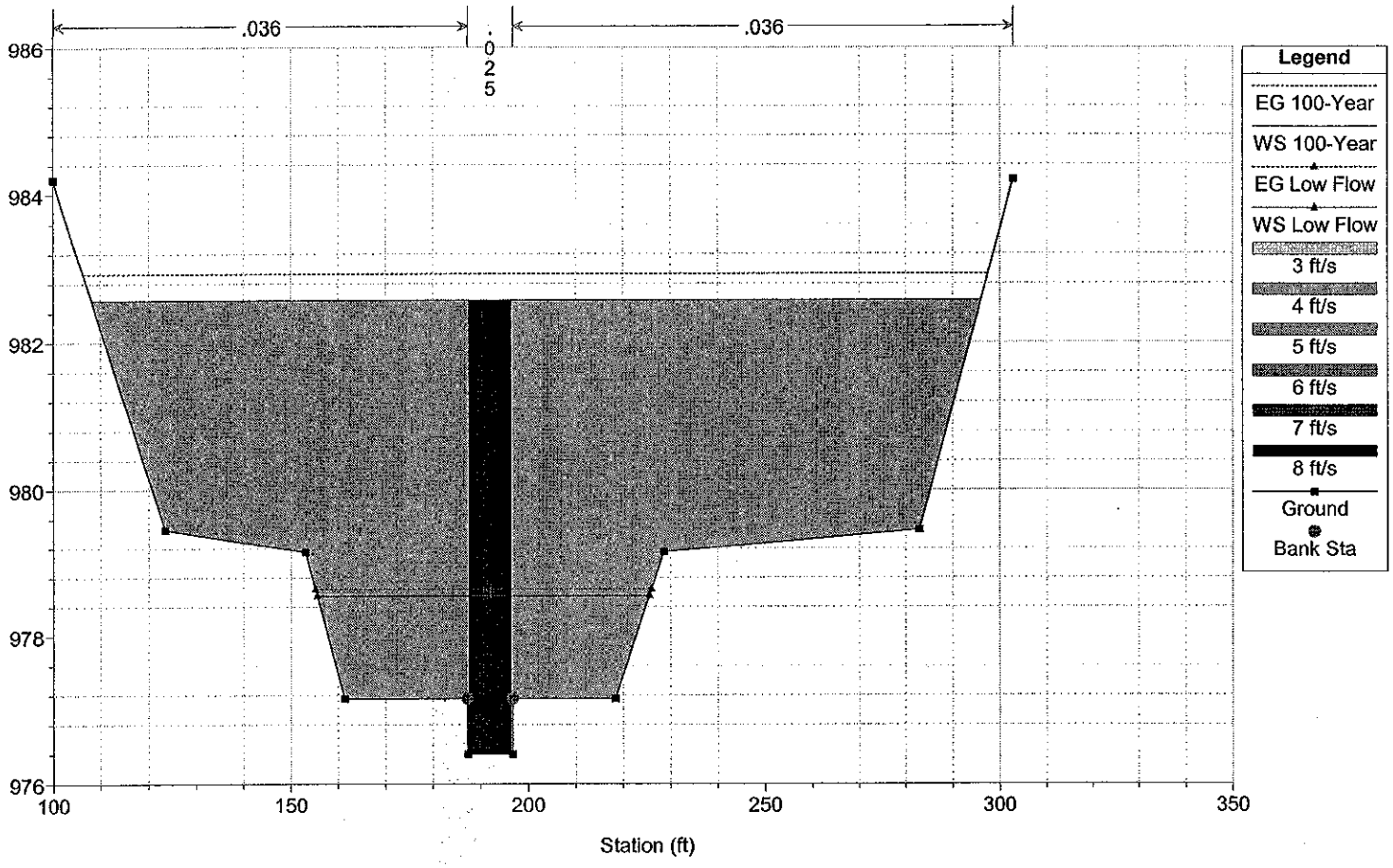
RS = 25558.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

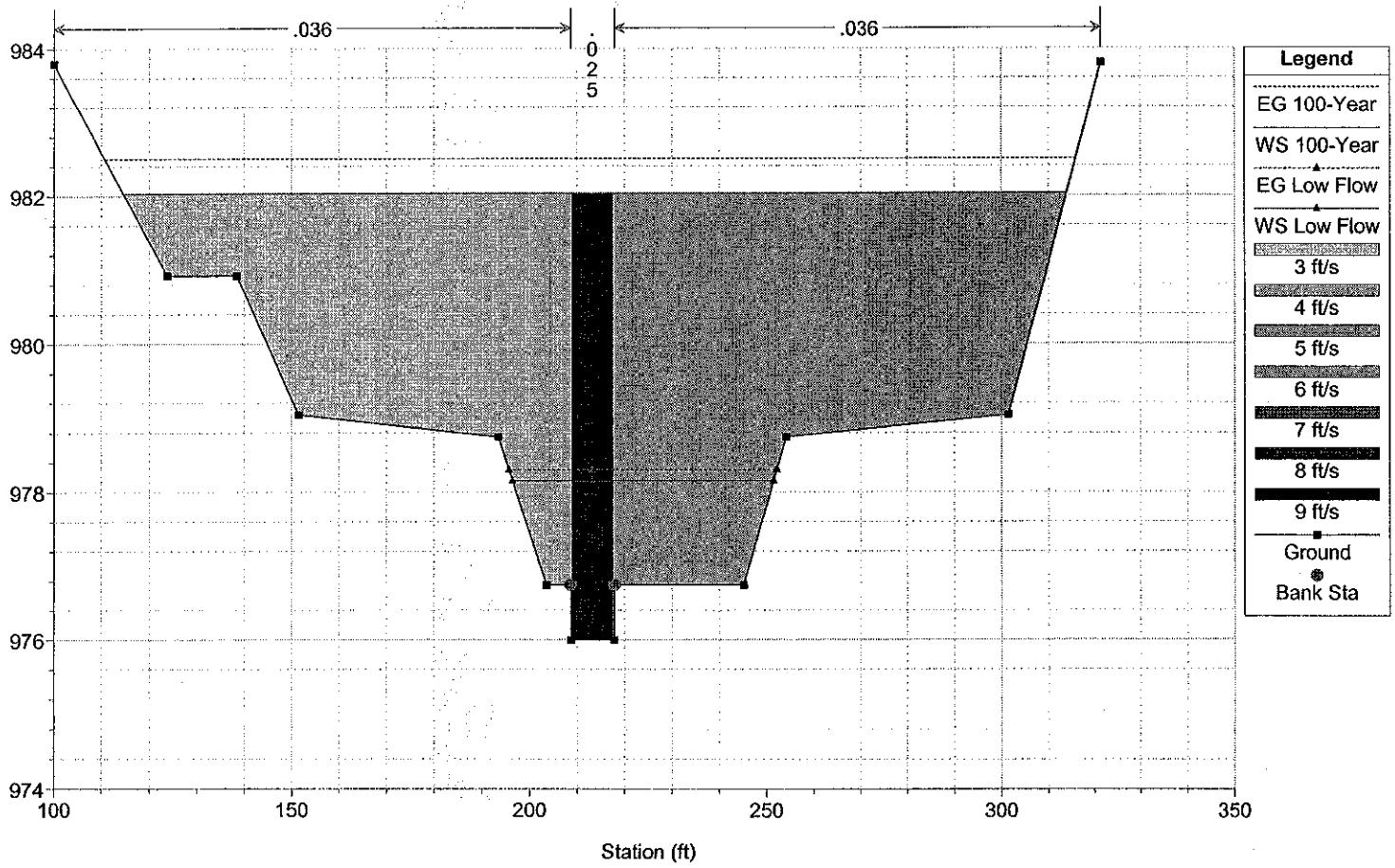
RS = 25379.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

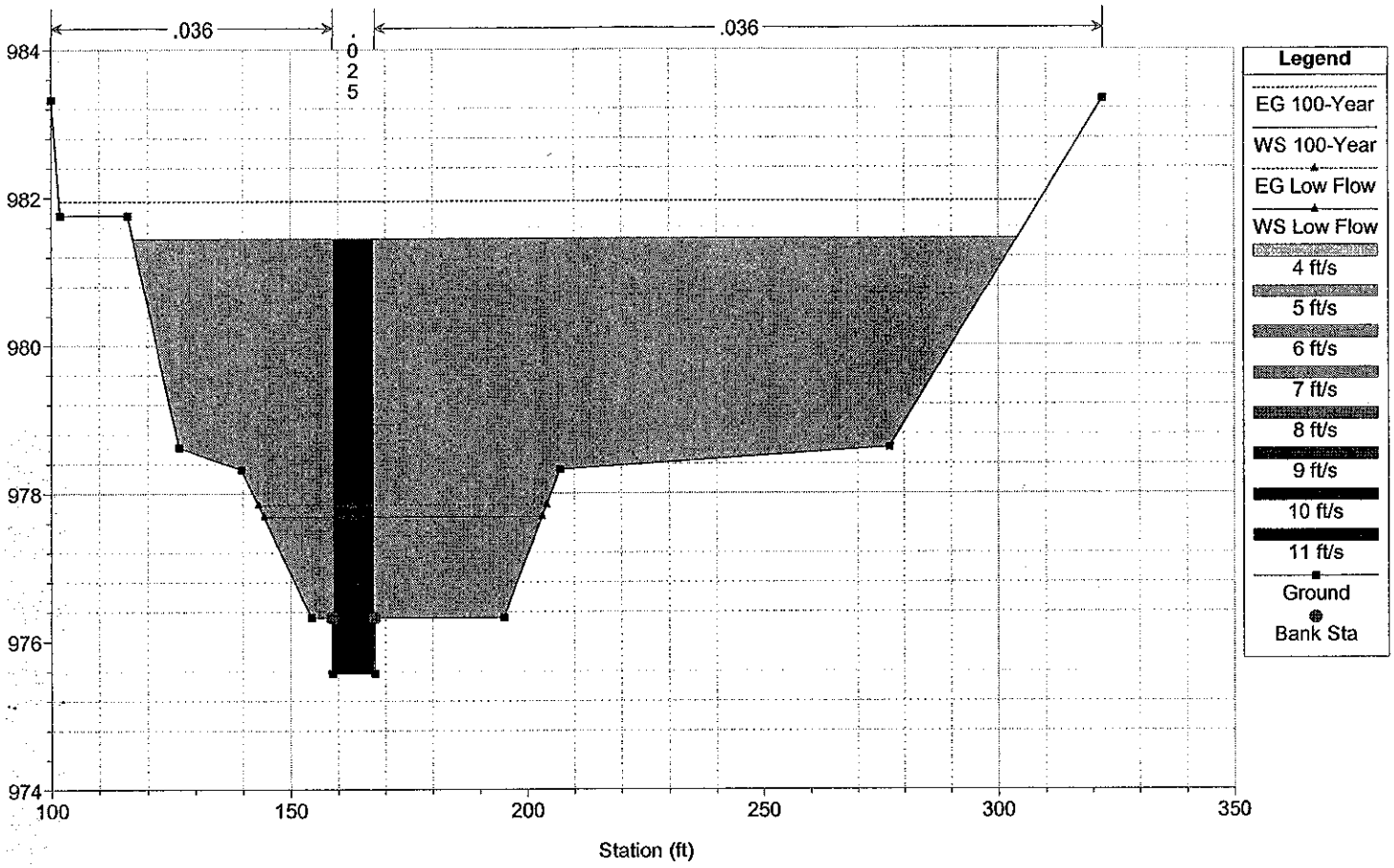
RS = 25182.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

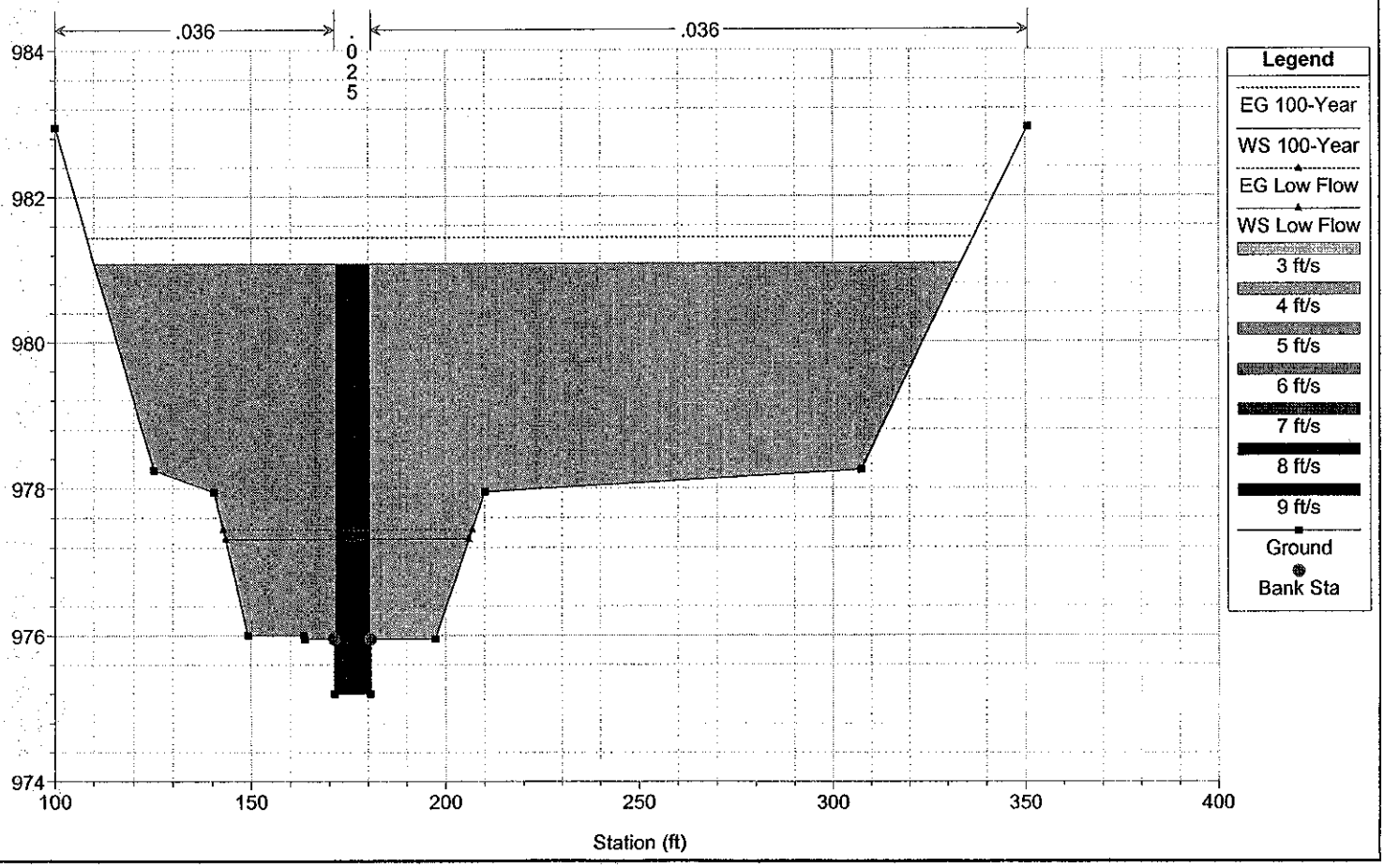
RS = 24978.4



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

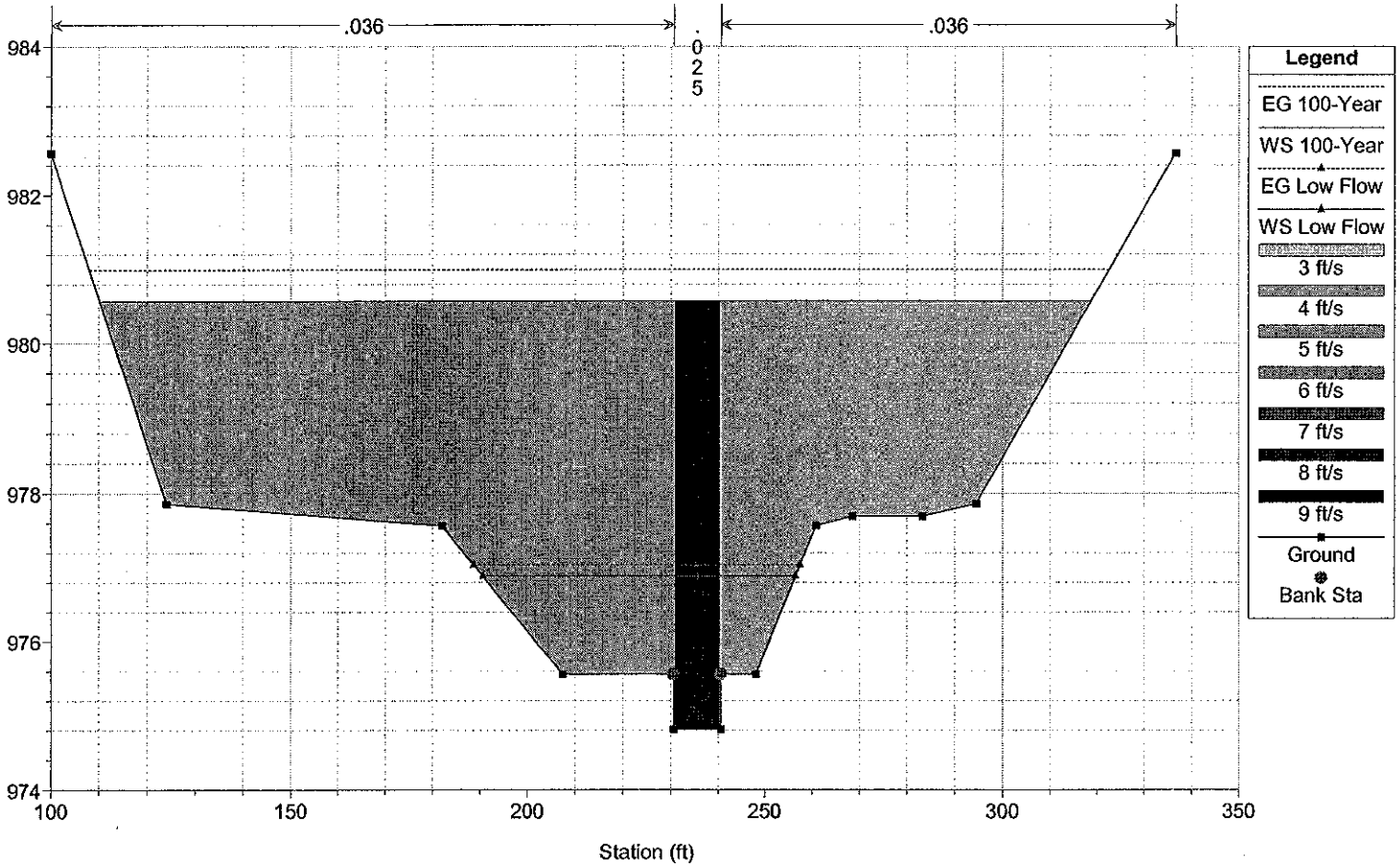
RS = 24802.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

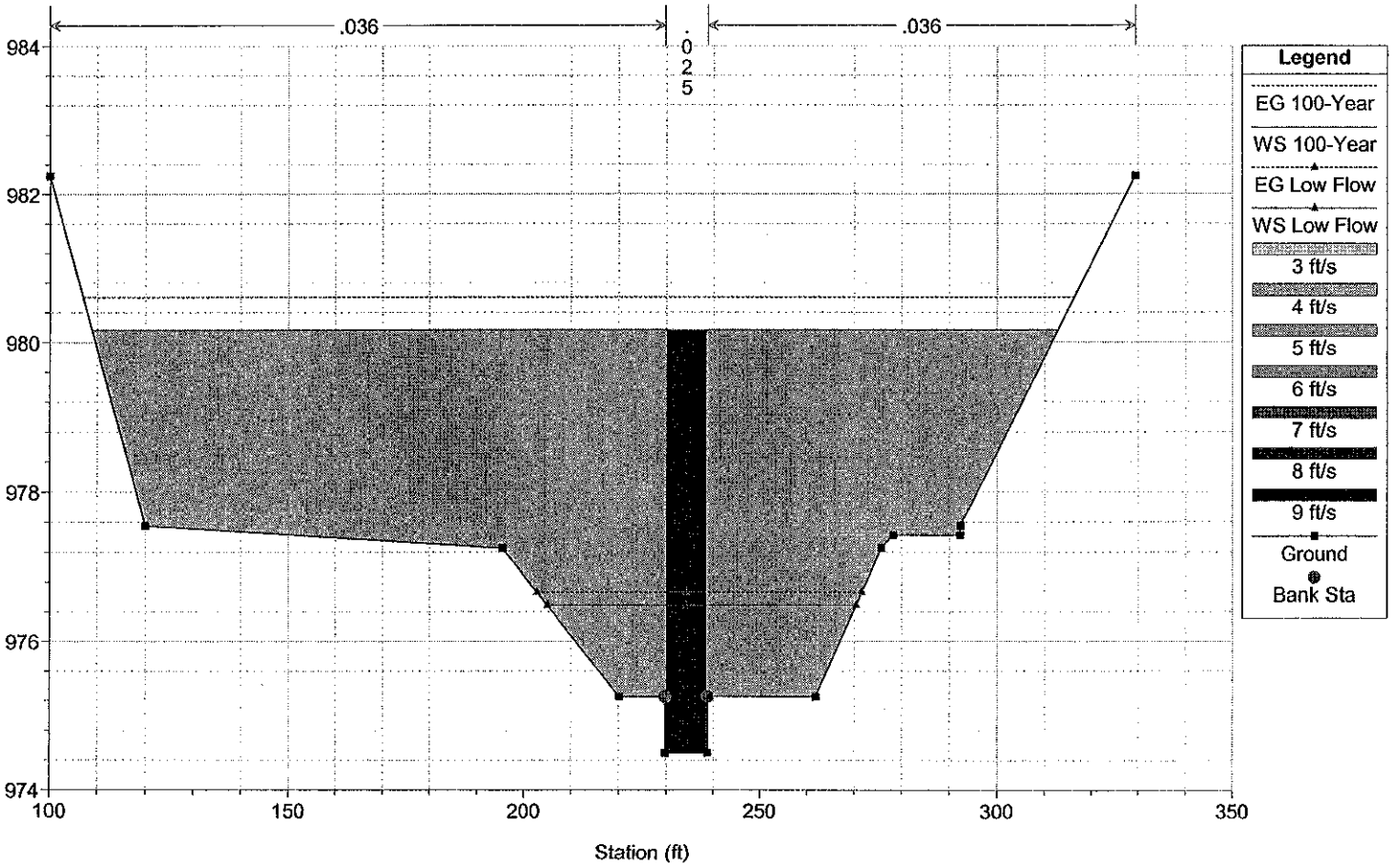
RS = 24611.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

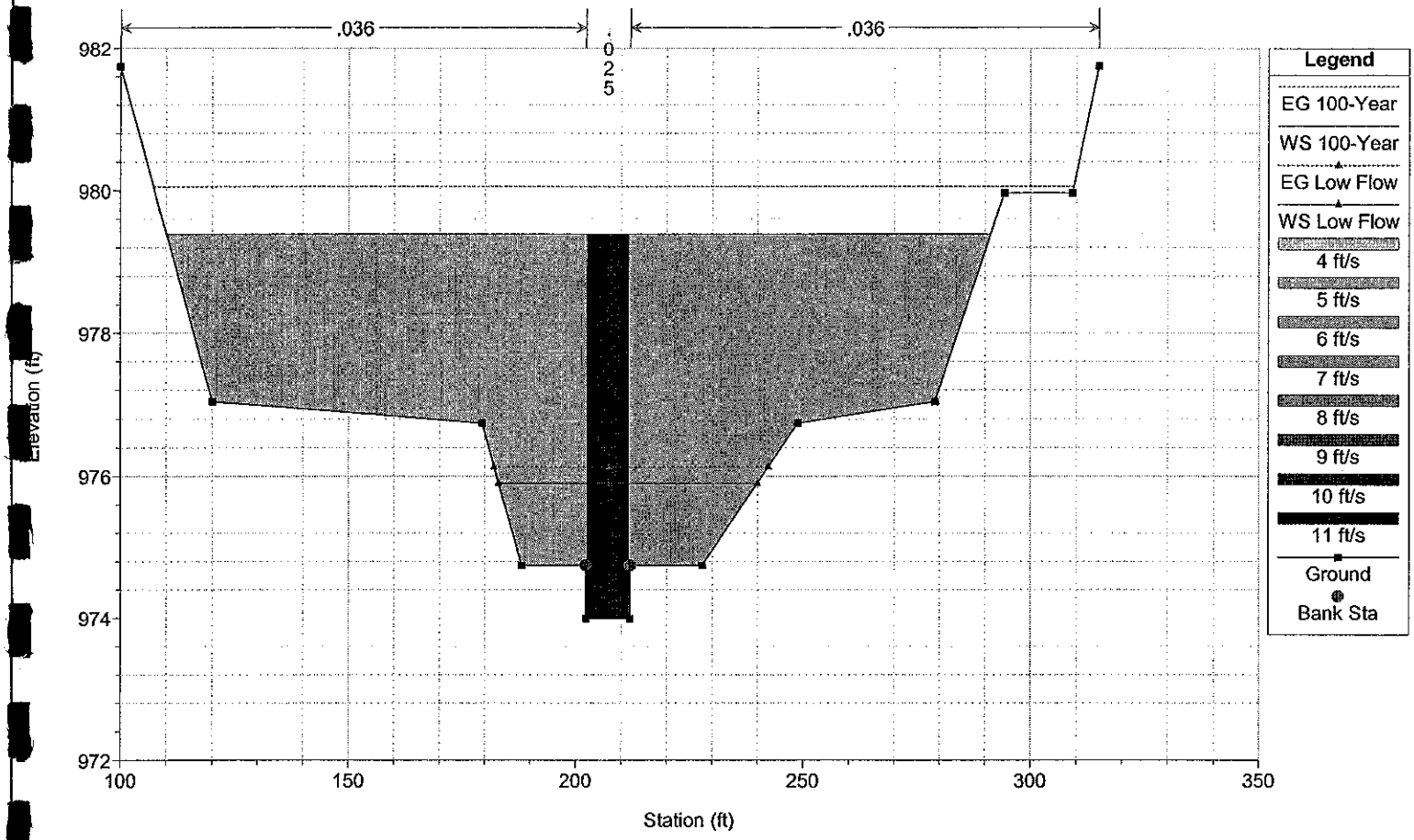
RS = 24462.45 Profile change at Southwest Specialty Foods sewer crossing



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

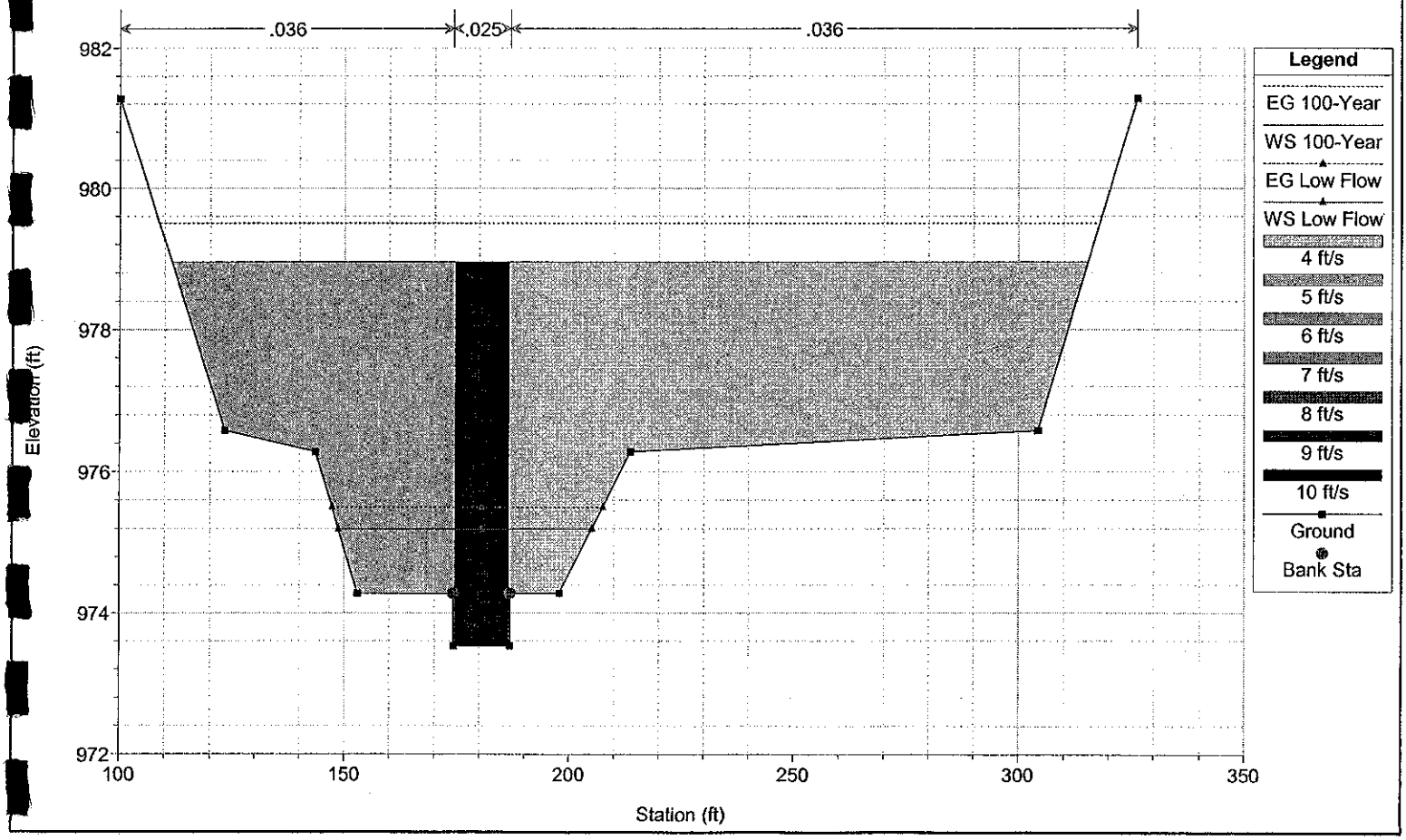
RS = 24300.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

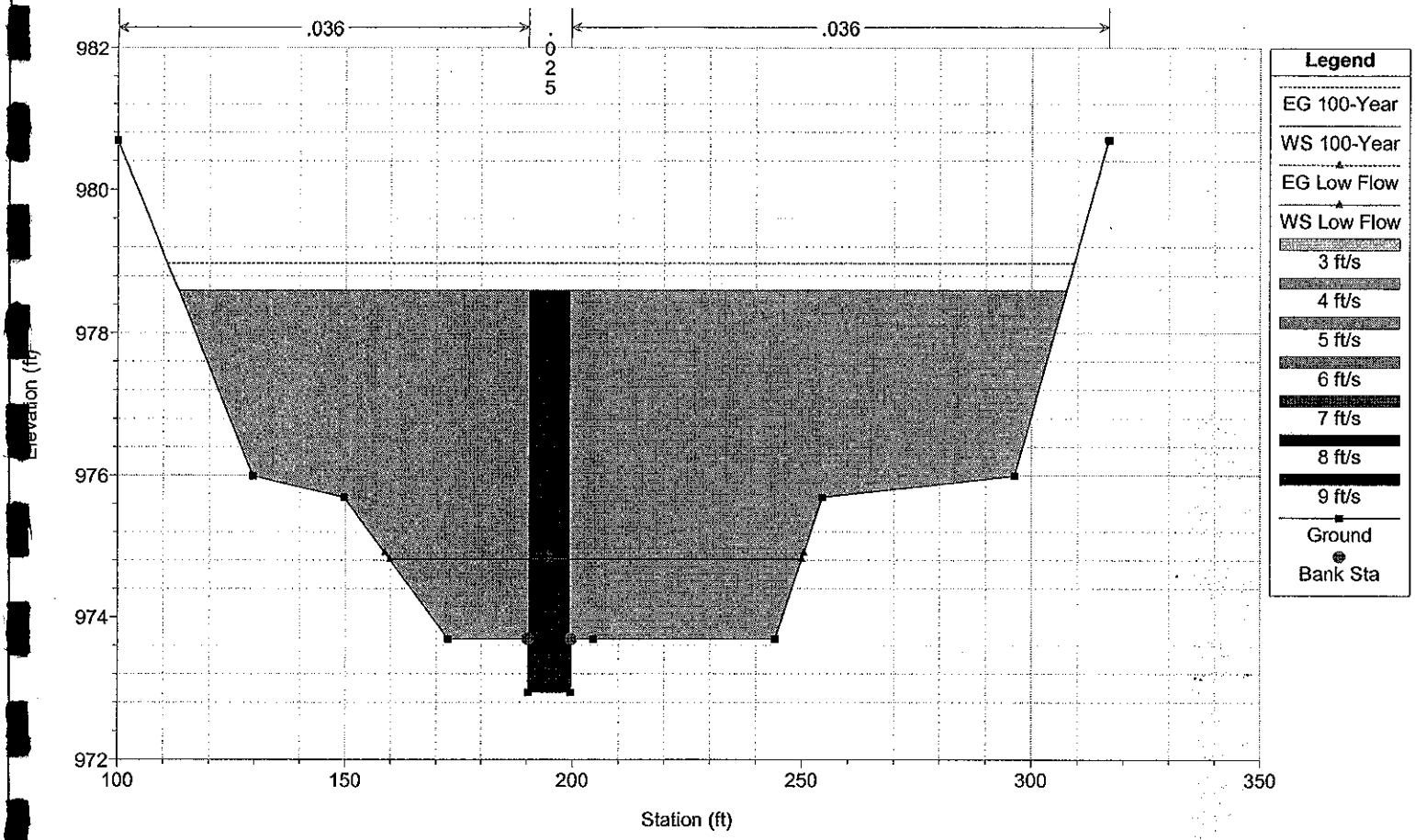
RS = 24152.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

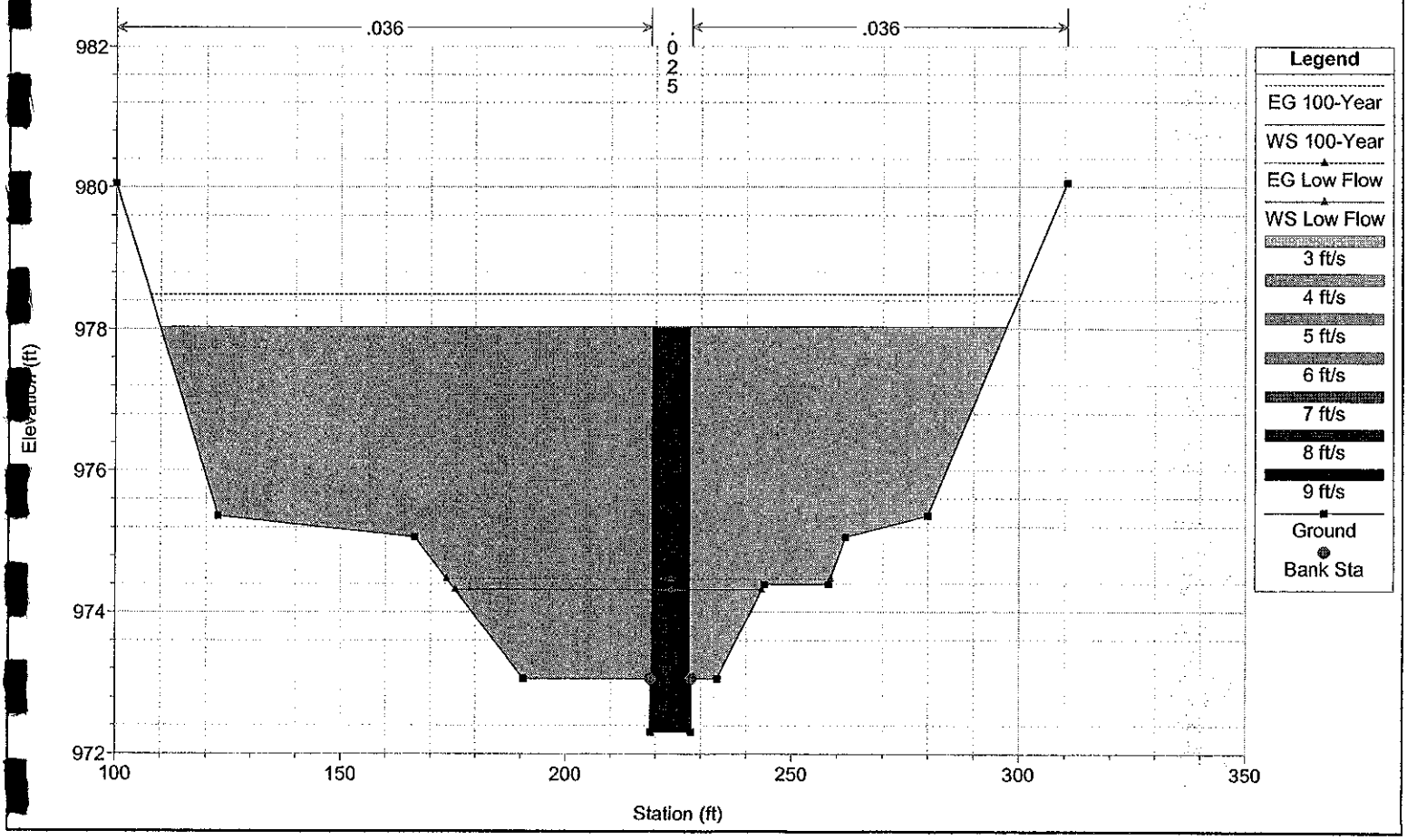
RS = 23962.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

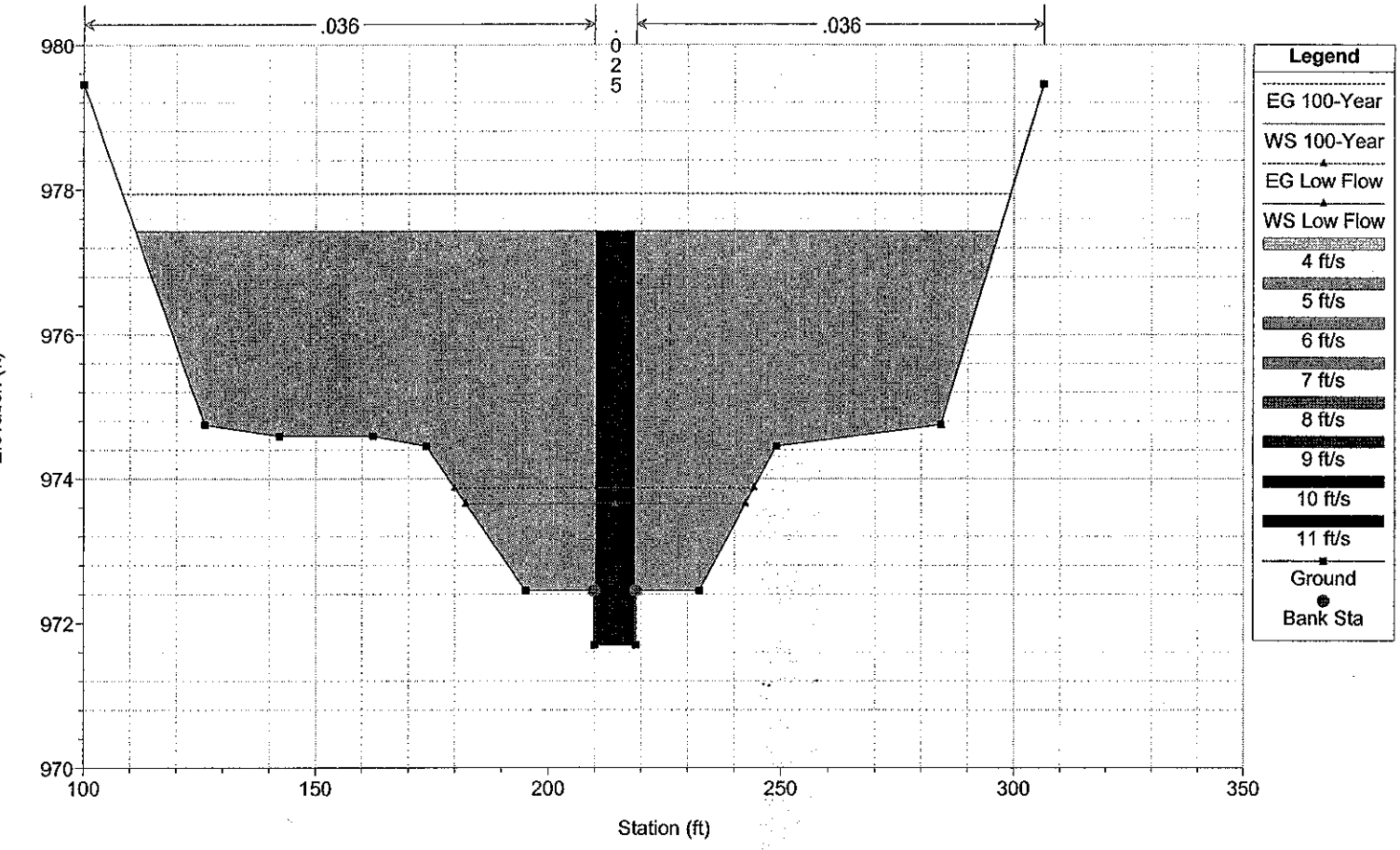
RS = 23762.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

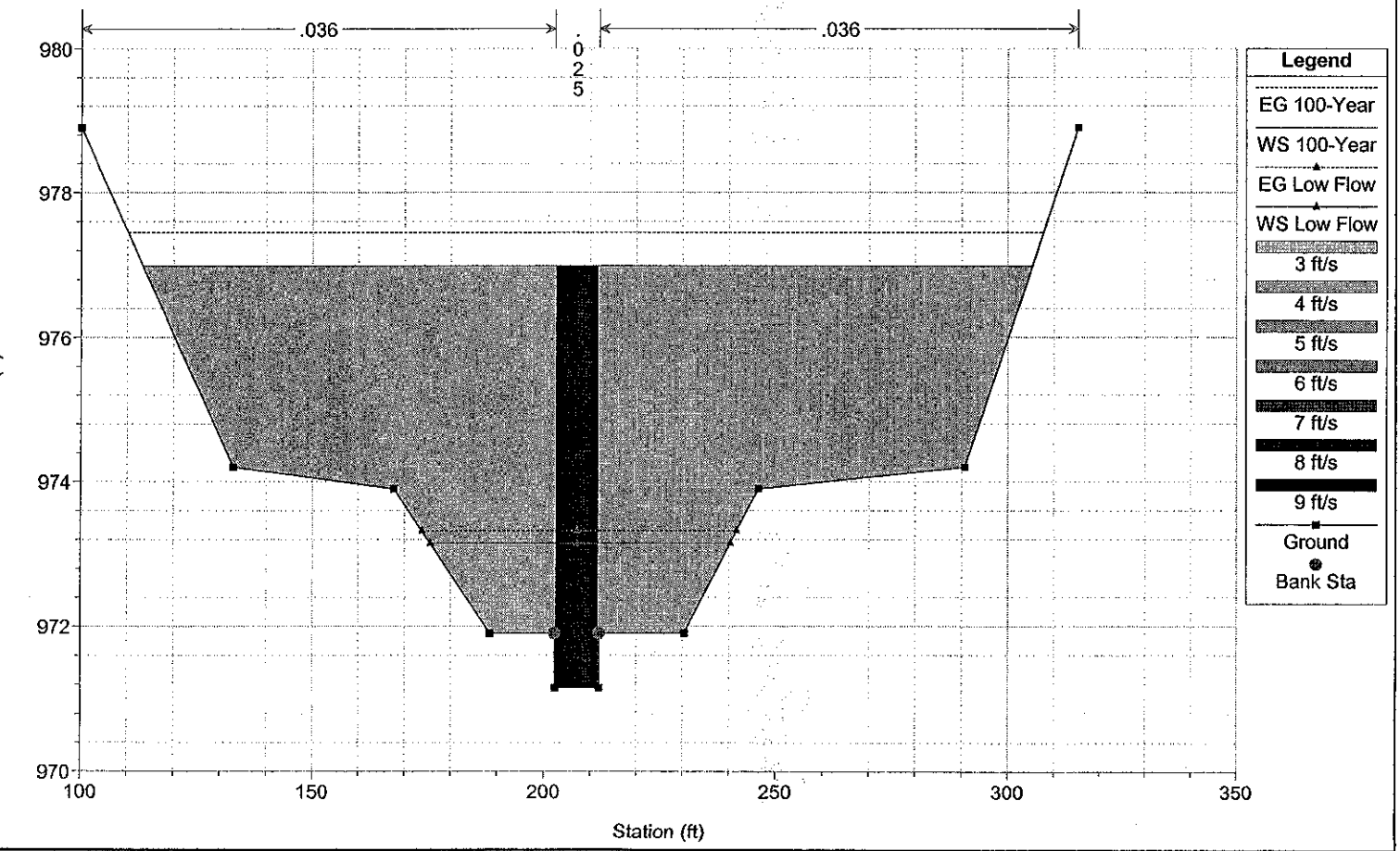
RS = 23566.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

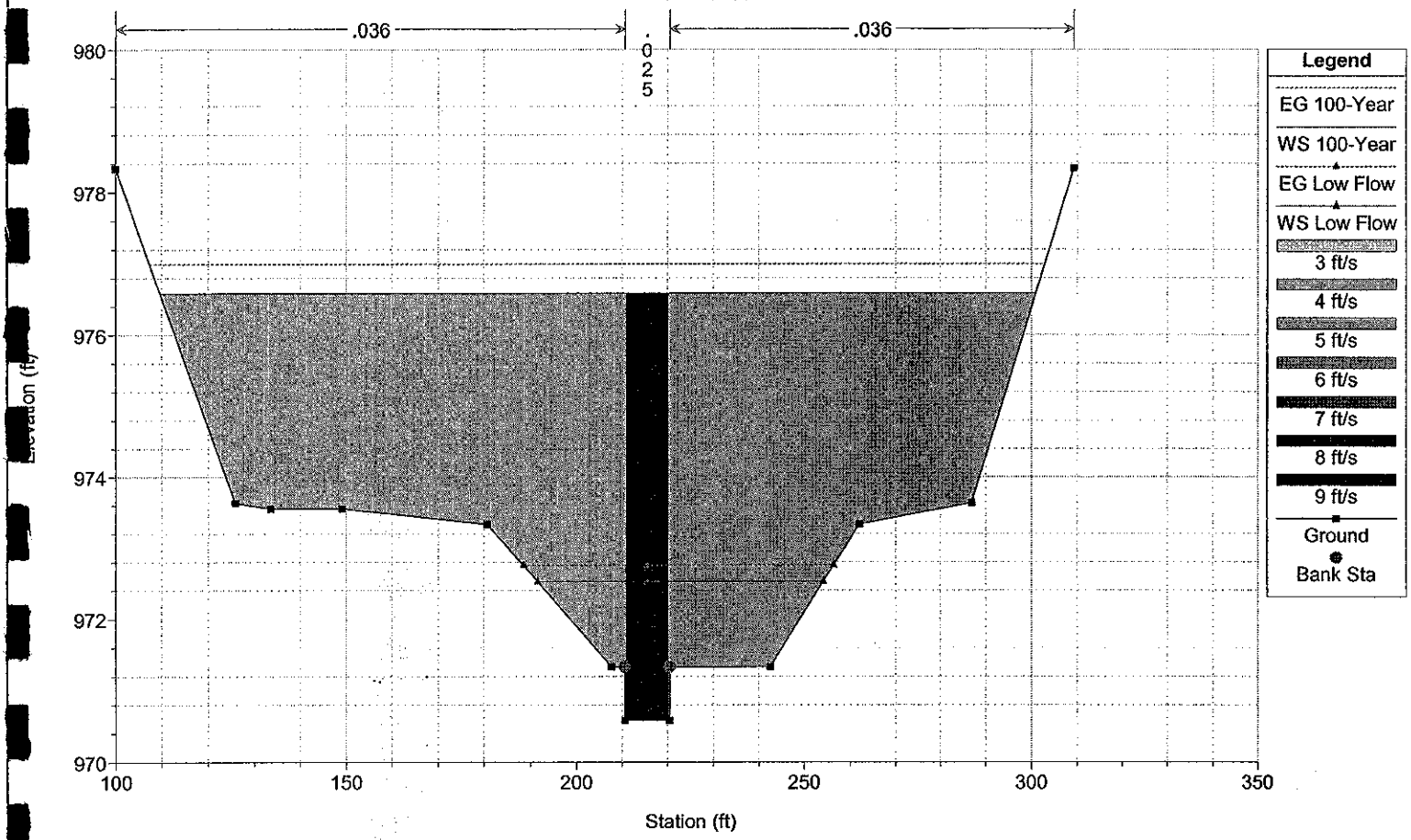
RS = 23390.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

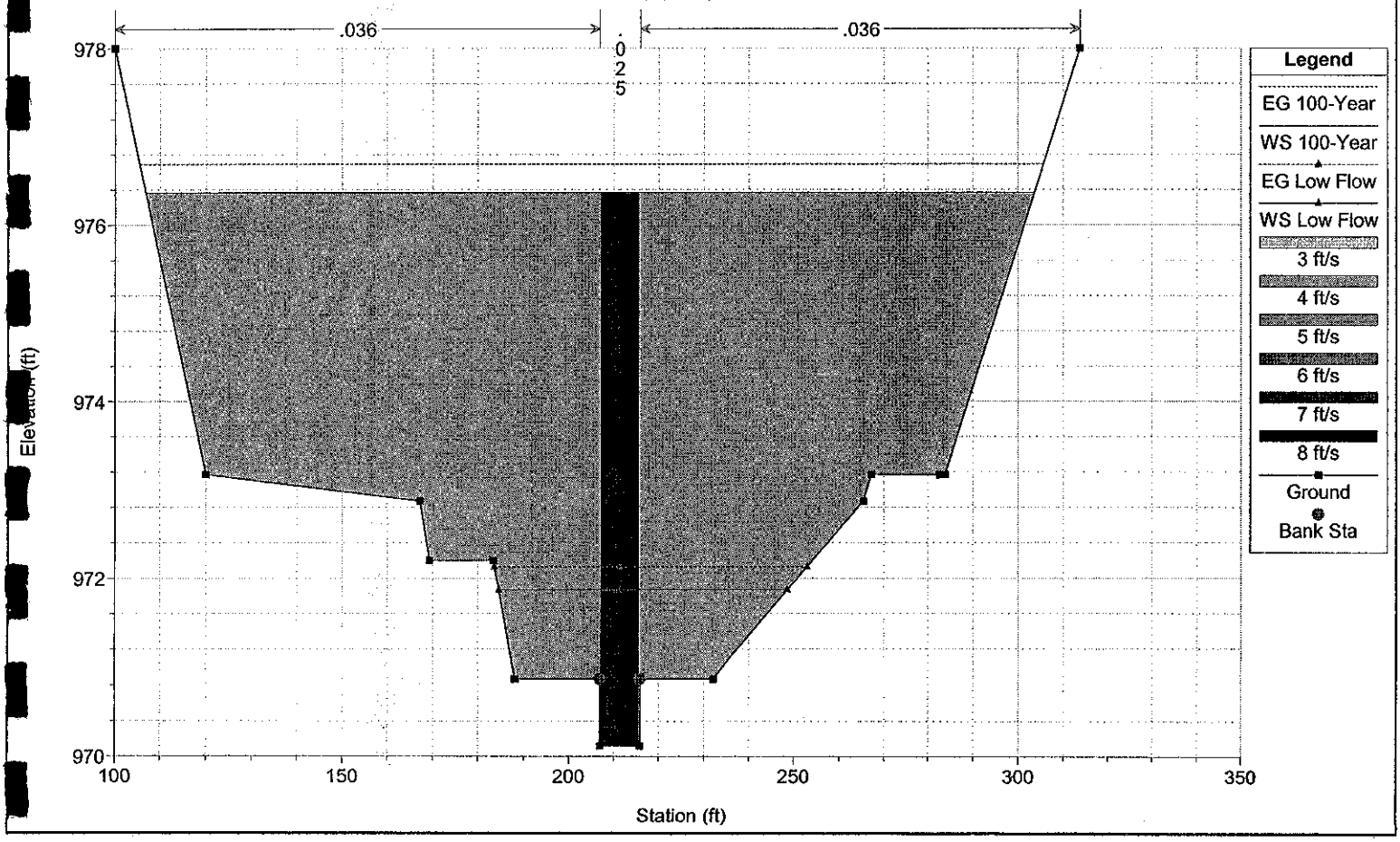
RS = 23203.98



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

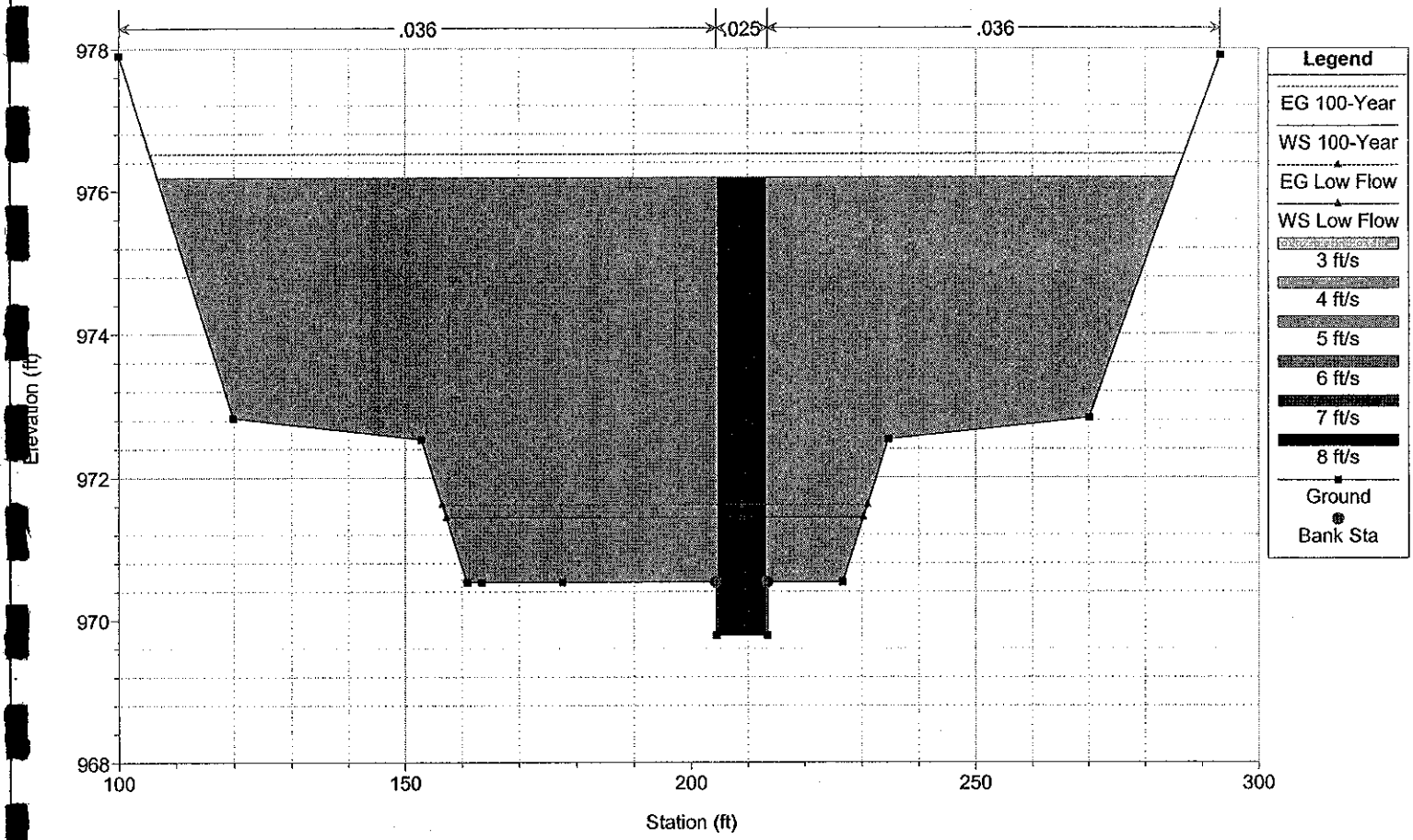
RS = 23054.4



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

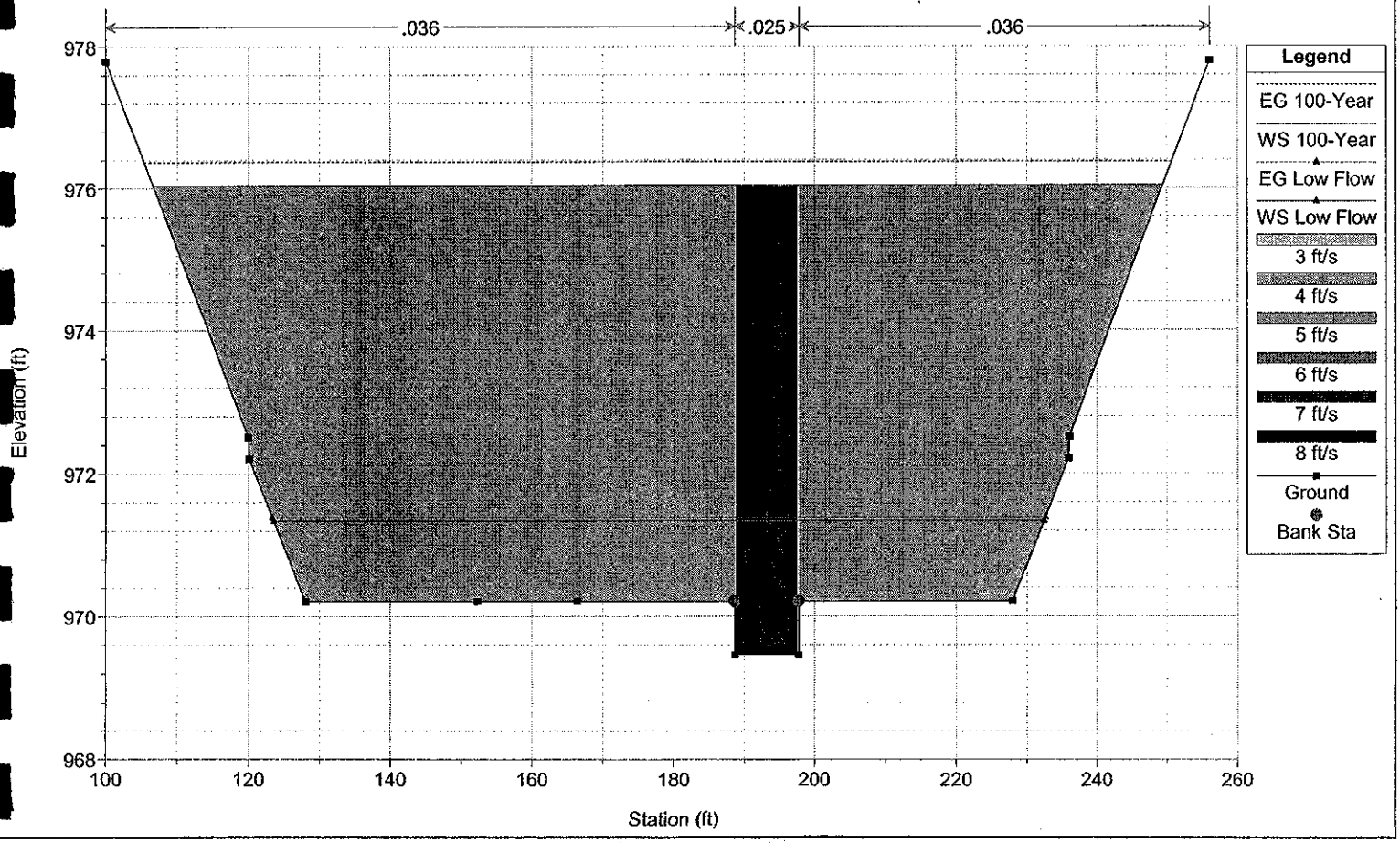
RS = 22946.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

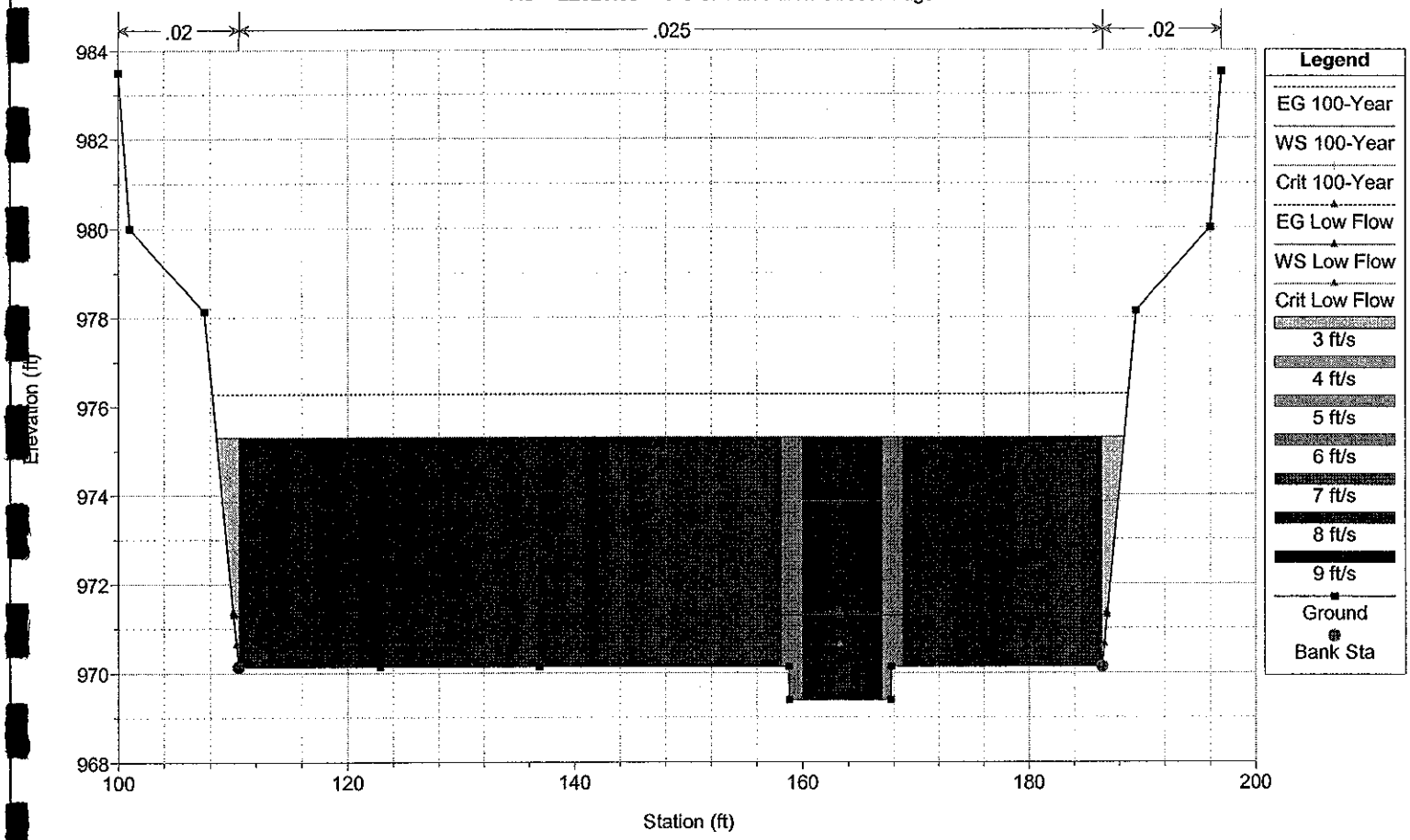
RS = 22845.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

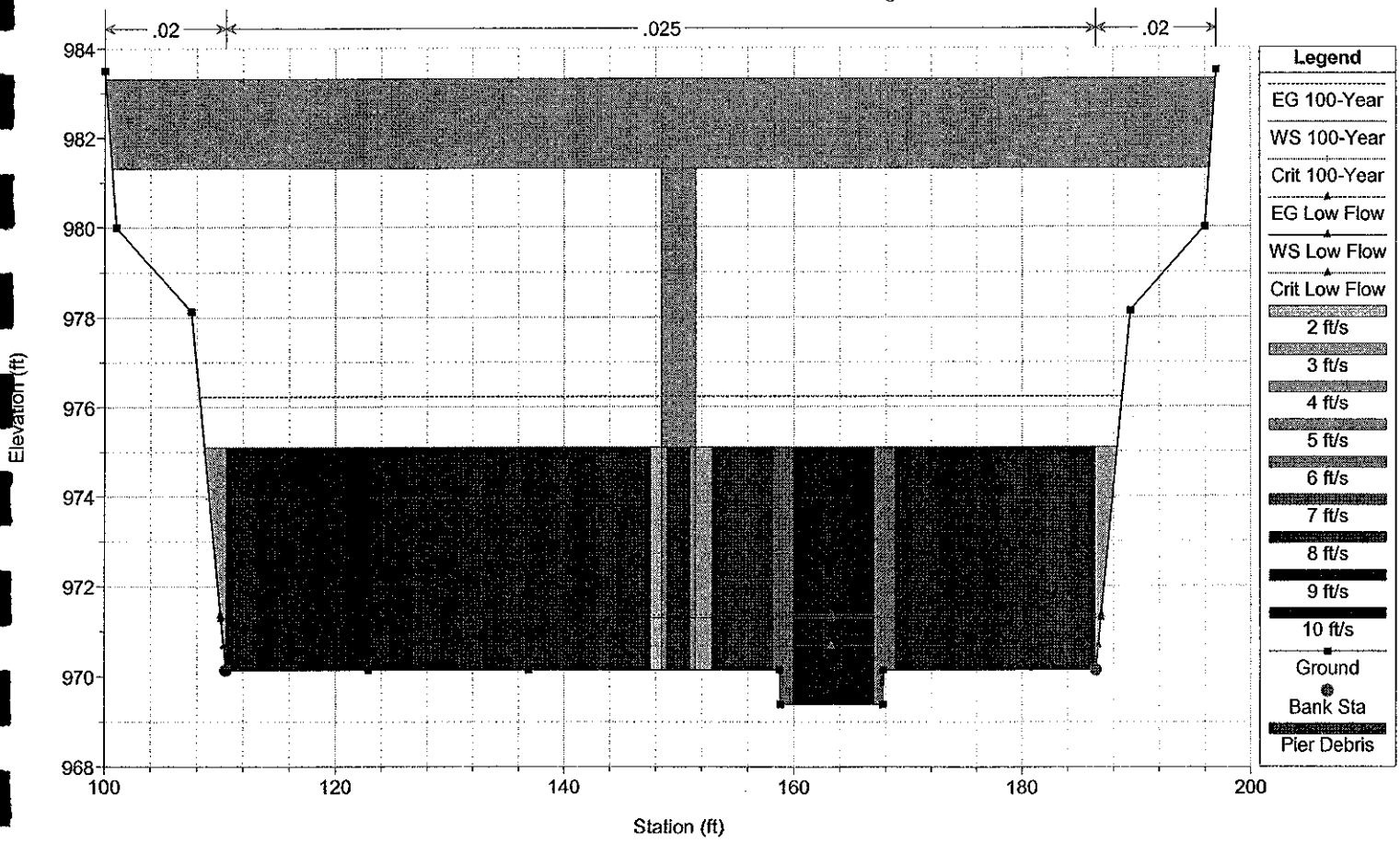
RS = 22820.93 U/S of Van Buren Street Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

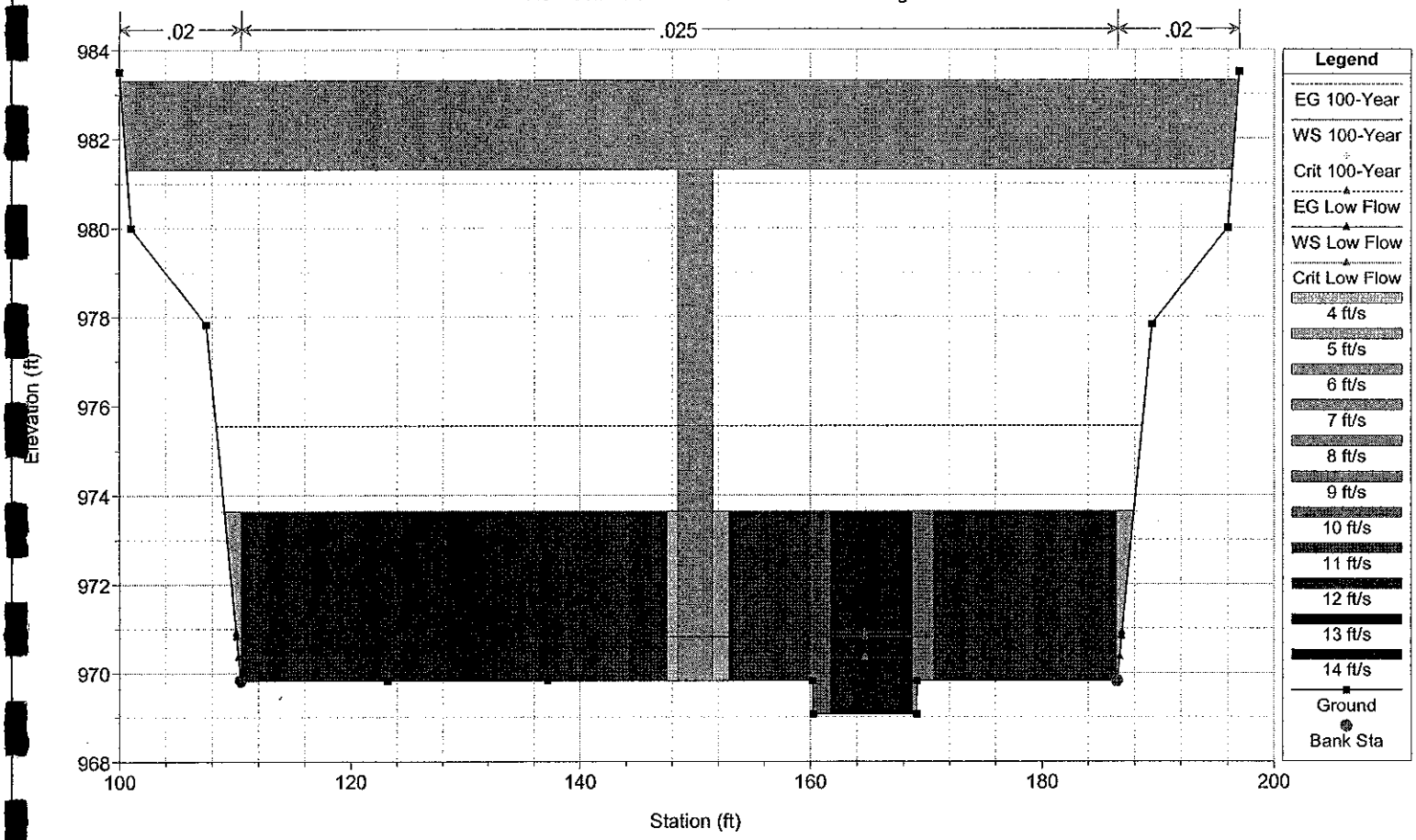
RS = 22774.93 BR Van Buren Road Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

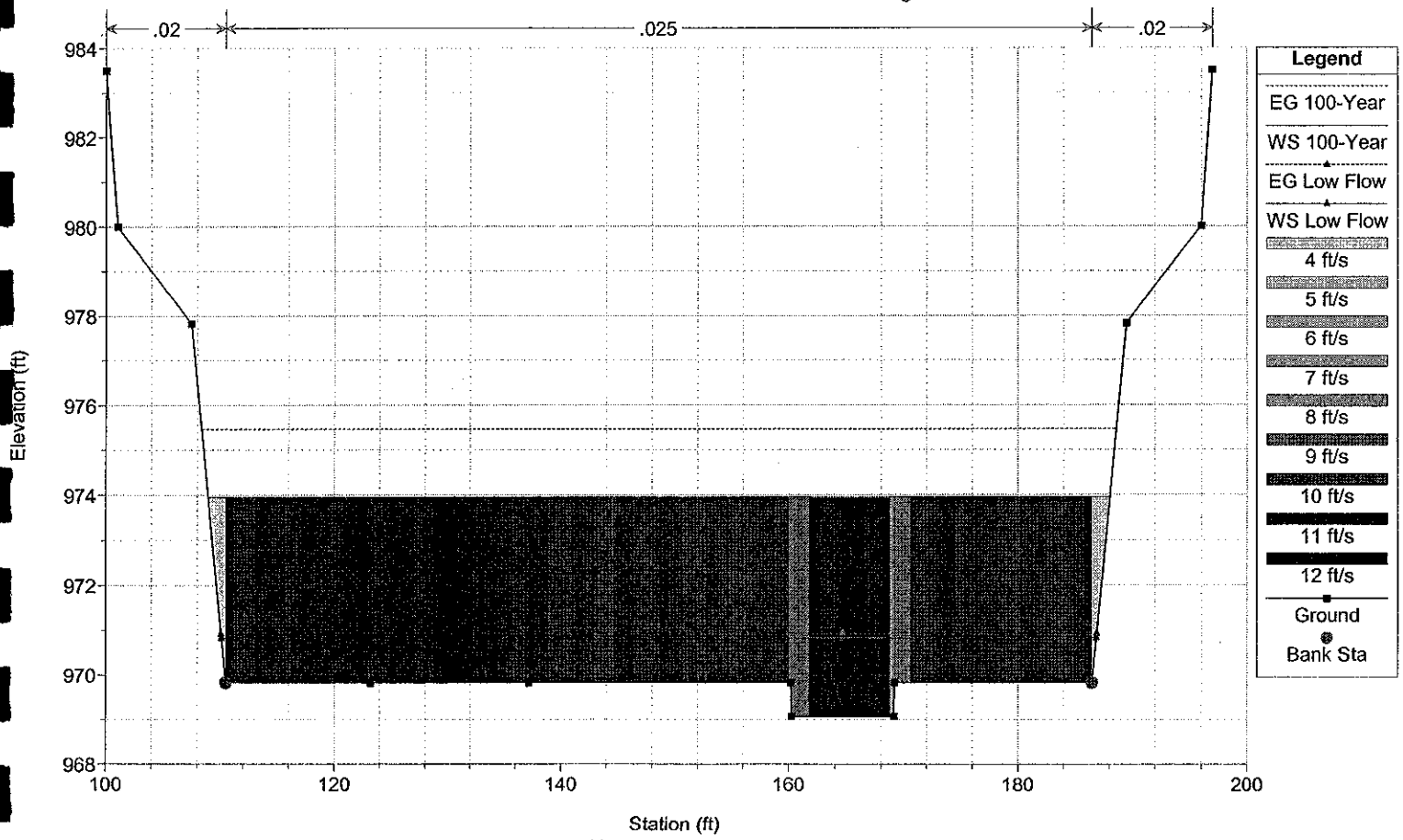
RS = 22774.93 BR Van Buren Road Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

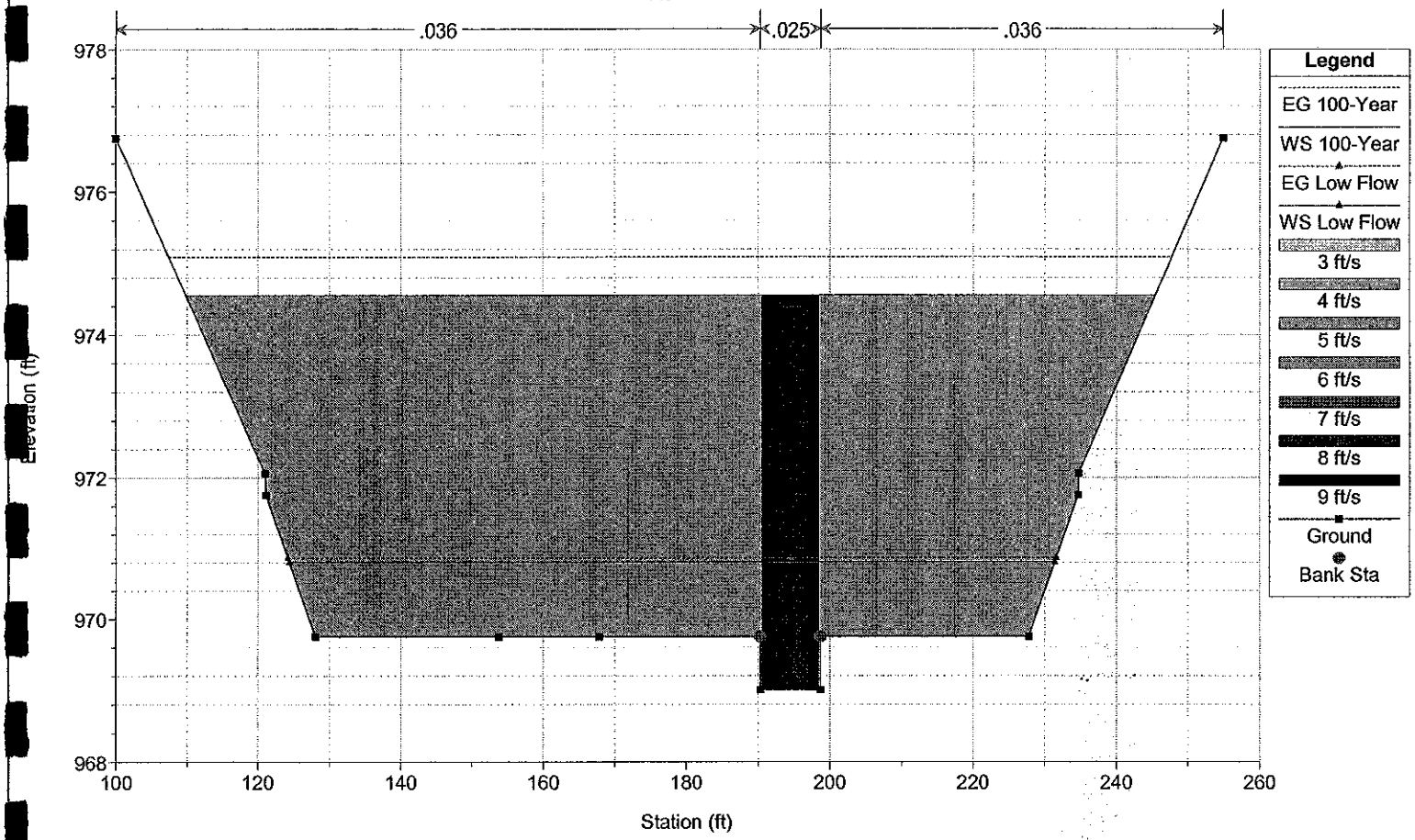
RS = 22728.93 D/S of Van Buren Street Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

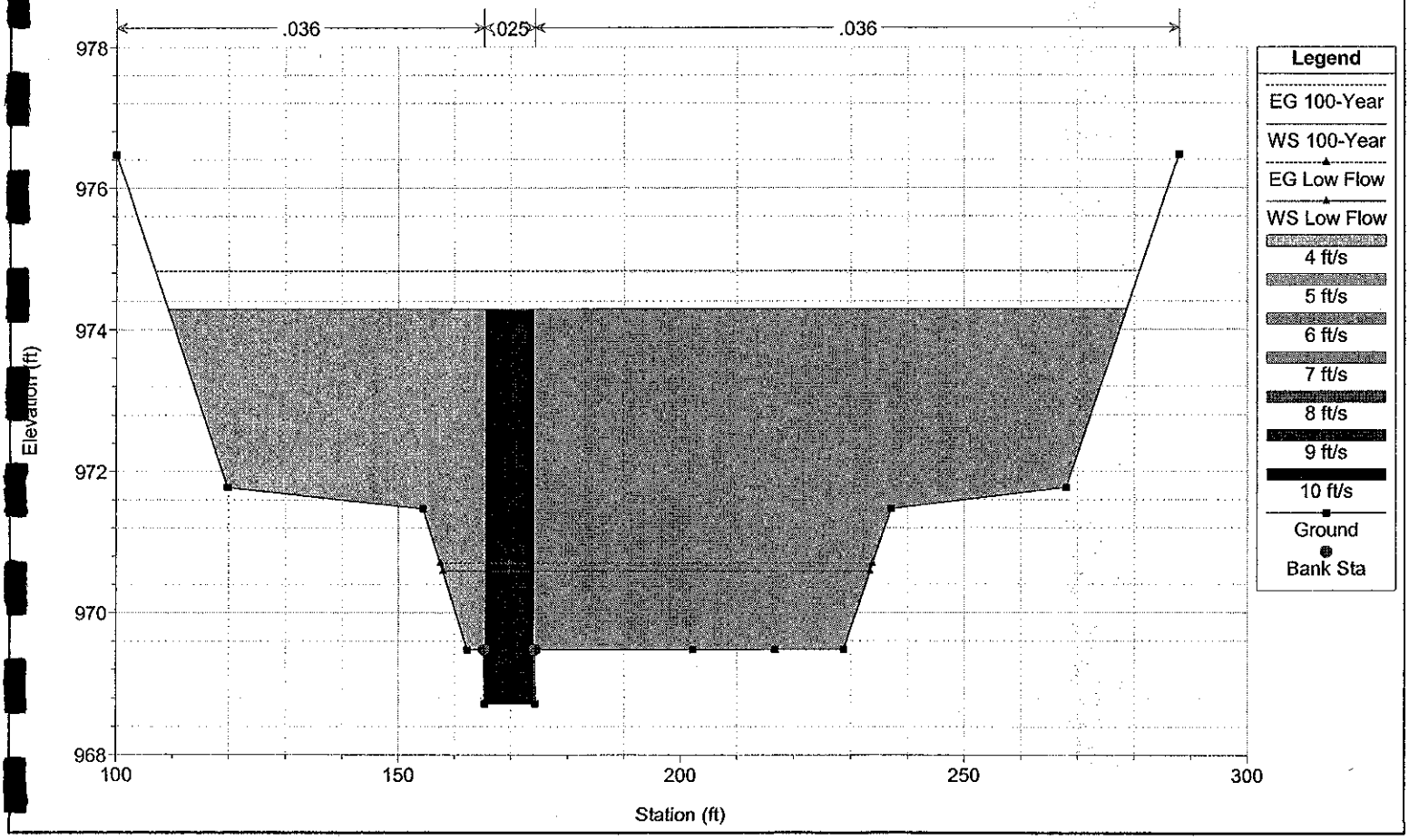
RS = 22705.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

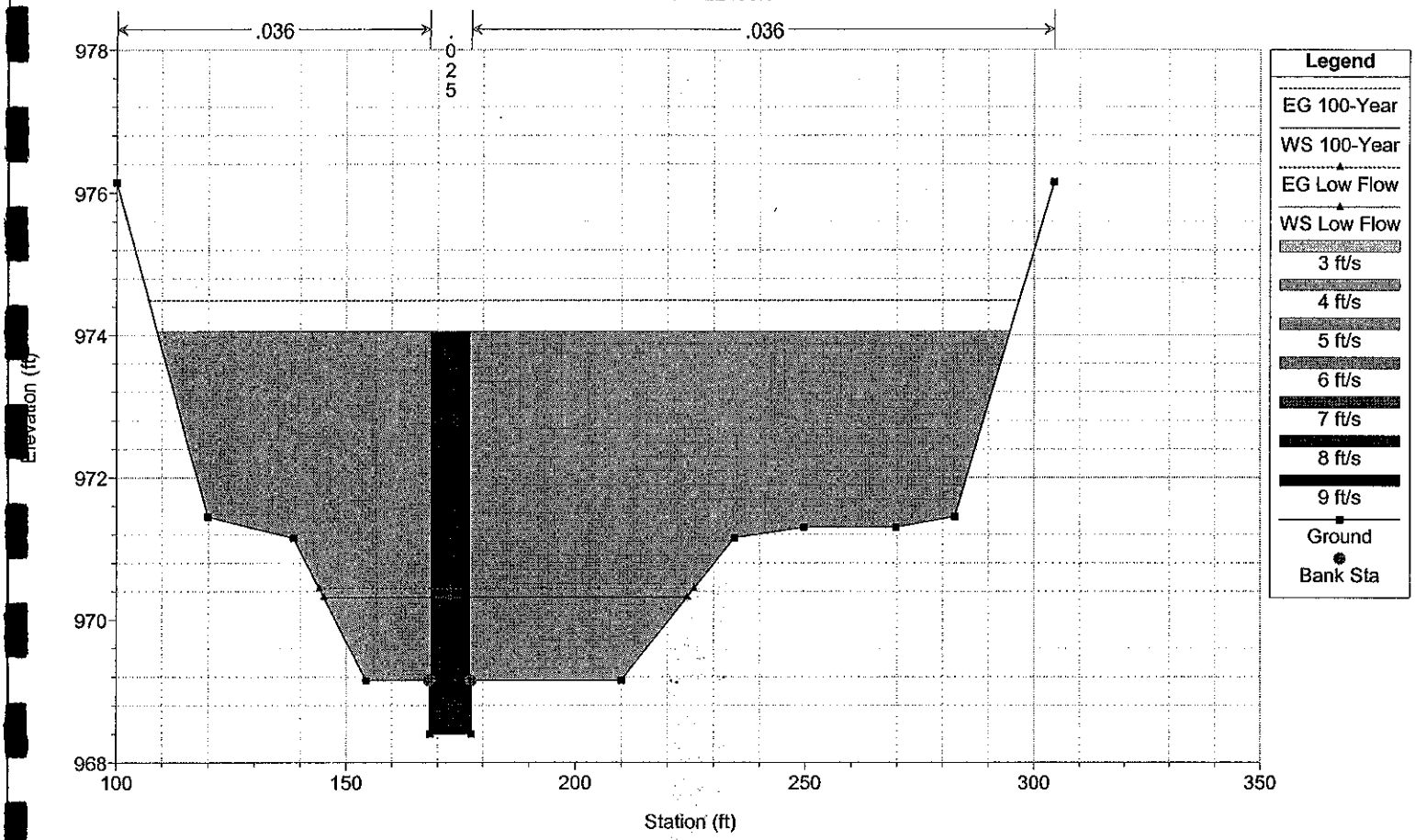
RS = 22611.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

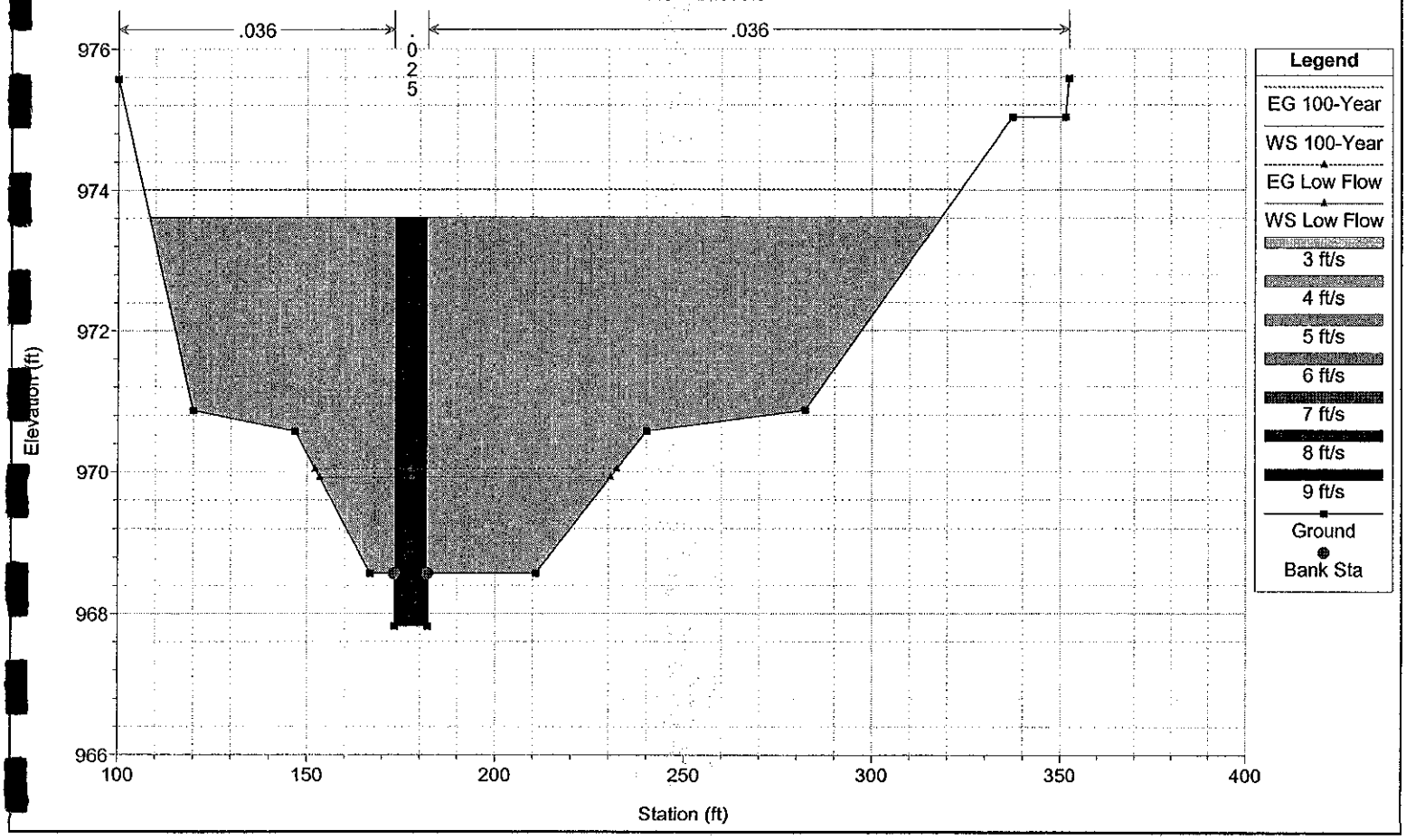
RS = 22496.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

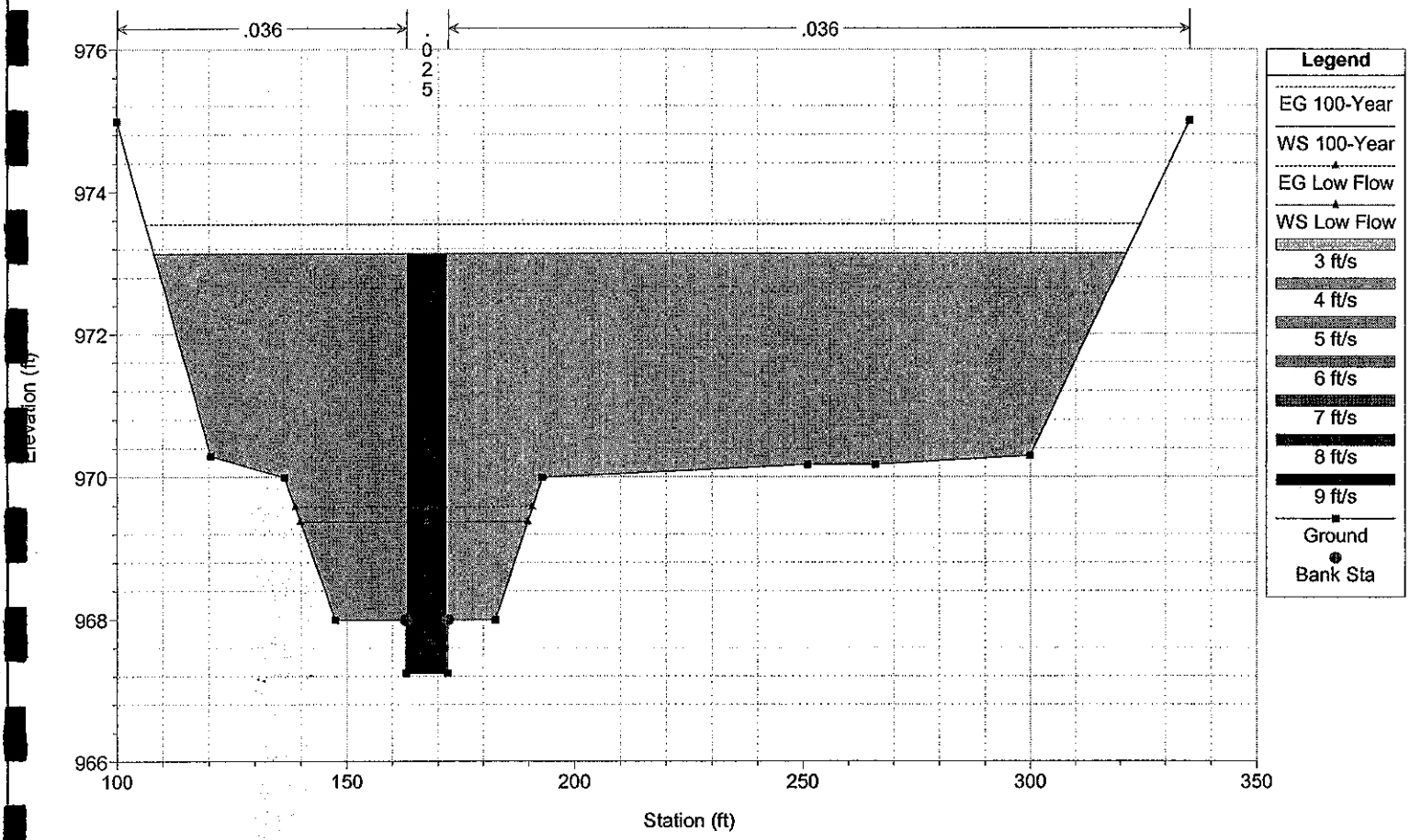
RS = 22300.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

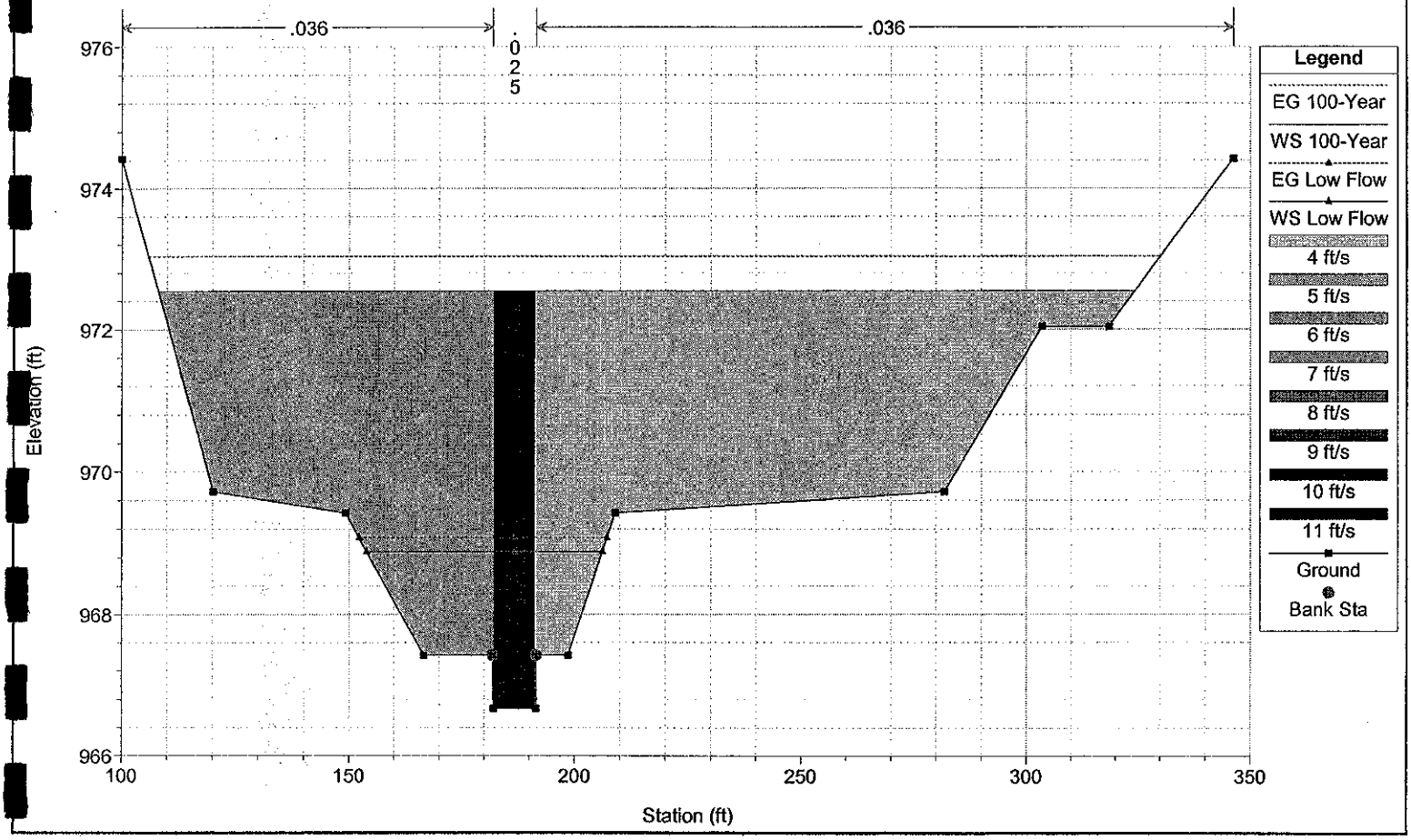
RS = 22102.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

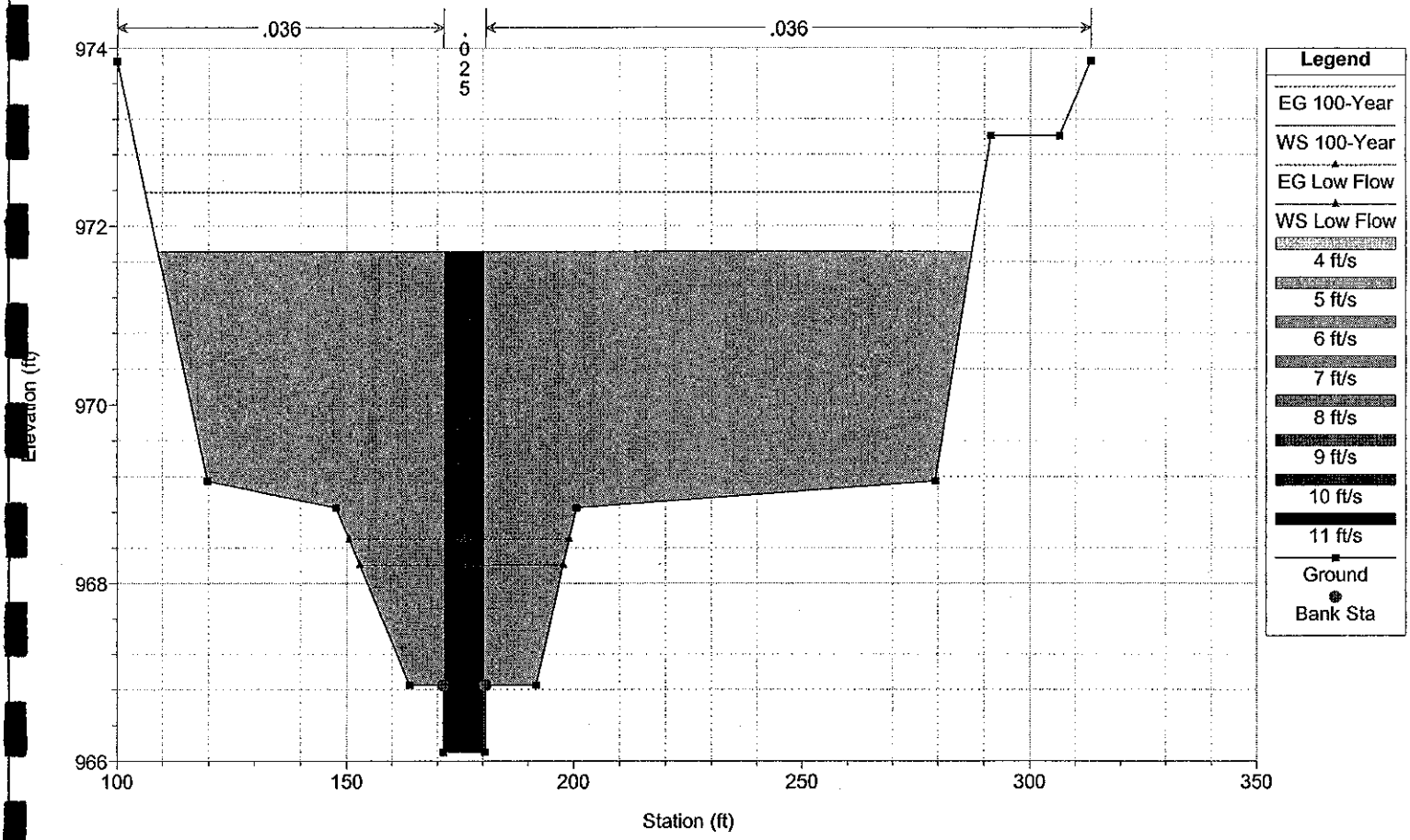
RS = 21911.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

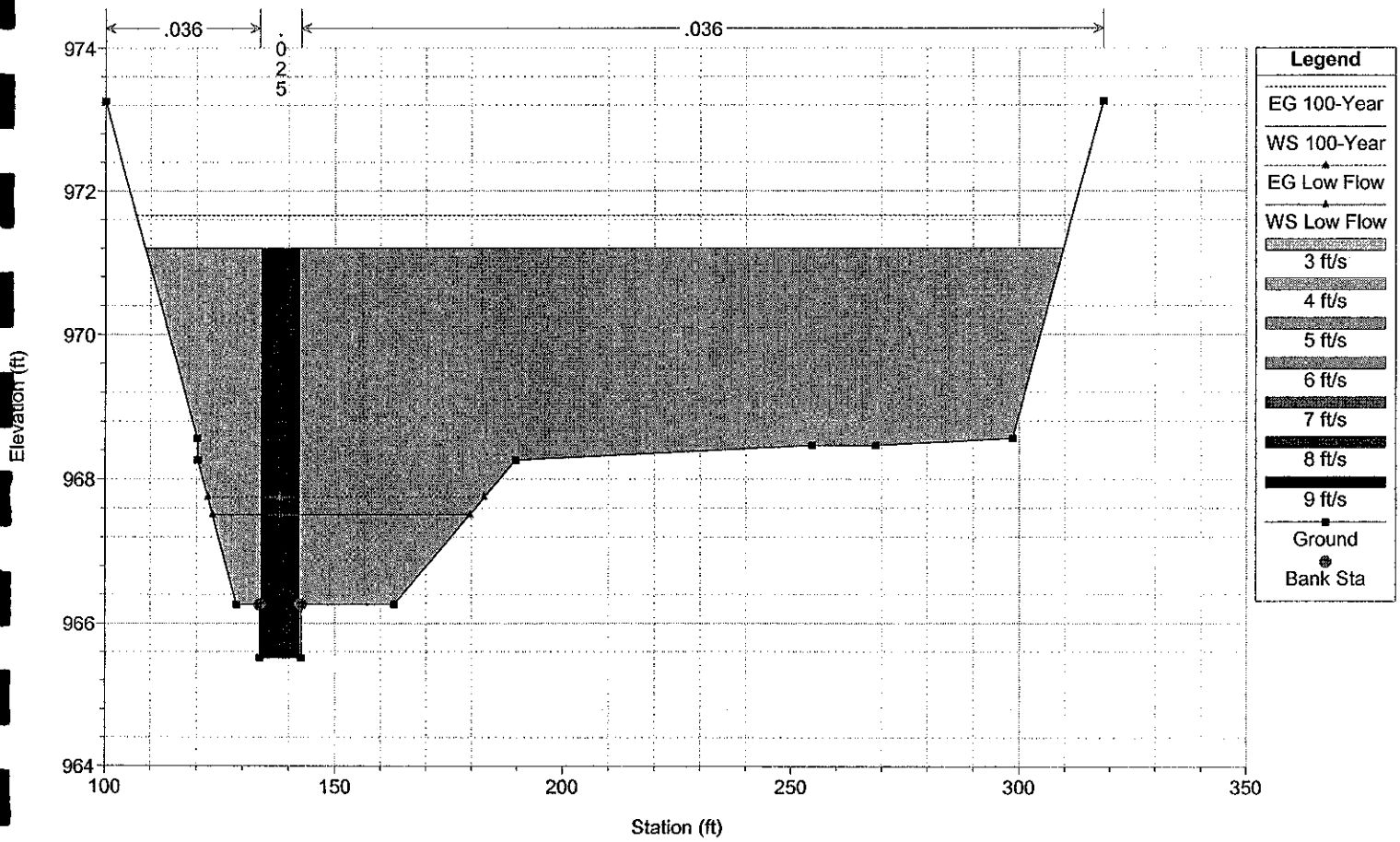
RS = 21718.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

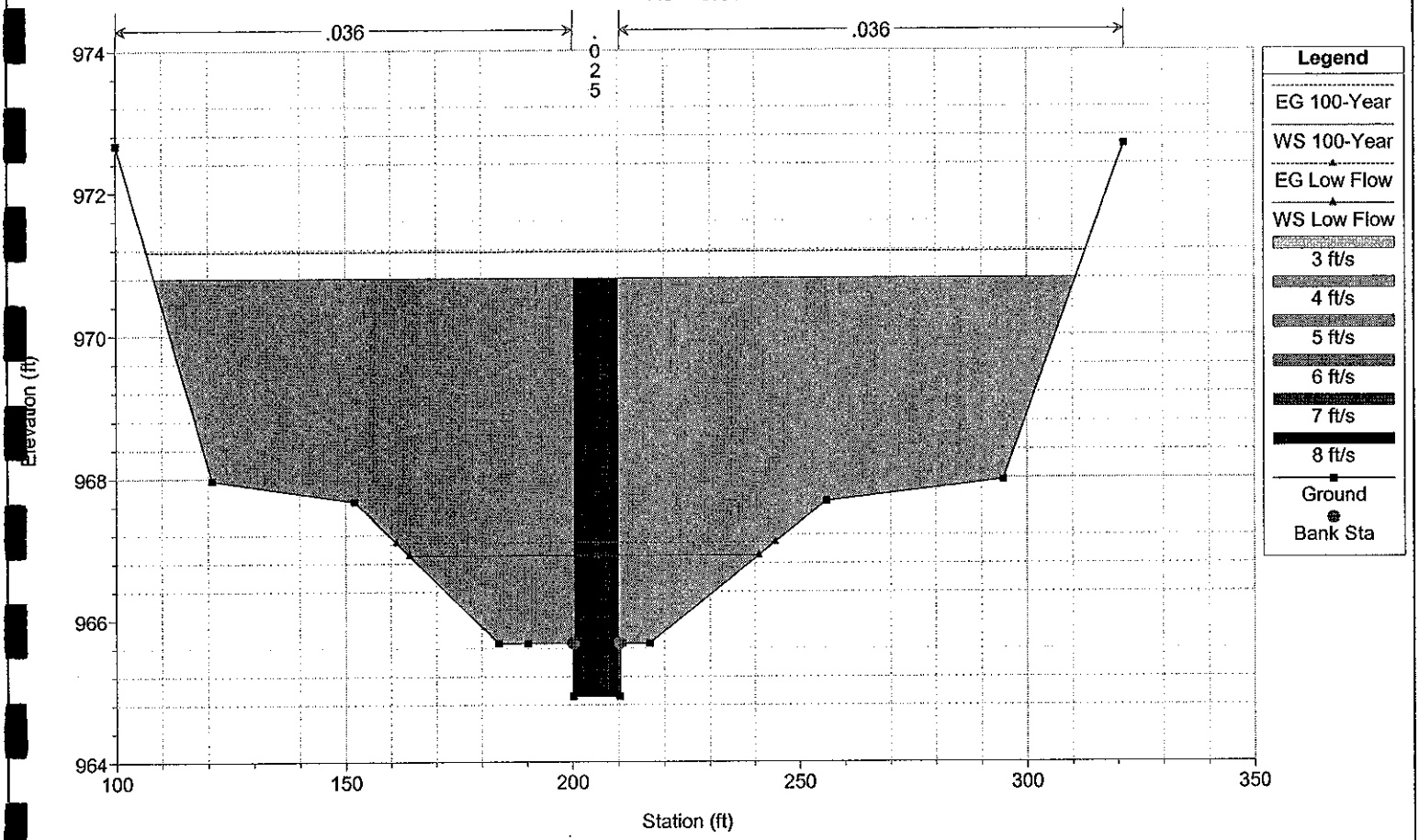
RS = 21517.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

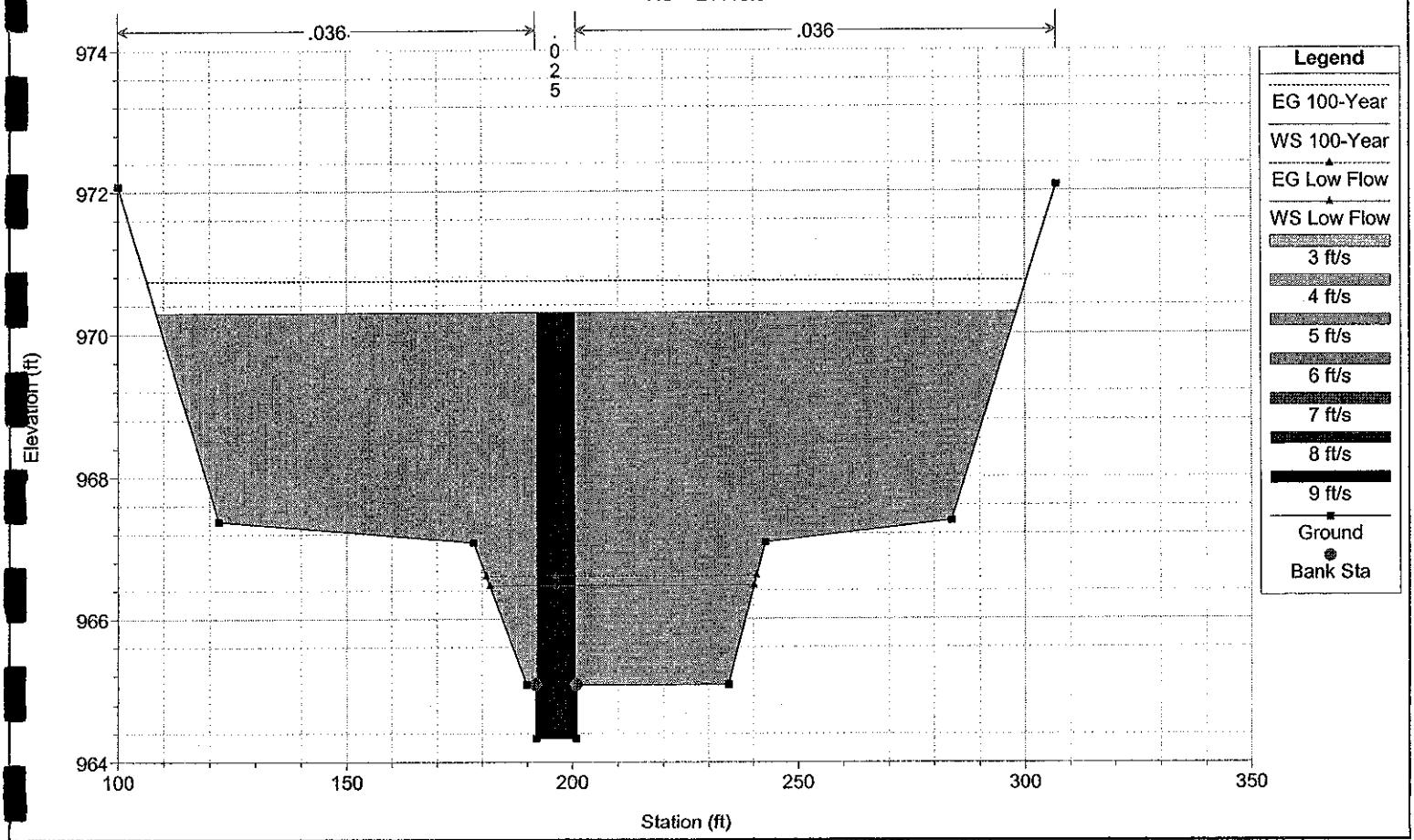
RS = 21318.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

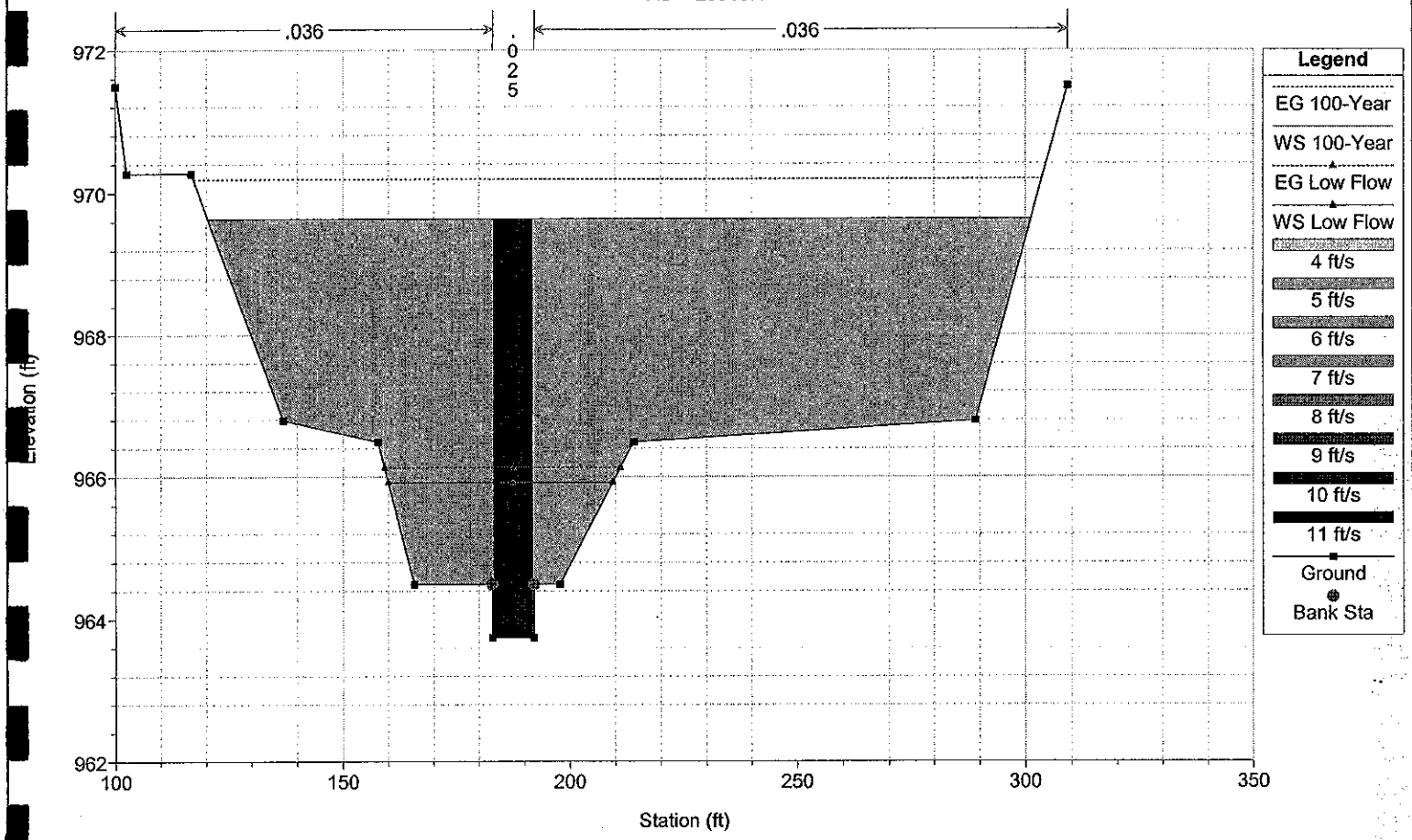
RS = 21118.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

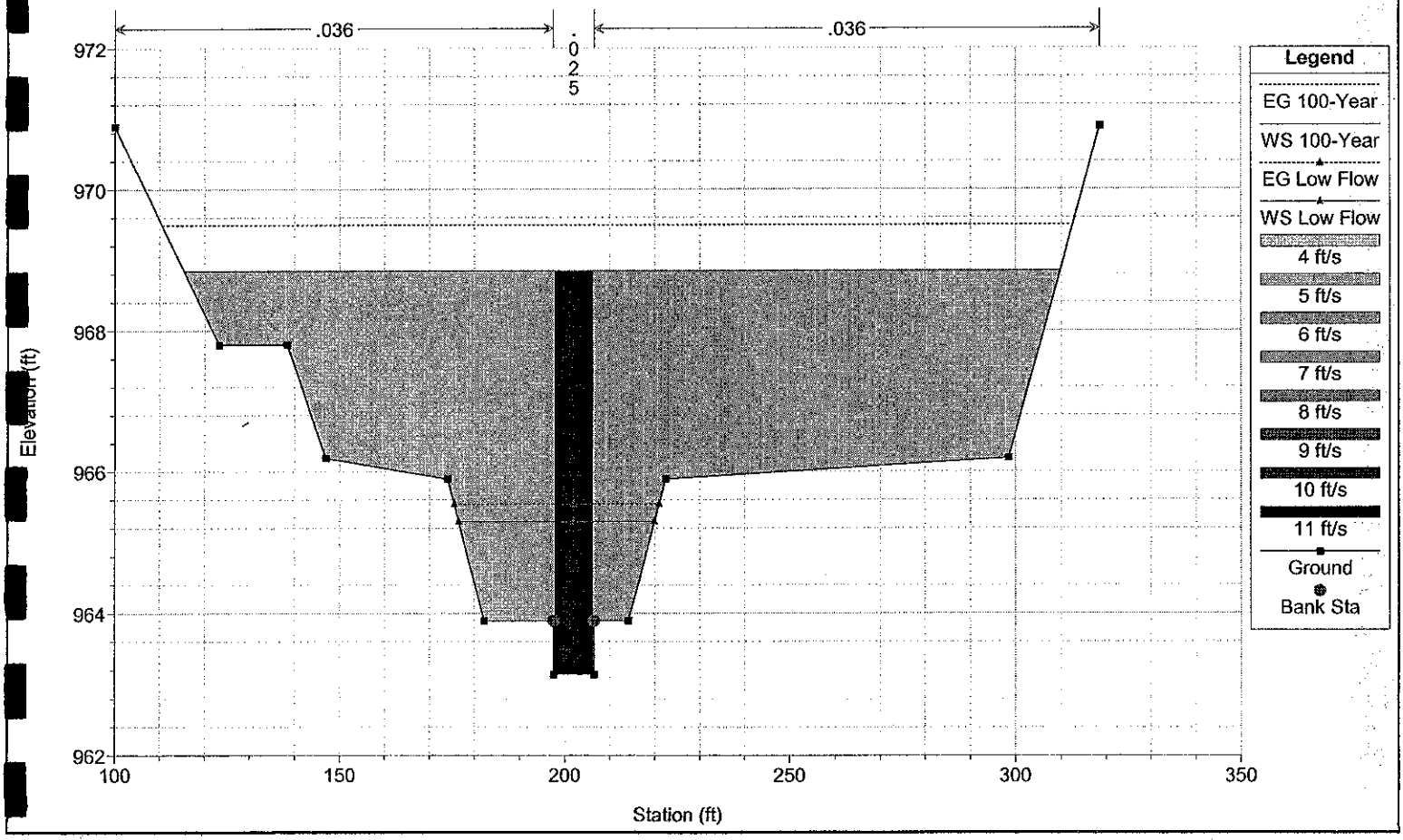
RS = 20918.4



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

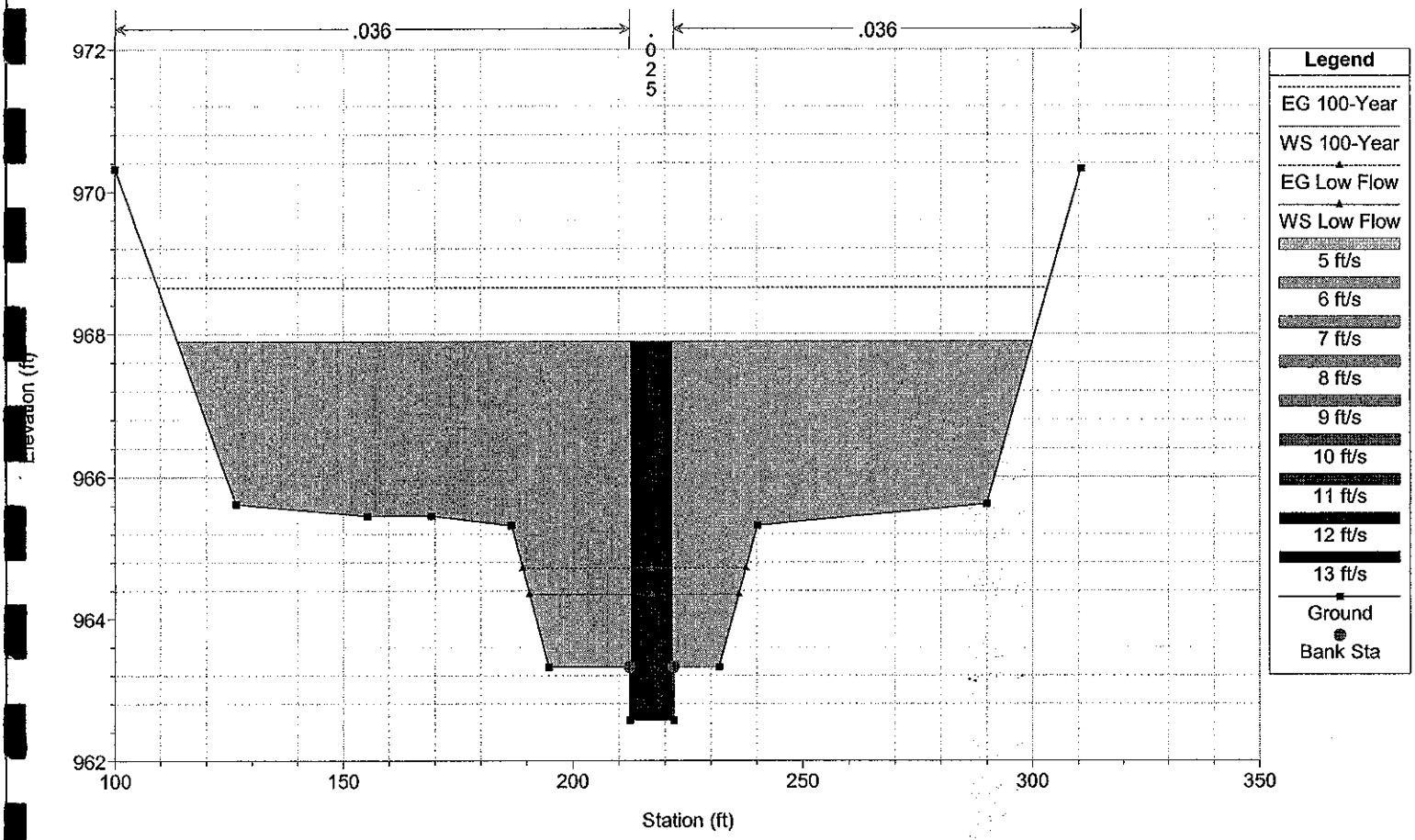
RS = 20718.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

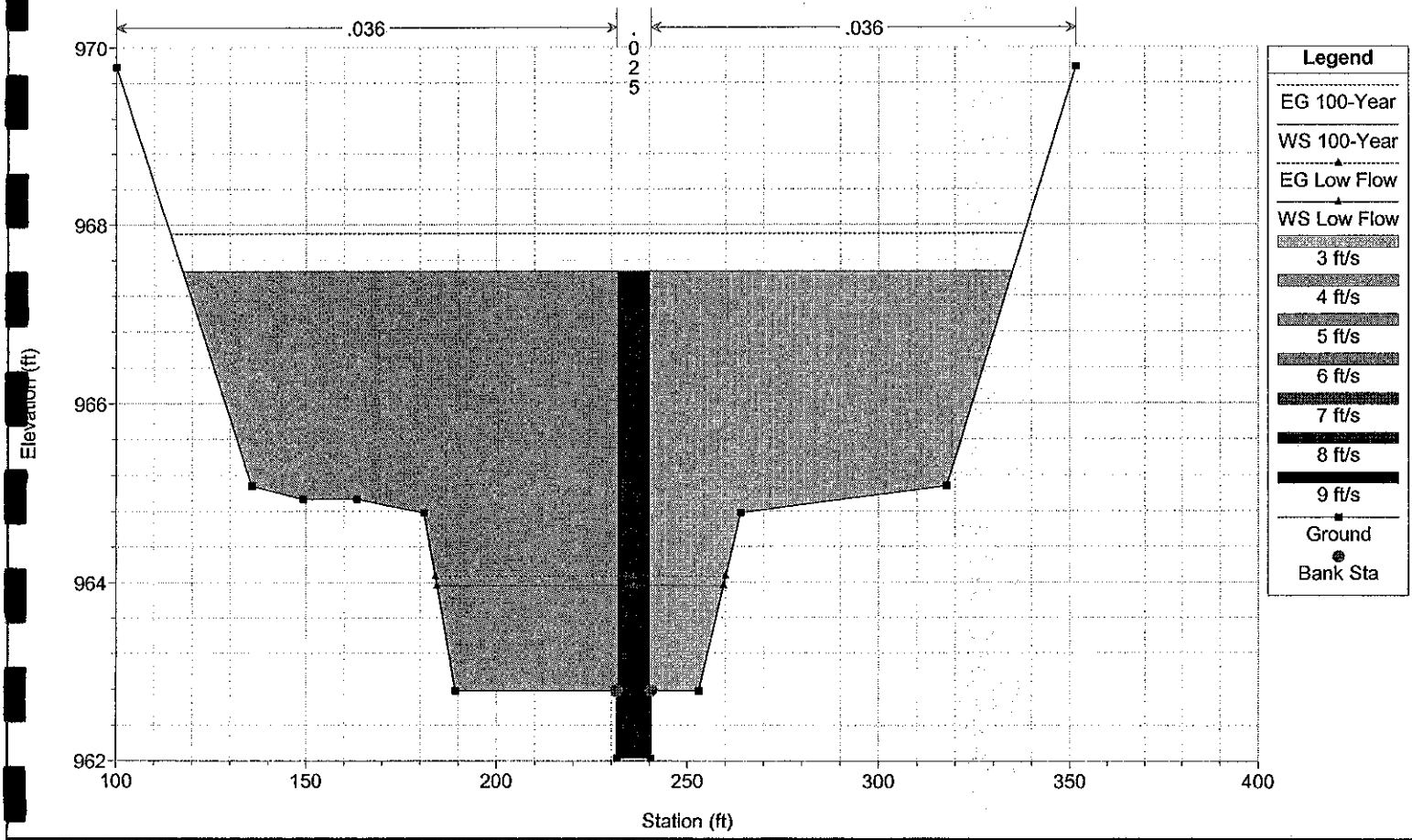
RS = 20524.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

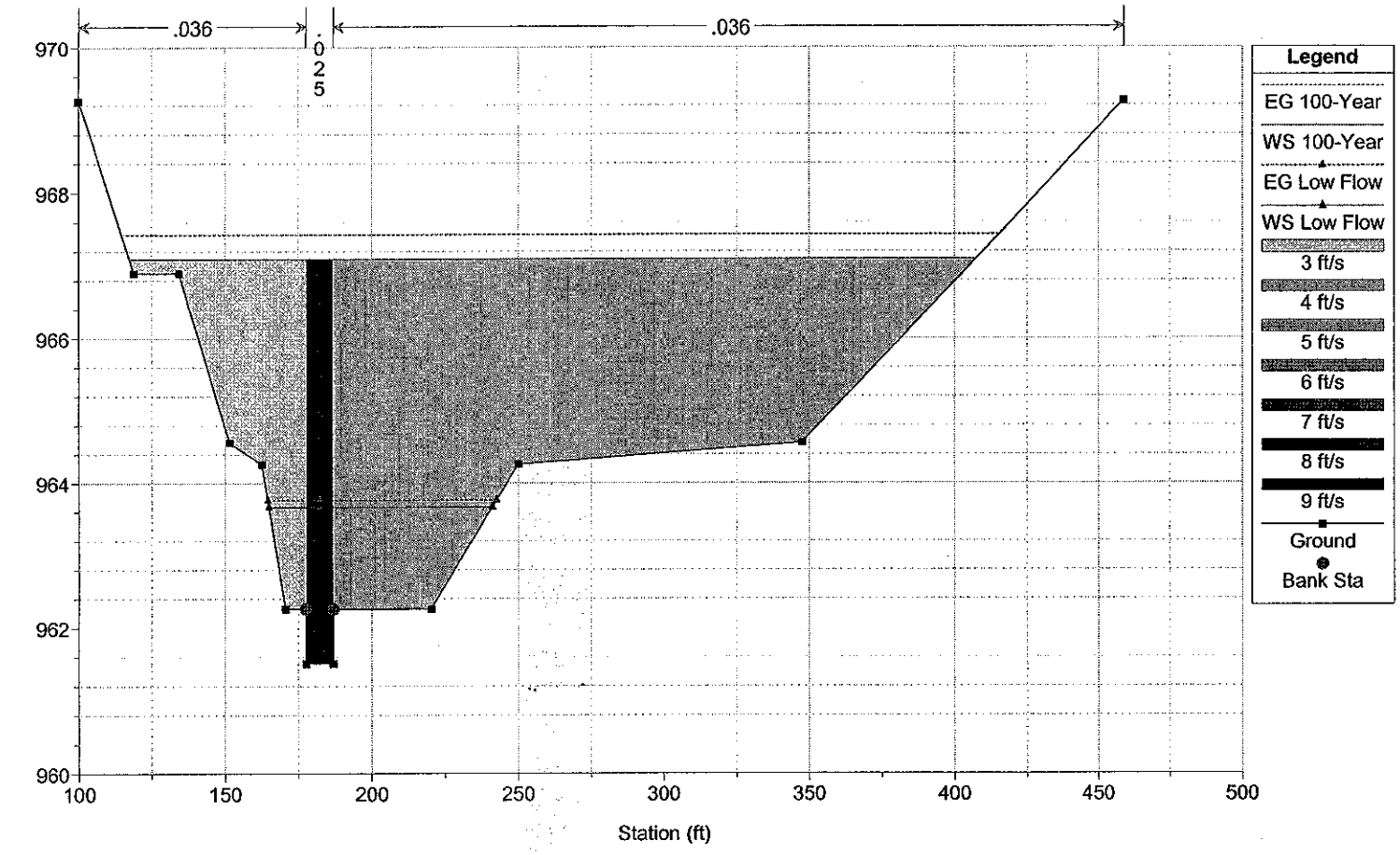
RS = 20341.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

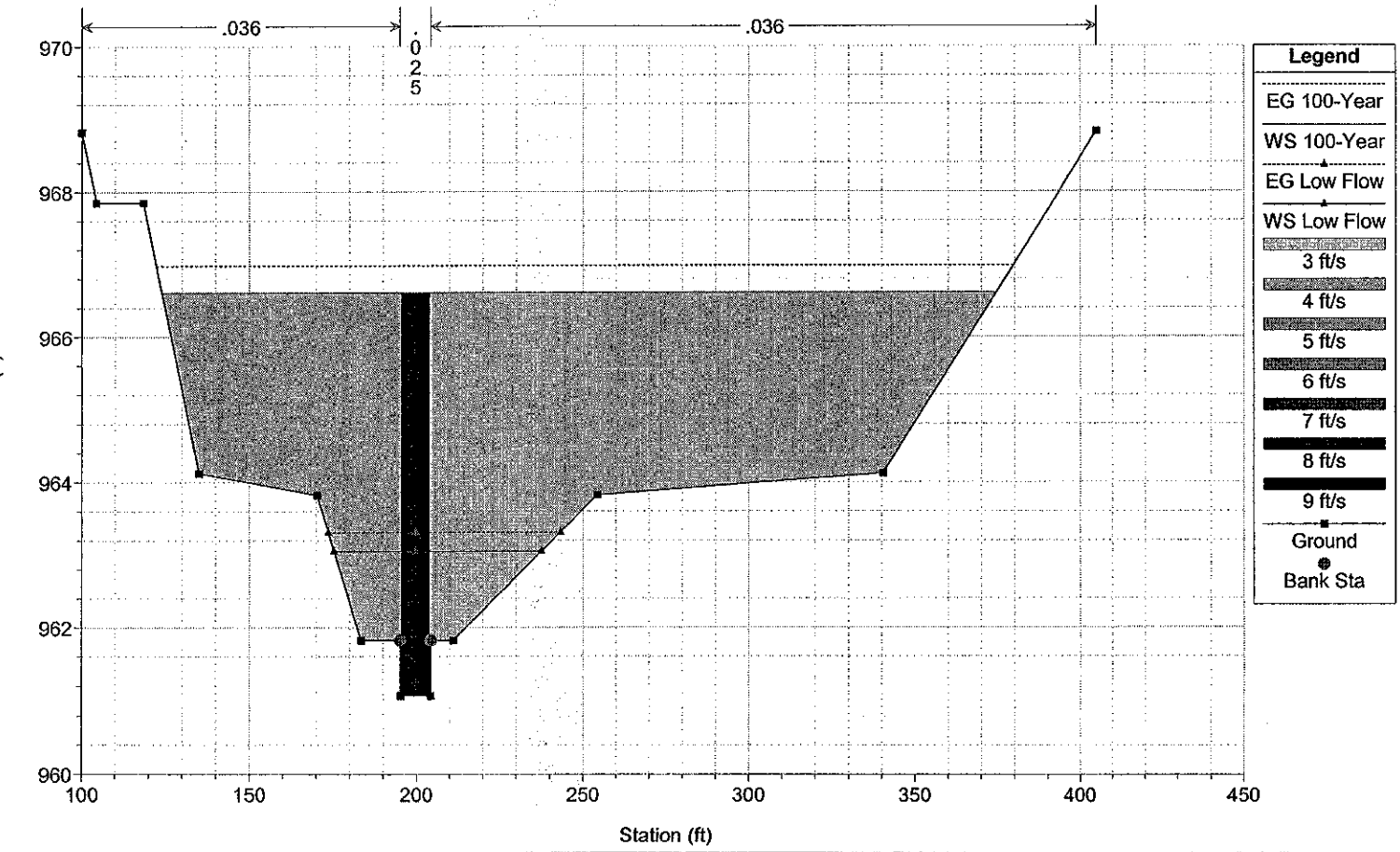
RS = 20164.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

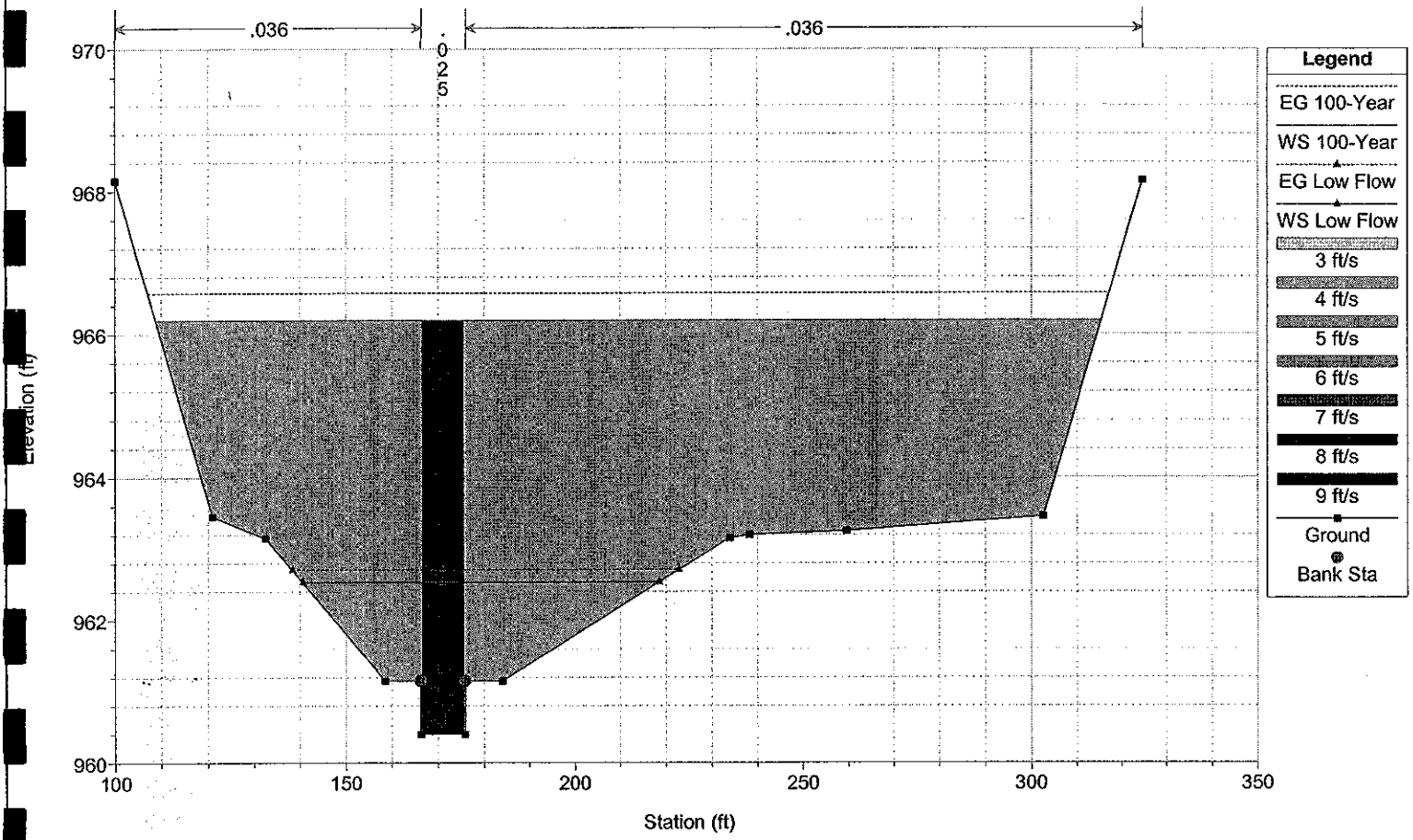
RS = 19974.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

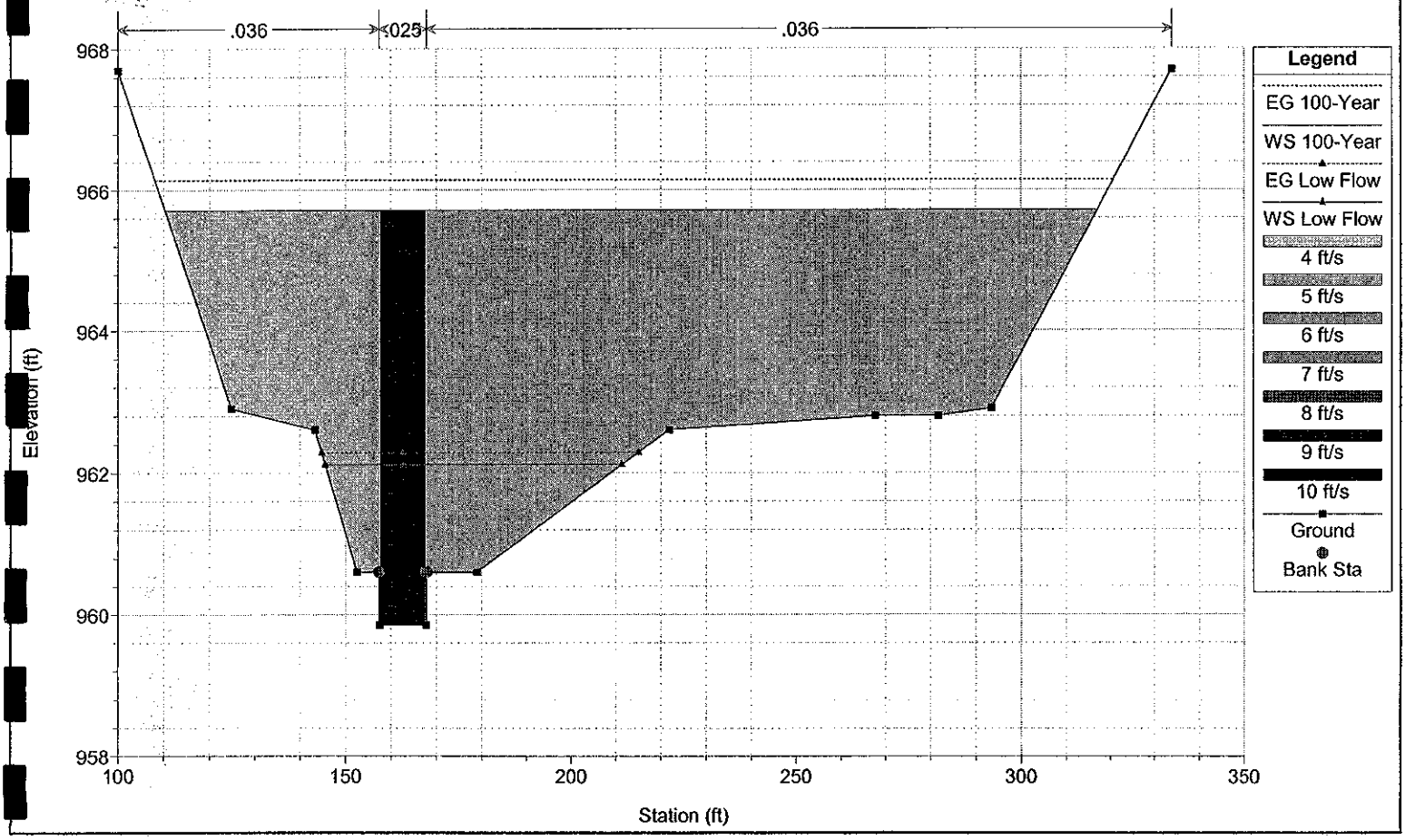
RS = 19790.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

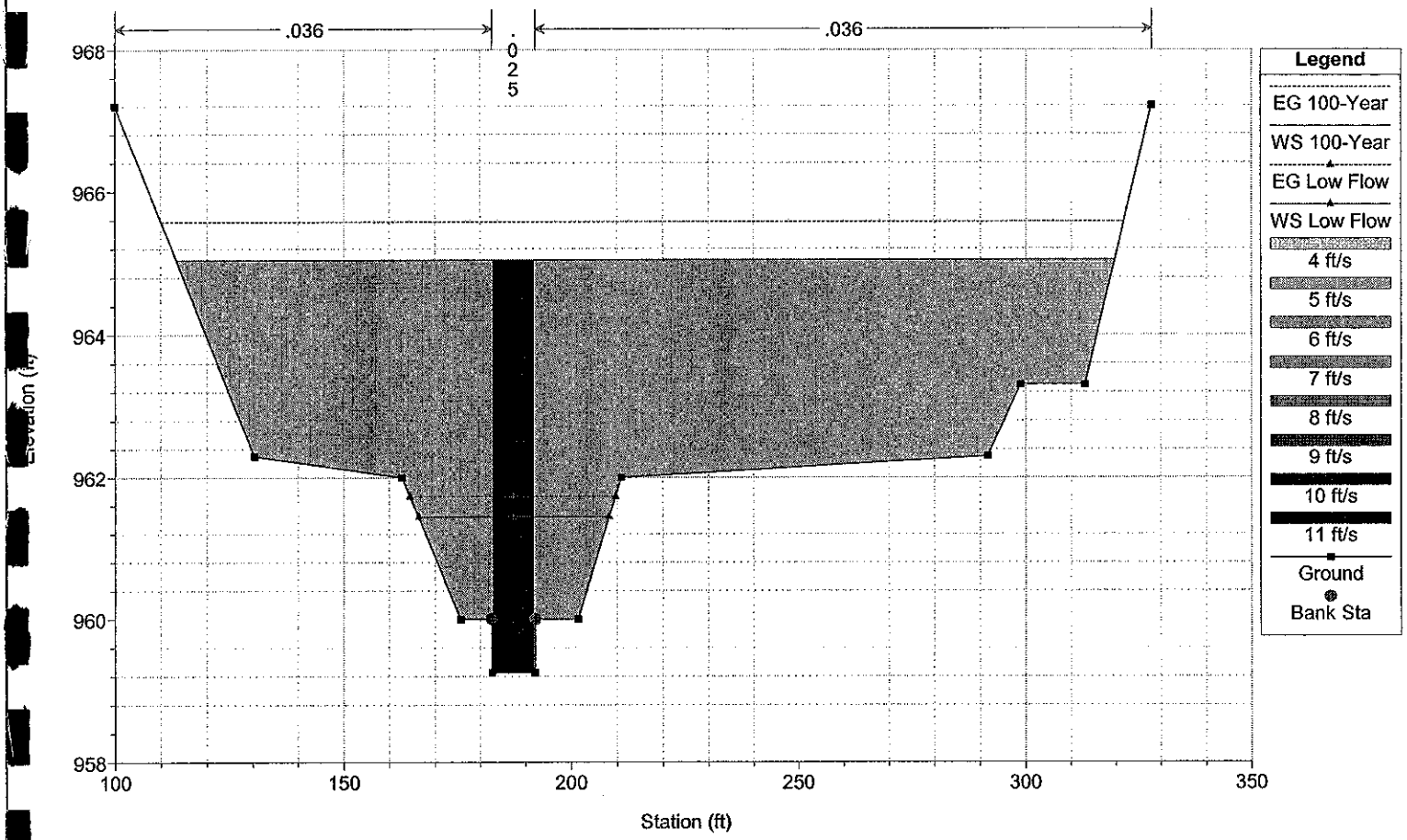
RS = 19602.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

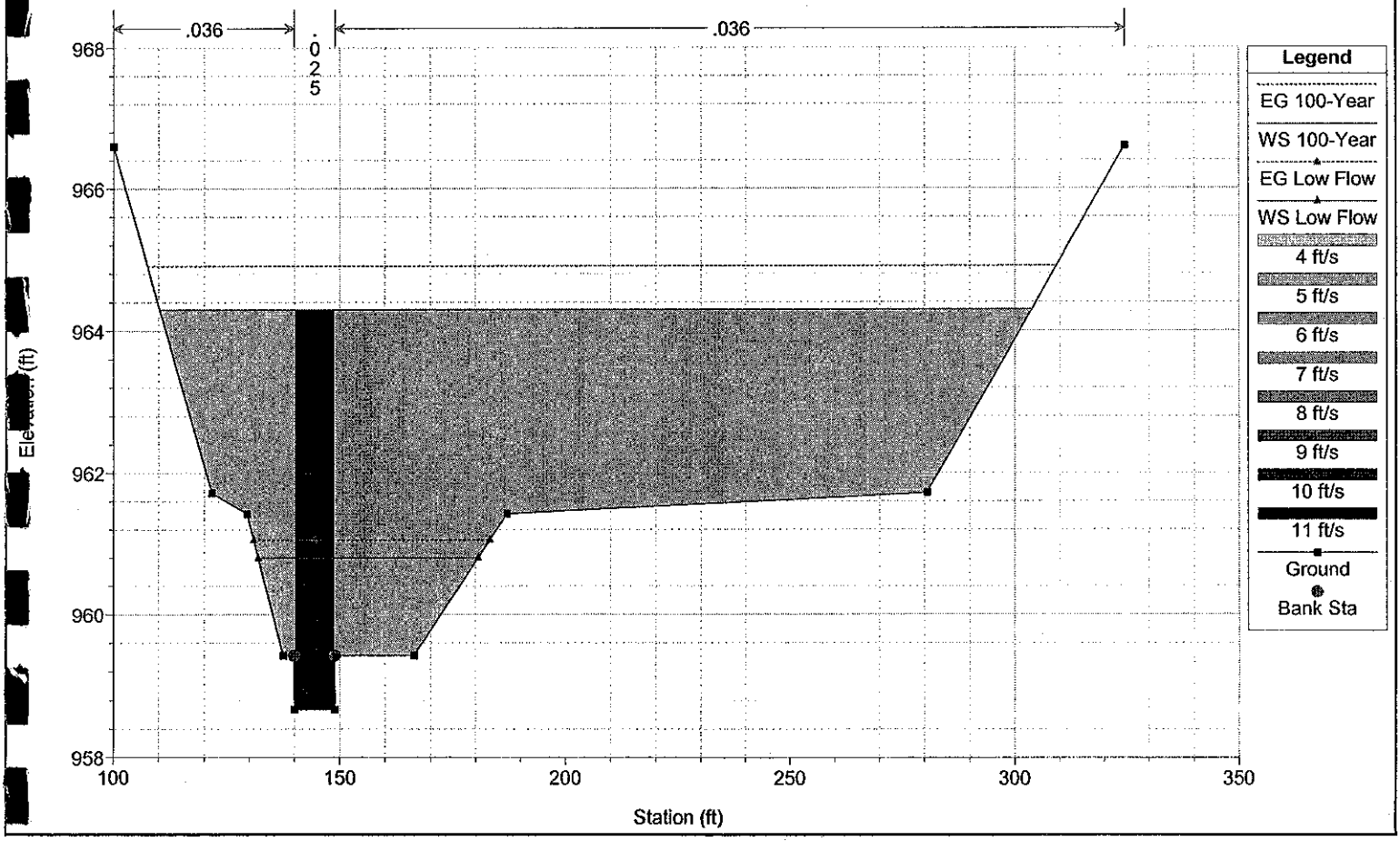
RS = 19400.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

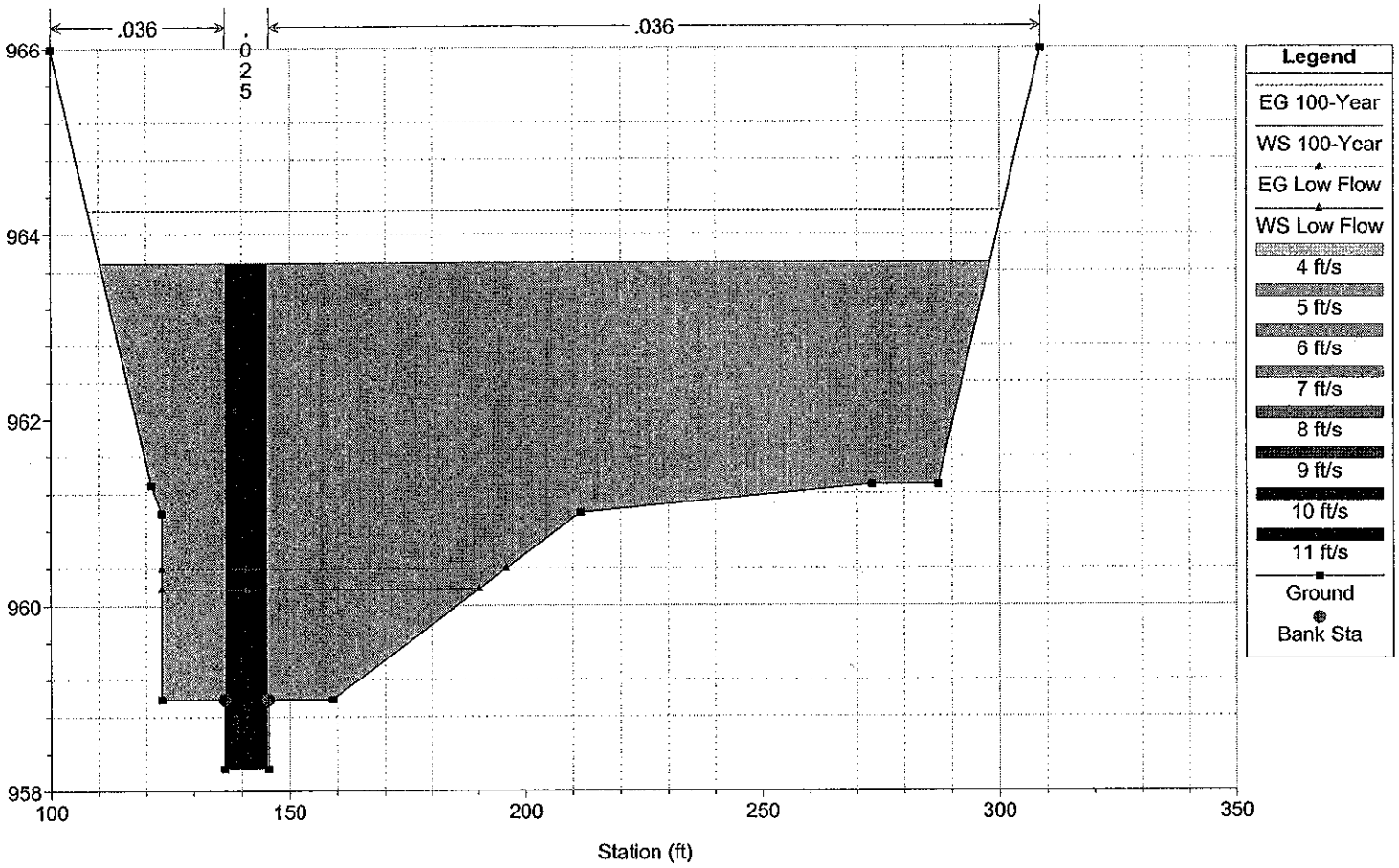
RS = 19205.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

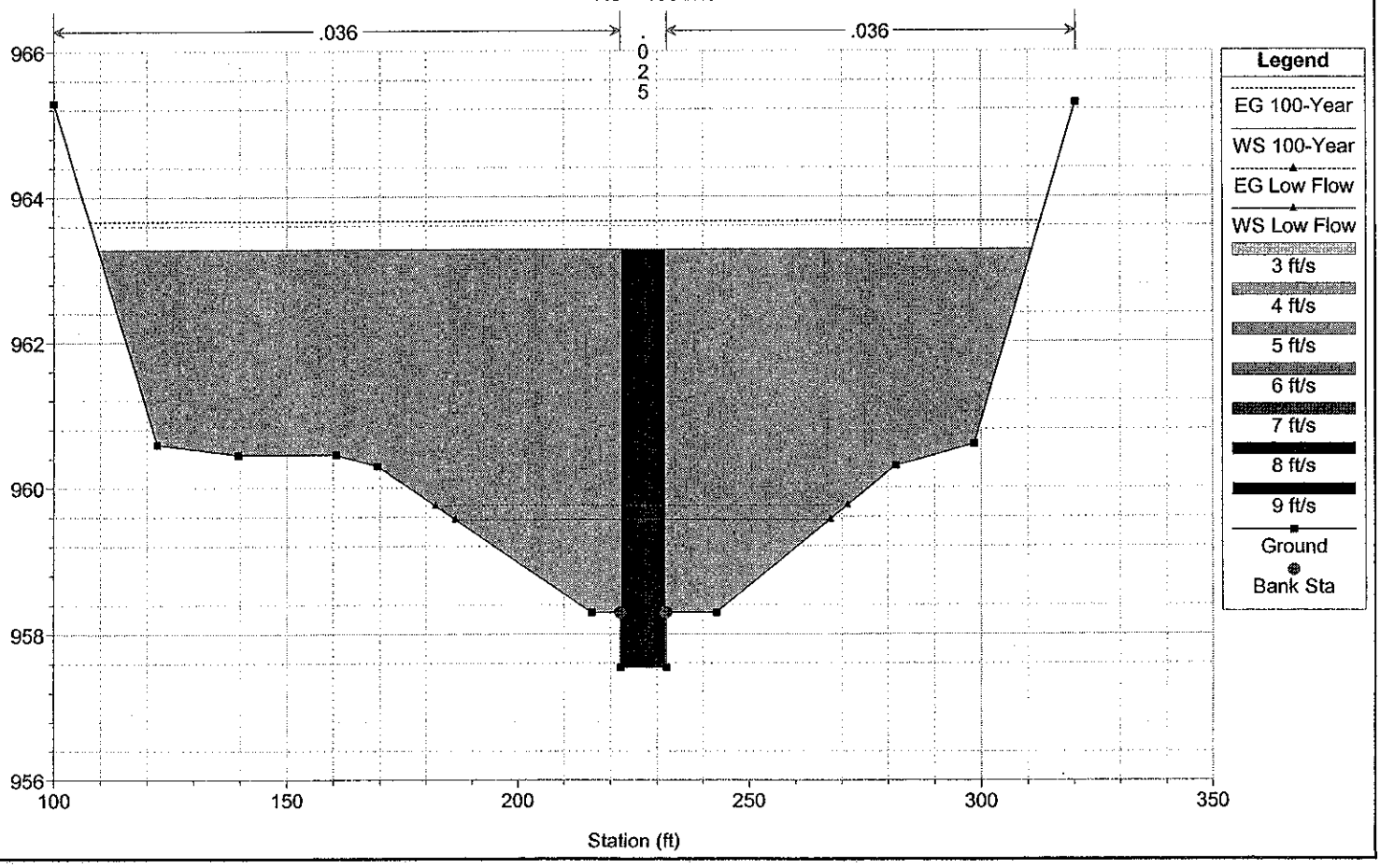
RS = 19017.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

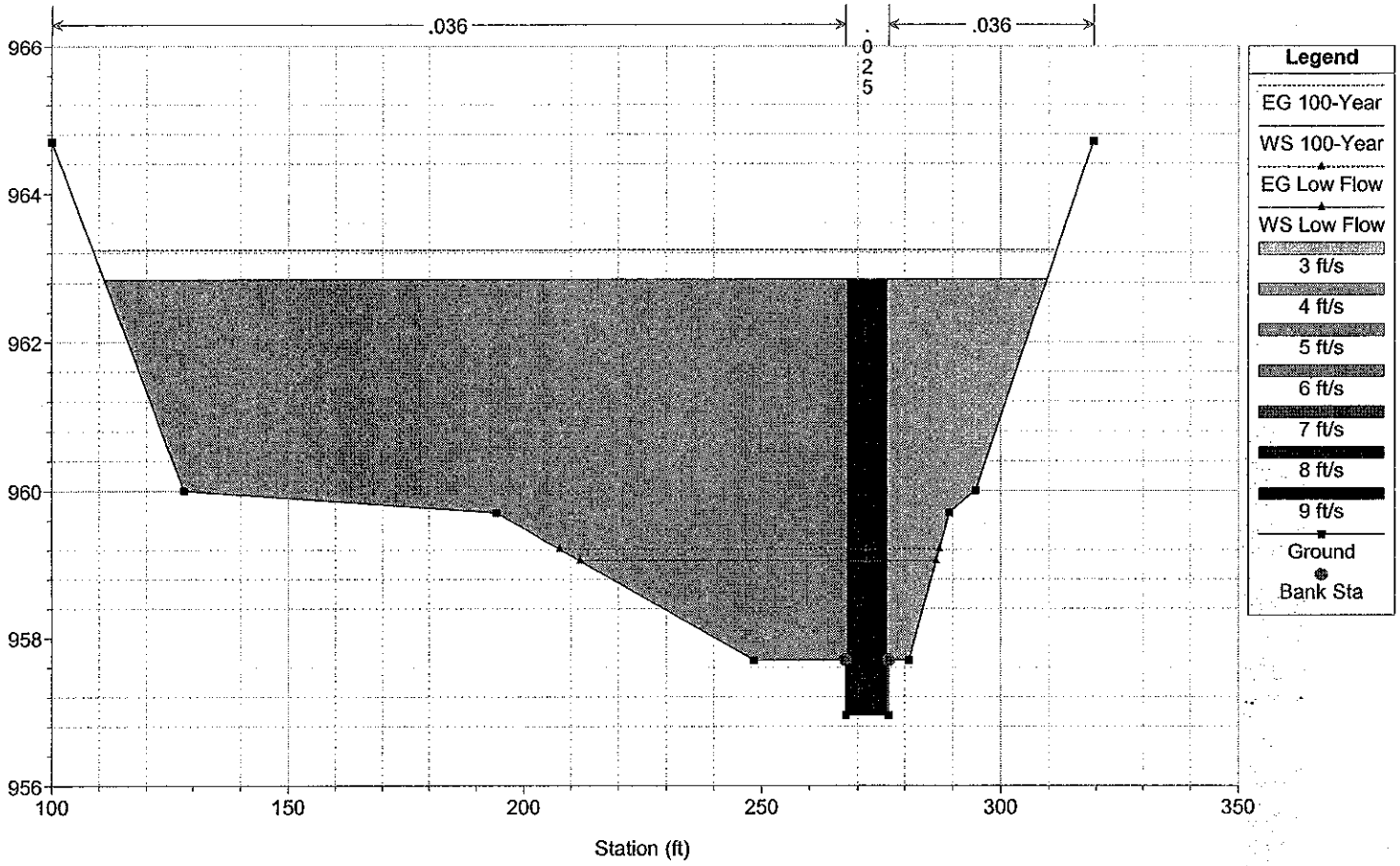
RS = 18821.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

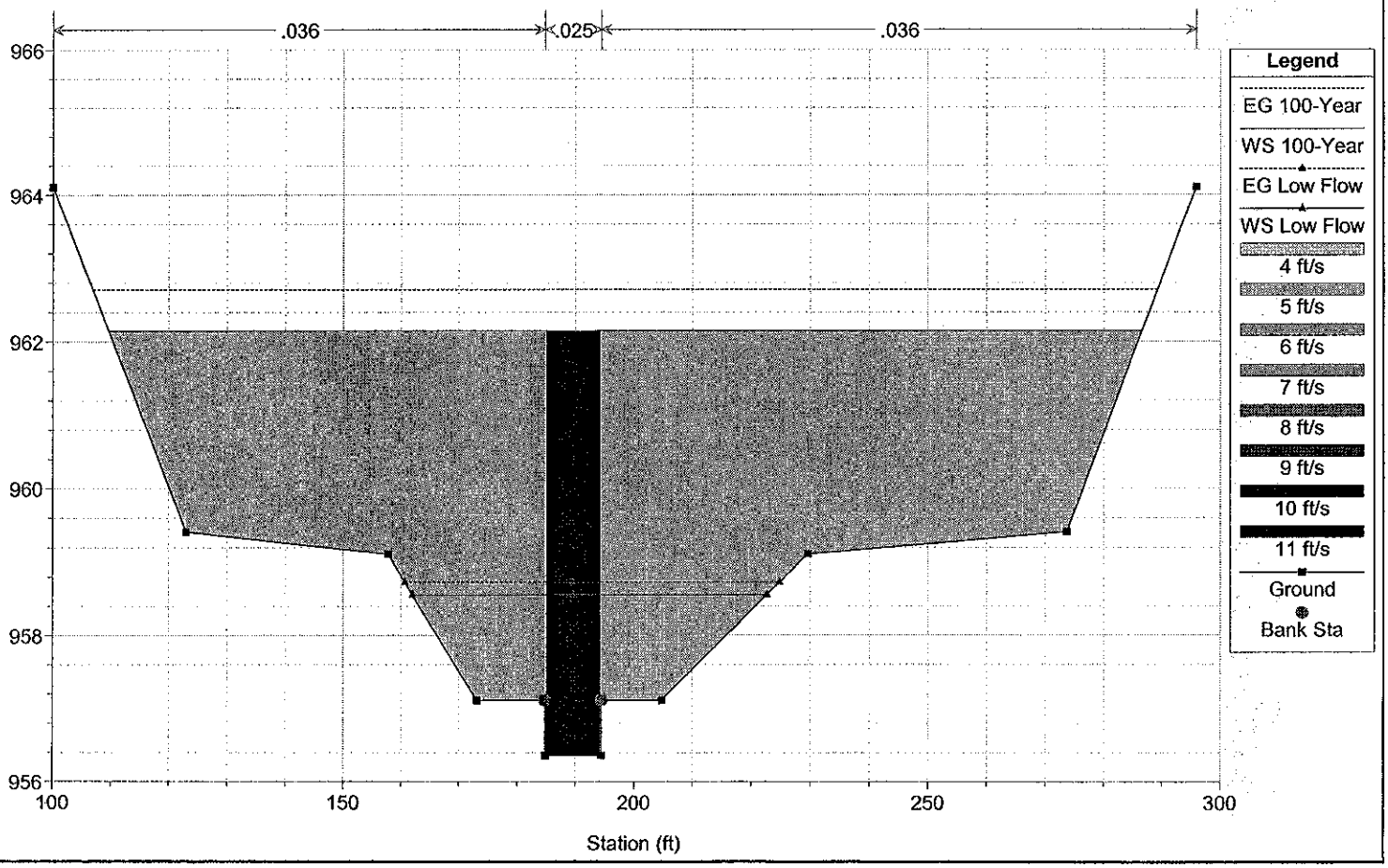
RS = 18623.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

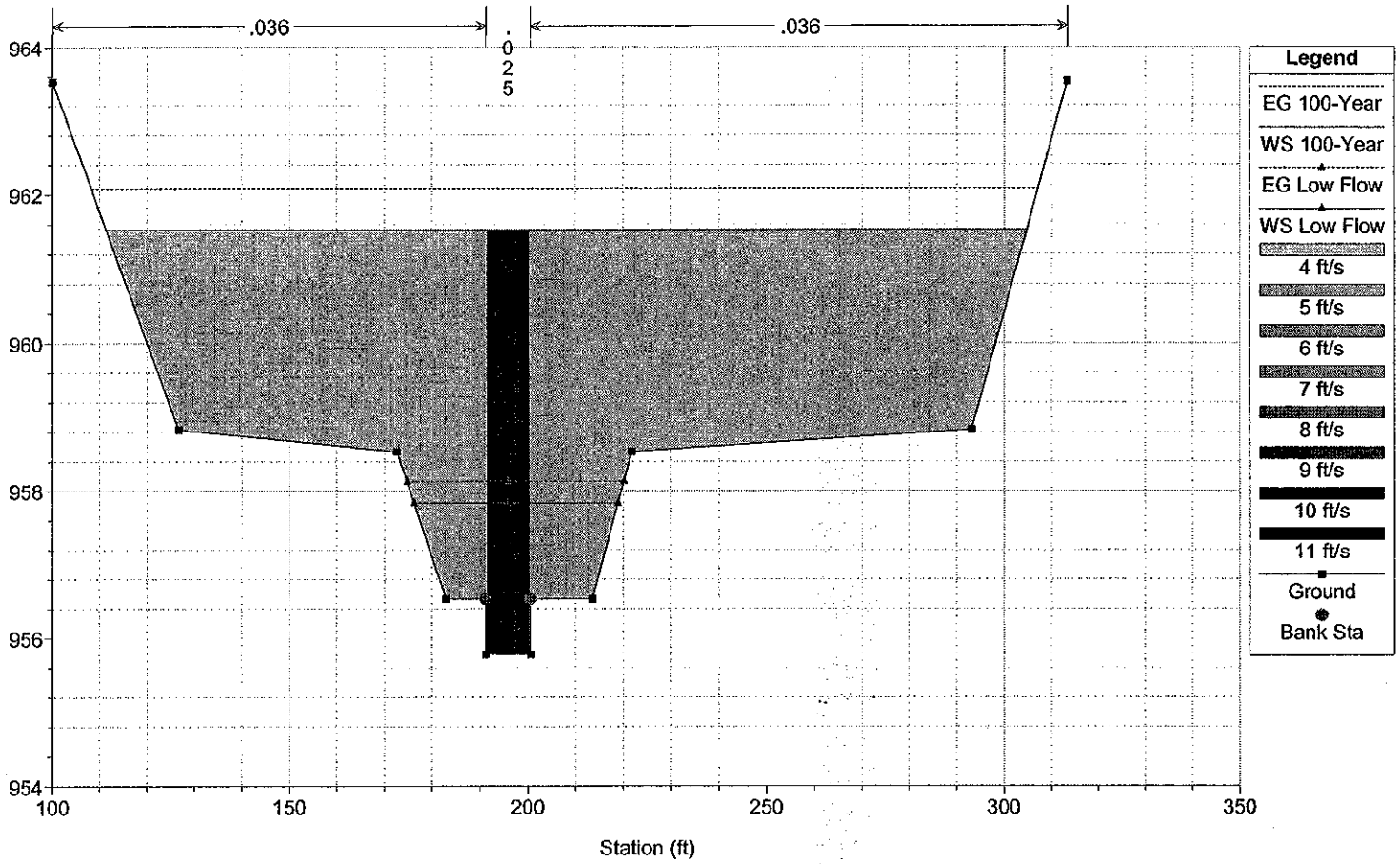
RS = 18424.2



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

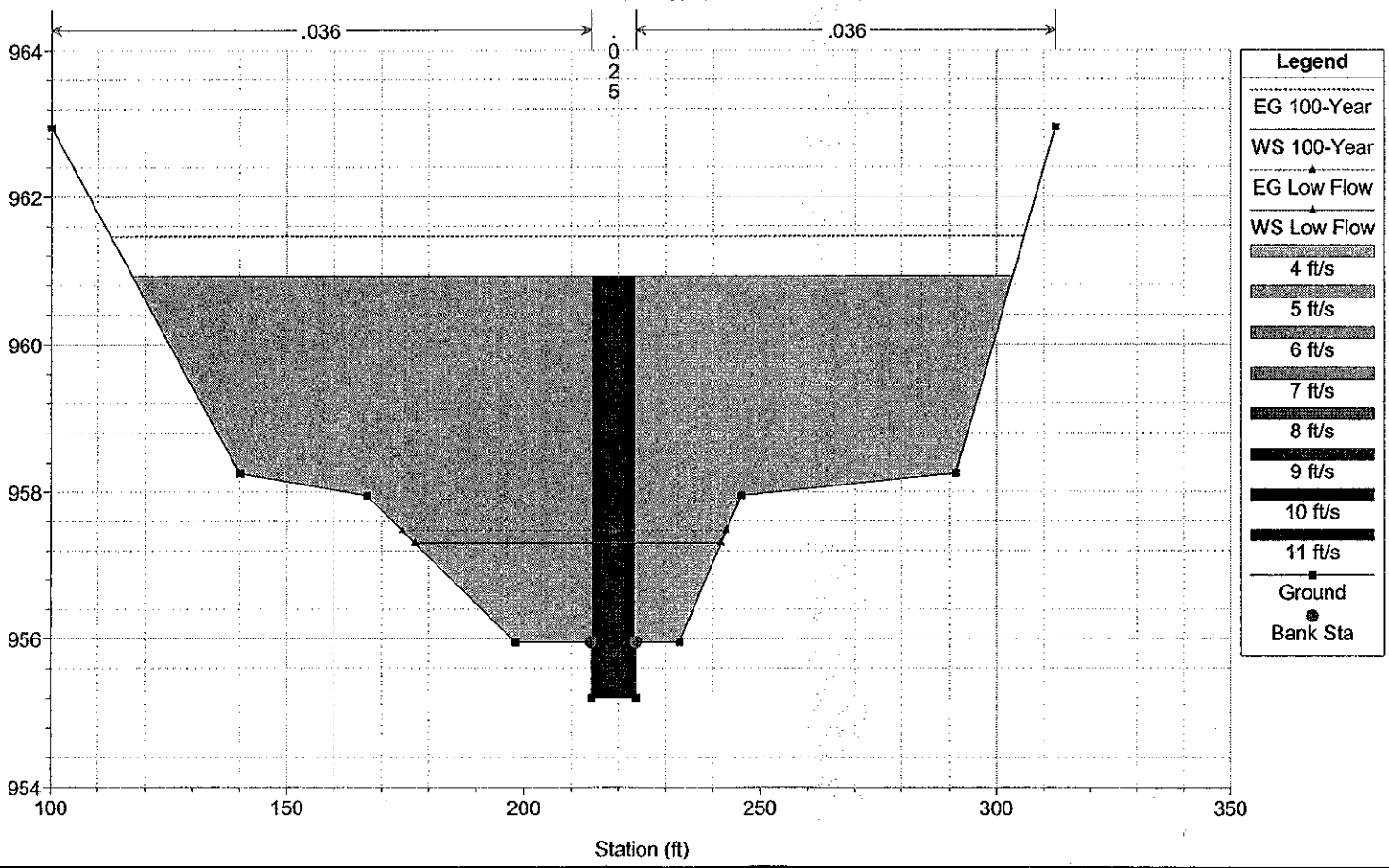
RS = 18226.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

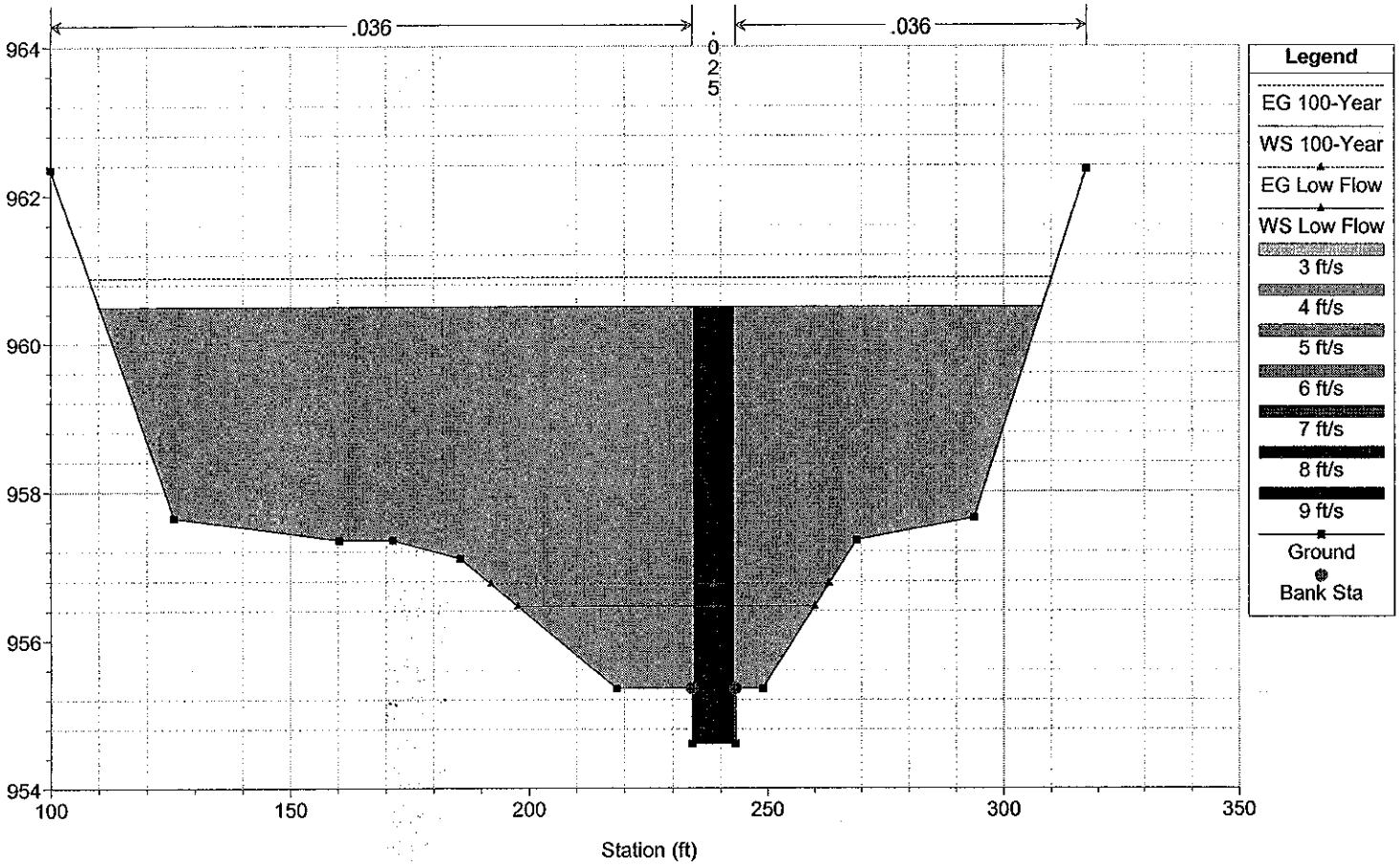
RS = 18029.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

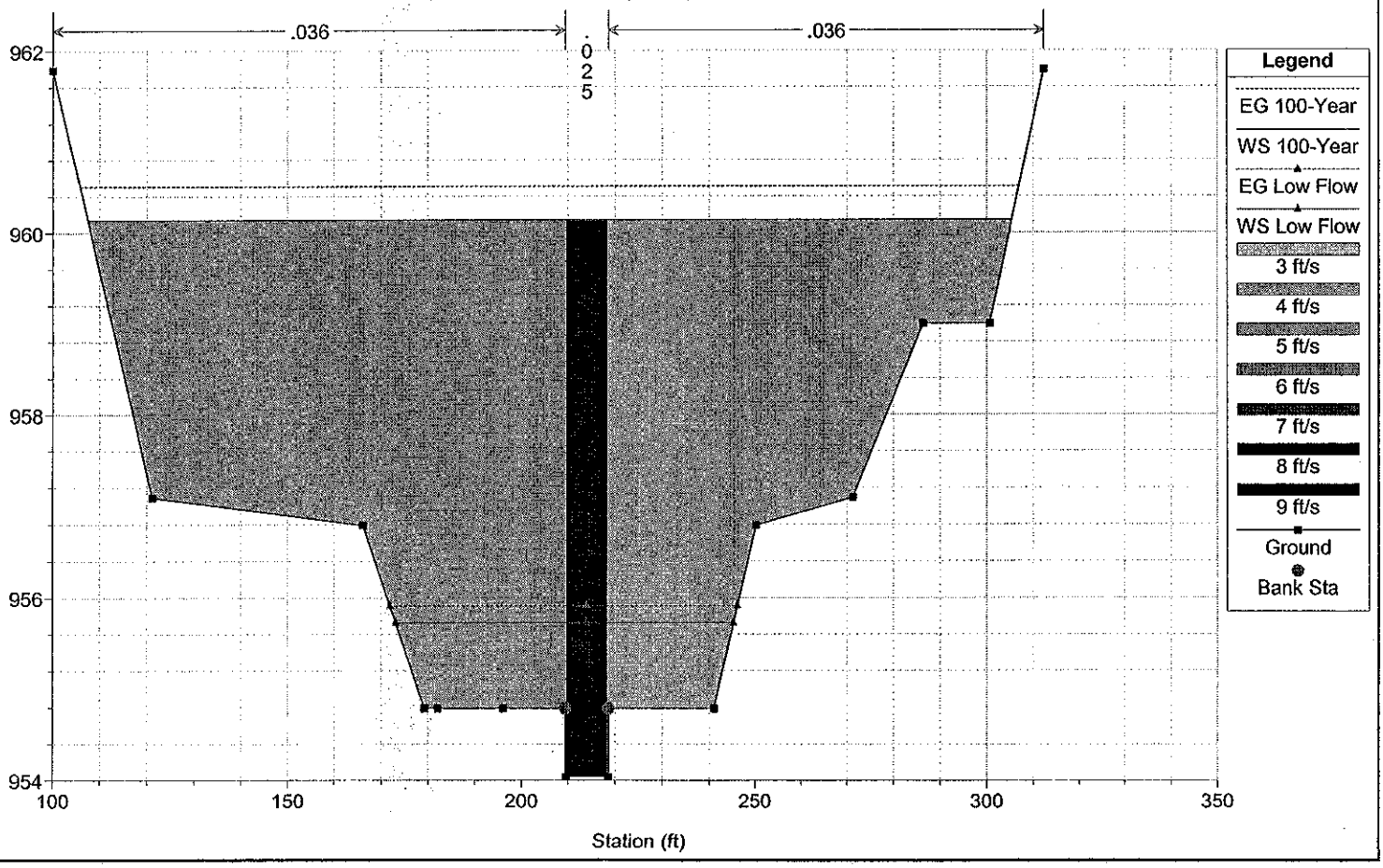
RS = 17826.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

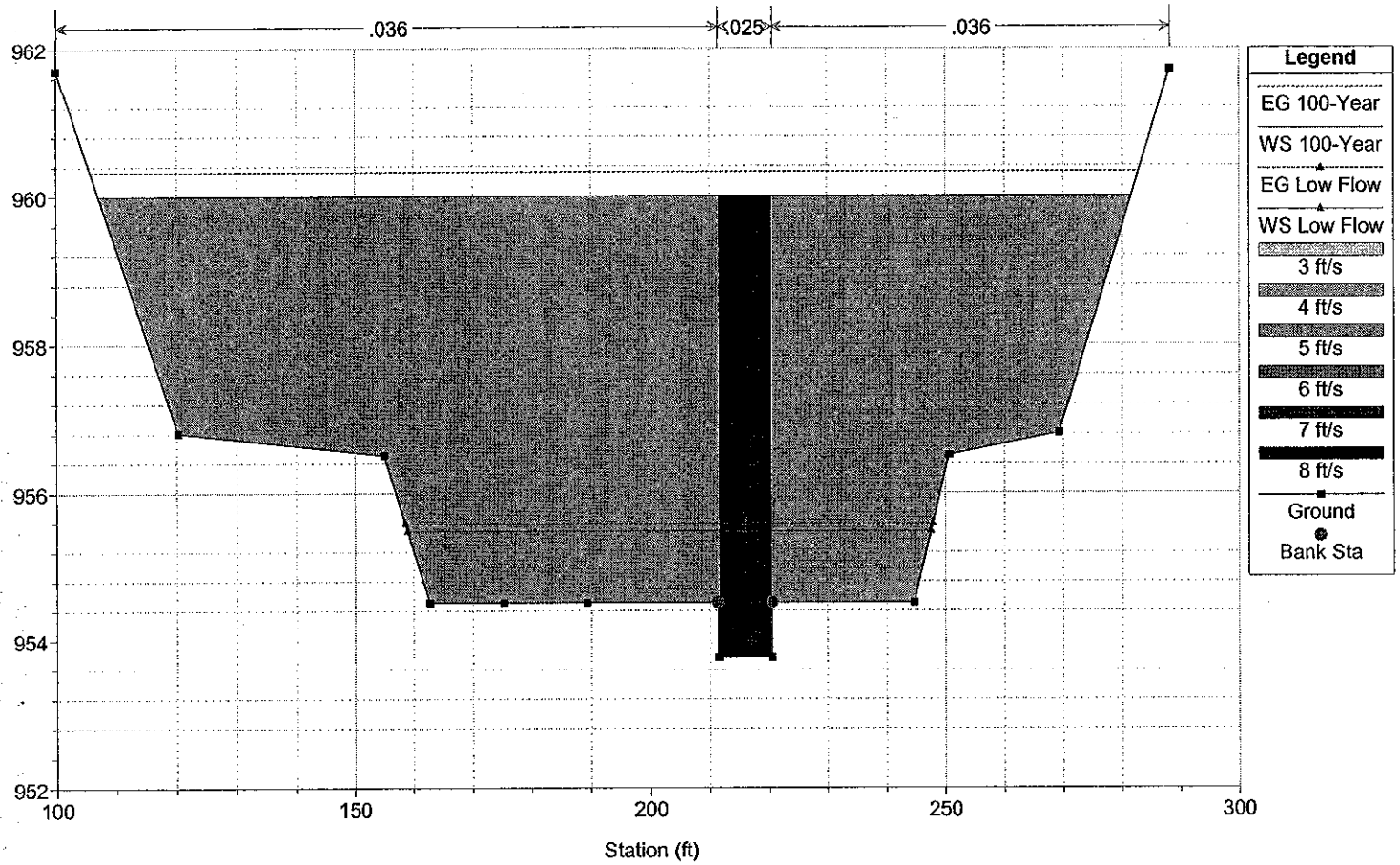
RS = 17644



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

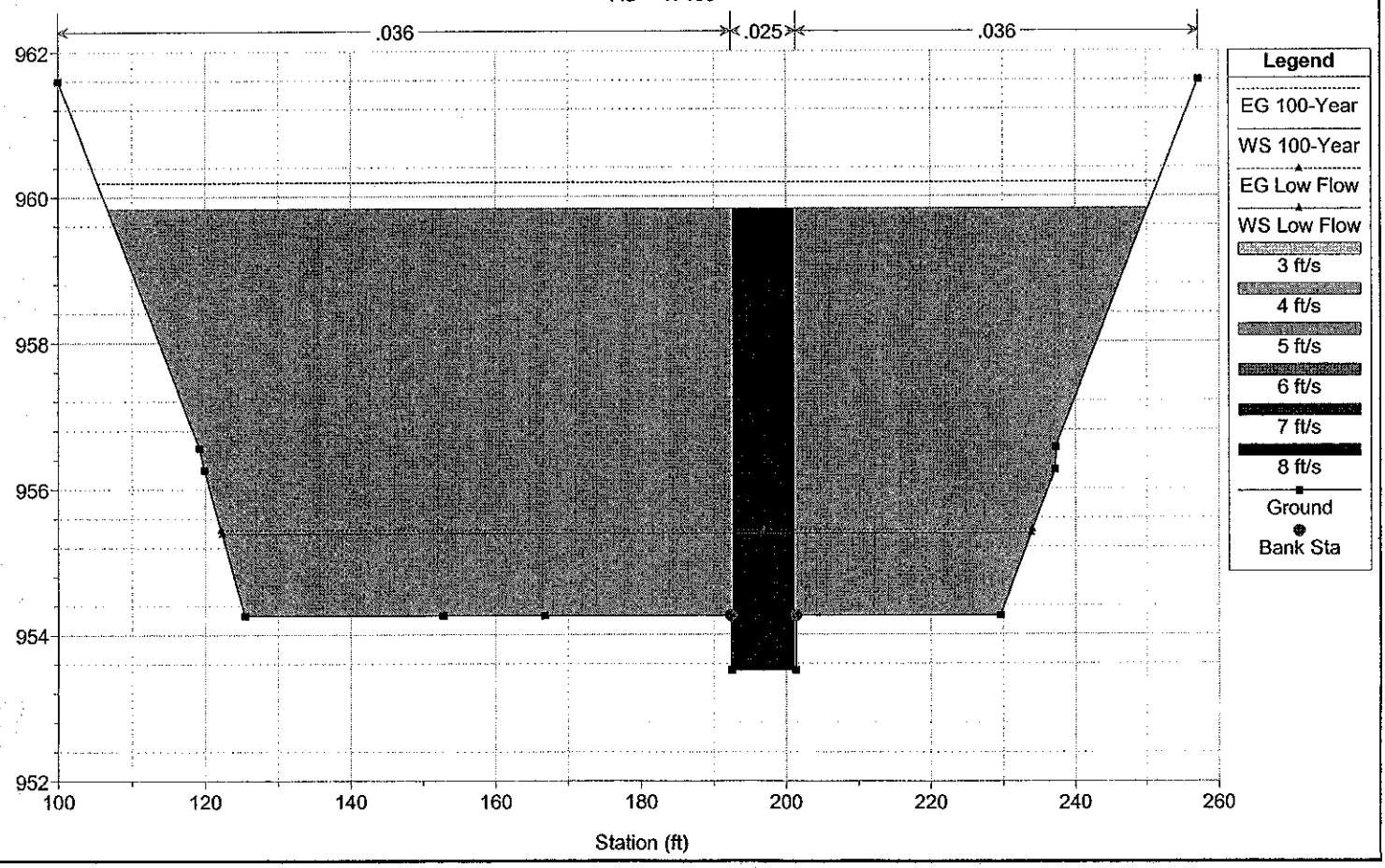
RS = 17545



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

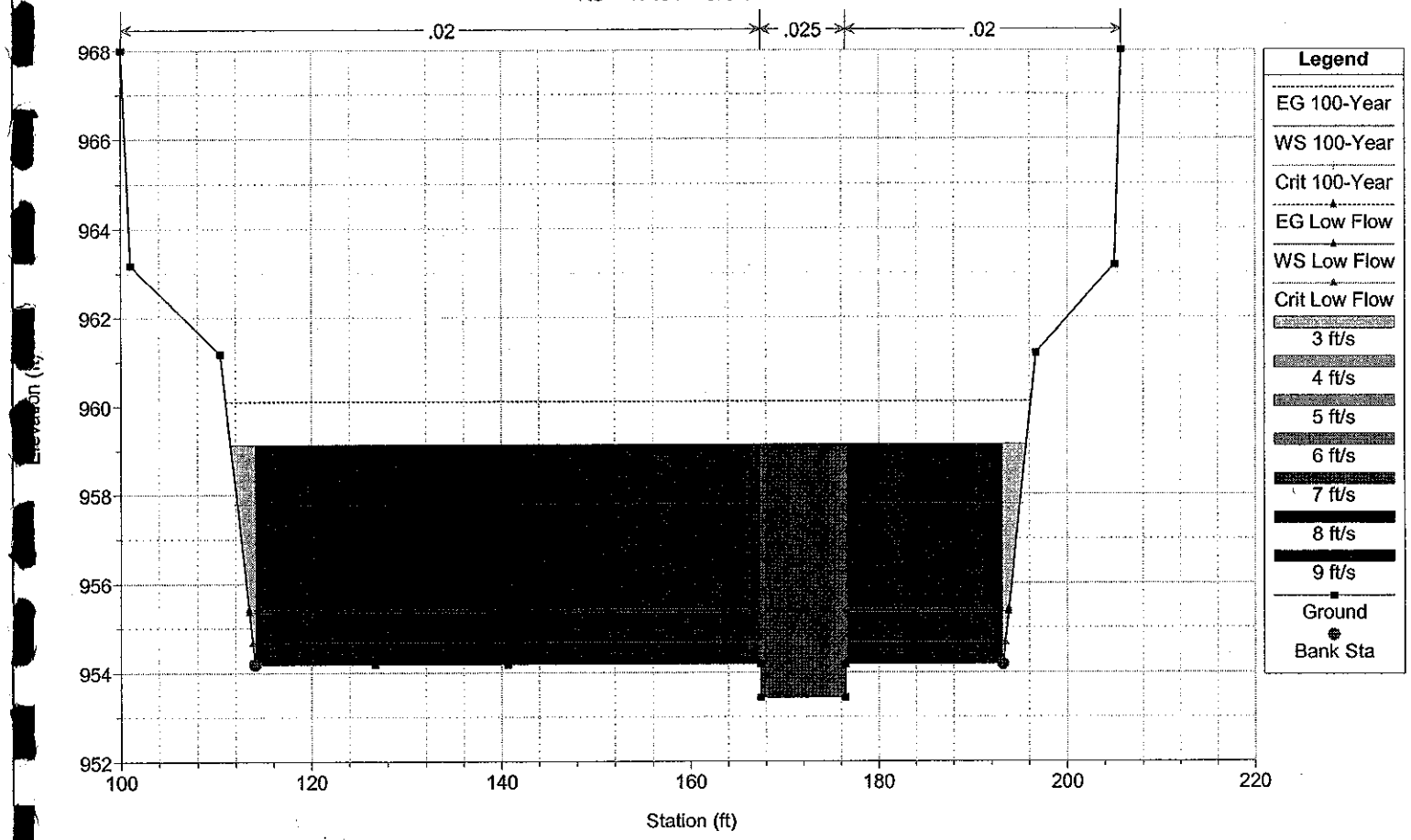
RS = 17459



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

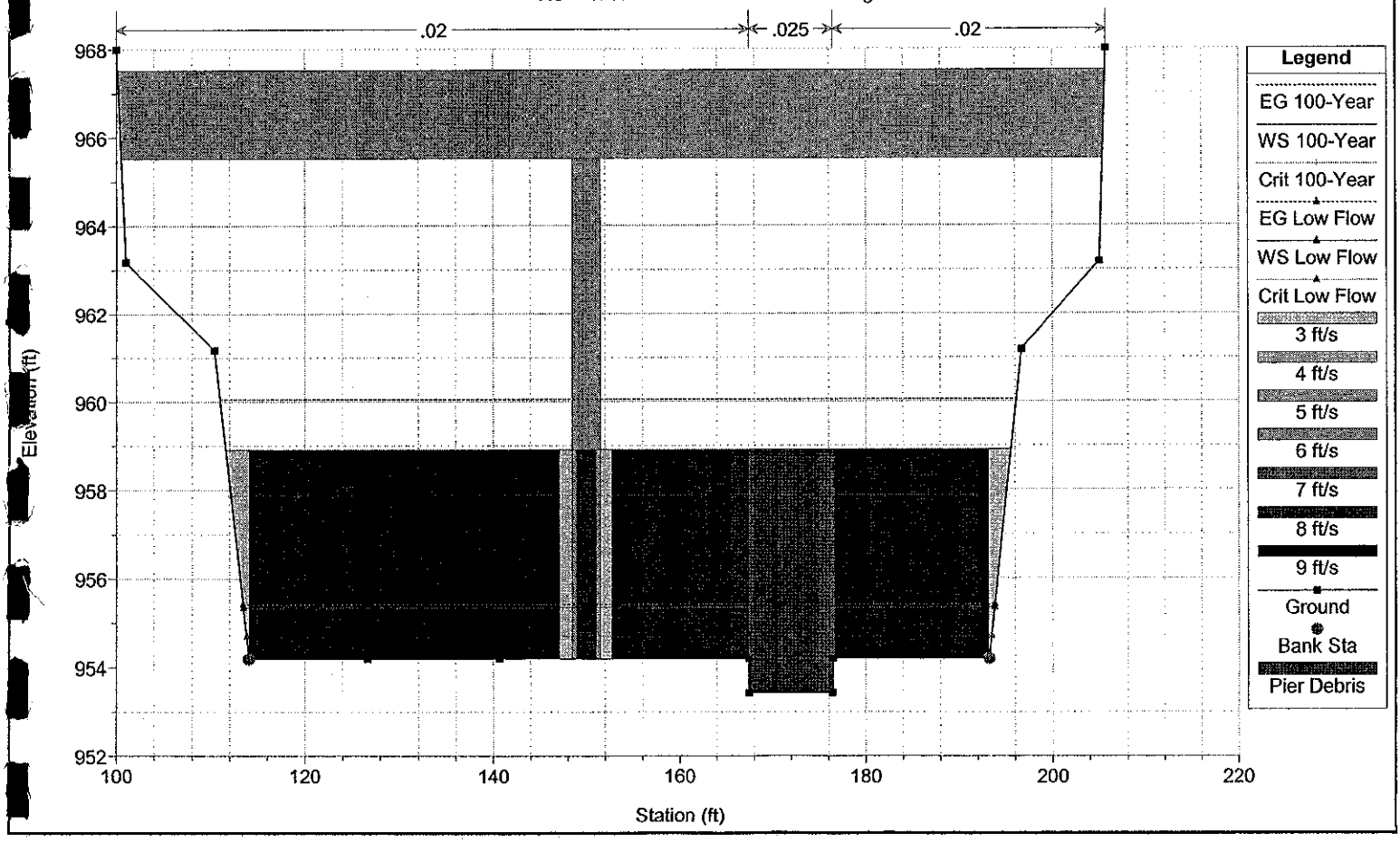
RS = 17434 U/S of Yuma Road



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

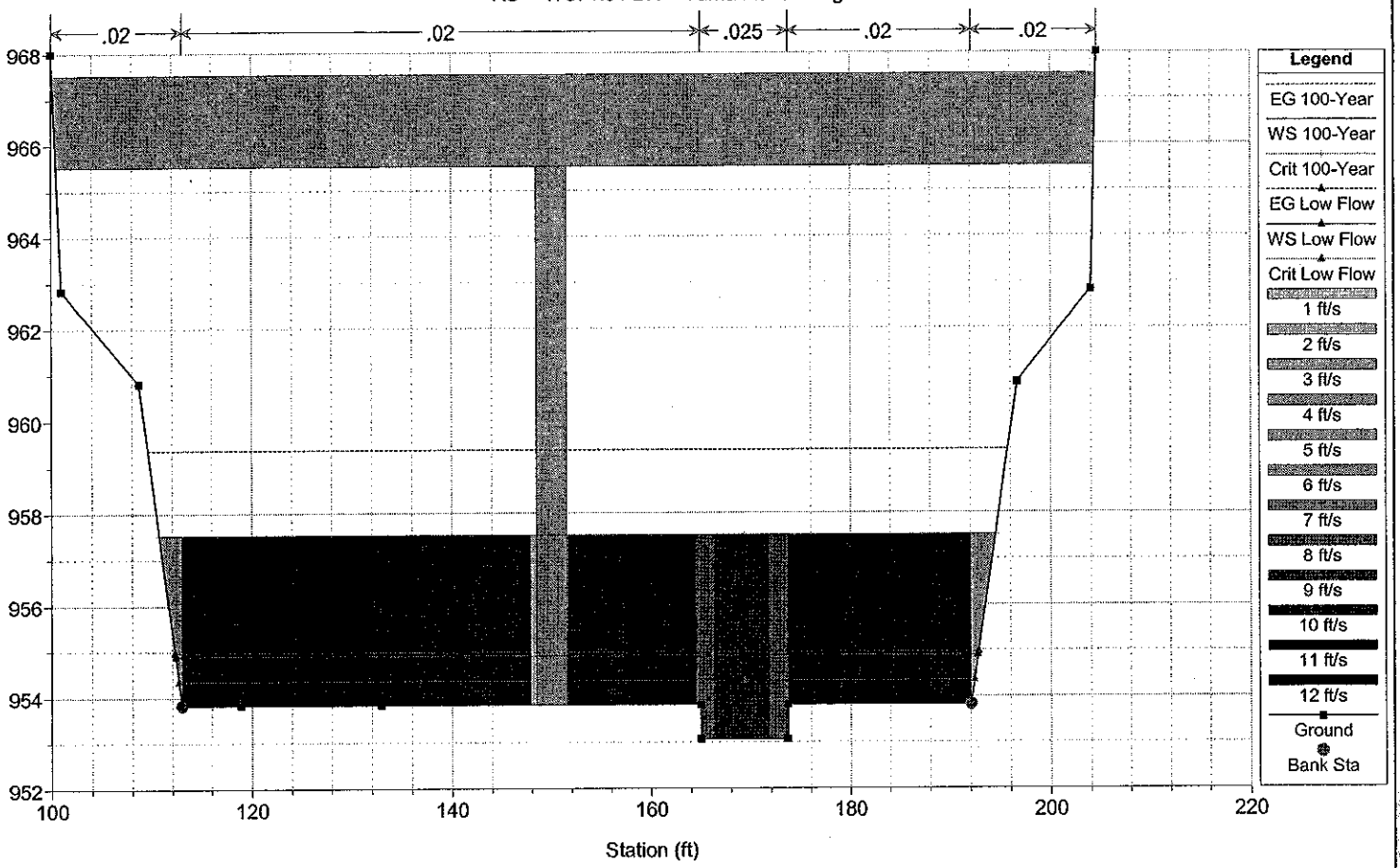
RS = 17371.91 BR Yuma Road Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

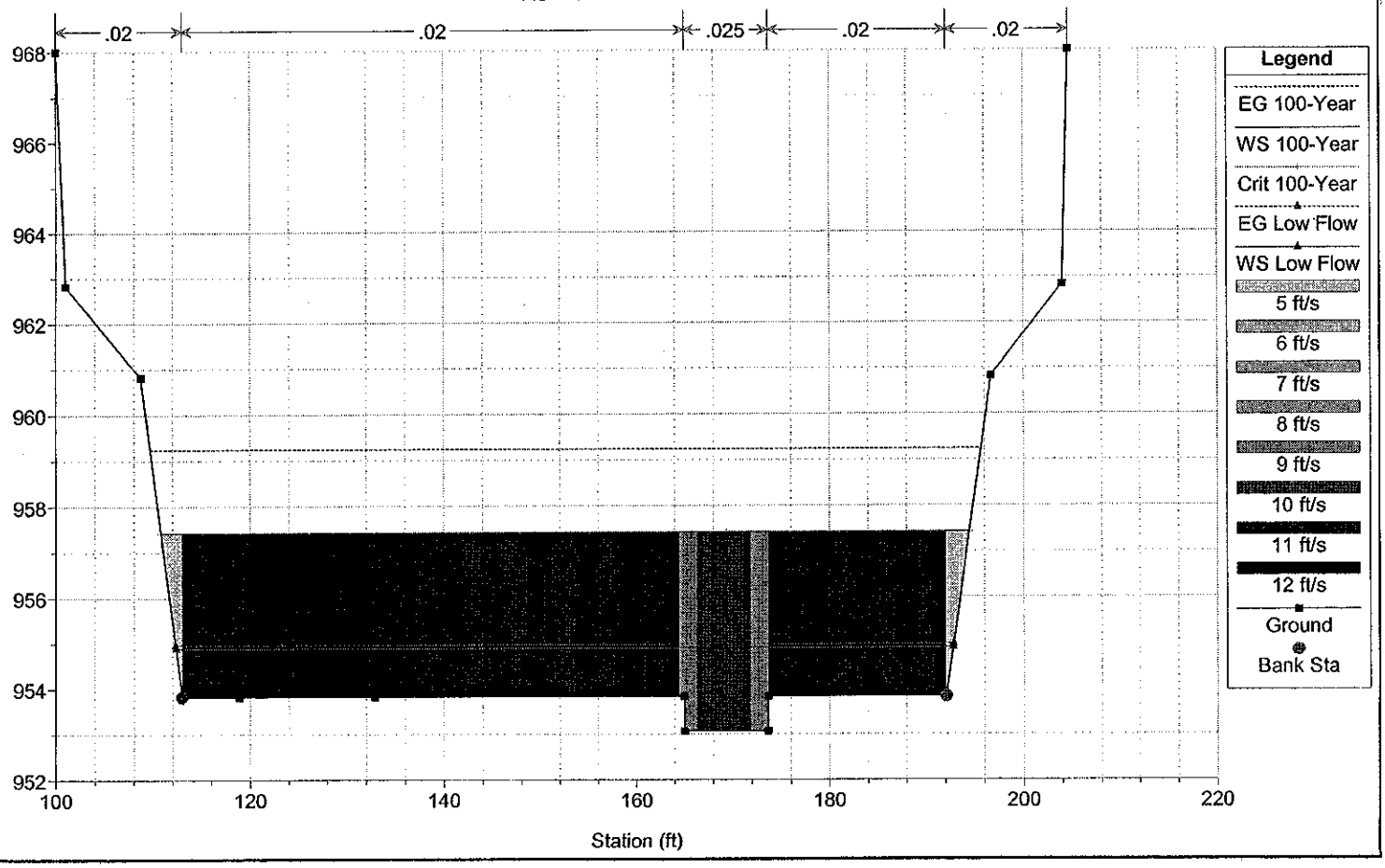
RS = 17371.91 BR Yuma Road Bridge



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

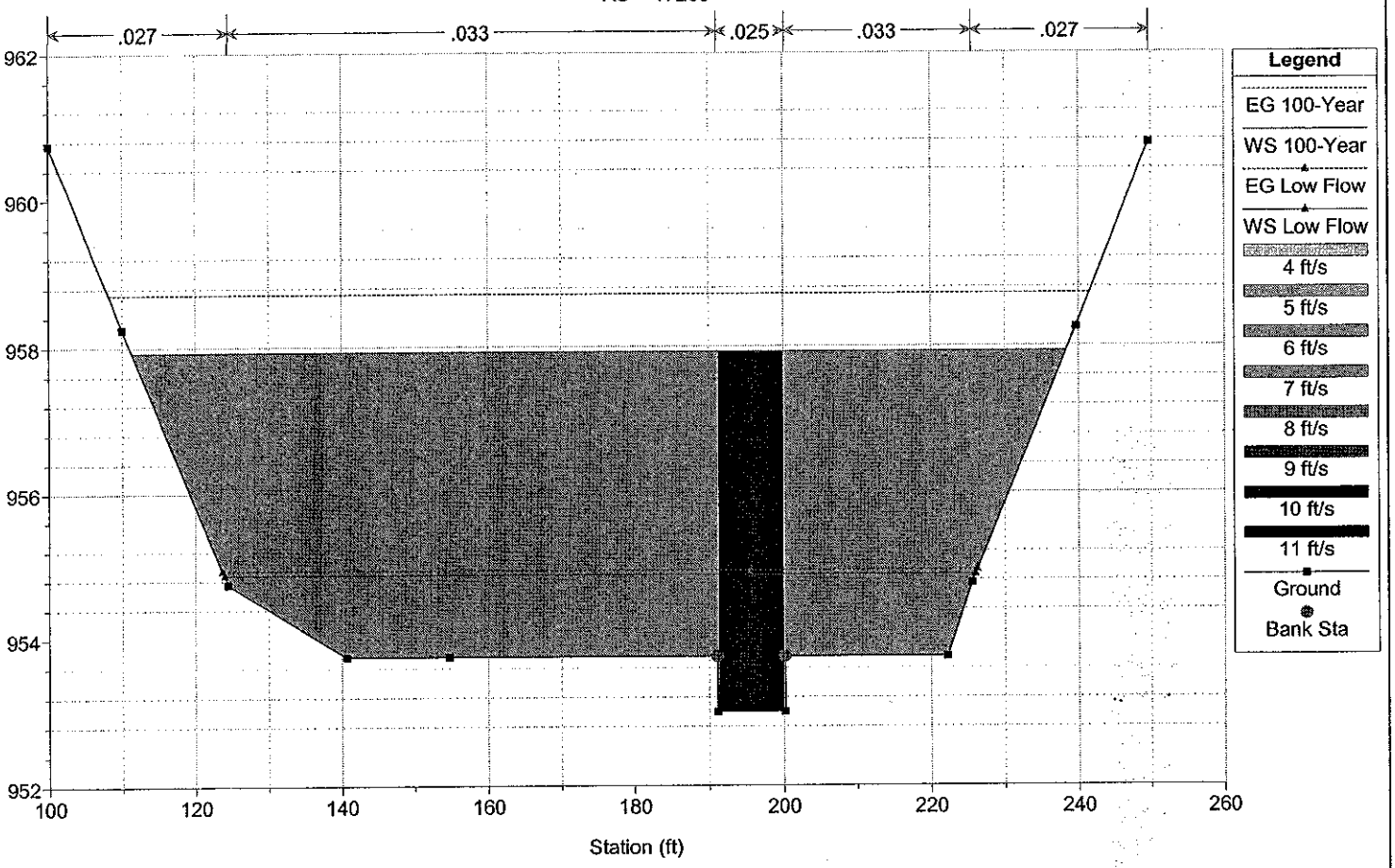
RS = 17310 D/S of Yuma Road



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

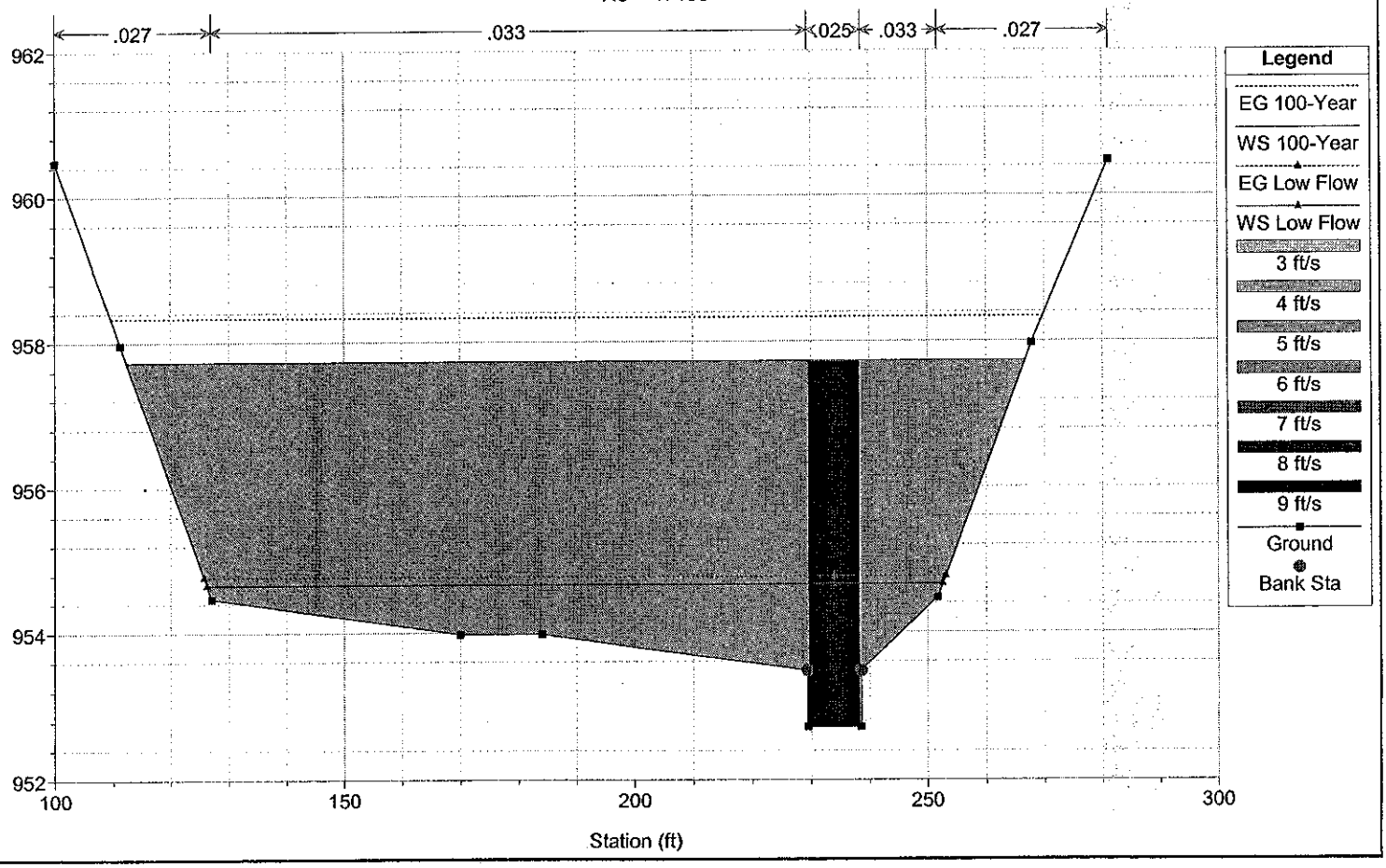
RS = 17285



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

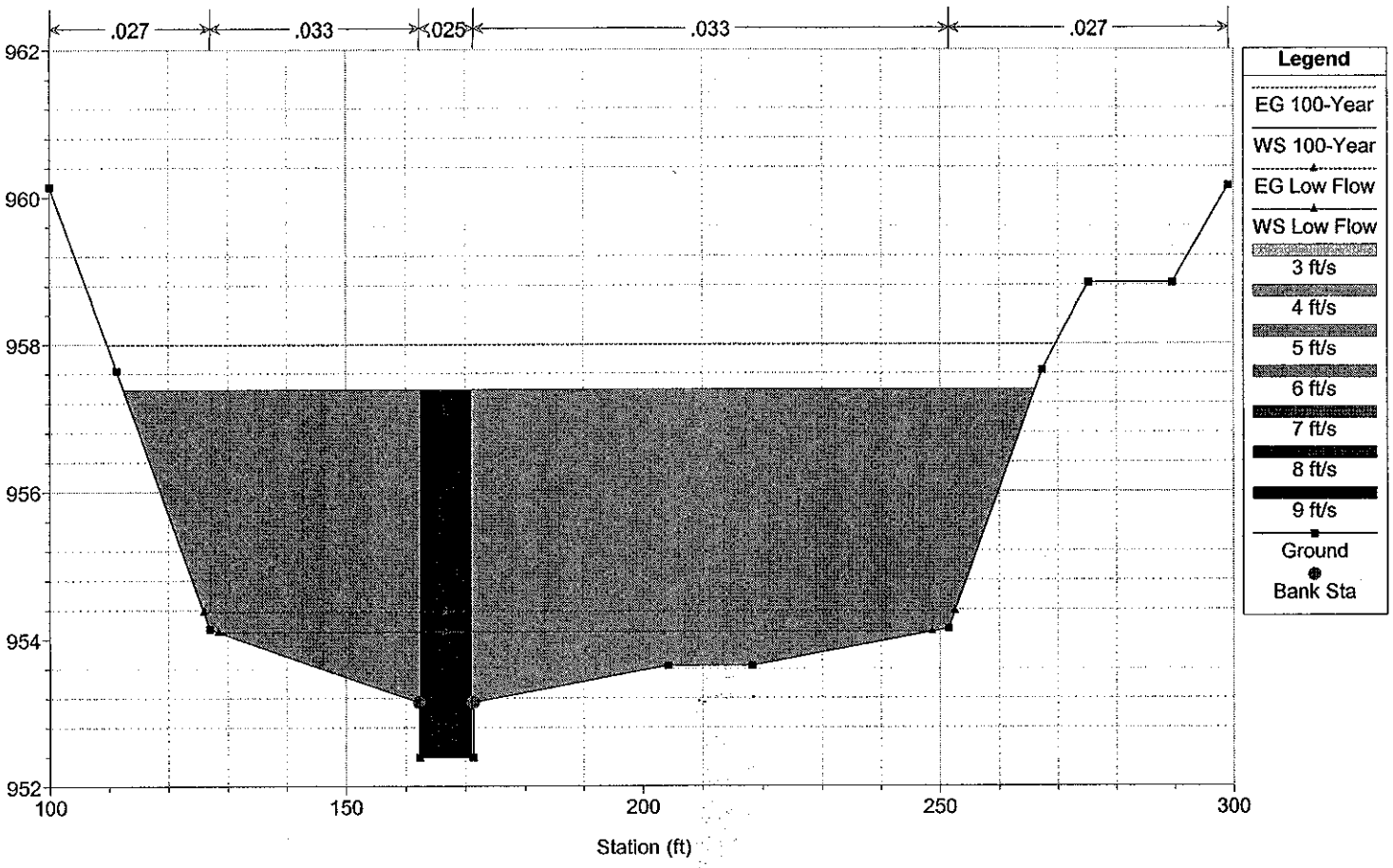
RS = 17188



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

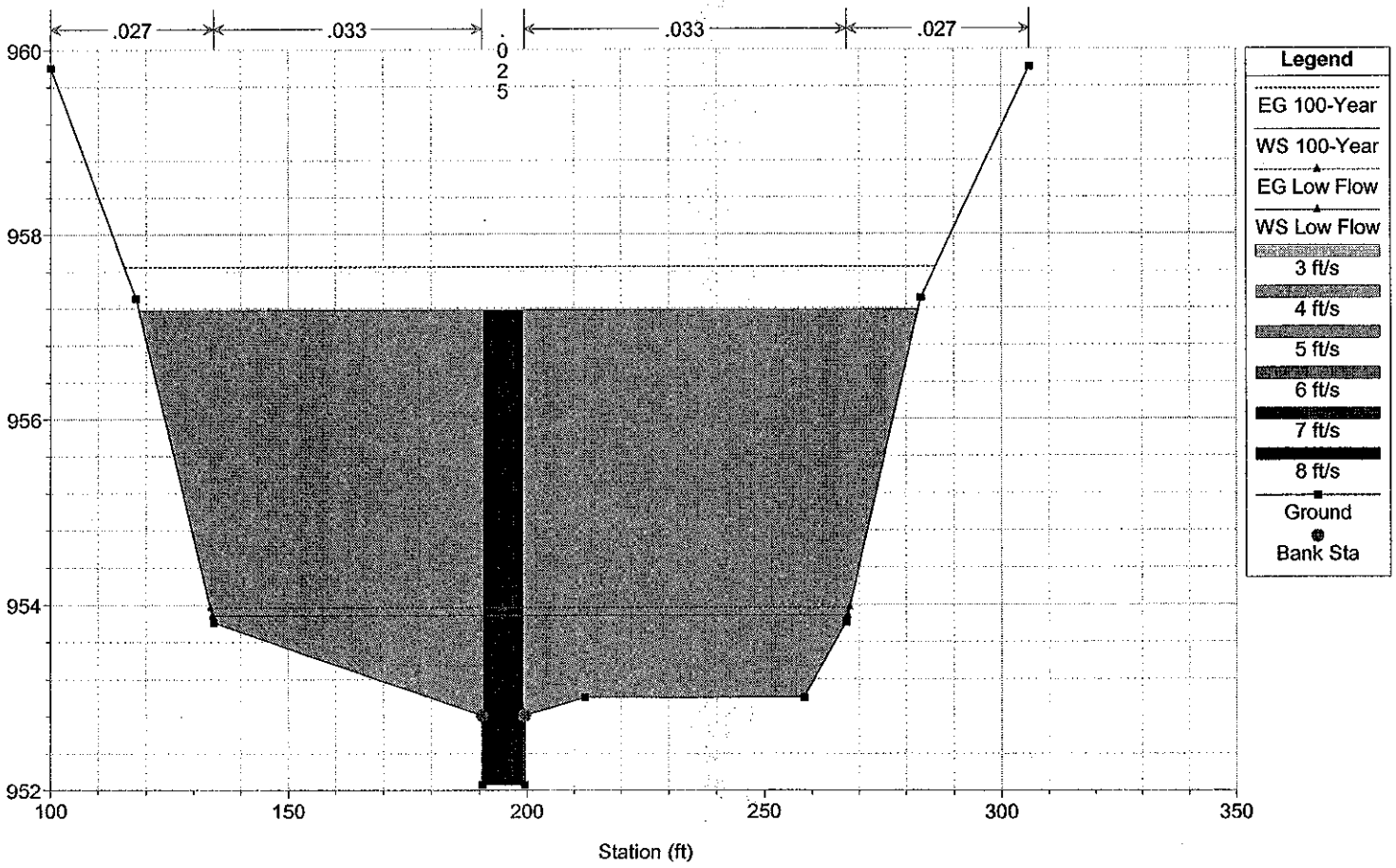
RS = 17076.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

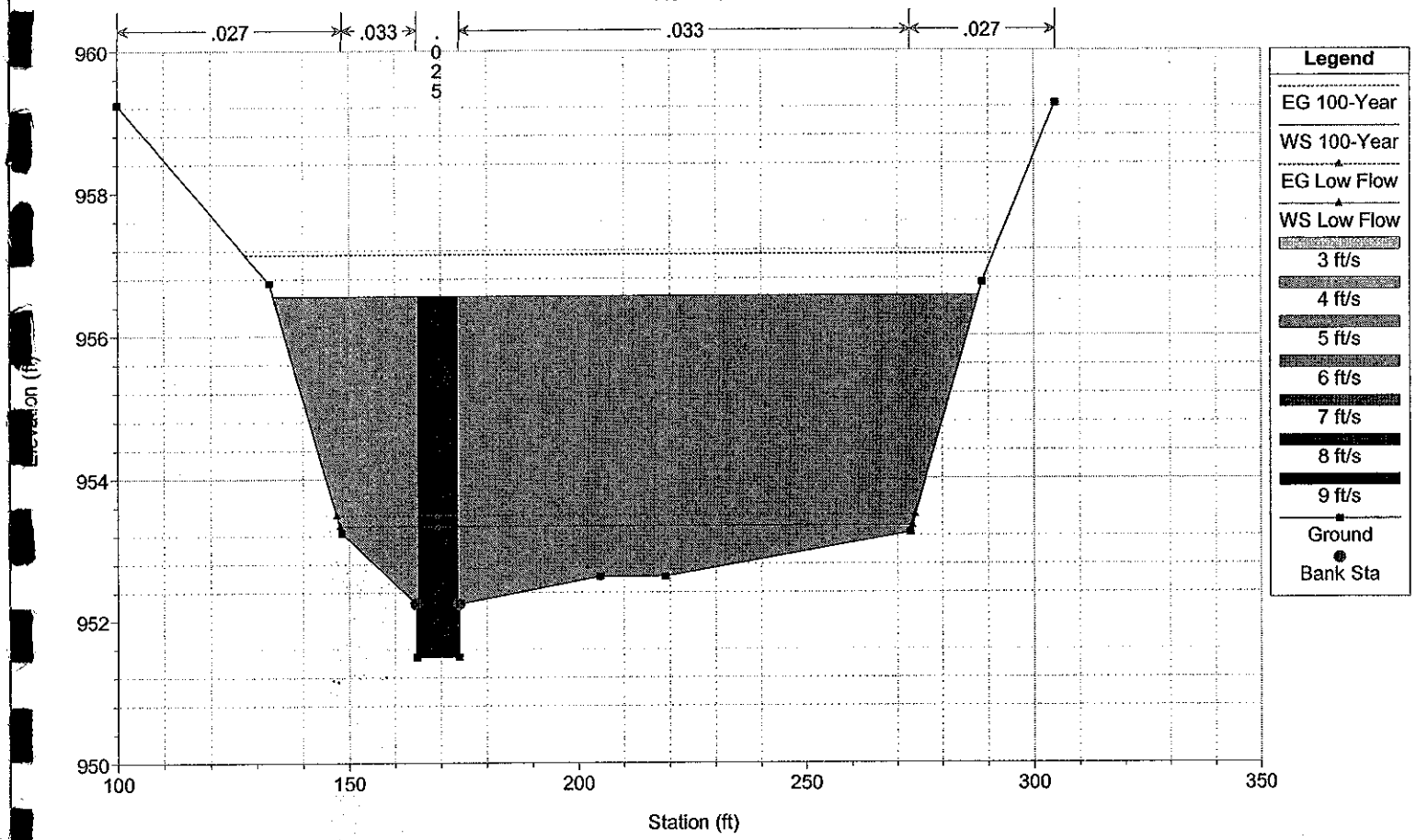
RS = 16961.4



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

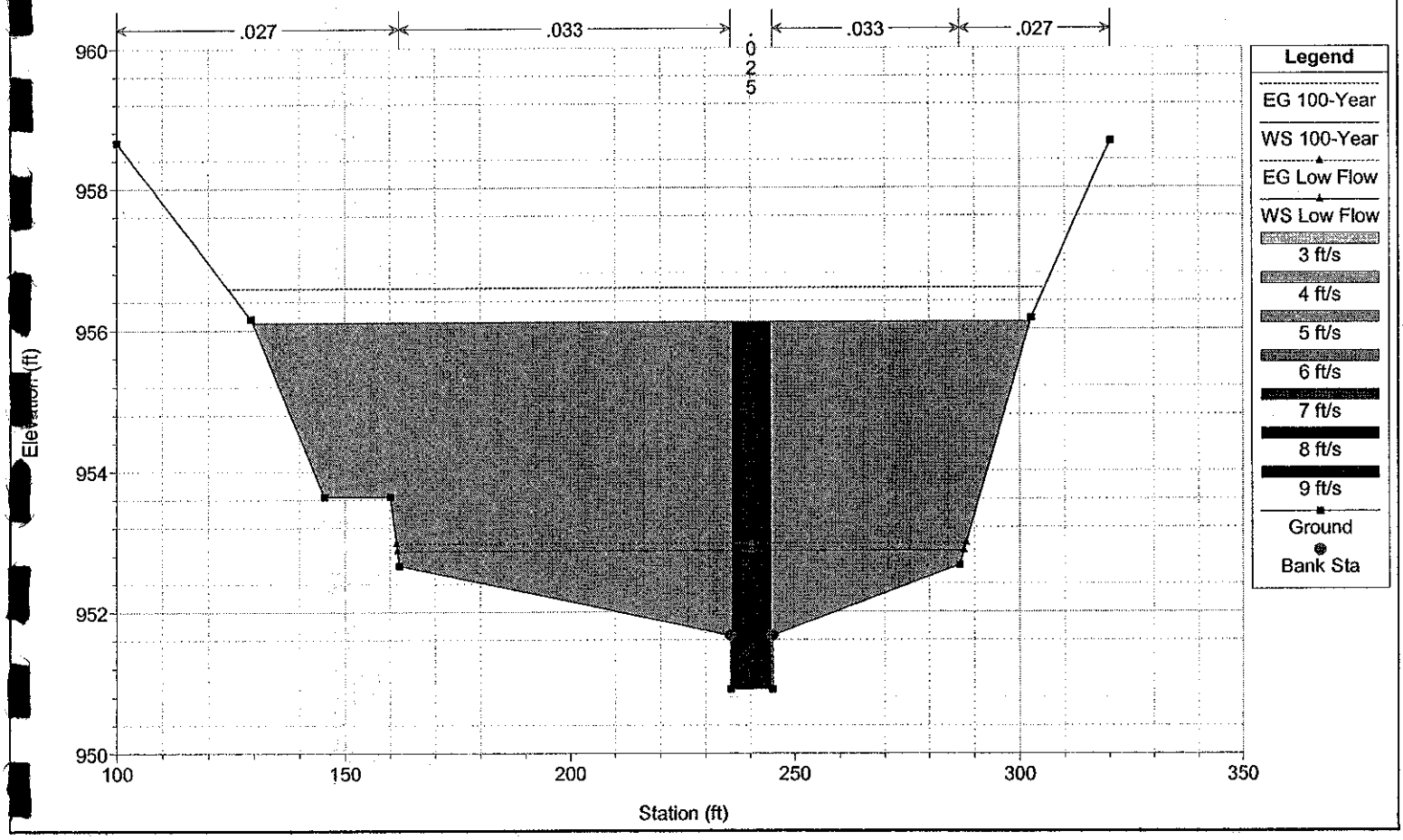
RS = 16762.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

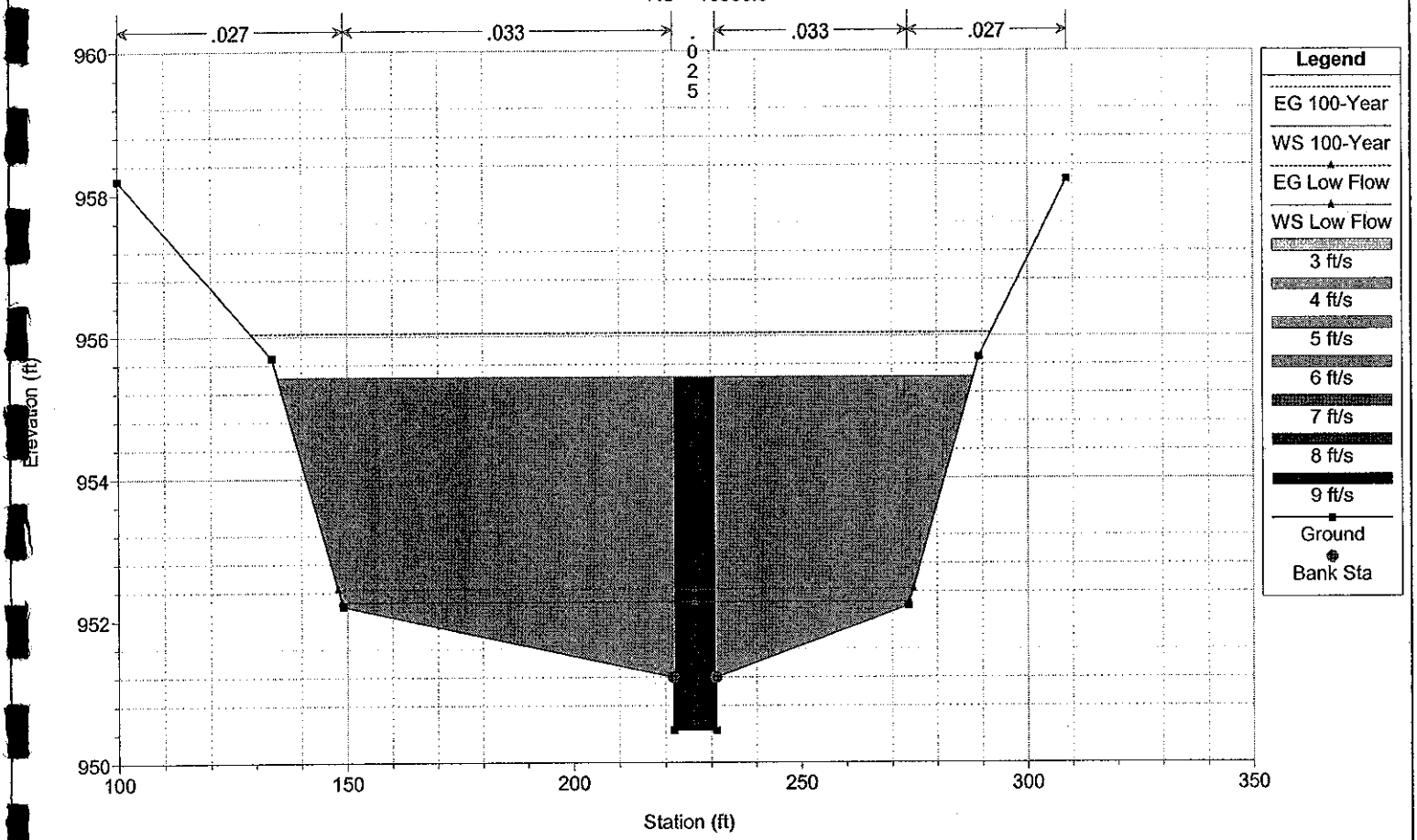
RS = 16562.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

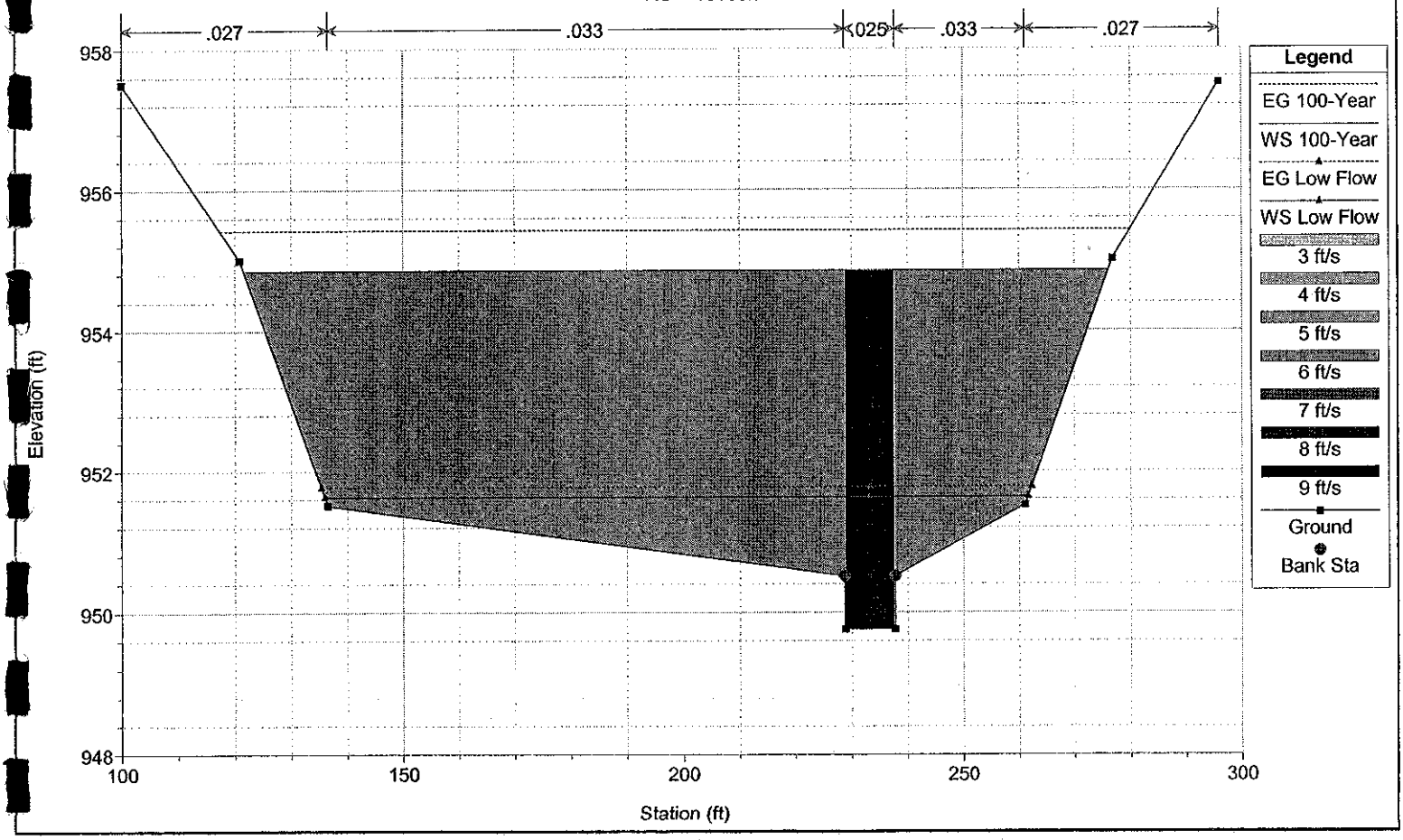
RS = 16366.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

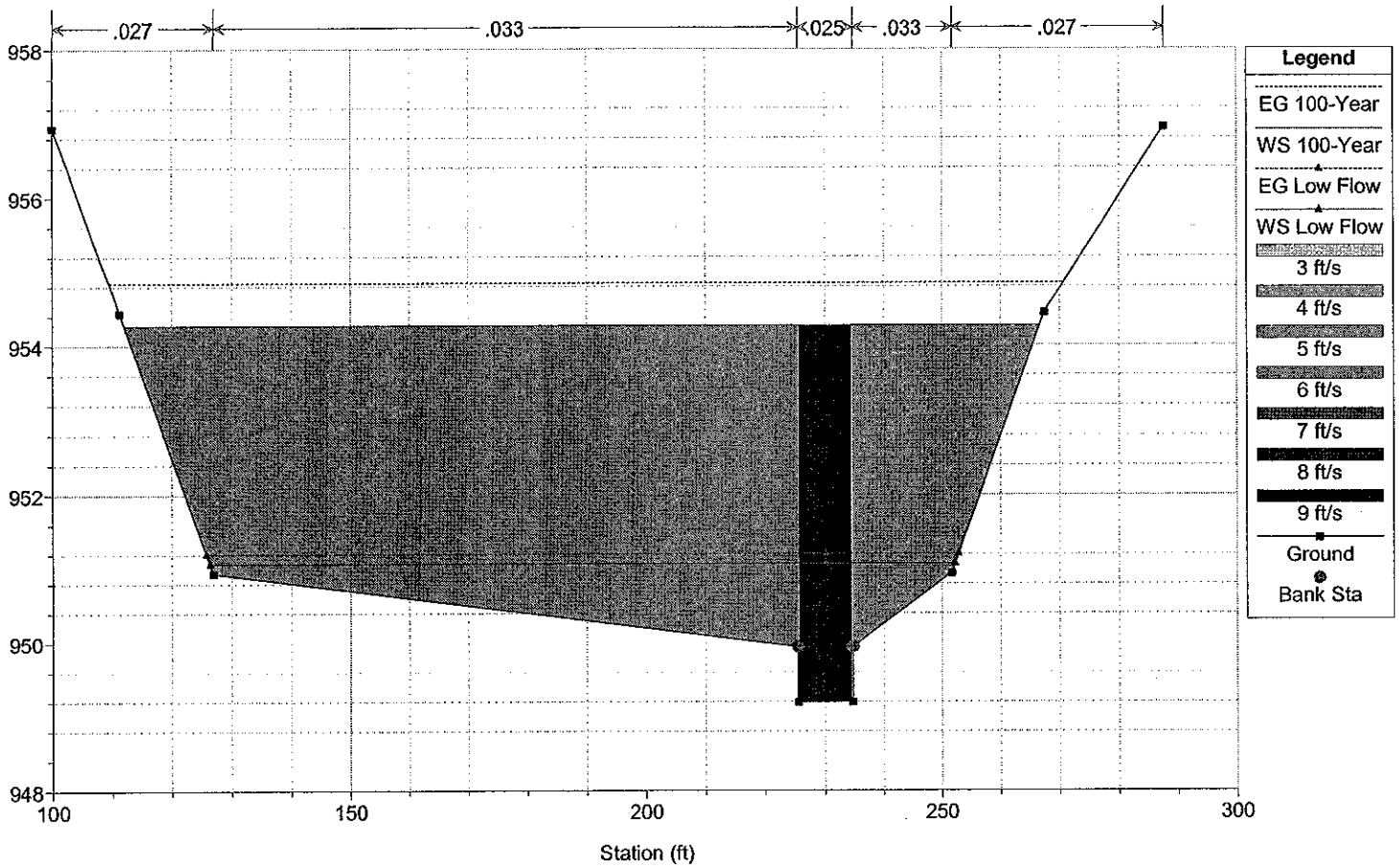
RS = 16165.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

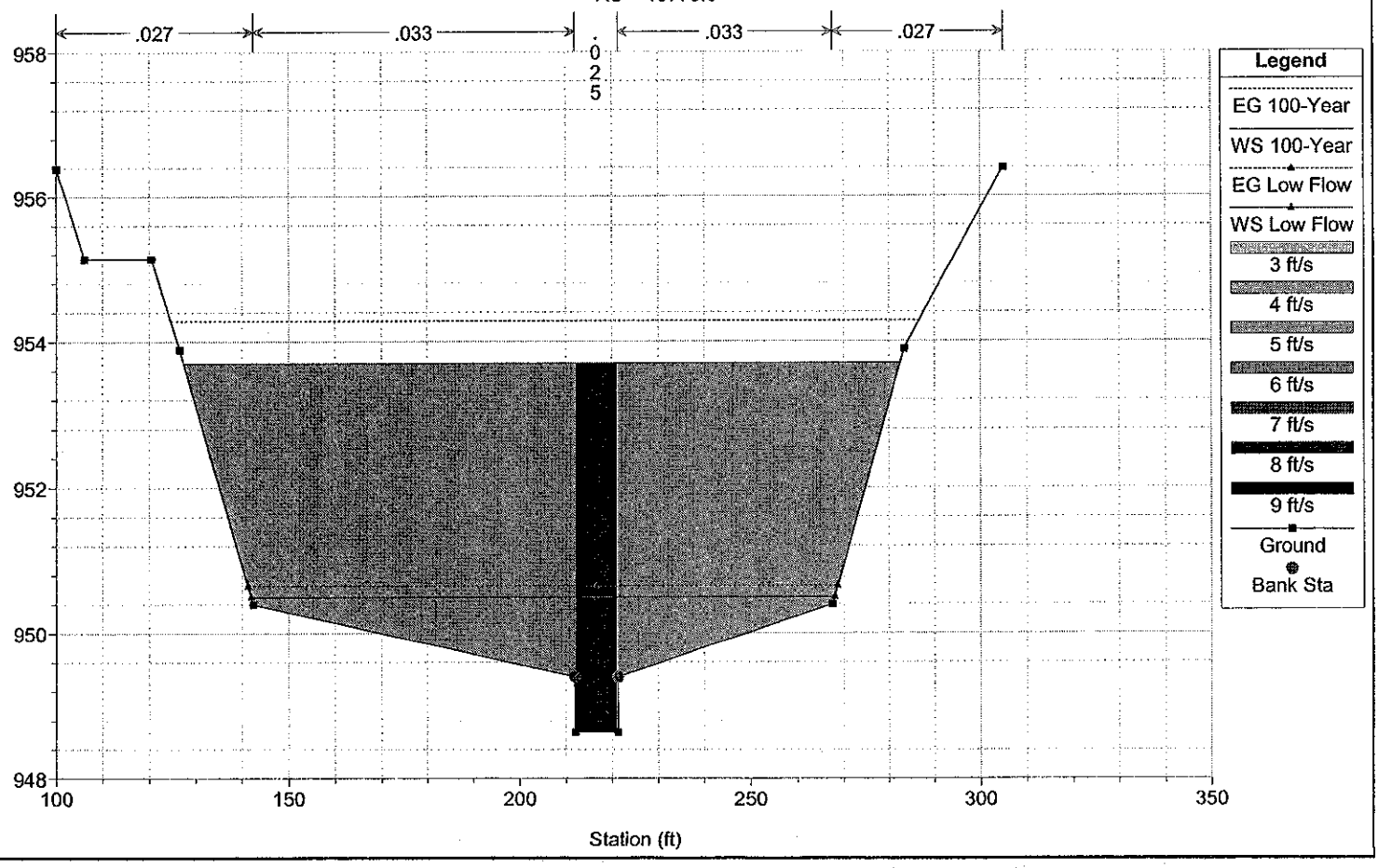
RS = 15969.0



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

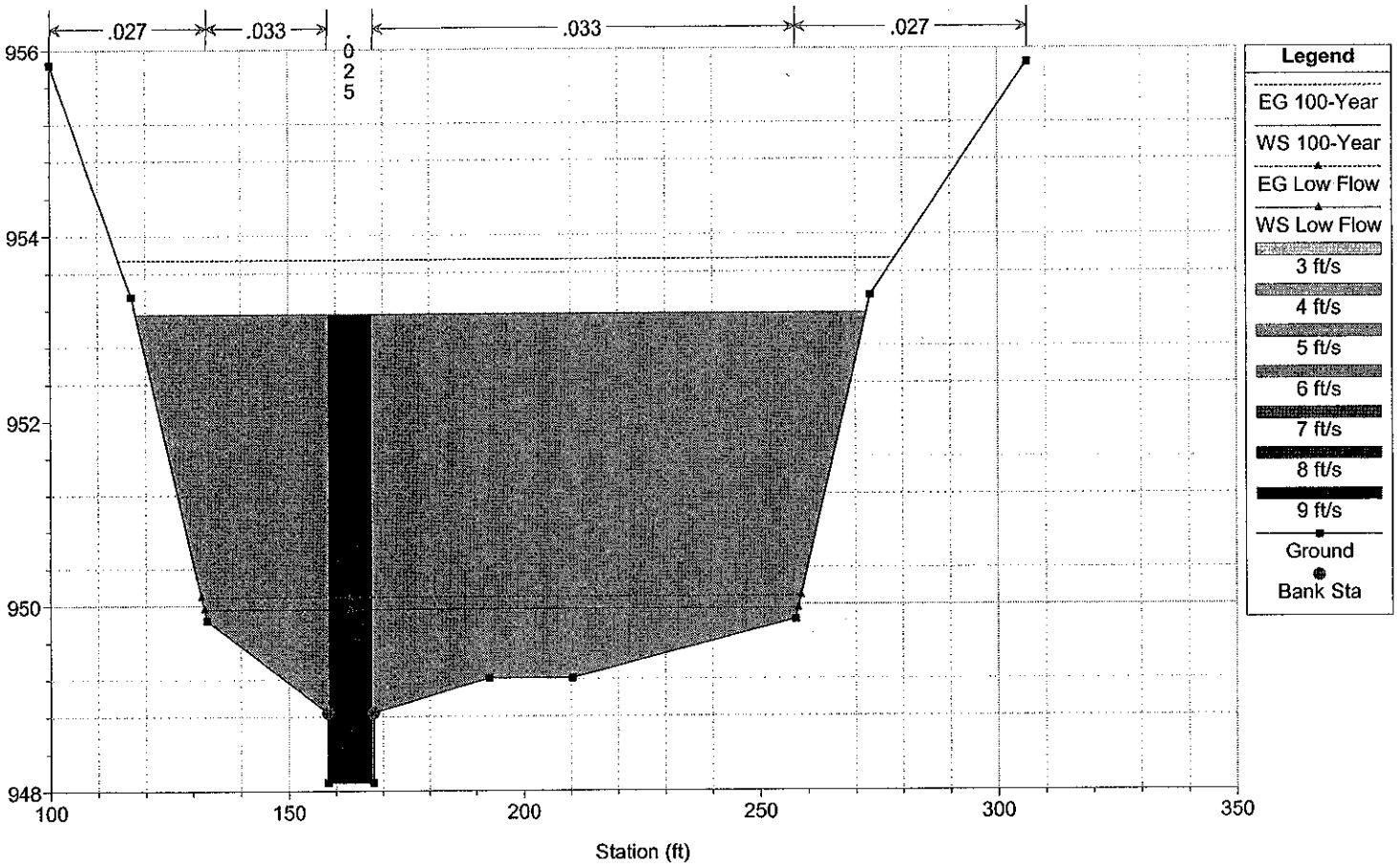
RS = 15779.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

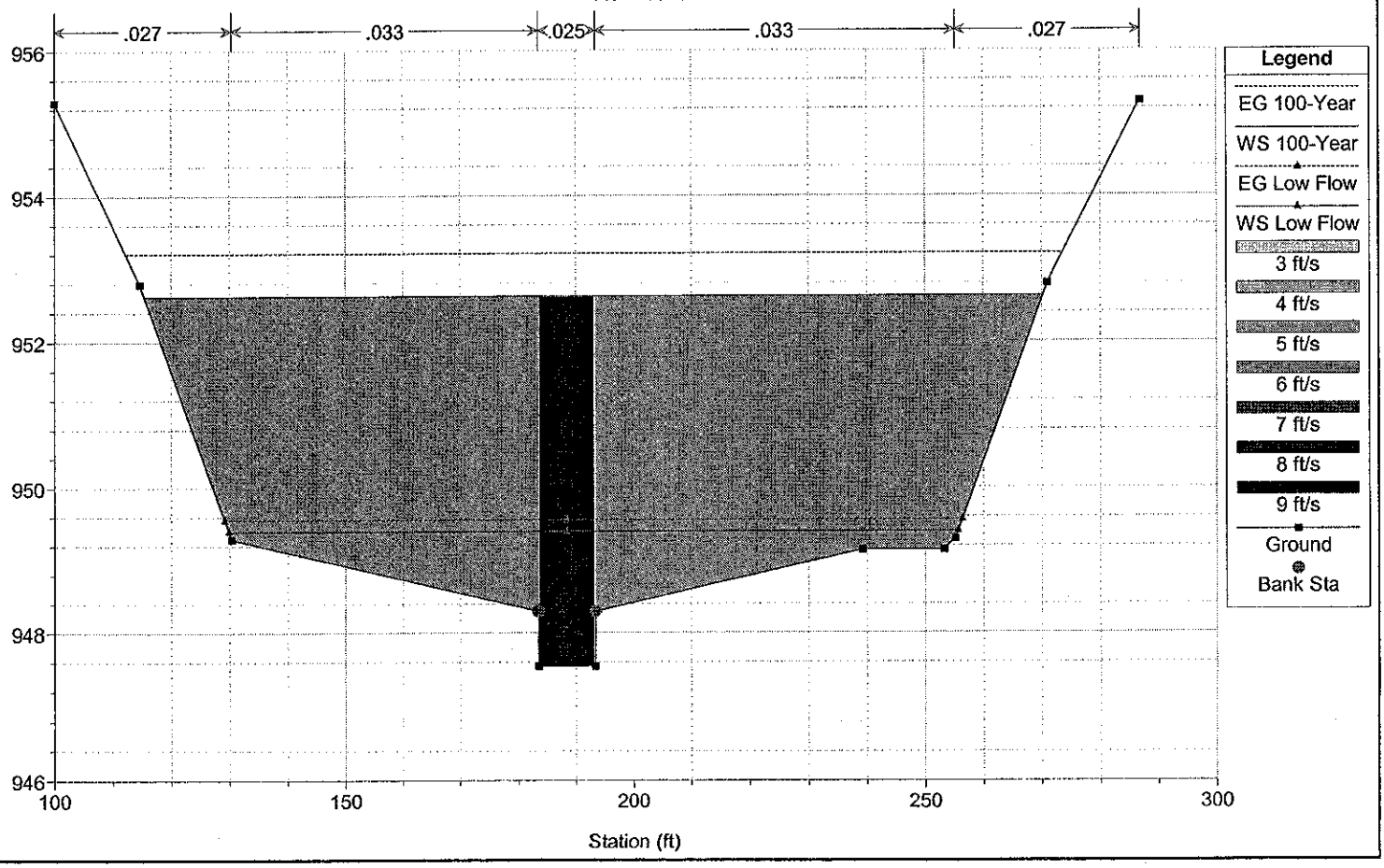
RS = 15590.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

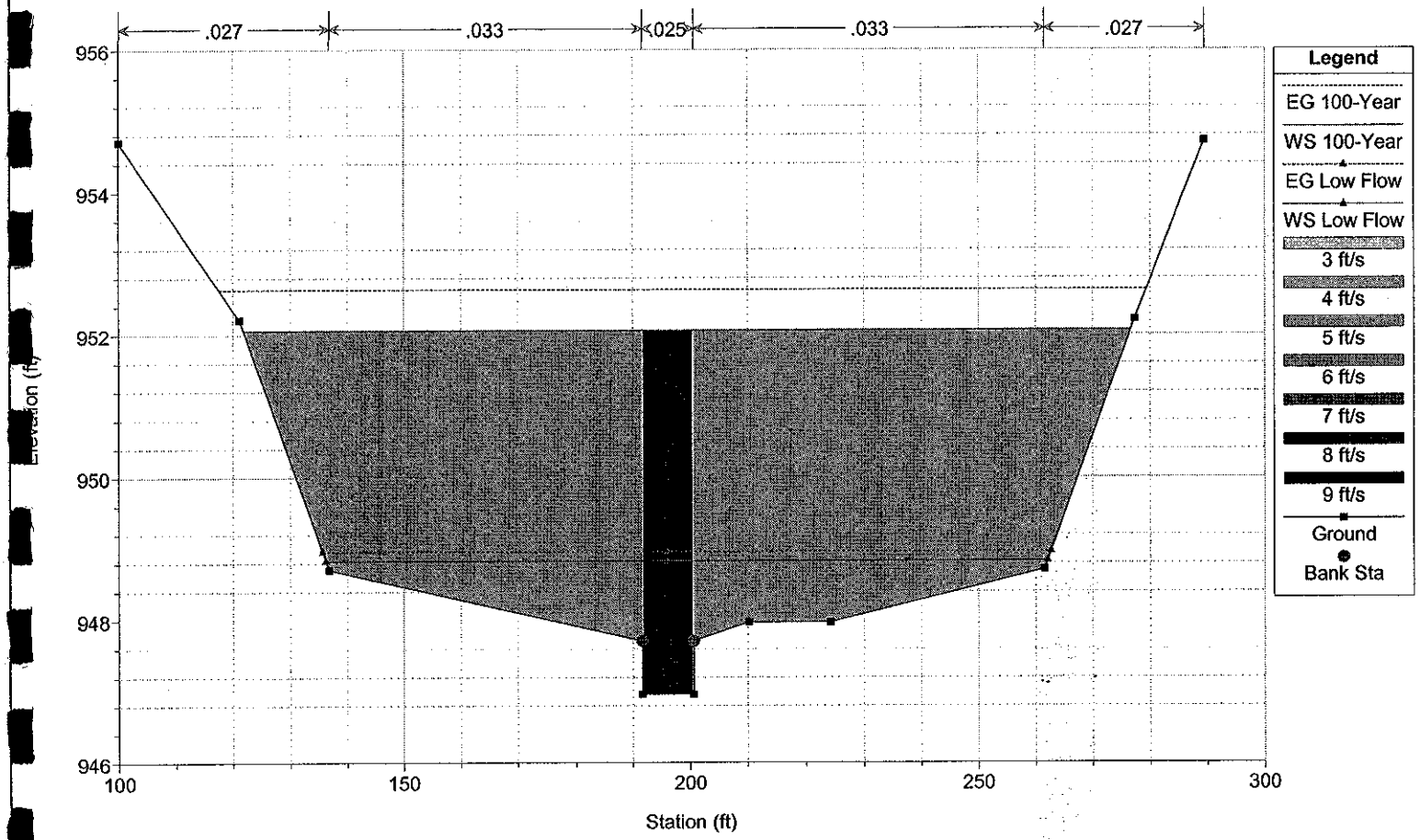
RS = 15401.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

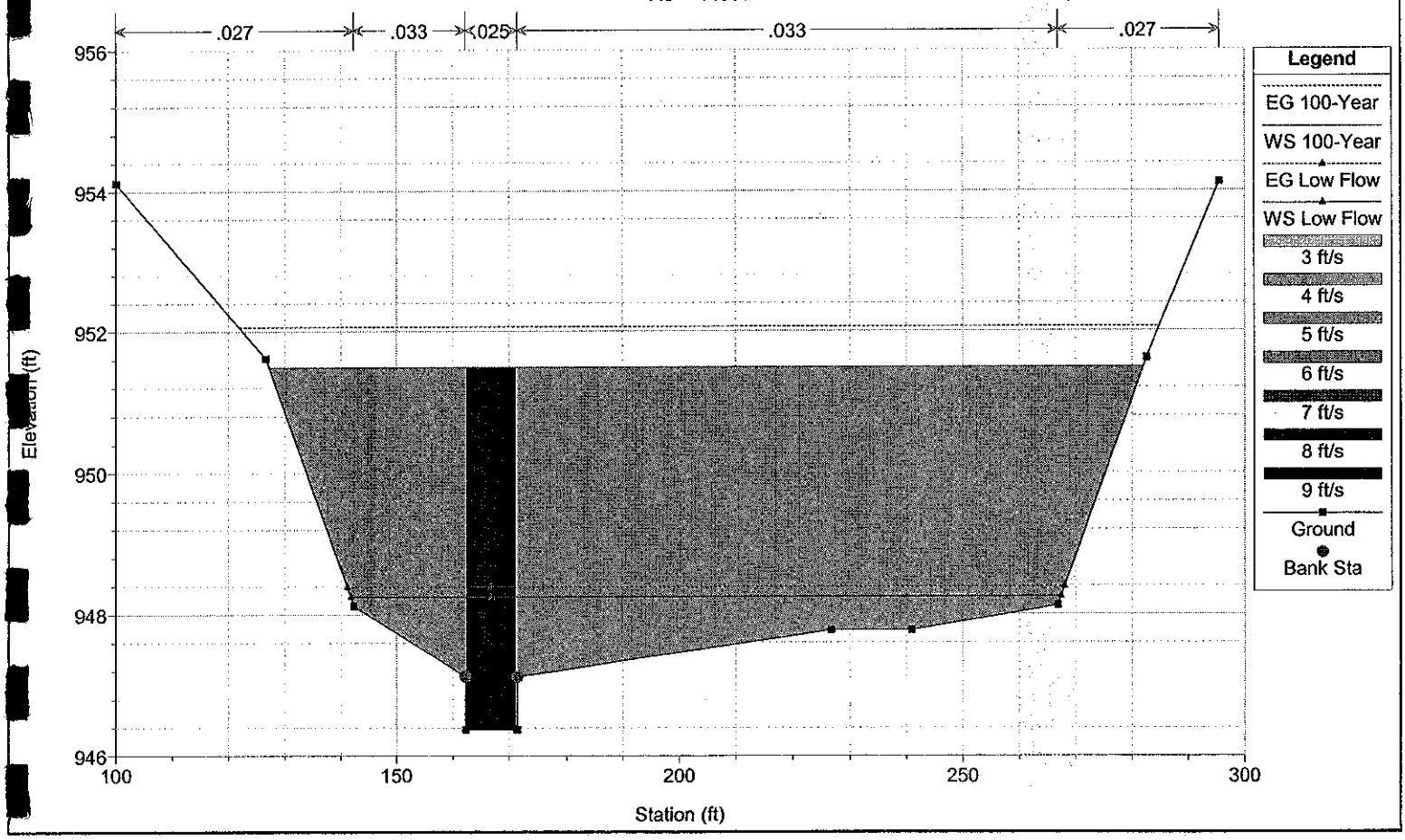
RS = 15199.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

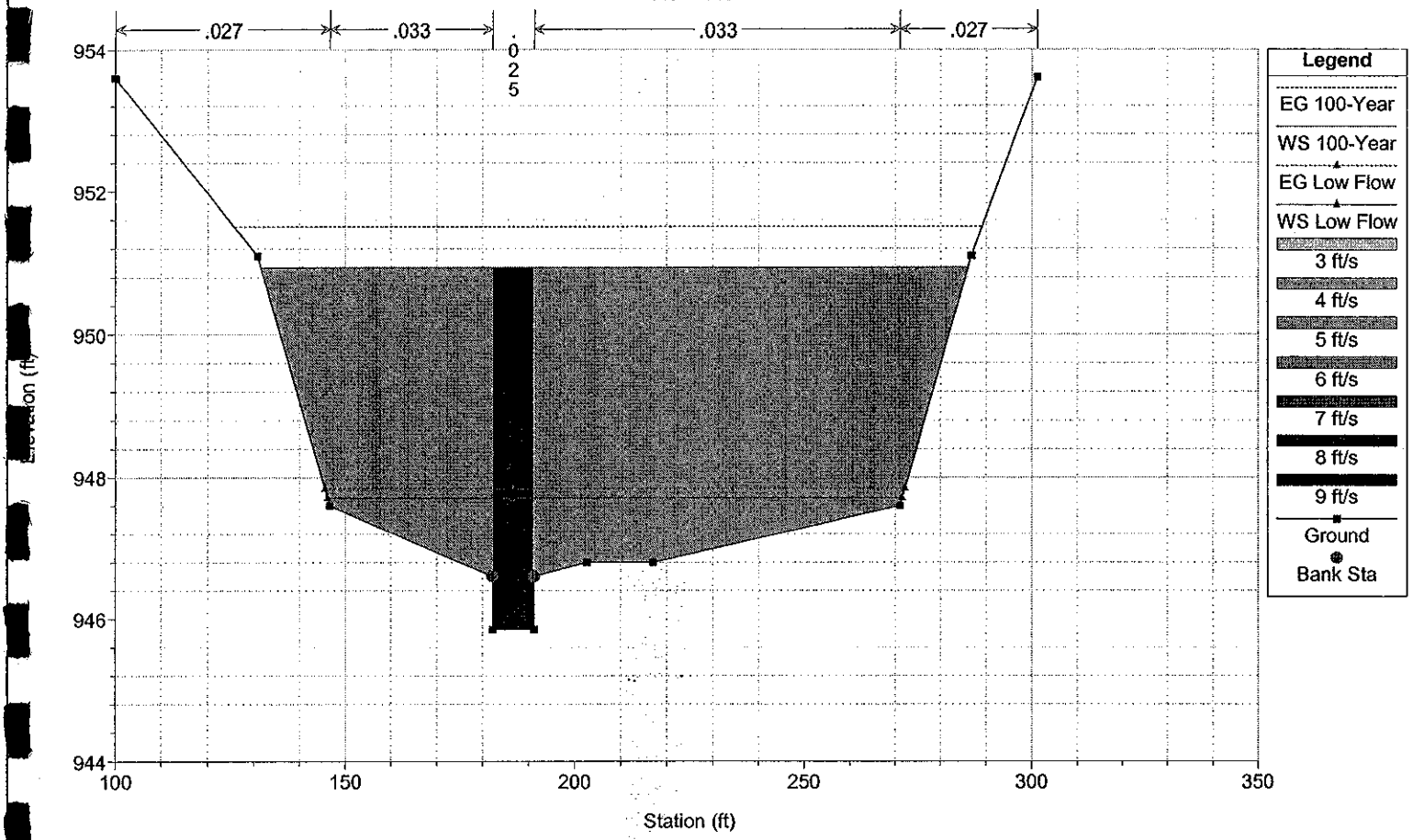
RS = 14998



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

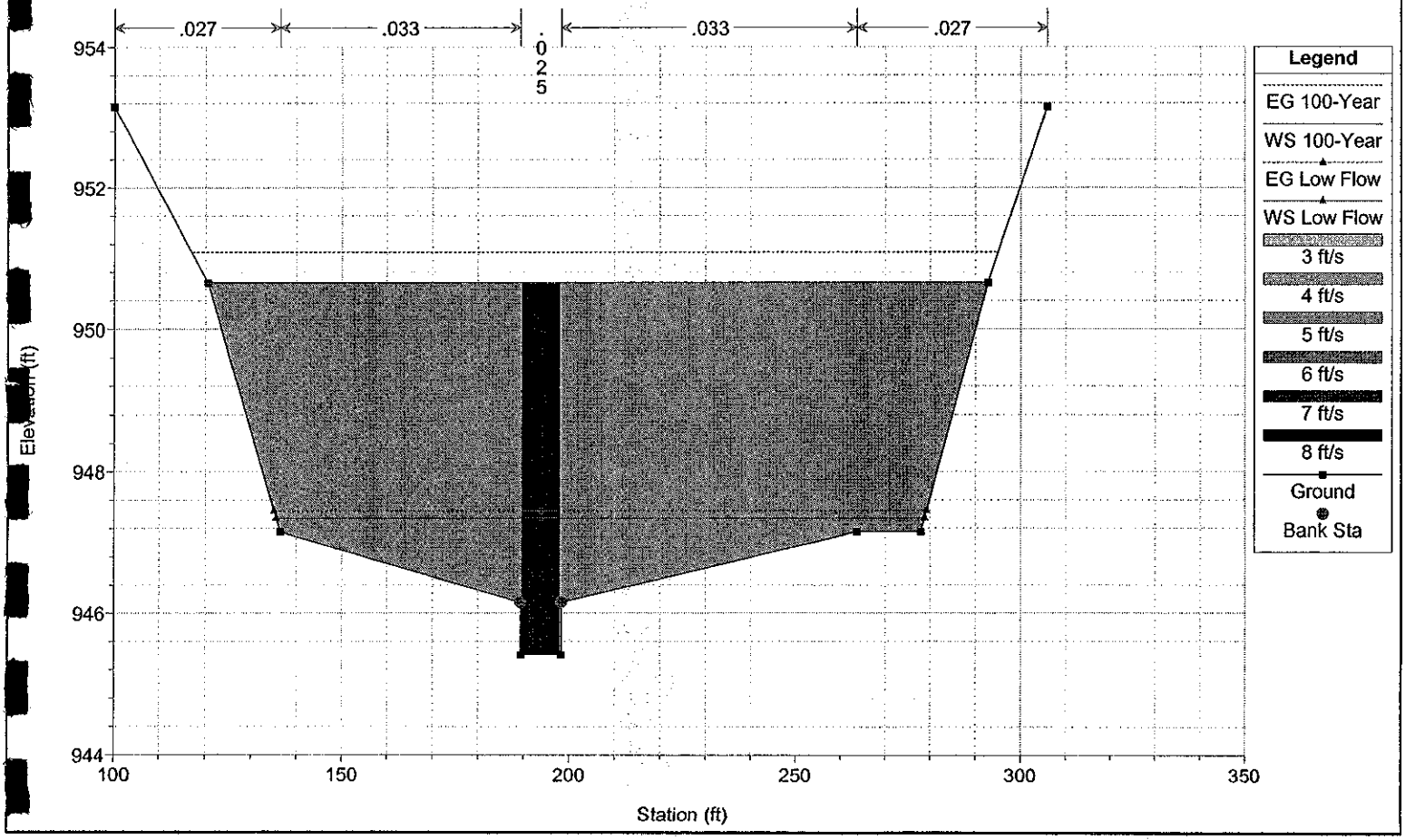
RS = 14817.3



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

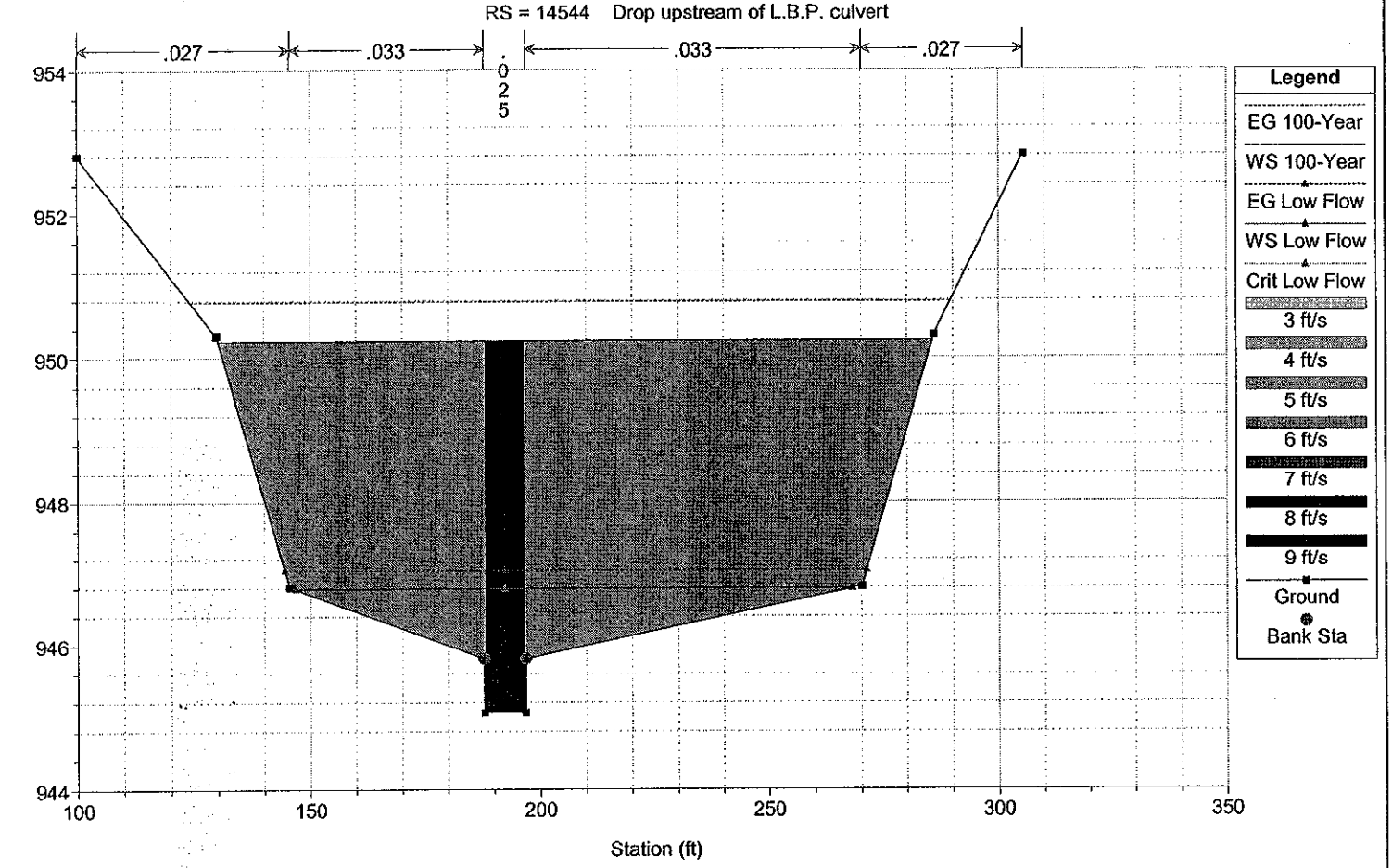
RS = 14663.1



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

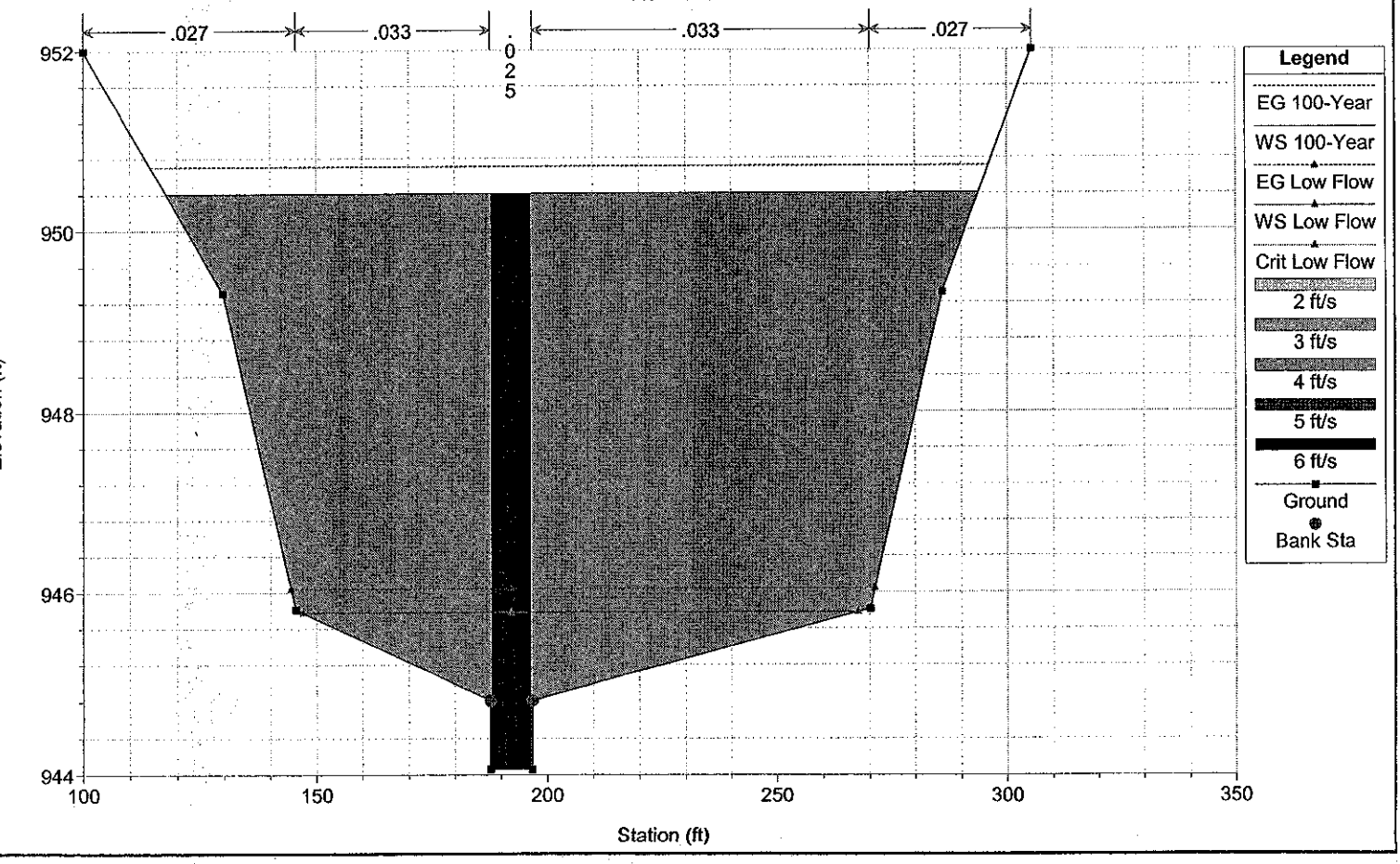
RS = 14544 Drop upstream of L.B.P. culvert



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

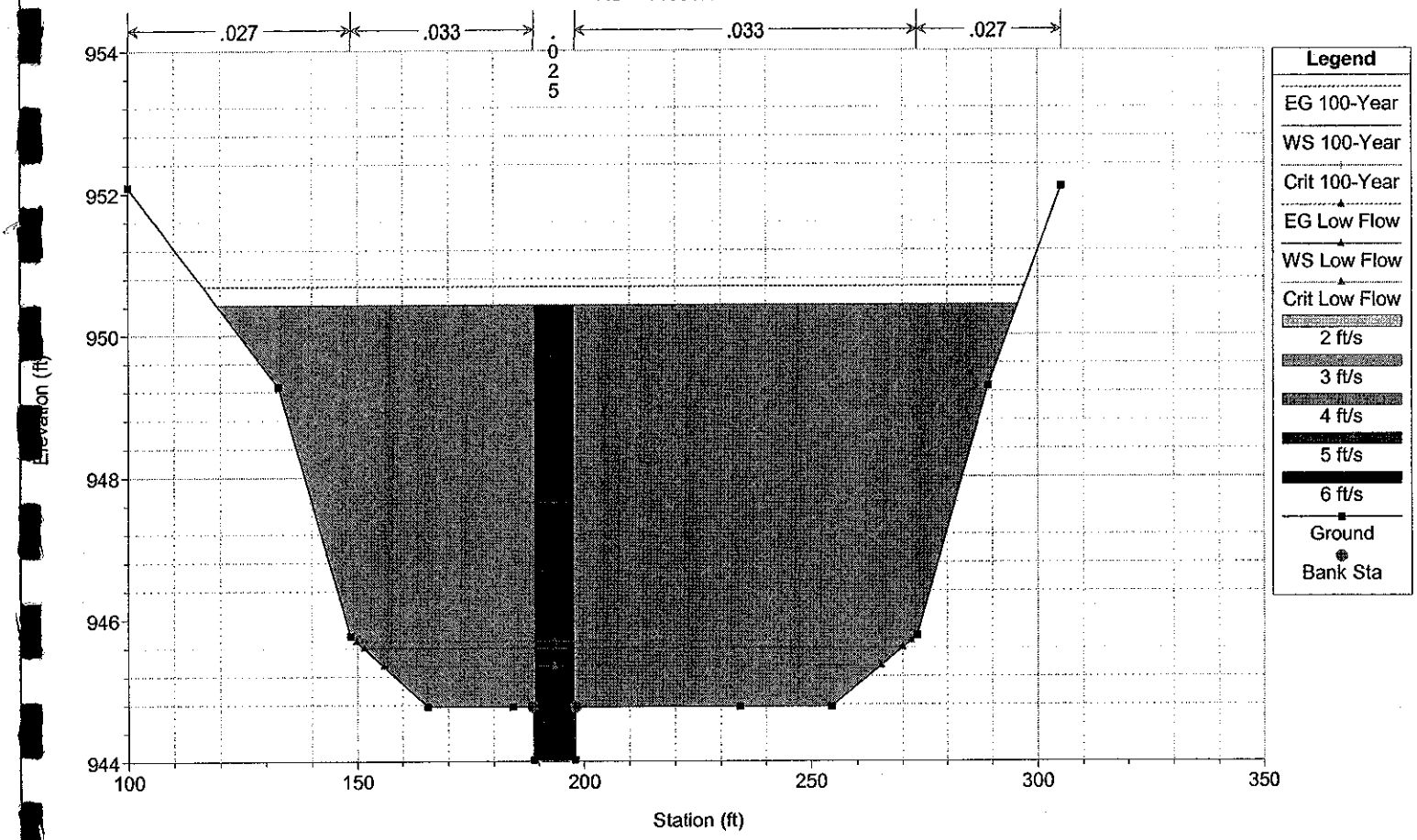
RS = 14543



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

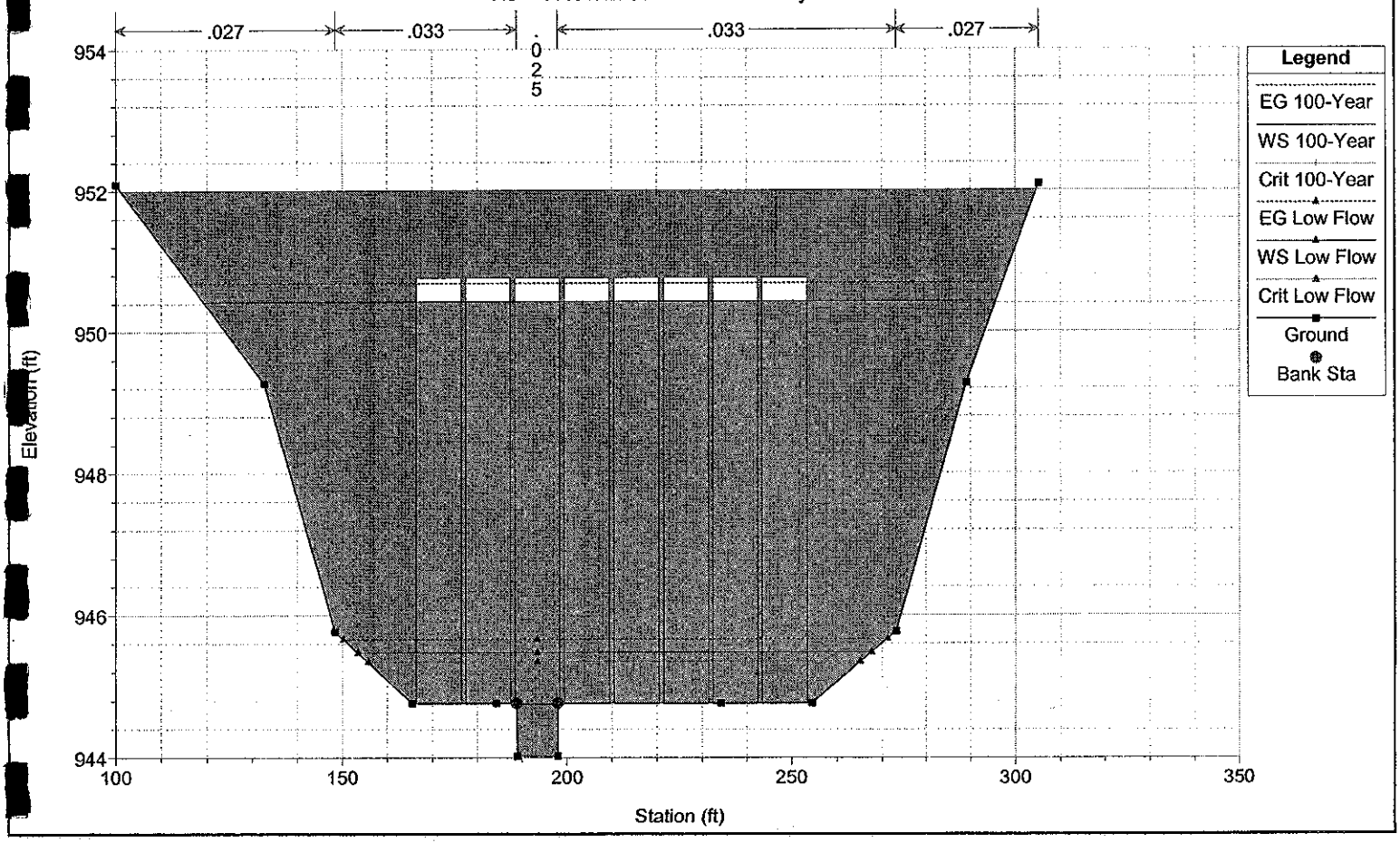
RS = 14531.42 U/S of RCBC



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

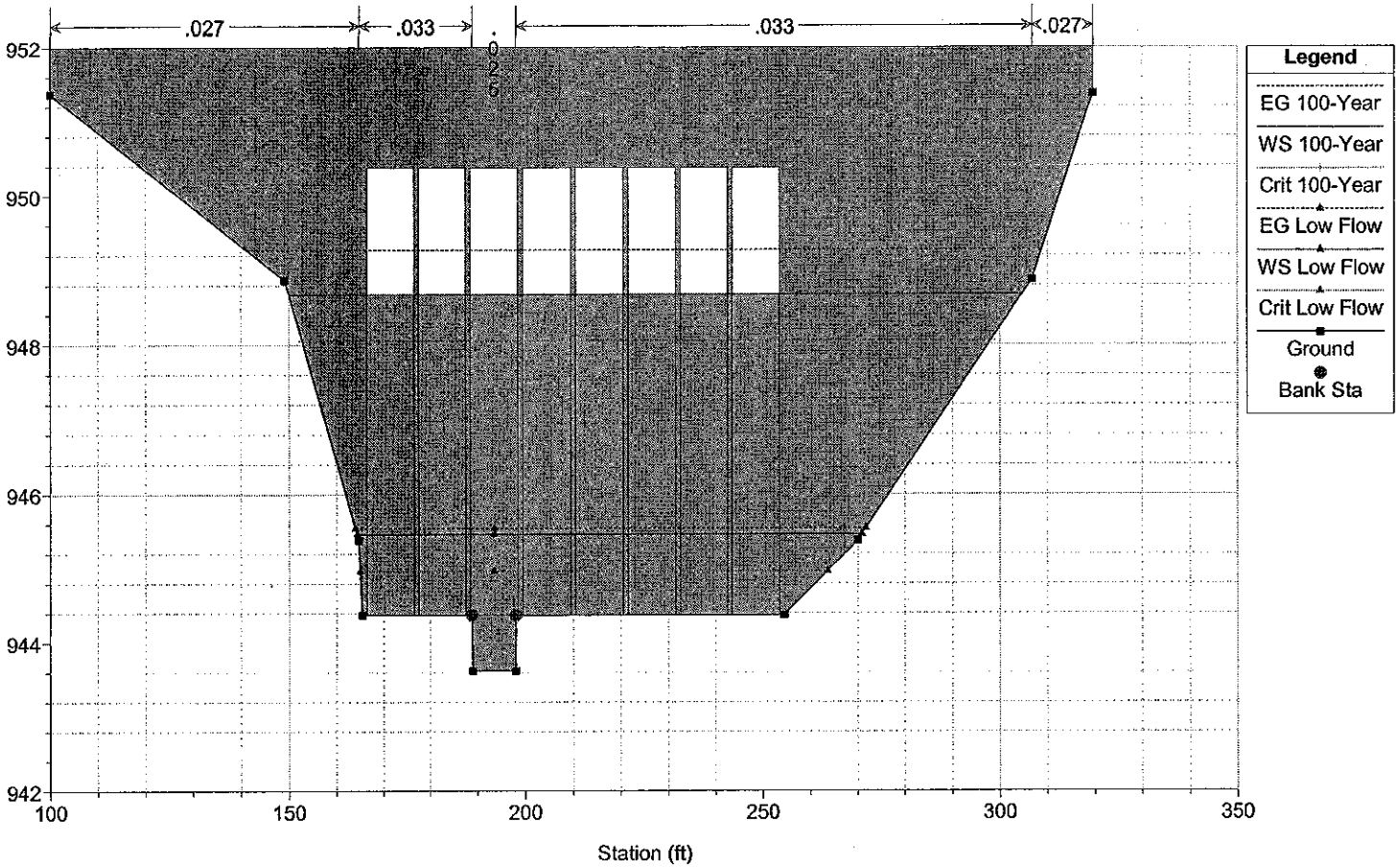
RS = 14461.42 Culv Lower Buckeye Road RCBC



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

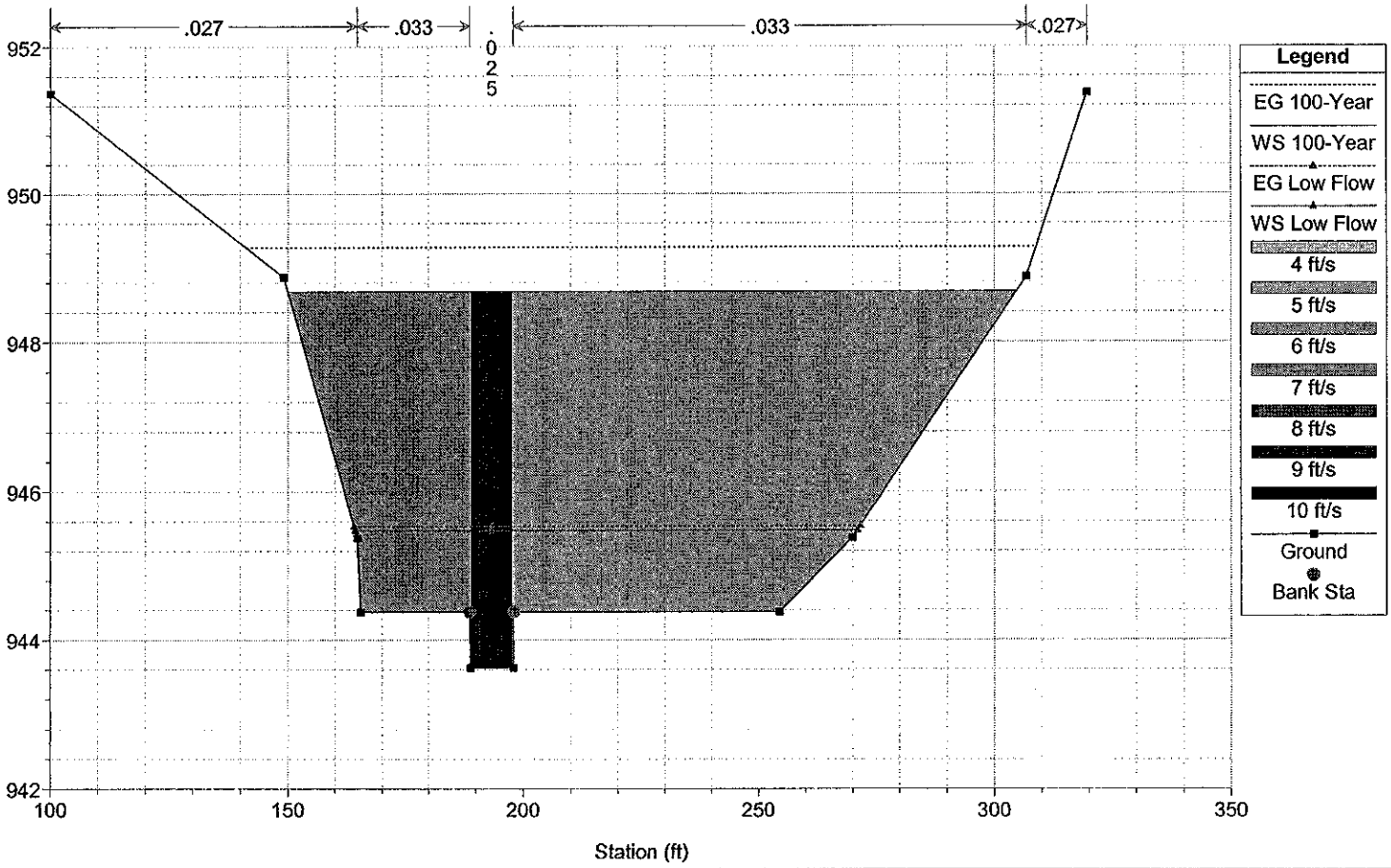
RS = 14461.42 Culv Lower Buckeye Road RCBC



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

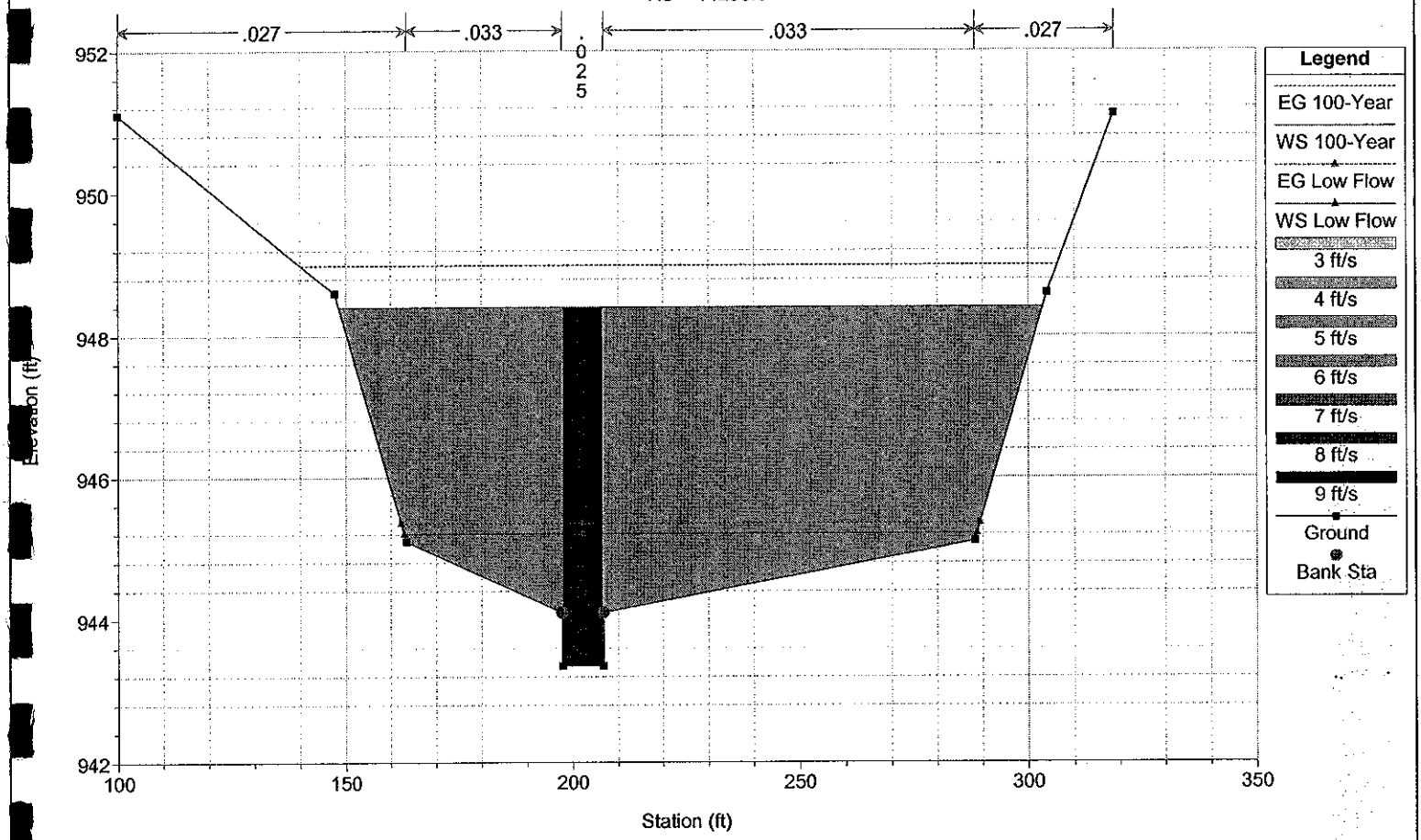
RS = 14391.42 D/S of RCBC



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

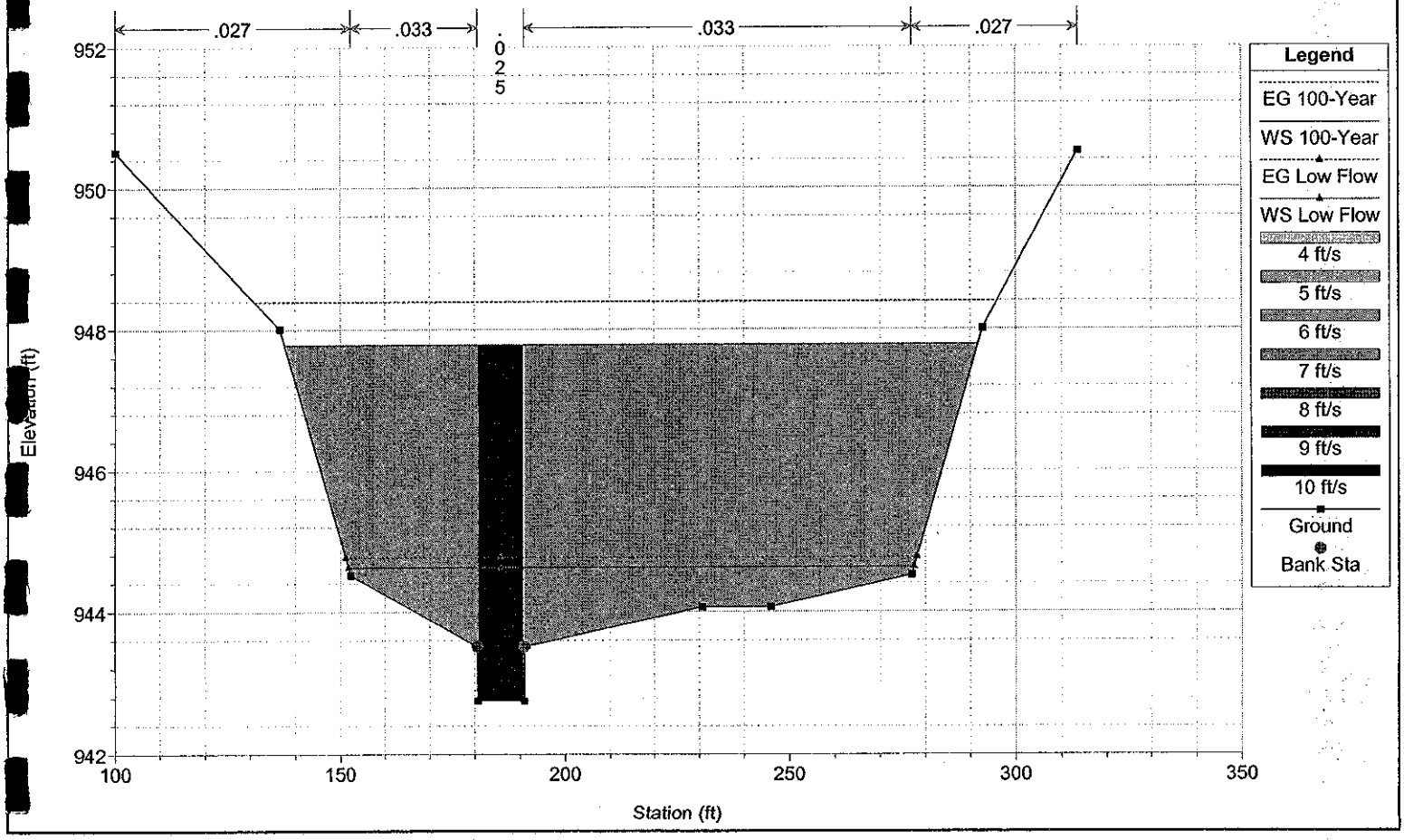
RS = 14298.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

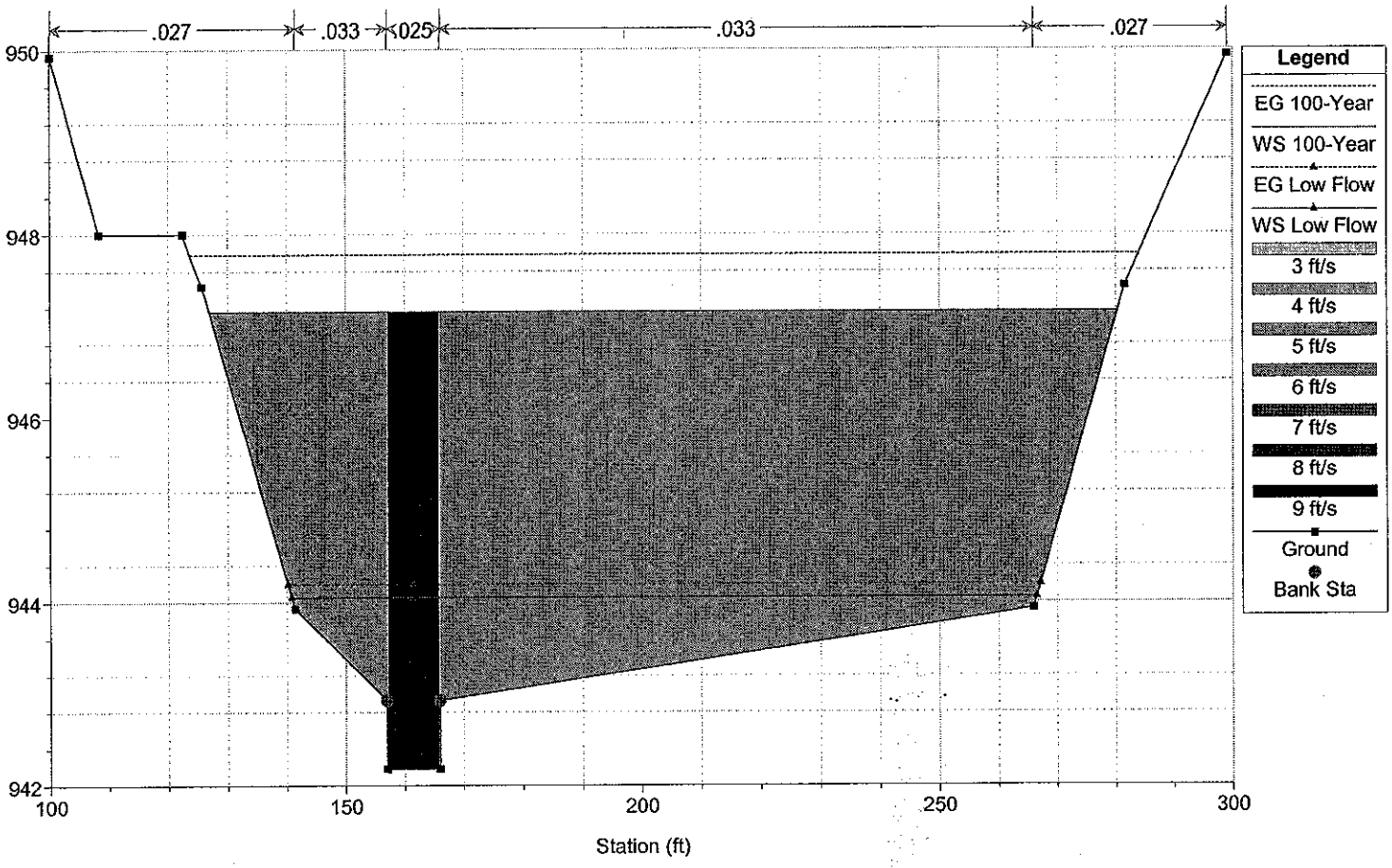
RS = 14096.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

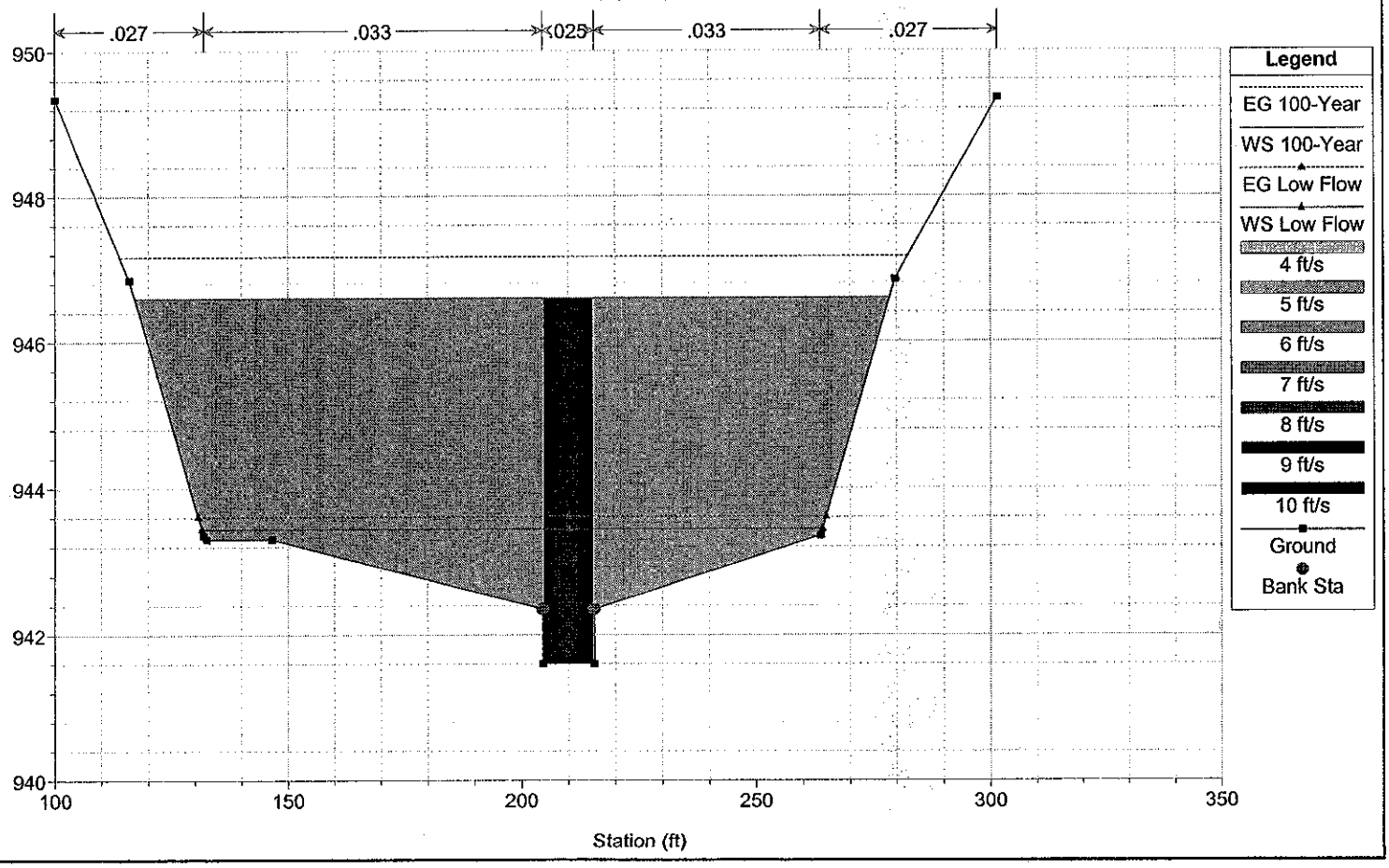
RS = 13894.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

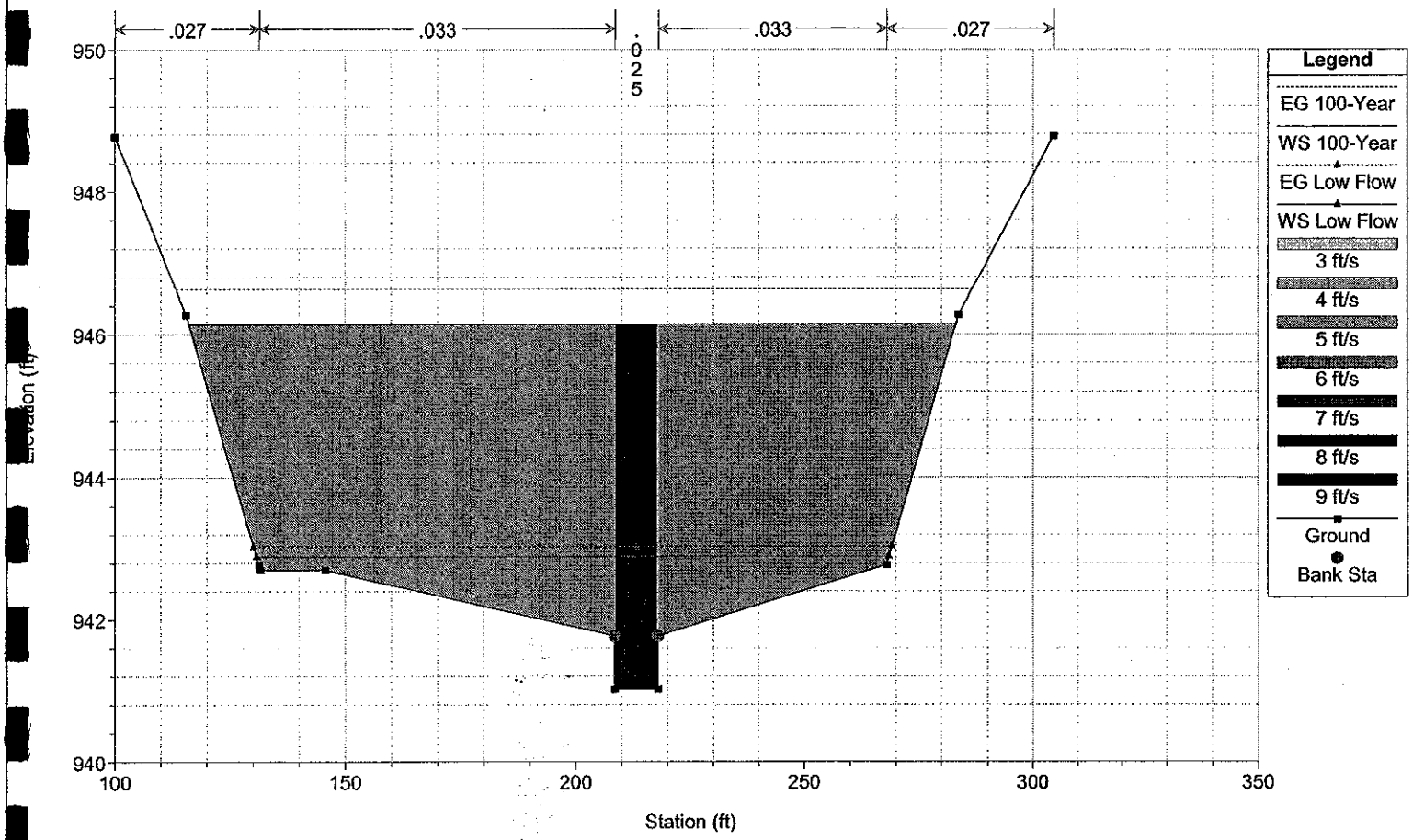
RS = 13694.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

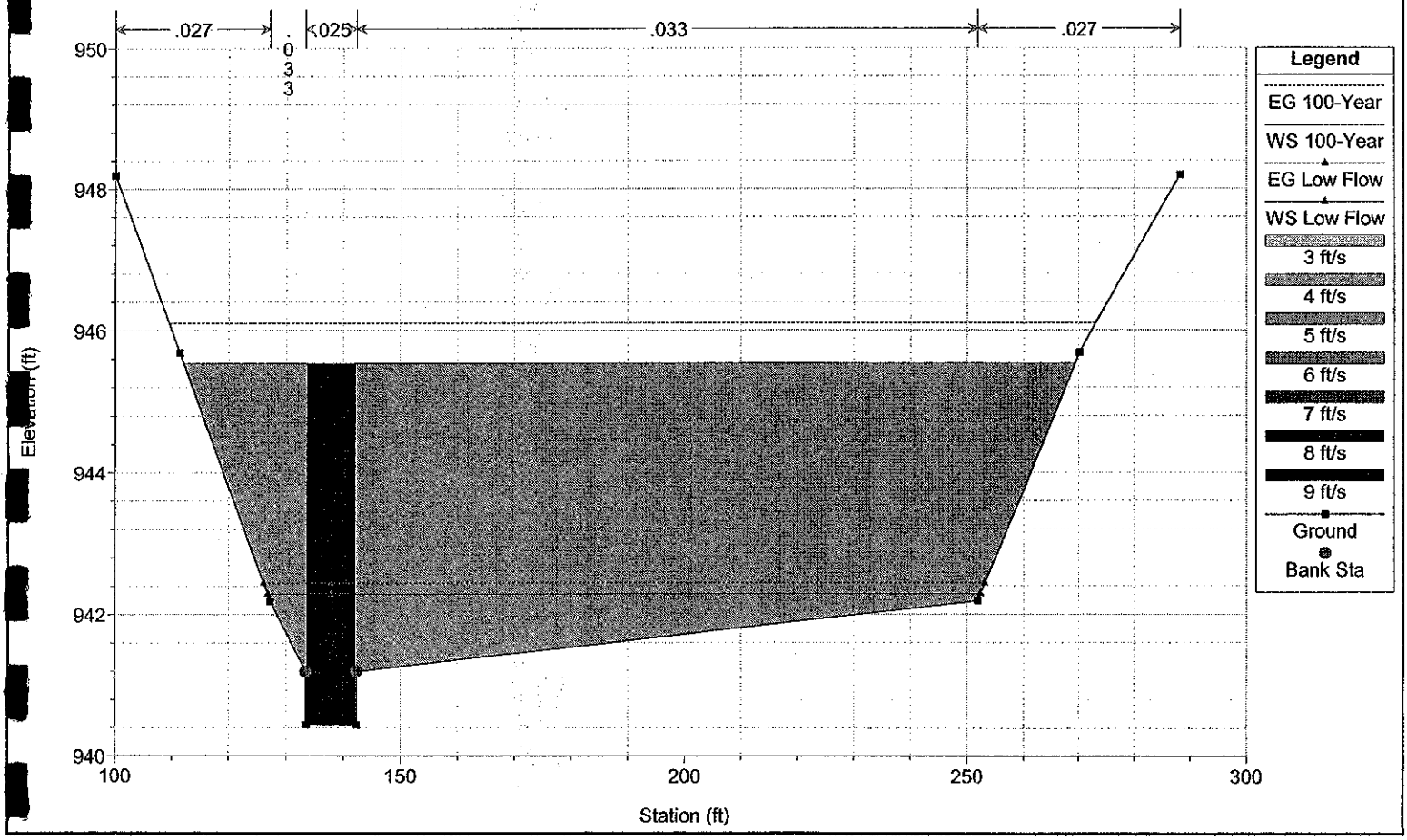
RS = 13494.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

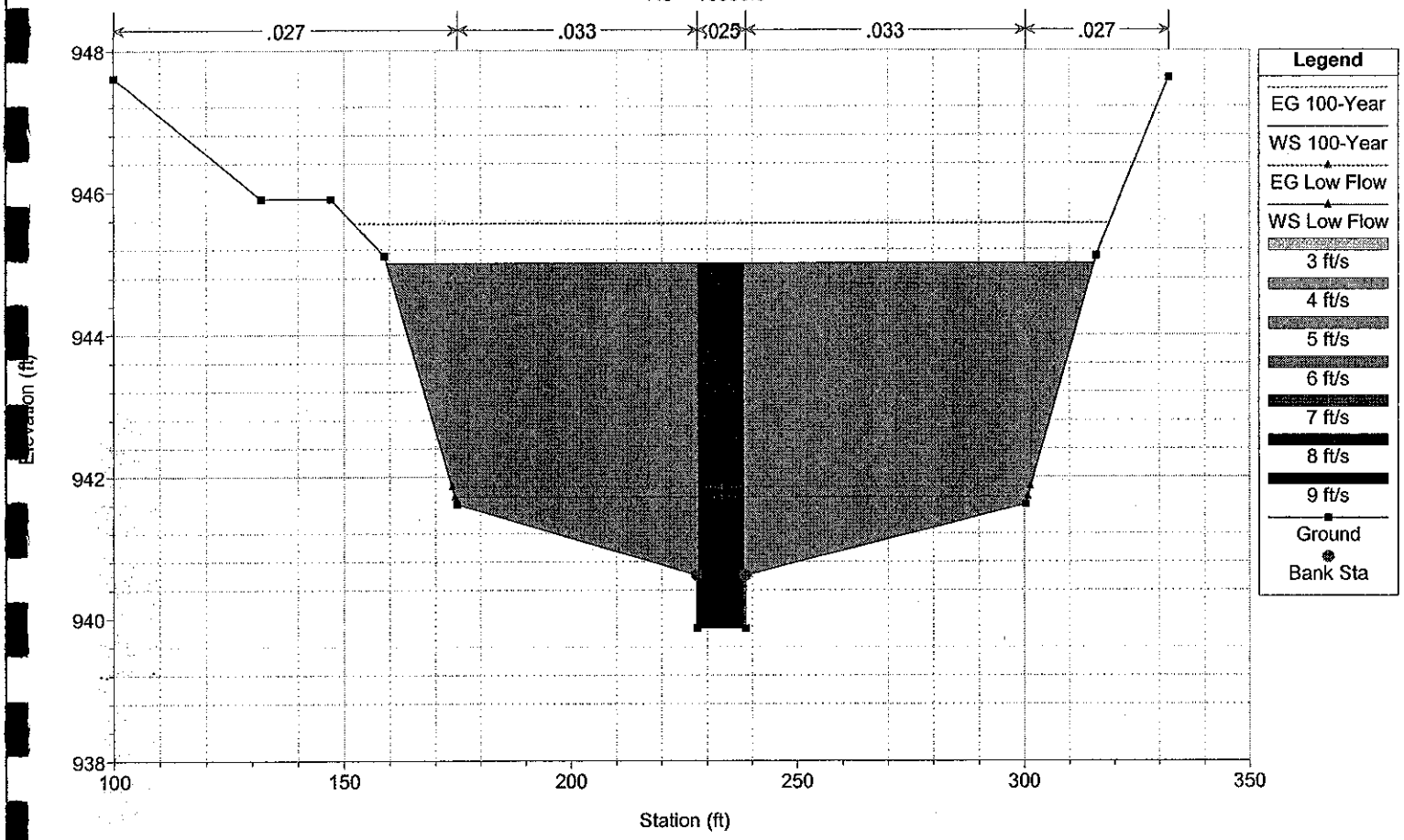
RS = 13294.6



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

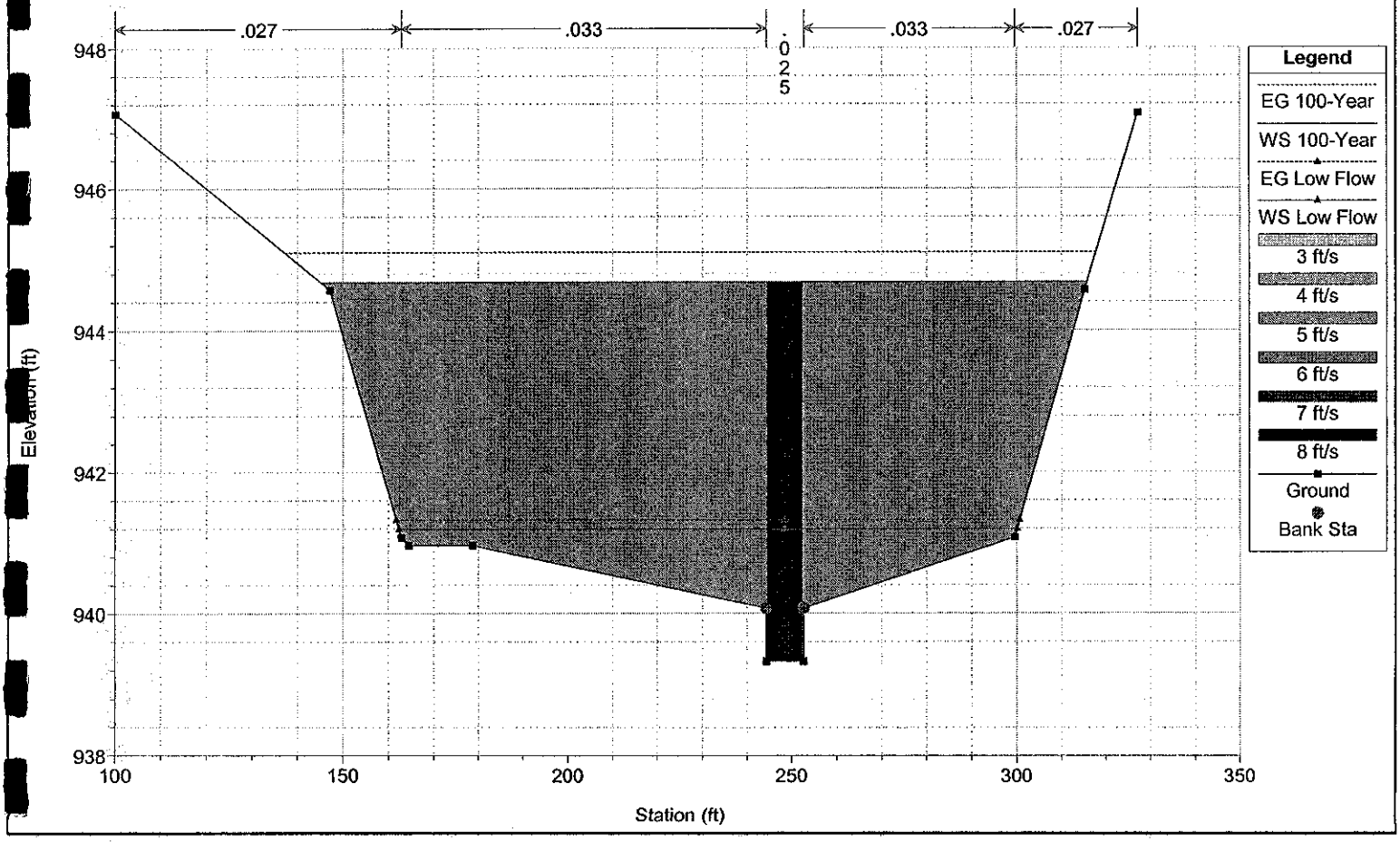
RS = 13095.9



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

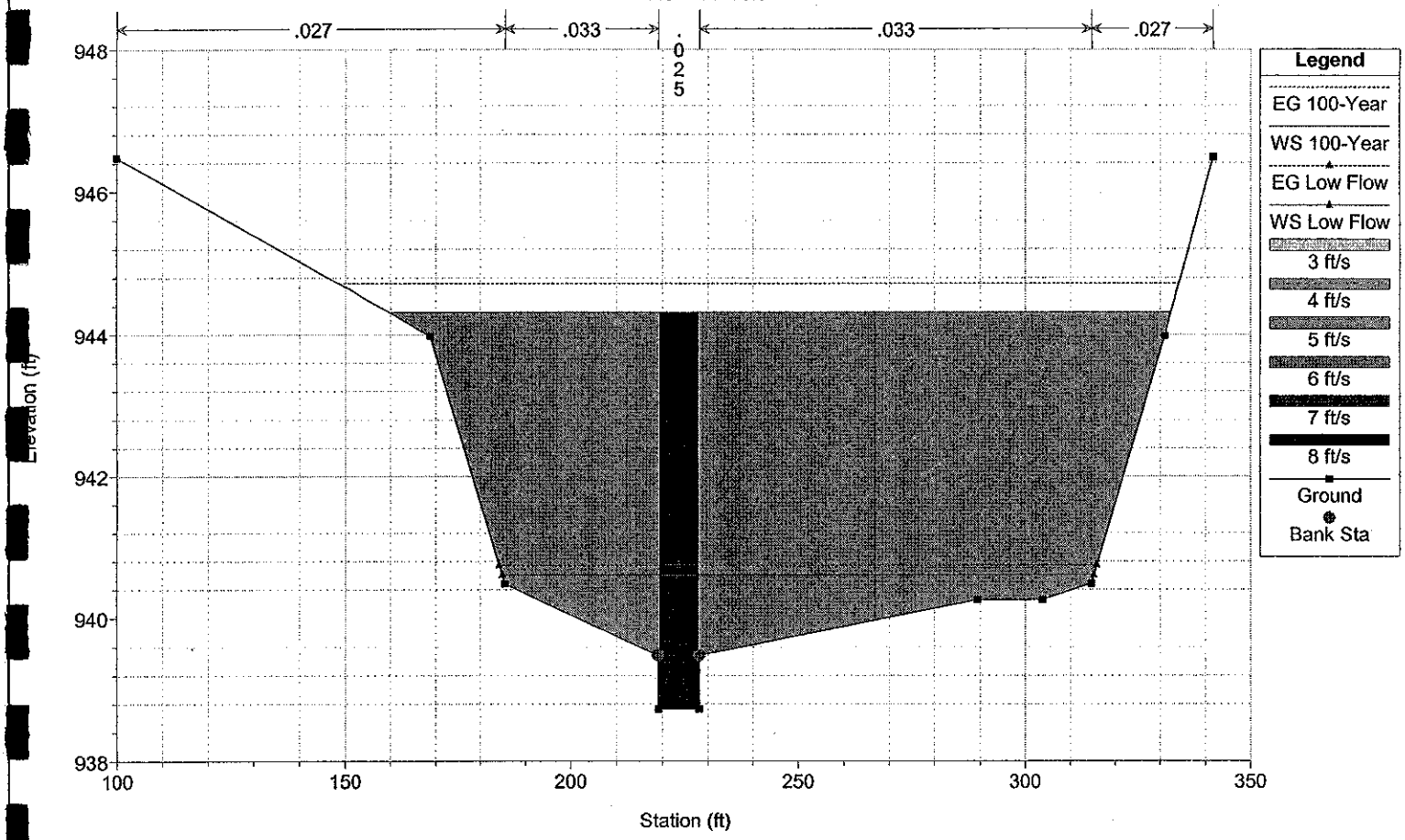
RS = 12908.8



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

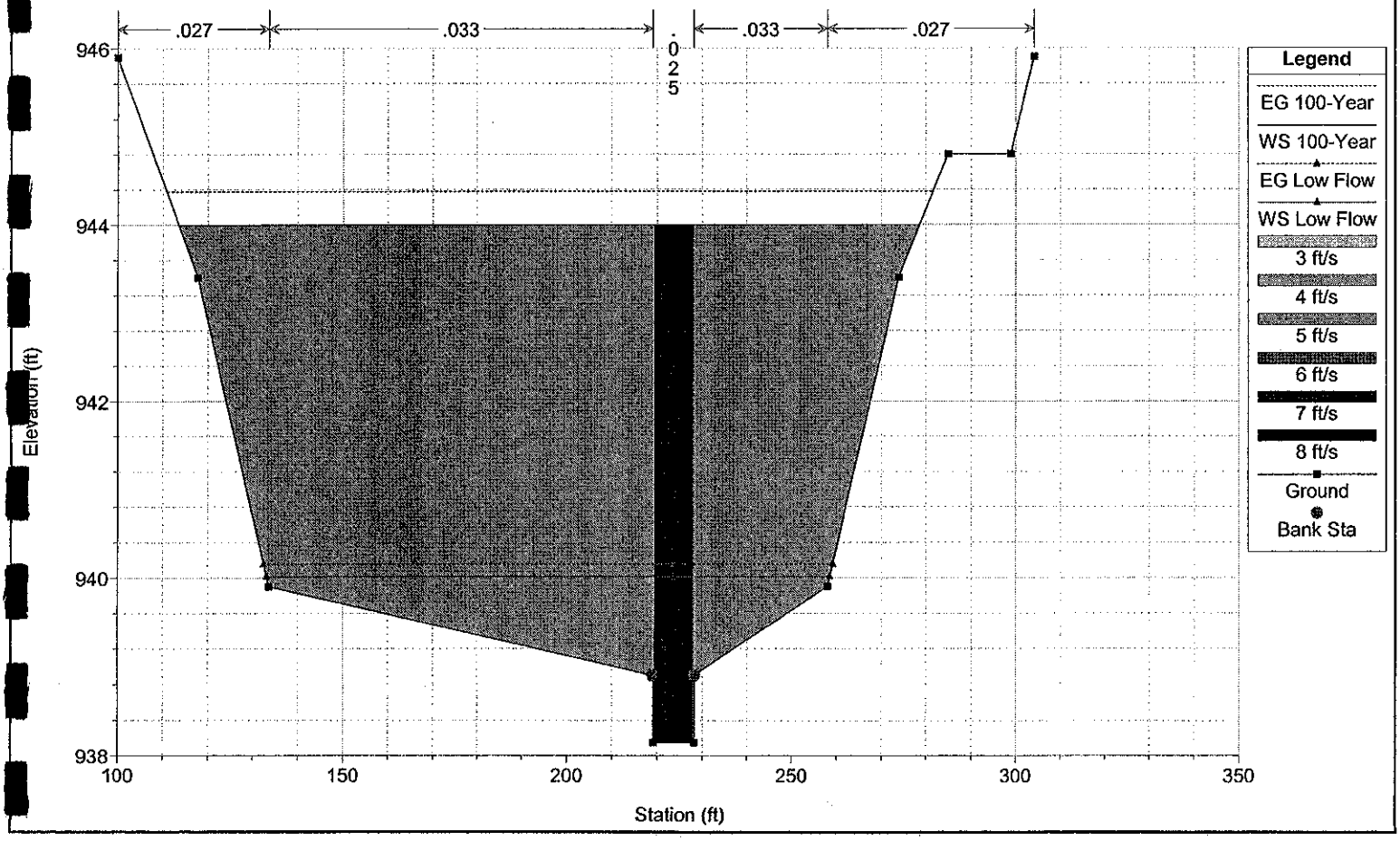
RS = 12708.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

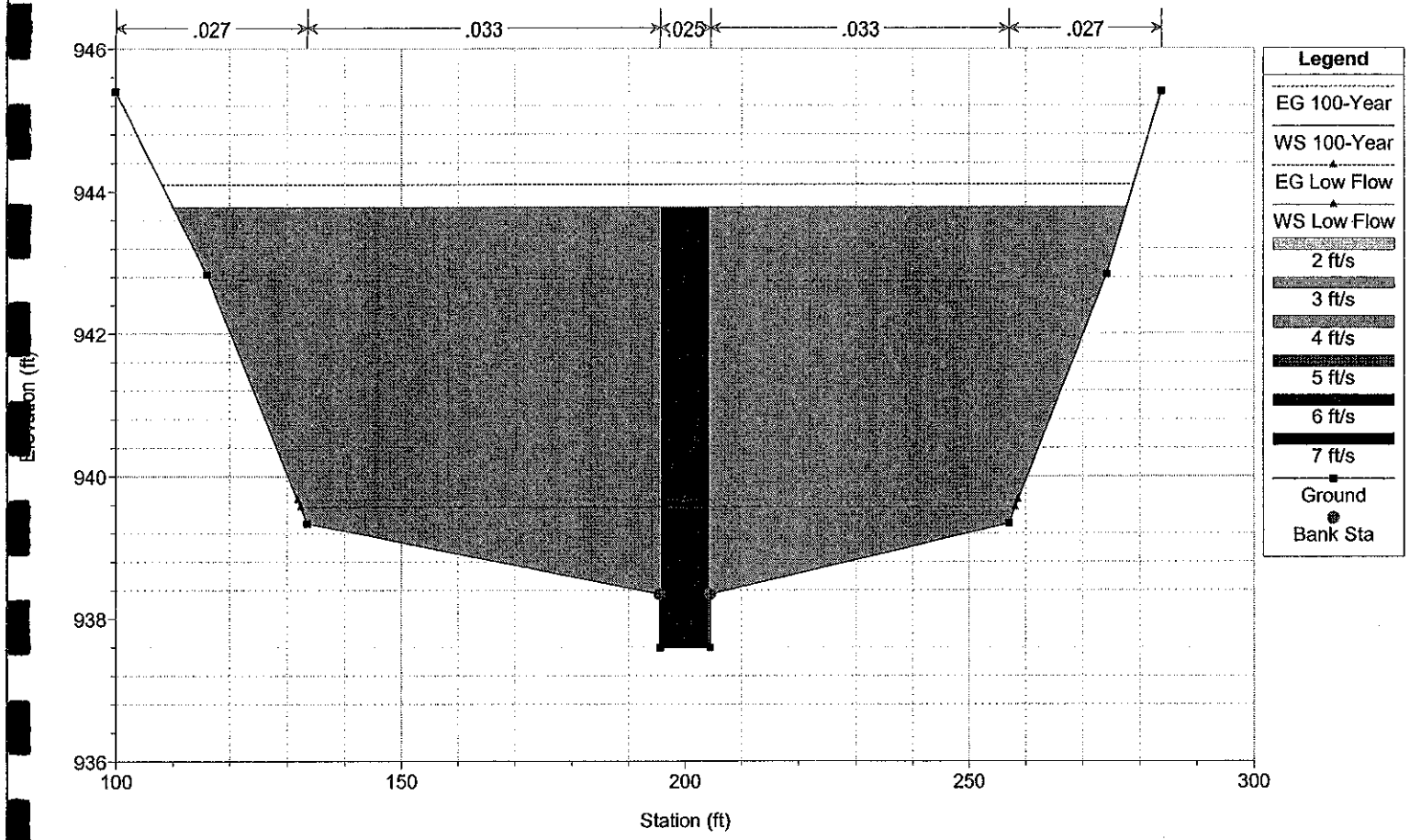
RS = 12508.7



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

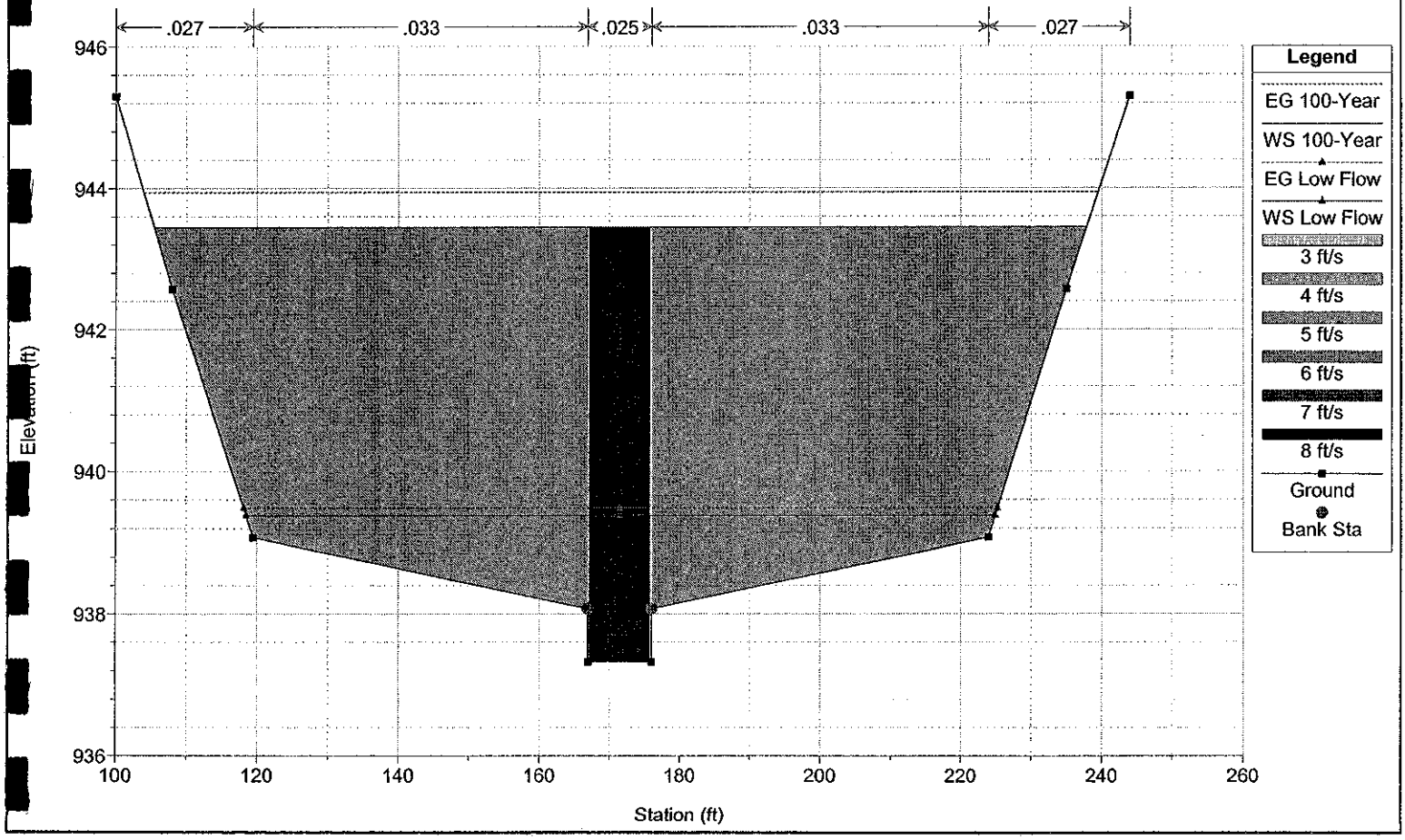
RS = 12315



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

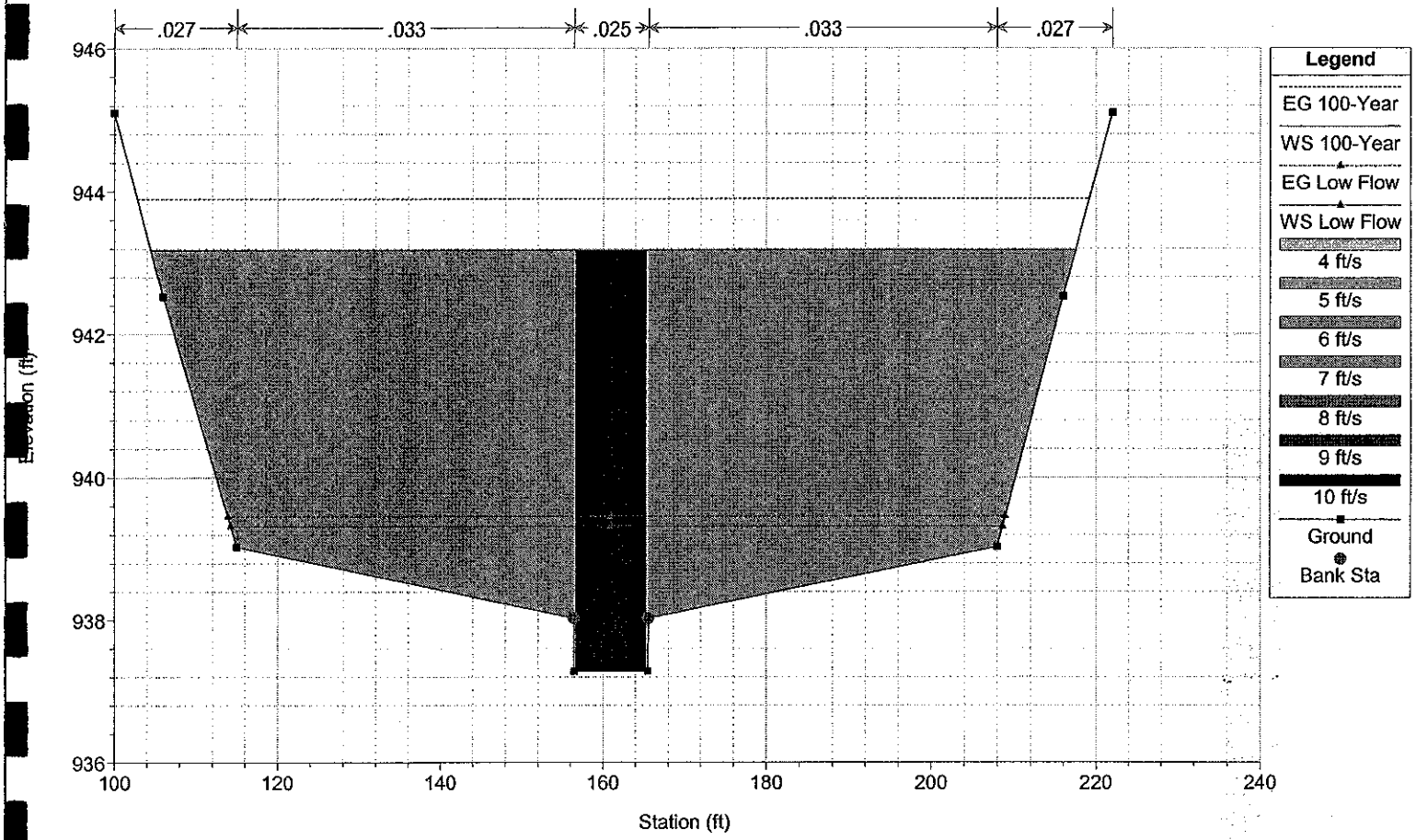
RS = 12220.5



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

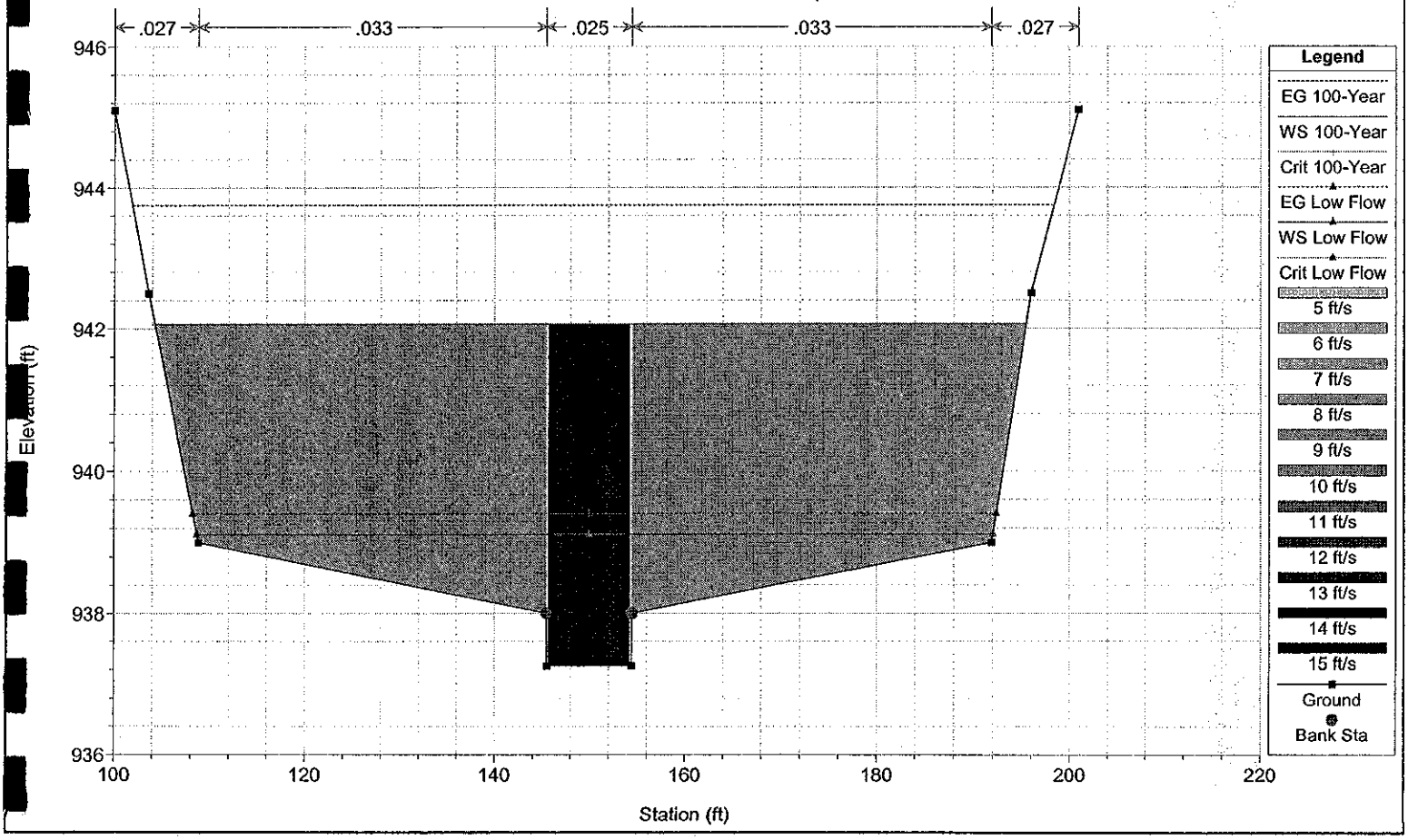
RS = 12209



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

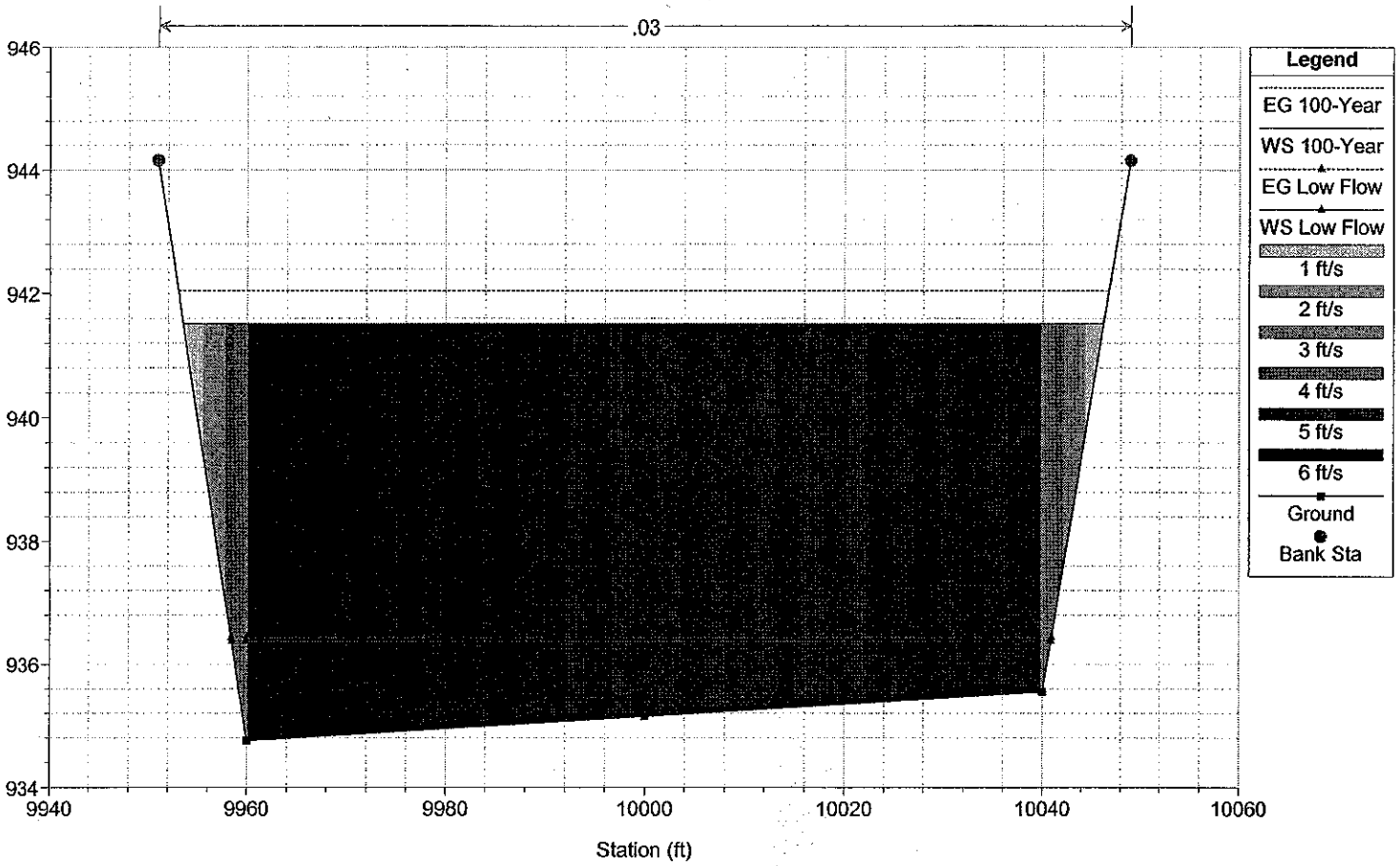
RS = 12197 U/S of Drop



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

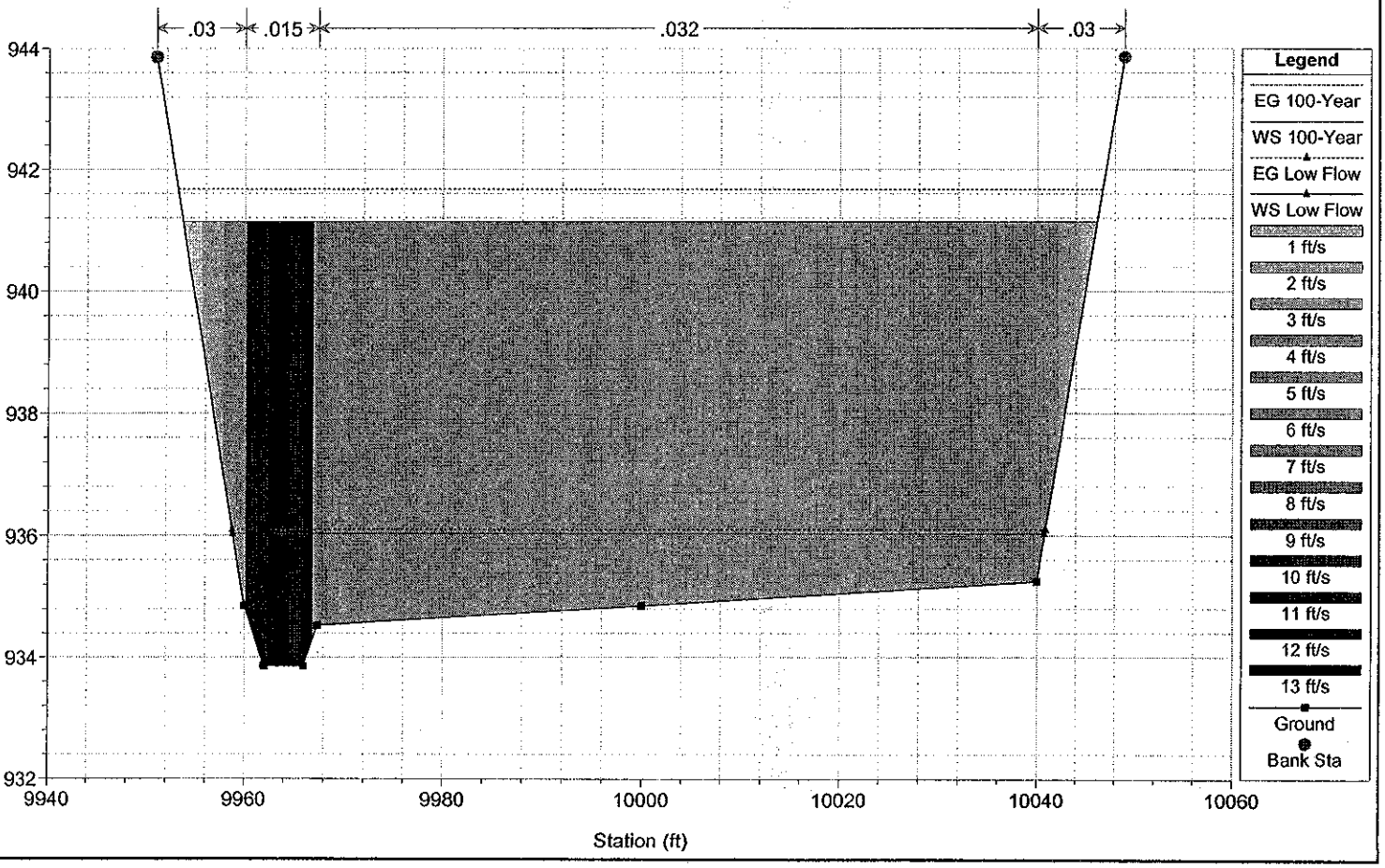
RS = 12195 Bottom of Drop, Phase I RS = 12195



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

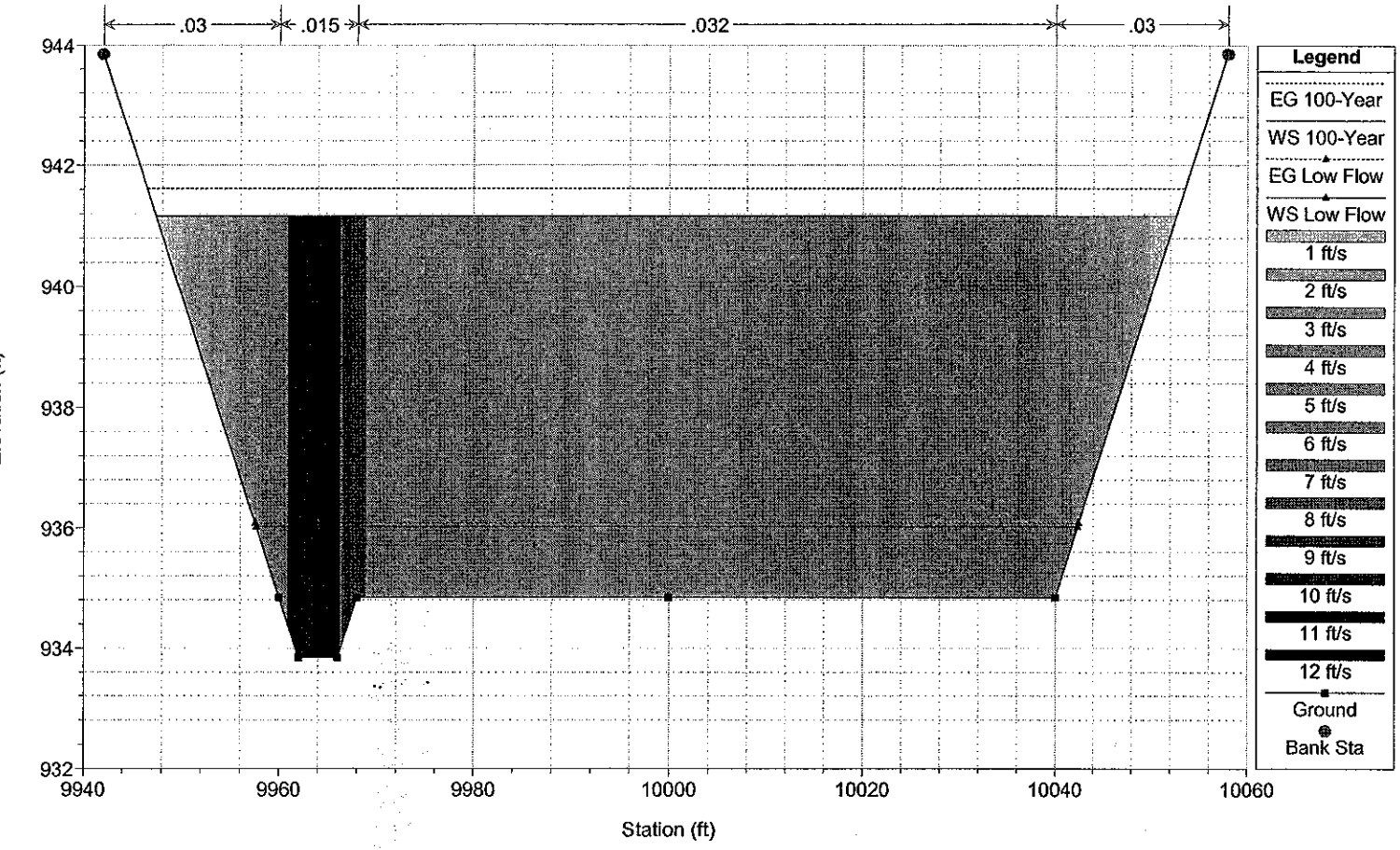
RS = 11943 Phase I RS = 11943



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

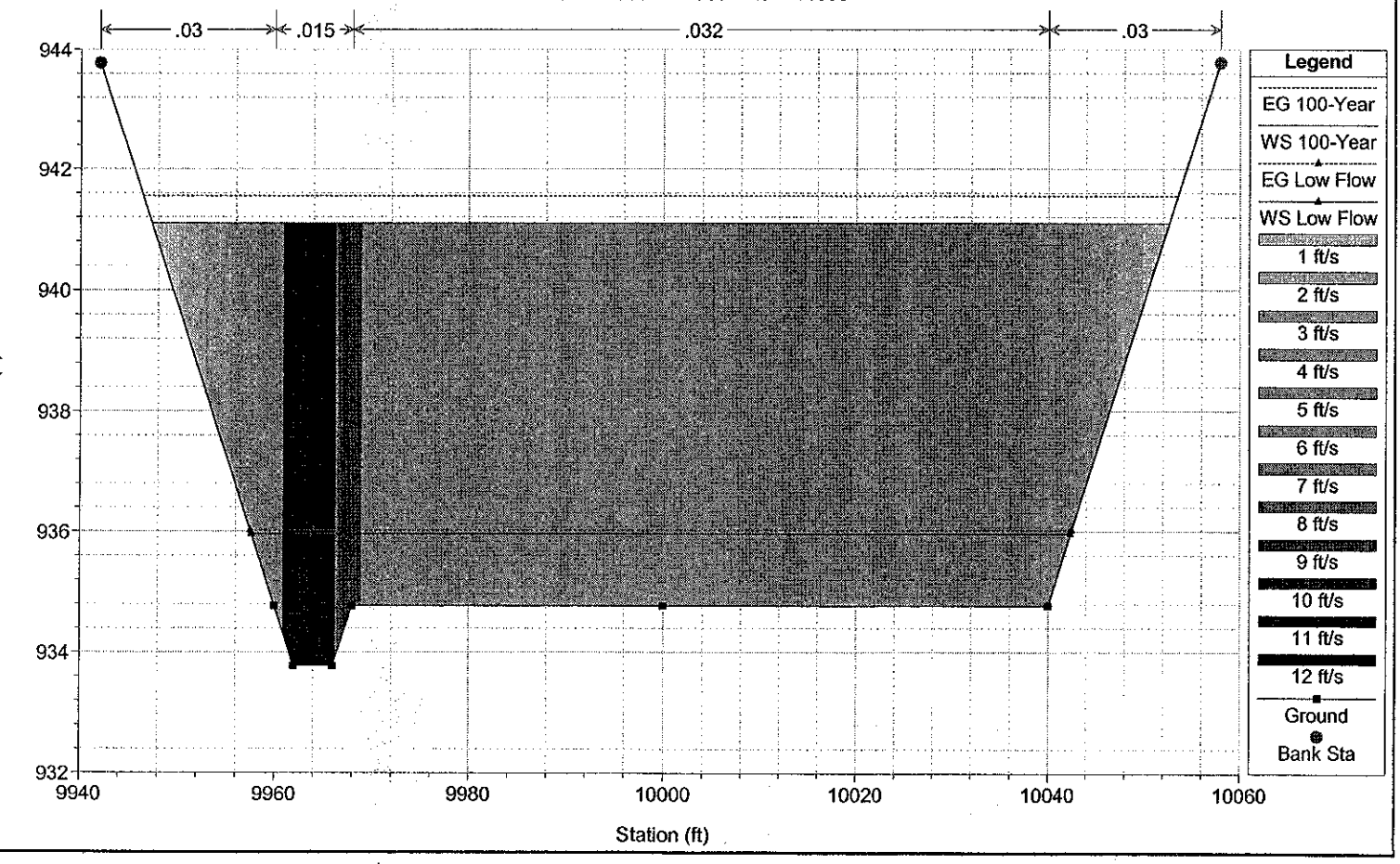
RS = 11932 Phase I RS = 11932



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

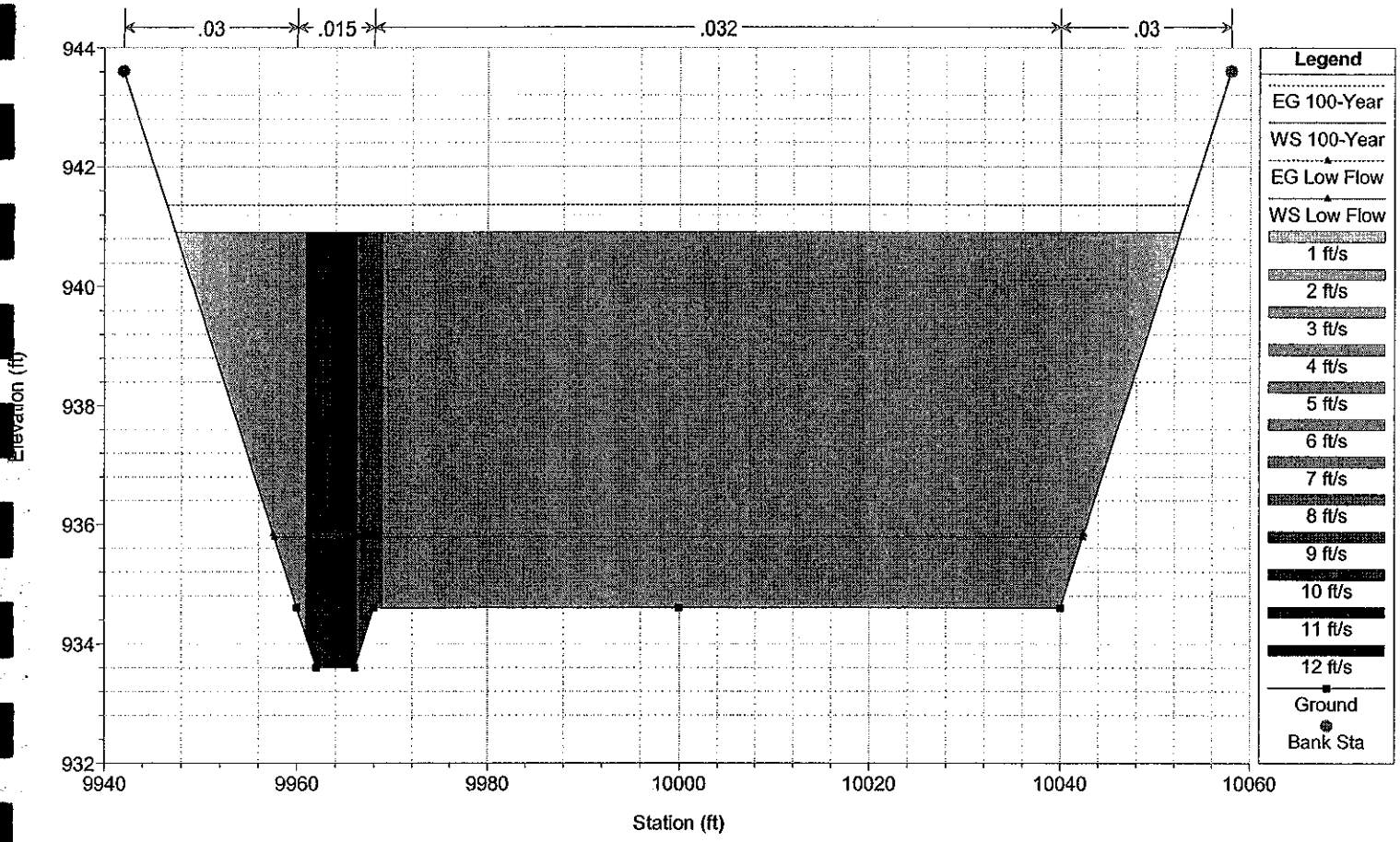
RS = 11883 Phase I RS = 11883



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

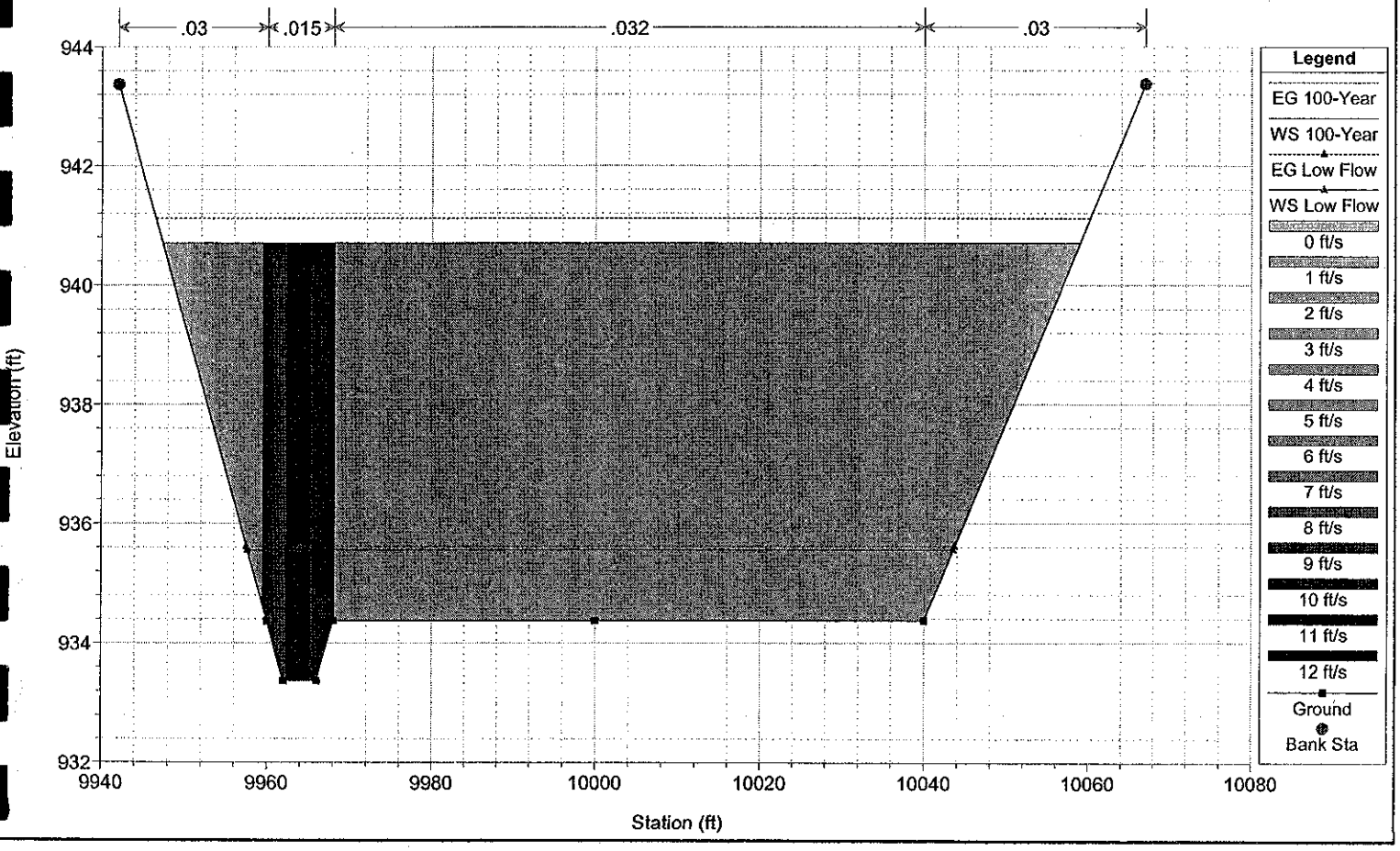
RS = 11735 Phase I RS = 11735



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

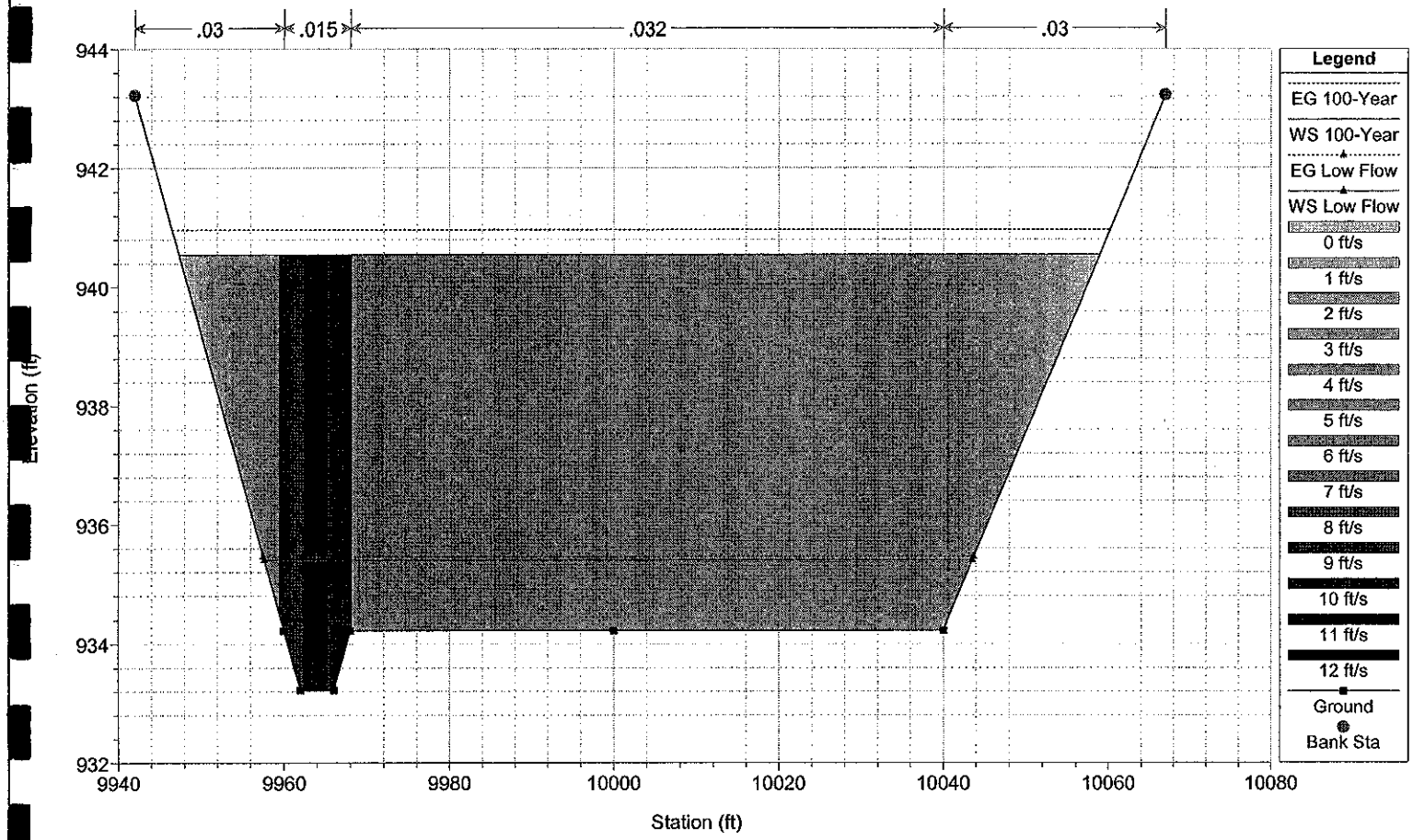
RS = 11550 Phase I RS = 11550



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

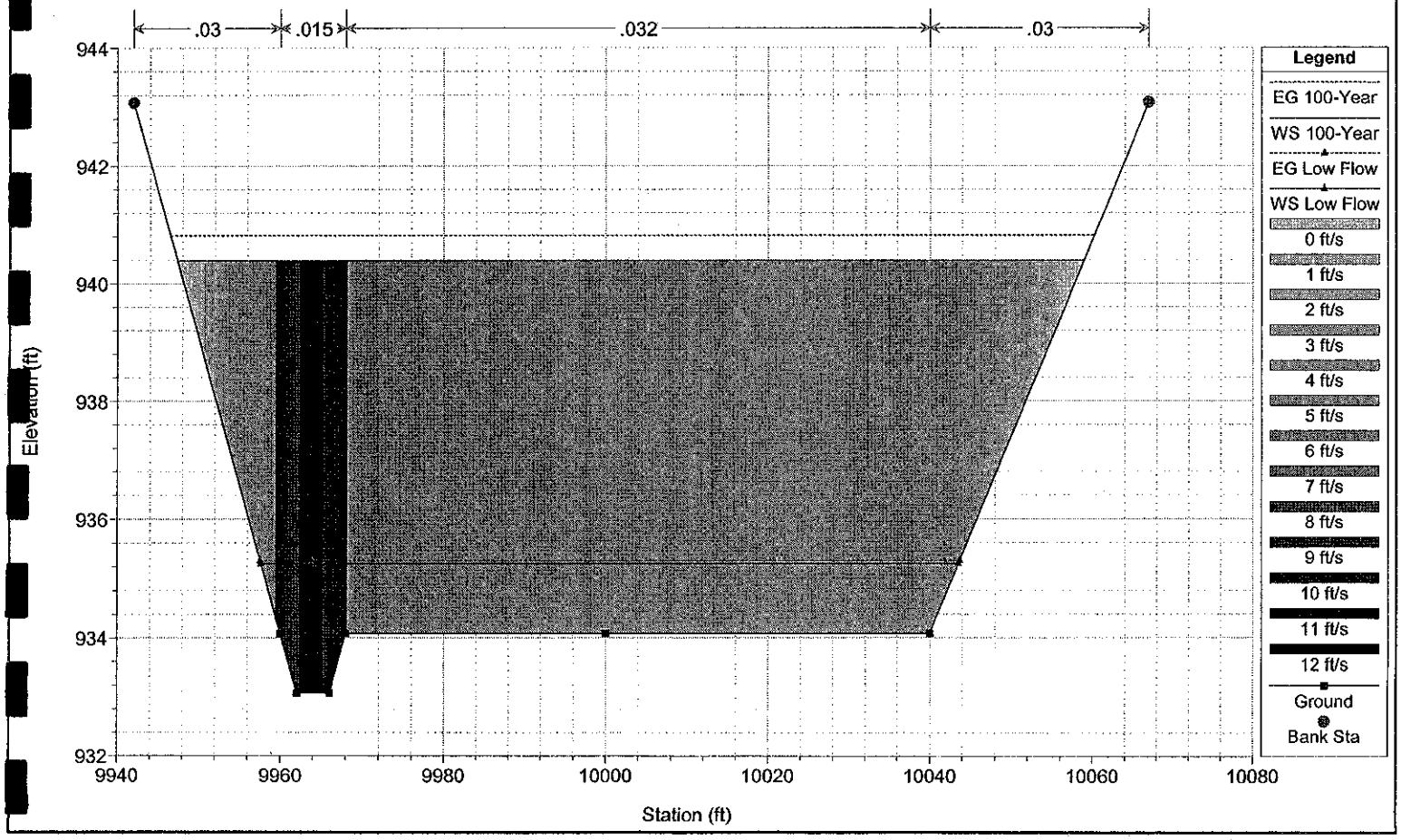
RS = 11425 Phase I RS = 11425



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

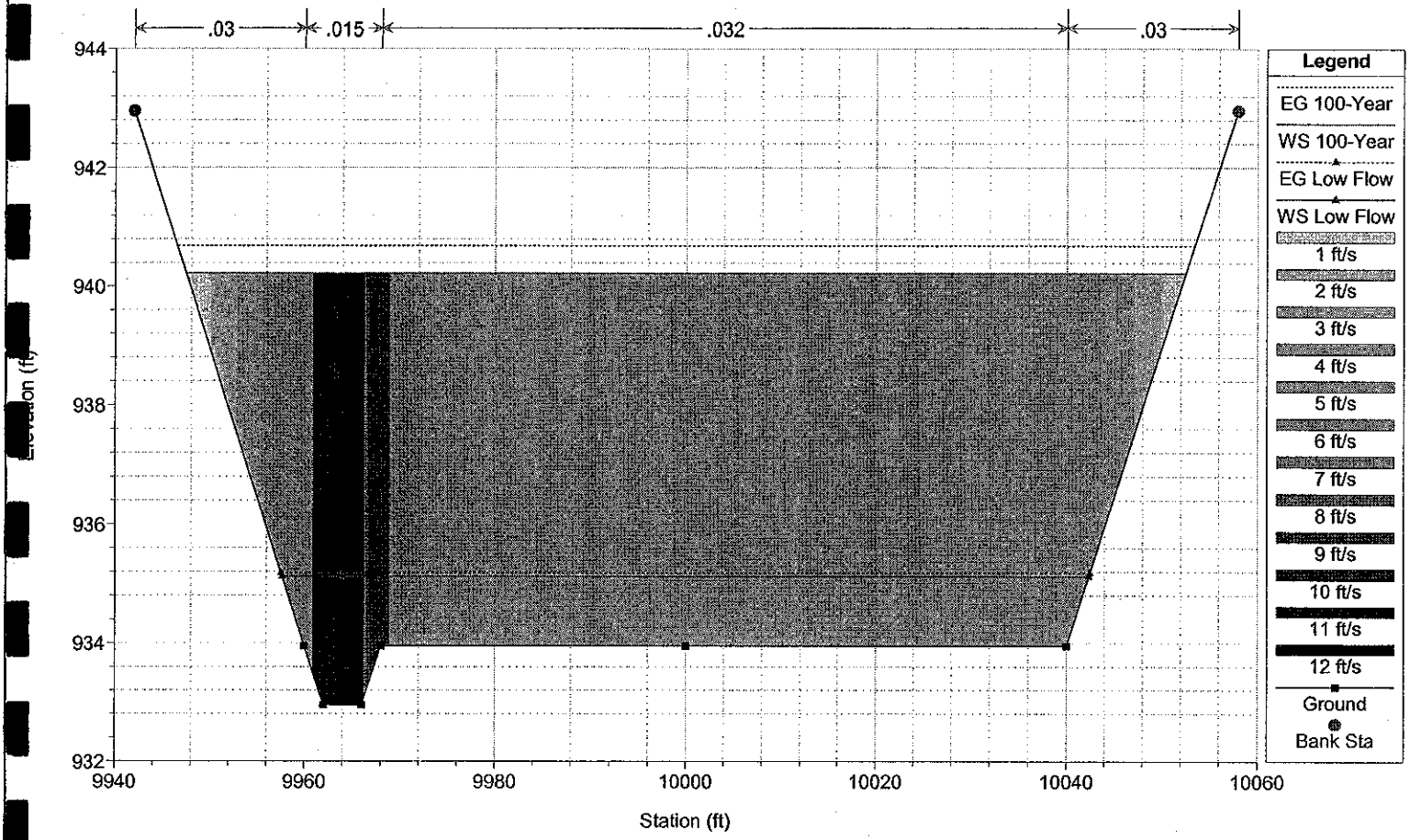
RS = 11300 Phase I RS = 11300



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

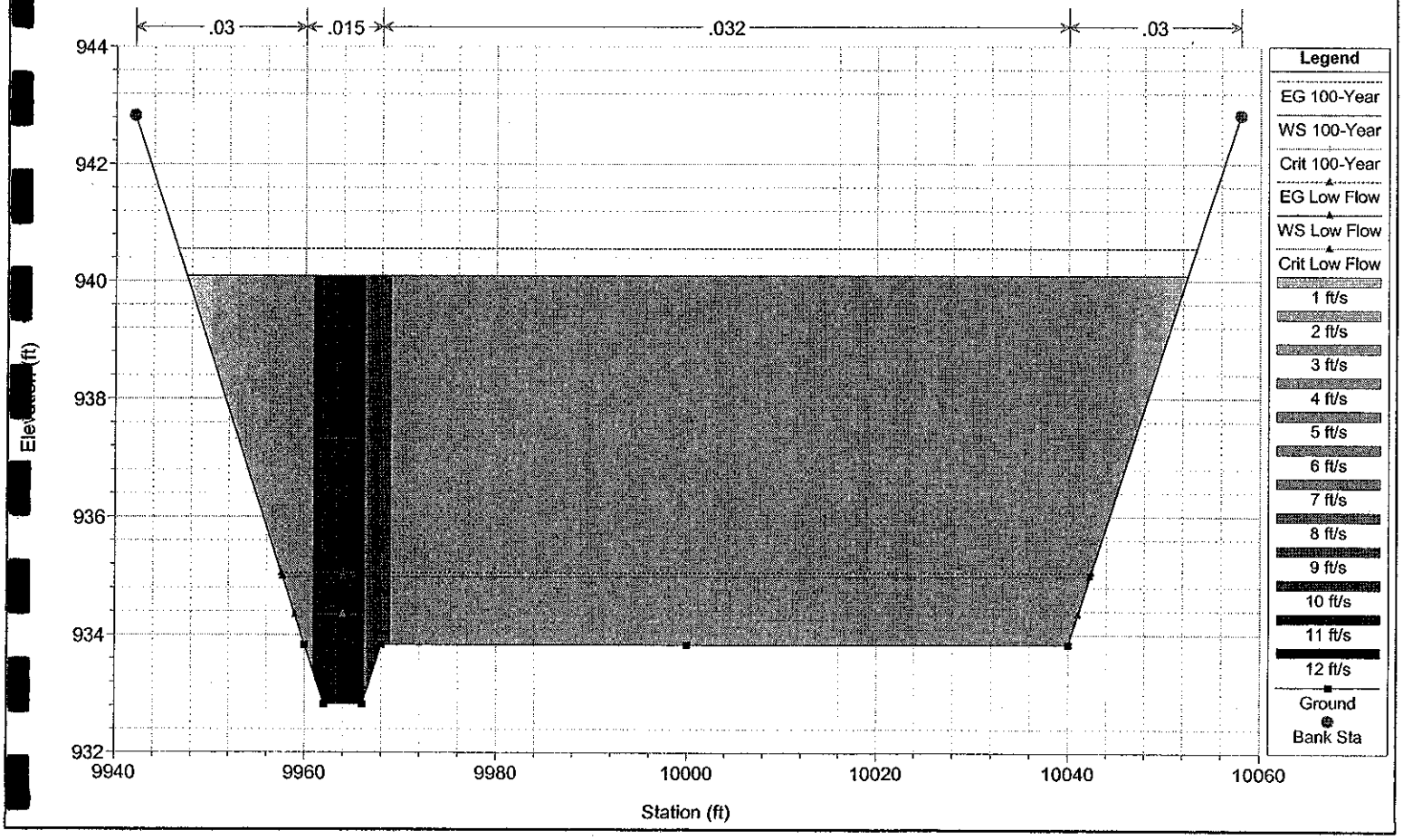
RS = 11200 Phase I RS = 11200



Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow

RS = 11100 Phase I RS = 11100



HEC-RAS

2.2 - Initial Condition
(Channel n = 0.029)

H AS P 0.02 er: B Wash ch: M hann

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	27173	100-Year	5319.00	984.50	992.04	990.85	992.88	0.003511	9.71	756.65	169.63	0.67
Main Channel	27173	Low Flow	200.00	984.50	987.33	987.02	987.91	0.007500	6.08	32.87	18.22	0.80
Main Channel	27150		Bridge									
Main Channel	27127	100-Year	5319.00	984.30	991.95		992.80	0.003586	9.80	753.86	170.93	0.68
Main Channel	27127	Low Flow	200.00	984.30	987.33	986.86	987.83	0.006020	5.67	35.27	18.26	0.72
Main Channel	27057	100-Year	5319.00	983.90	991.80	990.35	992.54	0.002898	9.09	805.15	171.30	0.62
Main Channel	27057	Low Flow	200.00	983.90	987.26	986.44	987.48	0.002596	4.09	73.95	143.88	0.48
Main Channel	27034		Bridge									
Main Channel	27011	100-Year	3200.00	983.40	991.71		992.03	0.001276	5.97	743.29	165.01	0.41
Main Channel	27011	Low Flow	200.00	983.40	986.30	986.30	987.15	0.012419	7.37	27.14	16.33	1.01
Main Channel	26936	100-Year	3200.00	981.30	991.56		991.92	0.001253	5.61	710.98	156.35	0.40
Main Channel	26936	Low Flow	200.00	981.30	984.44		985.03	0.006311	6.13	32.63	14.80	0.73
Main Channel	26883.44	100-Year	3200.00	981.03	990.54		991.73	0.003189	11.15	443.94	107.08	0.71
Main Channel	26883.44	Low Flow	200.00	981.03	984.01	983.60	984.71	0.005341	6.72	29.74	12.98	0.78
Main Channel	26871	100-Year	3200.00	981.00	990.02	990.02	991.64	0.004613	12.80	389.26	106.04	0.85
Main Channel	26871	Low Flow	200.00	981.00	983.57	983.57	984.60	0.009056	8.13	24.60	12.14	1.01
Main Channel	26862	100-Year	3200.00	978.50	985.29		985.60	0.000970	4.74	725.64	113.59	0.32
Main Channel	26862	Low Flow	200.00	978.50	981.27		981.27	0.000075	0.73	284.21	105.53	0.08
Main Channel	26822	100-Year	3200.00	978.50	985.25		985.56	0.000991	4.77	720.60	113.50	0.32
Main Channel	26822	Low Flow	200.00	978.50	981.26		981.27	0.000076	0.73	283.89	105.53	0.08
Main Channel	26821	100-Year	3200.00	978.50	984.92		985.53	0.002463	8.45	529.90	109.85	0.59
Main Channel	26821	Low Flow	200.00	978.50	981.22		981.27	0.000672	2.49	136.97	102.44	0.27
Main Channel	26806.44	100-Year	3200.00	978.50	984.98		985.45	0.002048	7.76	605.76	137.71	0.54
Main Channel	26806.44	Low Flow	200.00	978.50	981.21		981.26	0.000669	2.48	140.13	109.17	0.27
Main Channel	26677.6	100-Year	3200.00	978.50	984.73		985.19	0.001945	7.50	606.73	173.13	0.53
Main Channel	26677.6	Low Flow	200.00	978.50	981.05		981.14	0.001178	3.21	91.68	73.09	0.35
Main Channel	26495.2	100-Year	3200.00	978.50	984.33		984.81	0.002175	7.94	594.54	180.52	0.58
Main Channel	26495.2	Low Flow	200.00	978.50	980.74		980.87	0.001796	3.81	76.94	66.73	0.45
Main Channel	26300.4	100-Year	3200.00	978.30	983.88		984.38	0.002270	8.10	585.62	179.81	0.60
Main Channel	26300.4	Low Flow	200.00	978.30	980.30		980.46	0.002411	4.21	70.17	66.31	0.52

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	26101.6	100-Year	3200.00	977.89	983.48		983.94	0.002076	7.78	611.41	187.38	0.58
Main Channel	26101.6	Low Flow	200.00	977.89	979.85		980.00	0.002214	3.99	73.09	67.57	0.50
Main Channel	25901.7	100-Year	3200.00	977.48	983.14		983.55	0.001679	7.17	651.46	188.29	0.53
Main Channel	25901.7	Low Flow	200.00	977.48	979.67		979.73	0.000750	2.54	111.84	85.14	0.30
Main Channel	25701.5	100-Year	3200.00	977.06	982.78		983.19	0.001921	7.58	651.97	208.23	0.56
Main Channel	25701.5	Low Flow	200.00	977.06	979.38		979.51	0.001543	3.72	73.95	52.21	0.43
Main Channel	25558.8	100-Year	3200.00	976.77	982.55		982.91	0.001764	7.30	686.23	221.62	0.54
Main Channel	25558.8	Low Flow	200.00	976.77	978.62		979.08	0.006426	6.52	40.84	36.30	0.85
Main Channel	25379.3	100-Year	3200.00	976.40	982.19		982.60	0.001703	7.21	646.06	184.50	0.53
Main Channel	25379.3	Low Flow	200.00	976.40	978.42		978.52	0.001335	3.17	87.24	68.79	0.39
Main Channel	25182.2	100-Year	3200.00	975.99	981.64		982.18	0.002505	8.58	580.02	194.62	0.64
Main Channel	25182.2	Low Flow	200.00	975.99	978.03		978.19	0.002083	3.97	68.59	53.88	0.49
Main Channel	24978.4	100-Year	3200.00	975.57	981.05		981.63	0.002797	8.87	551.71	182.01	0.67
Main Channel	24978.4	Low Flow	200.00	975.57	977.57		977.73	0.002323	4.12	67.67	57.23	0.51
Main Channel	24802.1	100-Year	3200.00	975.20	980.72		981.12	0.001995	7.55	655.80	218.25	0.57
Main Channel	24802.1	Low Flow	200.00	975.20	977.19		977.33	0.001911	3.75	74.31	61.40	0.47
Main Channel	24611.0	100-Year	3200.00	974.81	980.22		980.70	0.002345	8.12	606.42	203.75	0.62
Main Channel	24611.0	Low Flow	200.00	974.81	976.78		976.93	0.002215	4.02	71.34	64.01	0.51
Main Channel	24462.45	100-Year	3200.00	974.50	979.84		980.33	0.002507	8.25	592.53	200.15	0.63
Main Channel	24462.45	Low Flow	200.00	974.50	976.38		976.56	0.002831	4.37	66.16	63.46	0.56
Main Channel	24300.2	100-Year	3200.00	973.99	979.00		979.78	0.004212	10.32	481.07	177.59	0.81
Main Channel	24300.2	Low Flow	200.00	973.99	975.83		976.05	0.003410	4.76	59.27	55.89	0.62
Main Channel	24152.7	100-Year	3200.00	973.53	978.56		979.19	0.003306	9.34	538.61	200.05	0.73
Main Channel	24152.7	Low Flow	200.00	973.53	975.09		975.41	0.005431	5.49	50.12	55.15	0.77
Main Channel	23962.1	100-Year	3200.00	972.94	978.21		978.65	0.002031	7.39	620.76	190.34	0.57
Main Channel	23962.1	Low Flow	200.00	972.94	974.70		974.80	0.001774	3.33	88.12	88.39	0.44
Main Channel	23762.2	100-Year	3200.00	972.31	977.66		978.19	0.002522	8.30	571.33	183.36	0.63
Main Channel	23762.2	Low Flow	200.00	972.31	974.21		974.37	0.002564	4.19	69.28	65.80	0.54
Main Channel	23566.1	100-Year	3200.00	971.70	977.11		977.67	0.002752	8.72	555.14	182.30	0.66
Main Channel	23566.1	Low Flow	200.00	971.70	973.55		973.77	0.003625	4.88	59.12	58.13	0.63

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	23390.8	100-Year	3200.00	971.15	976.73		977.21	0.002196	8.00	602.31	188.85	0.60
Main Channel	23390.8	Low Flow	200.00	971.15	973.04		973.21	0.002684	4.29	66.95	62.90	0.55
Main Channel	23203.98	100-Year	3200.00	970.58	976.42		976.83	0.001721	7.32	648.61	189.67	0.53
Main Channel	23203.98	Low Flow	200.00	970.58	972.44		972.66	0.003385	4.78	60.46	60.71	0.62
Main Channel	23054.4	100-Year	3200.00	970.12	976.28		976.59	0.001178	6.22	740.90	196.04	0.44
Main Channel	23054.4	Low Flow	200.00	970.12	971.78		972.04	0.005021	5.35	54.90	62.29	0.73
Main Channel	22946.3	100-Year	3200.00	969.78	976.16		976.47	0.001060	6.04	736.28	178.52	0.42
Main Channel	22946.3	Low Flow	200.00	969.78	971.36		971.54	0.003915	4.57	63.84	72.40	0.64
Main Channel	22845.6	100-Year	3200.00	969.46	976.05		976.37	0.000884	5.64	715.89	142.87	0.39
Main Channel	22845.6	Low Flow	200.00	969.46	971.28		971.33	0.000906	2.42	118.63	108.53	0.32
Main Channel	22820.93	100-Year	3200.00	969.39	975.30	973.84	976.27	0.002013	7.95	408.50	79.87	0.61
Main Channel	22820.93	Low Flow	200.00	969.39	971.23	970.64	971.30	0.001174	2.24	89.63	76.81	0.36
Main Channel	22774.93		Bridge									
Main Channel	22728.93	100-Year	3200.00	969.07	973.52	973.52	975.40	0.005965	11.03	293.33	78.78	1.00
Main Channel	22728.93	Low Flow	200.00	969.07	970.70		970.81	0.002230	2.71	73.88	76.66	0.49
Main Channel	22705.0	100-Year	3200.00	969.00	974.14		974.76	0.002453	7.90	510.59	132.05	0.61
Main Channel	22705.0	Low Flow	200.00	969.00	970.69		970.76	0.001386	2.83	103.45	106.31	0.38
Main Channel	22611.0	100-Year	3200.00	968.72	973.87		974.51	0.002958	8.75	520.78	166.01	0.68
Main Channel	22611.0	Low Flow	200.00	968.72	970.47		970.59	0.002207	3.68	77.24	74.55	0.49
Main Channel	22496.6	100-Year	3200.00	968.40	973.66		974.16	0.002423	8.04	578.50	182.35	0.62
Main Channel	22496.6	Low Flow	200.00	968.40	970.20		970.33	0.002319	3.85	76.53	76.87	0.51
Main Channel	22300.9	100-Year	3200.00	967.82	973.24		973.70	0.002250	7.90	617.00	203.76	0.60
Main Channel	22300.9	Low Flow	200.00	967.82	969.80		969.92	0.001900	3.71	79.81	74.44	0.46
Main Channel	22102.0	100-Year	3200.00	967.24	972.79		973.25	0.002267	8.07	619.91	209.14	0.60
Main Channel	22102.0	Low Flow	200.00	967.24	969.26		969.46	0.002784	4.55	60.10	48.77	0.56
Main Channel	21911.0	100-Year	3200.00	966.67	972.21		972.76	0.002793	8.96	578.44	211.00	0.67
Main Channel	21911.0	Low Flow	200.00	966.67	968.78		968.97	0.002422	4.38	63.30	50.79	0.53
Main Channel	21718.5	100-Year	3200.00	966.10	971.32		972.09	0.004088	10.41	483.29	175.49	0.80
Main Channel	21718.5	Low Flow	200.00	966.10	968.11		968.39	0.003745	5.26	51.90	43.67	0.66

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	21517.7	100-Year	3200.00	965.51	970.80		971.34	0.002832	8.71	568.35	197.56	0.67
Main Channel	21517.7	Low Flow	200.00	965.51	967.42		967.65	0.003532	4.92	58.07	54.63	0.63
Main Channel	21318.7	100-Year	3200.00	964.92	970.43		970.84	0.001880	7.37	644.34	198.79	0.55
Main Channel	21318.7	Low Flow	200.00	964.92	966.80		966.99	0.002976	4.52	67.34	72.96	0.58
Main Channel	21118.3	100-Year	3200.00	964.33	969.93		970.42	0.002249	8.07	593.79	186.32	0.60
Main Channel	21118.3	Low Flow	200.00	964.33	966.35		966.49	0.001995	3.84	71.12	57.21	0.48
Main Channel	20918.4	100-Year	3200.00	963.74	969.30		969.90	0.002874	9.09	540.91	177.46	0.68
Main Channel	20918.4	Low Flow	200.00	963.74	965.81		966.02	0.002752	4.59	59.64	48.12	0.56
Main Channel	20718.0	100-Year	3200.00	963.14	968.57		969.25	0.003647	10.06	516.83	191.16	0.76
Main Channel	20718.0	Low Flow	200.00	963.14	965.20		965.44	0.003006	4.79	55.77	42.70	0.59
Main Channel	20524.1	100-Year	3200.00	962.57	967.49		968.38	0.005259	11.38	453.46	182.21	0.90
Main Channel	20524.1	Low Flow	200.00	962.57	964.24		964.62	0.006353	6.08	44.75	44.56	0.83
Main Channel	20341.9	100-Year	3200.00	962.03	967.09		967.59	0.002753	8.34	588.38	211.80	0.65
Main Channel	20341.9	Low Flow	200.00	962.03	963.84		963.96	0.001953	3.54	79.98	73.92	0.46
Main Channel	20164.2	100-Year	3200.00	961.51	966.74		967.11	0.002188	7.62	687.99	263.74	0.59
Main Channel	20164.2	Low Flow	200.00	961.51	963.56		963.66	0.001426	3.29	87.66	74.37	0.41
Main Channel	19974.5	100-Year	3200.00	961.07	966.23		966.67	0.002552	8.15	636.12	243.71	0.63
Main Channel	19974.5	Low Flow	200.00	961.07	962.95		963.21	0.004104	5.27	56.30	59.60	0.68
Main Channel	19790.8	100-Year	3200.00	960.40	965.83		966.25	0.002049	7.59	633.98	203.34	0.57
Main Channel	19790.8	Low Flow	200.00	960.40	962.43		962.60	0.002527	4.37	71.08	74.14	0.54
Main Channel	19602.6	100-Year	3200.00	959.85	965.37		965.85	0.002291	8.17	609.02	202.26	0.61
Main Channel	19602.6	Low Flow	200.00	959.85	962.01		962.17	0.002079	4.16	70.88	63.18	0.50
Main Channel	19400.0	100-Year	3200.00	959.25	964.71		965.30	0.003082	9.33	556.91	203.07	0.70
Main Channel	19400.0	Low Flow	200.00	959.25	961.34		961.62	0.003455	5.20	51.70	40.76	0.63
Main Channel	19205.1	100-Year	3200.00	958.67	963.93		964.62	0.003784	10.03	509.07	188.60	0.77
Main Channel	19205.1	Low Flow	200.00	958.67	960.70		960.95	0.003359	5.01	55.53	47.30	0.62
Main Channel	19017.6	100-Year	3200.00	958.24	963.28		963.94	0.003590	9.52	515.89	184.07	0.75
Main Channel	19017.6	Low Flow	200.00	958.24	960.09		960.30	0.003519	4.82	61.76	64.56	0.63
Main Channel	18821.3	100-Year	3200.00	957.54	962.89		963.34	0.002138	7.69	618.82	197.77	0.59
Main Channel	18821.3	Low Flow	200.00	957.54	959.46		959.65	0.002991	4.59	68.31	76.94	0.58

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	18623.3	100-Year	3200.00	956.95	962.48		962.92	0.002067	7.67	621.17	194.53	0.58
Main Channel	18623.3	Low Flow	200.00	956.95	958.94		959.10	0.002527	4.29	71.04	71.22	0.54
Main Channel	18424.2	100-Year	3200.00	956.36	961.79		962.41	0.002987	9.17	529.95	173.63	0.69
Main Channel	18424.2	Low Flow	200.00	956.36	958.45		958.62	0.002286	4.24	67.75	58.58	0.52
Main Channel	18226.7	100-Year	3200.00	955.78	961.19		961.80	0.003152	9.37	539.87	190.05	0.71
Main Channel	18226.7	Low Flow	200.00	955.78	957.73		958.02	0.003989	5.33	50.29	41.68	0.67
Main Channel	18029.7	100-Year	3200.00	955.20	960.64		961.21	0.002743	8.78	554.84	182.56	0.66
Main Channel	18029.7	Low Flow	200.00	955.20	957.21		957.38	0.002467	4.28	68.11	62.46	0.53
Main Channel	17826.9	100-Year	3200.00	954.60	960.32		960.72	0.001760	7.25	655.02	196.25	0.53
Main Channel	17826.9	Low Flow	200.00	954.60	956.37		956.67	0.005059	5.62	53.20	59.99	0.74
Main Channel	17644	100-Year	3200.00	954.04	960.08		960.42	0.001391	6.68	704.28	197.41	0.48
Main Channel	17644	Low Flow	200.00	954.04	955.64		955.83	0.003910	4.61	63.35	71.24	0.64
Main Channel	17545	100-Year	3200.00	953.76	959.98		960.29	0.001048	5.91	734.27	174.46	0.42
Main Channel	17545	Low Flow	200.00	953.76	955.43		955.53	0.002021	3.41	85.17	88.26	0.47
Main Channel	17459	100-Year	3200.00	953.51	959.83		960.19	0.001118	6.16	691.25	143.47	0.43
Main Channel	17459	Low Flow	200.00	953.51	955.36		955.40	0.000874	2.40	124.98	111.43	0.31
Main Channel	17434	100-Year	3200.00	953.43	959.12	957.78	960.09	0.001436	7.95	410.30	84.18	0.62
Main Channel	17434	Low Flow	200.00	953.43	955.32	954.67	955.38	0.000643	2.06	97.28	80.27	0.33
Main Channel	17371.91		Bridge									
Main Channel	17310	100-Year	3200.00	953.07	957.42	957.42	959.23	0.004053	10.85	299.56	83.68	1.00
Main Channel	17310	Low Flow	200.00	953.07	954.83		954.92	0.000925	2.30	87.38	80.39	0.39
Main Channel	17285	100-Year	3200.00	953.00	957.68		958.56	0.003668	9.14	429.16	125.03	0.75
Main Channel	17285	Low Flow	200.00	953.00	954.82		954.88	0.001204	2.79	105.28	101.68	0.36
Main Channel	17188	100-Year	3200.00	952.72	957.50		958.17	0.003036	8.45	493.00	152.21	0.68
Main Channel	17188	Low Flow	200.00	952.72	954.62		954.73	0.002143	3.83	92.46	126.05	0.49
Main Channel	17076.5	100-Year	3200.00	952.39	957.14		957.83	0.003150	8.55	486.86	151.47	0.69
Main Channel	17076.5	Low Flow	200.00	952.39	954.05		954.34	0.006073	5.89	62.79	115.52	0.81
Main Channel	16961.4	100-Year	3200.00	952.06	956.96		957.48	0.002145	7.21	561.26	162.00	0.57
Main Channel	16961.4	Low Flow	200.00	952.06	953.84		953.92	0.001825	3.38	100.33	133.28	0.45
Main Channel	16762.7	100-Year	3200.00	951.49	956.32		956.97	0.002870	8.28	501.37	152.24	0.66

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	16762.7	Low Flow	200.00	951.49	953.29		953.44	0.003187	4.51	80.61	124.92	0.59
Main Channel	16562.9	100-Year	3200.00	950.91	955.89		956.42	0.002317	7.59	555.05	170.27	0.60
Main Channel	16562.9	Low Flow	200.00	950.91	952.82		952.93	0.001997	3.72	94.58	125.78	0.47
Main Channel	16366.6	100-Year	3200.00	950.45	955.18		955.88	0.003173	8.60	485.29	151.26	0.70
Main Channel	16366.6	Low Flow	200.00	950.45	952.22		952.40	0.003690	4.81	76.38	124.67	0.64
Main Channel	16165.7	100-Year	3200.00	949.76	954.62		955.26	0.002835	8.23	503.75	152.50	0.66
Main Channel	16165.7	Low Flow	200.00	949.76	951.59		951.73	0.002918	4.35	83.32	125.27	0.57
Main Channel	15969.0	100-Year	3200.00	949.19	954.03		954.68	0.002863	8.27	502.12	152.43	0.66
Main Channel	15969.0	Low Flow	200.00	949.19	951.03		951.16	0.002765	4.26	84.74	125.48	0.55
Main Channel	15779.9	100-Year	3200.00	948.64	953.47		954.12	0.002866	8.27	502.70	153.02	0.66
Main Channel	15779.9	Low Flow	200.00	948.64	950.45		950.60	0.003055	4.44	81.99	125.77	0.58
Main Channel	15590.8	100-Year	3200.00	948.09	952.93		953.57	0.002840	8.27	502.79	152.36	0.66
Main Channel	15590.8	Low Flow	200.00	948.09	949.92		950.05	0.002670	4.19	85.37	125.20	0.55
Main Channel	15401.8	100-Year	3200.00	947.54	952.39		953.04	0.002837	8.30	503.45	152.83	0.66
Main Channel	15401.8	Low Flow	200.00	947.54	949.36		949.52	0.003053	4.47	81.02	125.42	0.59
Main Channel	15199.3	100-Year	3200.00	946.96	951.85		952.47	0.002694	8.07	512.21	153.08	0.64
Main Channel	15199.3	Low Flow	200.00	946.96	948.79		948.92	0.002710	4.20	85.67	125.52	0.55
Main Channel	14998	100-Year	3200.00	946.37	951.31		951.93	0.002635	8.04	515.79	153.30	0.64
Main Channel	14998	Low Flow	200.00	946.37	948.21		948.35	0.002857	4.33	83.75	125.30	0.56
Main Channel	14817.3	100-Year	3200.00	945.85	950.81		951.41	0.002512	7.86	523.38	153.41	0.62
Main Channel	14817.3	Low Flow	200.00	945.85	947.66		947.79	0.002827	4.25	84.47	125.04	0.56
Main Channel	14663.1	100-Year	3200.00	945.40	950.59		951.02	0.001740	6.74	613.27	171.65	0.52
Main Channel	14663.1	Low Flow	200.00	945.40	947.30		947.40	0.002049	3.74	96.48	142.93	0.48
Main Channel	14544	100-Year	3200.00	945.06	950.25		950.77	0.002103	7.41	554.88	155.62	0.57
Main Channel	14544	Low Flow	200.00	945.06	946.74	946.74	947.00	0.005538	5.67	65.12	116.55	0.77
Main Channel	14543	100-Year	3200.00	944.06	950.41		950.70	0.000865	5.45	748.14	176.29	0.38
Main Channel	14543	Low Flow	200.00	944.06	945.73	945.73	946.00	0.005669	5.72	64.33	115.70	0.78
Main Channel	14531.42	100-Year	3200.00	944.02	950.43	947.61	950.68	0.000694	4.88	798.64	176.45	0.34
Main Channel	14531.42	Low Flow	200.00	944.02	945.59	945.32	945.68	0.002234	3.42	92.31	118.50	0.48
Main Channel	14461.42		Culvert									

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	14391.42	100-Year	3200.00	943.62	948.44		949.11	0.003022	8.52	497.69	151.26	0.68
Main Channel	14391.42	Low Flow	200.00	943.62	945.43		945.48	0.001120	2.69	109.73	106.02	0.35
Main Channel	14298.9	100-Year	3200.00	943.35	948.17		948.83	0.002900	8.30	500.50	152.66	0.67
Main Channel	14298.9	Low Flow	200.00	943.35	945.16		945.31	0.003078	4.45	81.79	125.48	0.58
Main Channel	14096.5	100-Year	3200.00	942.76	947.56		948.23	0.002932	8.41	497.39	152.17	0.68
Main Channel	14096.5	Low Flow	200.00	942.76	944.58		944.73	0.002749	4.26	83.84	125.26	0.56
Main Channel	13894.6	100-Year	3200.00	942.18	946.92		947.61	0.003184	8.58	485.22	151.37	0.70
Main Channel	13894.6	Low Flow	200.00	942.18	944.01		944.15	0.002861	4.32	83.87	125.25	0.56
Main Channel	13694.6	100-Year	3200.00	941.60	946.37		946.99	0.002799	8.22	513.97	159.32	0.66
Main Channel	13694.6	Low Flow	200.00	941.60	943.41		943.57	0.003010	4.46	81.75	132.40	0.59
Main Channel	13494.6	100-Year	3200.00	941.02	945.92		946.46	0.002349	7.57	550.93	165.02	0.60
Main Channel	13494.6	Low Flow	200.00	941.02	942.85		942.99	0.002733	4.24	87.50	137.44	0.55
Main Channel	13294.6	100-Year	3200.00	940.44	945.29		945.93	0.002810	8.20	507.60	154.94	0.66
Main Channel	13294.6	Low Flow	200.00	940.44	942.25		942.40	0.003187	4.52	80.86	125.27	0.59
Main Channel	13095.9	100-Year	3200.00	939.86	944.77		945.38	0.002594	8.06	518.26	154.14	0.64
Main Channel	13095.9	Low Flow	200.00	939.86	941.67		941.82	0.002706	4.23	84.12	126.07	0.55
Main Channel	12908.8	100-Year	3200.00	939.32	944.46		944.92	0.001894	6.95	591.21	167.21	0.54
Main Channel	12908.8	Low Flow	200.00	939.32	941.15		941.28	0.002932	4.33	86.61	137.39	0.57
Main Channel	12708.5	100-Year	3200.00	938.73	944.12		944.56	0.001672	6.78	607.27	166.65	0.51
Main Channel	12708.5	Low Flow	200.00	938.73	940.57		940.70	0.002765	4.25	85.98	130.05	0.55
Main Channel	12508.7	100-Year	3200.00	938.15	943.84		944.25	0.001398	6.36	635.18	162.73	0.47
Main Channel	12508.7	Low Flow	200.00	938.15	939.96		940.11	0.003170	4.46	81.10	125.04	0.58
Main Channel	12315	100-Year	3200.00	937.59	943.66		943.99	0.001049	5.81	698.60	166.34	0.42
Main Channel	12315	Low Flow	200.00	937.59	939.52		939.62	0.001965	3.70	95.05	125.32	0.47
Main Channel	12220.5	100-Year	3200.00	937.32	943.35		943.85	0.001544	7.03	570.13	131.88	0.50
Main Channel	12220.5	Low Flow	200.00	937.32	939.34		939.44	0.001798	3.65	91.65	106.21	0.45
Main Channel	12209	100-Year	3200.00	937.28	943.09		943.81	0.002322	8.41	475.11	112.60	0.61
Main Channel	12209	Low Flow	200.00	937.28	939.28		939.42	0.002226	4.04	81.51	94.23	0.50
Main Channel	12197	100-Year	3200.00	937.25	941.99	941.99	943.67	0.007227	12.93	312.77	91.02	1.05
Main Channel	12197	Low Flow	200.00	937.25	939.07	939.07	939.36	0.005061	5.72	58.75	83.27	0.75

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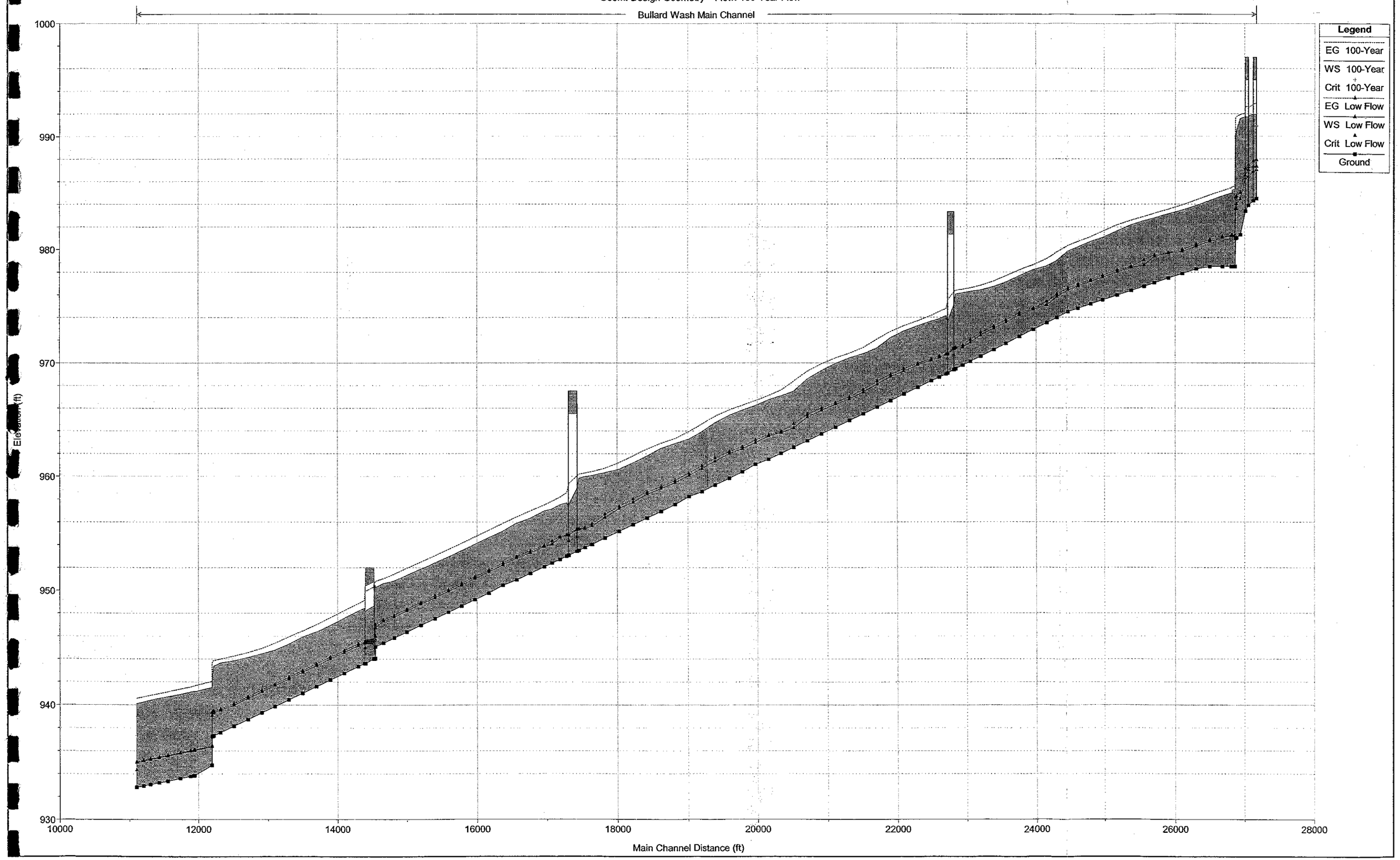
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	12195	100-Year	3200.00	934.75	941.51		942.04	0.001391	5.83	549.03	92.70	0.42
Main Channel	12195	Low Flow	200.00	934.75	936.37		936.44	0.001304	2.01	99.47	82.42	0.32
Main Channel	11943	100-Year	3200.00	933.85	941.13		941.67	0.001482	5.89	543.45	92.44	0.43
Main Channel	11943	Low Flow	200.00	933.85	936.03		936.09	0.001391	2.03	98.53	82.00	0.33
Main Channel	11932	100-Year	3200.00	933.84	941.16		941.61	0.001277	5.41	591.25	105.27	0.40
Main Channel	11932	Low Flow	200.00	933.84	936.02		936.08	0.001238	1.94	103.01	84.71	0.31
Main Channel	11883	100-Year	3200.00	933.77	941.10		941.55	0.001272	5.40	592.06	105.30	0.40
Main Channel	11883	Low Flow	200.00	933.77	935.96		936.02	0.001202	1.92	103.94	84.76	0.31
Main Channel	11735	100-Year	3200.00	933.60	940.90		941.36	0.001287	5.43	589.70	105.21	0.40
Main Channel	11735	Low Flow	200.00	933.60	935.78		935.84	0.001241	1.94	102.94	84.71	0.31
Main Channel	11550	100-Year	3200.00	933.37	940.69		941.12	0.001221	5.23	611.86	111.62	0.39
Main Channel	11550	Low Flow	200.00	933.37	935.55		935.61	0.001219	1.92	104.00	85.91	0.31
Main Channel	11425	100-Year	3200.00	933.22	940.54		940.97	0.001223	5.23	611.50	111.60	0.39
Main Channel	11425	Low Flow	200.00	933.22	935.40		935.46	0.001230	1.93	103.72	85.89	0.31
Main Channel	11300	100-Year	3200.00	933.07	940.39		940.81	0.001226	5.24	611.01	111.58	0.39
Main Channel	11300	Low Flow	200.00	933.07	935.24		935.30	0.001246	1.94	103.29	85.87	0.31
Main Channel	11200	100-Year	3200.00	932.95	940.22		940.68	0.001311	5.46	586.07	105.07	0.41
Main Channel	11200	Low Flow	200.00	932.95	935.12		935.18	0.001281	1.96	101.93	84.66	0.32
Main Channel	11100	100-Year	3200.00	932.83	940.09	937.32	940.55	0.001321	5.47	584.67	105.02	0.41
Main Channel	11100	Low Flow	200.00	932.83	934.98	934.34	935.04	0.001320	1.98	100.98	84.62	0.32

Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design (n=0.029) - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow



HEC-RAS

2.3 - Neglected Condition
(Channel n = 0.055)

HE[illegible]S Pl[illegible] 0.055 [illegible]er: Bu[illegible] Wash[illegible]ch: M[illegible]anne[illegible]

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	27173	100-Year	5319.00	984.50	992.81	991.40	993.68	0.004186	11.43	889.32	173.14	0.75
Main Channel	27173	Low Flow	200.00	984.50	987.37	987.02	987.92	0.007061	5.95	33.61	18.40	0.78
Main Channel	27150		Bridge									
Main Channel	27127	100-Year	5319.00	984.30	992.76		993.63	0.004162	11.41	892.88	174.38	0.75
Main Channel	27127	Low Flow	200.00	984.30	987.37		987.85	0.005690	5.55	36.01	18.44	0.70
Main Channel	27057	100-Year	5319.00	983.90	992.54	990.91	993.33	0.003618	10.89	932.95	174.47	0.70
Main Channel	27057	Low Flow	200.00	983.90	987.07	986.44	987.47	0.004617	5.14	46.56	141.00	0.64
Main Channel	27034		Bridge									
Main Channel	27011	100-Year	3200.00	983.40	992.48		992.82	0.001496	6.96	871.56	169.43	0.45
Main Channel	27011	Low Flow	200.00	983.40	986.30	986.30	987.15	0.012419	7.37	27.14	16.33	1.01
Main Channel	26936	100-Year	3200.00	981.30	992.35		992.71	0.001173	5.88	835.94	161.07	0.39
Main Channel	26936	Low Flow	200.00	981.30	984.44		985.03	0.006311	6.13	32.63	14.80	0.73
Main Channel	26883.44	100-Year	3200.00	981.03	991.05		992.49	0.003481	12.16	499.08	108.10	0.75
Main Channel	26883.44	Low Flow	200.00	981.03	984.01	983.60	984.71	0.005341	6.72	29.74	12.98	0.78
Main Channel	26871	100-Year	3200.00	981.00	990.49	990.49	992.40	0.004875	13.73	439.07	106.98	0.88
Main Channel	26871	Low Flow	200.00	981.00	983.57	983.57	984.60	0.009056	8.13	24.60	12.14	1.01
Main Channel	26862	100-Year	3200.00	978.50	986.64		986.87	0.001173	5.88	880.07	116.28	0.36
Main Channel	26862	Low Flow	200.00	978.50	981.63		981.63	0.000111	0.96	322.32	106.25	0.10
Main Channel	26822	100-Year	3200.00	978.50	986.59		986.82	0.001198	5.92	874.13	116.17	0.37
Main Channel	26822	Low Flow	200.00	978.50	981.62		981.63	0.000111	0.96	321.84	106.24	0.10
Main Channel	26821	100-Year	3200.00	978.50	986.30		986.80	0.002345	9.39	683.45	112.61	0.59
Main Channel	26821	Low Flow	200.00	978.50	981.58		981.62	0.000605	2.56	173.90	103.16	0.26
Main Channel	26806.44	100-Year	3200.00	978.50	986.36		986.73	0.001912	8.52	802.10	148.11	0.54
Main Channel	26806.44	Low Flow	200.00	978.50	981.57		981.61	0.000594	2.54	179.98	111.90	0.26
Main Channel	26677.6	100-Year	3200.00	978.50	986.10		986.47	0.002074	8.84	852.47	185.51	0.57
Main Channel	26677.6	Low Flow	200.00	978.50	981.40		981.50	0.001244	3.59	117.90	77.19	0.37
Main Channel	26495.2	100-Year	3200.00	978.50	985.69		986.08	0.002214	9.22	850.10	194.94	0.61
Main Channel	26495.2	Low Flow	200.00	978.50	981.07		981.22	0.001844	4.24	100.23	73.66	0.47
Main Channel	26300.4	100-Year	3200.00	978.30	985.24		985.64	0.002279	9.39	839.57	193.33	0.63
Main Channel	26300.4	Low Flow	200.00	978.30	980.64		980.81	0.002329	4.59	93.94	74.74	0.53

HEC-RAS Plan: 0.055 River: Buffalo Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	26101.6	100-Year	3200.00	977.89	984.83		985.20	0.002109	9.05	873.70	201.55	0.61
Main Channel	26101.6	Low Flow	200.00	977.89	980.22		980.37	0.002053	4.31	99.31	75.48	0.50
Main Channel	25901.7	100-Year	3200.00	977.48	984.44		984.80	0.001820	8.57	906.01	203.79	0.57
Main Channel	25901.7	Low Flow	200.00	977.48	980.03		980.10	0.000830	2.96	143.43	91.89	0.33
Main Channel	25701.5	100-Year	3200.00	977.06	984.09		984.41	0.001944	8.74	933.22	221.87	0.58
Main Channel	25701.5	Low Flow	200.00	977.06	979.68		979.85	0.001792	4.35	90.33	55.86	0.47
Main Channel	25558.8	100-Year	3200.00	976.77	983.85		984.14	0.001766	8.36	982.42	232.73	0.55
Main Channel	25558.8	Low Flow	200.00	976.77	978.99		979.43	0.004881	6.42	54.90	39.92	0.76
Main Channel	25379.3	100-Year	3200.00	976.40	983.45		983.80	0.001958	8.82	885.28	196.01	0.59
Main Channel	25379.3	Low Flow	200.00	976.40	978.80		978.90	0.001409	3.64	113.45	72.23	0.41
Main Channel	25182.2	100-Year	3200.00	975.99	982.93		983.36	0.002463	9.76	840.50	210.65	0.65
Main Channel	25182.2	Low Flow	200.00	975.99	978.38		978.55	0.002139	4.47	87.85	57.18	0.51
Main Channel	24978.4	100-Year	3200.00	975.57	982.30		982.79	0.002972	10.48	796.00	211.12	0.71
Main Channel	24978.4	Low Flow	200.00	975.57	977.91		978.09	0.002346	4.60	87.97	61.79	0.53
Main Channel	24802.1	100-Year	3200.00	975.20	981.93		982.26	0.002120	8.89	930.97	235.86	0.60
Main Channel	24802.1	Low Flow	200.00	975.20	977.53		977.68	0.002017	4.27	95.24	64.99	0.49
Main Channel	24611.0	100-Year	3200.00	974.81	981.41		981.82	0.002455	9.49	858.64	220.50	0.65
Main Channel	24611.0	Low Flow	200.00	974.81	977.09		977.26	0.002259	4.48	92.11	69.93	0.52
Main Channel	24462.45	100-Year	3200.00	974.50	981.03		981.43	0.002648	9.69	838.80	214.55	0.67
Main Channel	24462.45	Low Flow	200.00	974.50	976.68		976.88	0.002905	4.89	86.21	69.28	0.58
Main Channel	24300.2	100-Year	3200.00	973.99	980.20		980.86	0.004153	11.82	703.60	203.39	0.84
Main Channel	24300.2	Low Flow	200.00	973.99	976.02		976.31	0.004172	5.62	70.12	58.72	0.70
Main Channel	24152.7	100-Year	3200.00	973.53	979.81		980.32	0.002818	10.00	796.53	212.11	0.70
Main Channel	24152.7	Low Flow	200.00	973.53	975.40		975.70	0.004139	5.39	67.31	58.95	0.70
Main Channel	23962.1	100-Year	3200.00	972.94	979.44		979.80	0.002265	8.98	863.11	203.44	0.62
Main Channel	23962.1	Low Flow	200.00	972.94	975.05		975.15	0.001734	3.71	120.03	94.21	0.45
Main Channel	23762.2	100-Year	3200.00	972.31	978.85		979.29	0.002778	9.95	796.13	196.80	0.69
Main Channel	23762.2	Low Flow	200.00	972.31	974.52		974.71	0.002726	4.78	92.79	85.85	0.57
Main Channel	23566.1	100-Year	3200.00	971.70	978.20		978.70	0.003132	10.52	761.63	193.59	0.73
Main Channel	23566.1	Low Flow	200.00	971.70	973.84		974.09	0.003563	5.35	77.24	63.75	0.64

HE[redacted]S Pl[redacted] 0.055 [redacted]er: Bu[redacted] Wash [redacted]ch: M[redacted]anne[redacted]tinue[redacted]

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	23390.8	100-Year	3200.00	971.15	977.69		978.17	0.002886	10.19	788.78	200.58	0.70
Main Channel	23390.8	Low Flow	200.00	971.15	973.33		973.53	0.002773	4.80	86.14	68.28	0.57
Main Channel	23203.98	100-Year	3200.00	970.58	977.17		977.64	0.002739	10.01	794.50	197.42	0.69
Main Channel	23203.98	Low Flow	200.00	970.58	972.70		972.96	0.003485	5.29	76.79	66.67	0.64
Main Channel	23054.4	100-Year	3200.00	970.12	976.87		977.24	0.002290	9.22	857.57	202.13	0.63
Main Channel	23054.4	Low Flow	200.00	970.12	972.03		972.33	0.005000	5.87	71.47	67.46	0.75
Main Channel	22946.3	100-Year	3200.00	969.78	976.58		976.98	0.002367	9.43	811.88	182.08	0.64
Main Channel	22946.3	Low Flow	200.00	969.78	971.61		971.81	0.004090	5.16	82.50	74.44	0.67
Main Channel	22845.6	100-Year	3200.00	969.46	976.32		976.75	0.002268	9.29	755.27	144.94	0.62
Main Channel	22845.6	Low Flow	200.00	969.46	971.48		971.55	0.001413	3.24	140.48	110.12	0.40
Main Channel	22820.93	100-Year	3200.00	969.39	975.88	973.84	976.67	0.001408	7.14	455.67	80.31	0.52
Main Channel	22820.93	Low Flow	200.00	969.39	971.47	970.64	971.52	0.000628	1.85	108.23	77.00	0.27
Main Channel	22774.93		Bridge									
Main Channel	22728.93	100-Year	3200.00	969.07	975.23		976.12	0.001715	7.58	429.03	80.06	0.57
Main Channel	22728.93	Low Flow	200.00	969.07	971.07		971.13	0.000763	1.97	102.05	76.94	0.30
Main Channel	22705.0	100-Year	3200.00	969.00	975.44		975.95	0.003047	10.24	690.15	143.46	0.71
Main Channel	22705.0	Low Flow	200.00	969.00	971.04		971.10	0.001416	3.24	140.94	108.71	0.40
Main Channel	22611.0	100-Year	3200.00	968.72	975.17		975.66	0.003013	10.26	742.98	176.98	0.71
Main Channel	22611.0	Low Flow	200.00	968.72	970.81		970.93	0.002176	4.11	103.17	77.30	0.50
Main Channel	22496.6	100-Year	3200.00	968.40	974.91		975.32	0.002569	9.54	813.64	193.42	0.66
Main Channel	22496.6	Low Flow	200.00	968.40	970.55		970.68	0.002228	4.24	104.21	83.83	0.51
Main Channel	22300.9	100-Year	3200.00	967.82	974.44		974.82	0.002457	9.43	874.00	224.75	0.65
Main Channel	22300.9	Low Flow	200.00	967.82	970.15		970.28	0.001929	4.16	106.86	82.90	0.48
Main Channel	22102.0	100-Year	3200.00	967.24	973.94		974.33	0.002454	9.52	868.58	222.84	0.65
Main Channel	22102.0	Low Flow	200.00	967.24	969.58		969.81	0.002802	5.04	76.31	52.20	0.58
Main Channel	21911.0	100-Year	3200.00	966.67	973.35		973.82	0.002839	10.24	829.85	229.20	0.70
Main Channel	21911.0	Low Flow	200.00	966.67	969.08		969.31	0.002519	4.89	79.36	54.99	0.56
Main Channel	21718.5	100-Year	3200.00	966.10	972.57		973.18	0.003644	11.34	708.76	184.66	0.79
Main Channel	21718.5	Low Flow	200.00	966.10	968.39		968.72	0.003689	5.71	64.92	47.26	0.67

HEC-RAS Plan: n=0.055 River: Bullard Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	21517.7	100-Year	3200.00	965.51	972.09		972.50	0.002628	9.71	830.67	208.61	0.67
Main Channel	21517.7	Low Flow	200.00	965.51	967.68		967.96	0.003705	5.51	73.42	59.37	0.66
Main Channel	21318.7	100-Year	3200.00	964.92	971.67		972.02	0.002030	8.78	899.41	211.40	0.60
Main Channel	21318.7	Low Flow	200.00	964.92	967.13		967.32	0.002575	4.69	93.45	84.72	0.56
Main Channel	21118.3	100-Year	3200.00	964.33	971.16		971.57	0.002442	9.60	829.97	198.16	0.65
Main Channel	21118.3	Low Flow	200.00	964.33	966.69		966.85	0.002071	4.35	91.64	60.68	0.50
Main Channel	20918.4	100-Year	3200.00	963.74	970.37		970.97	0.003555	11.36	736.91	202.03	0.78
Main Channel	20918.4	Low Flow	200.00	963.74	966.13		966.37	0.002763	5.07	75.77	52.02	0.58
Main Channel	20718.0	100-Year	3200.00	963.14	969.57		970.21	0.003993	11.79	714.21	203.00	0.82
Main Channel	20718.0	Low Flow	200.00	963.14	965.45		965.75	0.003429	5.52	66.67	44.74	0.64
Main Channel	20524.1	100-Year	3200.00	962.57	968.70		969.39	0.004376	12.02	681.58	194.33	0.86
Main Channel	20524.1	Low Flow	200.00	962.57	964.56		964.94	0.005235	6.20	59.26	47.15	0.78
Main Channel	20341.9	100-Year	3200.00	962.03	968.29		968.67	0.002747	9.60	853.73	229.60	0.68
Main Channel	20341.9	Low Flow	200.00	962.03	964.20		964.31	0.001958	3.99	106.52	77.29	0.48
Main Channel	20164.2	100-Year	3200.00	961.51	967.92		968.21	0.002183	8.72	1037.02	316.44	0.61
Main Channel	20164.2	Low Flow	200.00	961.51	963.88		963.99	0.001610	3.86	112.59	80.46	0.44
Main Channel	19974.5	100-Year	3200.00	961.07	967.46		967.79	0.002349	9.02	949.73	266.10	0.63
Main Channel	19974.5	Low Flow	200.00	961.07	963.22		963.52	0.003986	5.68	73.47	67.19	0.68
Main Channel	19790.8	100-Year	3200.00	960.40	967.01		967.37	0.002238	9.05	880.78	214.16	0.62
Main Channel	19790.8	Low Flow	200.00	960.40	962.73		962.92	0.002461	4.73	94.59	85.32	0.55
Main Channel	19602.6	100-Year	3200.00	959.85	966.49		966.92	0.002537	9.71	842.23	217.38	0.66
Main Channel	19602.6	Low Flow	200.00	959.85	962.31		962.50	0.002077	4.53	90.83	70.94	0.51
Main Channel	19400.0	100-Year	3200.00	959.25	965.84		966.34	0.003069	10.55	792.38	214.32	0.72
Main Channel	19400.0	Low Flow	200.00	959.25	961.63		961.96	0.003403	5.63	63.87	43.95	0.64
Main Channel	19205.1	100-Year	3200.00	958.67	965.14		965.70	0.003520	11.11	747.79	204.93	0.77
Main Channel	19205.1	Low Flow	200.00	958.67	960.98		961.28	0.003469	5.55	69.40	51.32	0.64
Main Channel	19017.6	100-Year	3200.00	958.24	964.57		965.07	0.003240	10.52	759.55	195.70	0.74
Main Channel	19017.6	Low Flow	200.00	958.24	960.35		960.60	0.003637	5.36	79.73	71.52	0.65
Main Channel	18821.3	100-Year	3200.00	957.54	964.13		964.50	0.002241	9.05	871.56	209.42	0.62
Main Channel	18821.3	Low Flow	200.00	957.54	959.76		959.96	0.002775	4.87	92.75	89.45	0.58

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	18623.3	100-Year	3200.00	956.95	963.68		964.05	0.002305	9.24	862.29	207.94	0.63
Main Channel	18623.3	Low Flow	200.00	956.95	959.26		959.44	0.002485	4.69	95.13	81.10	0.55
Main Channel	18424.2	100-Year	3200.00	956.36	962.93		963.49	0.003223	10.81	734.37	184.63	0.74
Main Channel	18424.2	Low Flow	200.00	956.36	958.75		958.96	0.002356	4.71	86.34	64.63	0.54
Main Channel	18226.7	100-Year	3200.00	955.78	962.30		962.84	0.003288	10.84	757.01	201.13	0.75
Main Channel	18226.7	Low Flow	200.00	955.78	958.02		958.35	0.003863	5.76	62.91	44.39	0.68
Main Channel	18029.7	100-Year	3200.00	955.20	961.63		962.18	0.003402	10.93	740.39	195.35	0.76
Main Channel	18029.7	Low Flow	200.00	955.20	957.49		957.69	0.002623	4.82	86.65	68.71	0.56
Main Channel	17826.9	100-Year	3200.00	954.60	961.09		961.52	0.002783	9.91	808.59	204.33	0.69
Main Channel	17826.9	Low Flow	200.00	954.60	956.62		956.97	0.004974	6.09	69.04	67.14	0.75
Main Channel	17644	100-Year	3200.00	954.04	960.57		961.01	0.002783	9.95	803.53	201.76	0.69
Main Channel	17644	Low Flow	200.00	954.04	955.91		956.11	0.003978	5.16	82.72	74.19	0.67
Main Channel	17545	100-Year	3200.00	953.76	960.34		960.74	0.002474	9.43	796.47	177.29	0.65
Main Channel	17545	Low Flow	200.00	953.76	955.65		955.77	0.002638	4.23	104.47	89.74	0.54
Main Channel	17459	100-Year	3200.00	953.51	960.06		960.52	0.002618	9.66	724.36	145.25	0.67
Main Channel	17459	Low Flow	200.00	953.51	955.53		955.59	0.001337	3.15	144.80	112.58	0.39
Main Channel	17434	100-Year	3200.00	953.43	959.65	957.78	960.44	0.001024	7.18	455.12	84.73	0.54
Main Channel	17434	Low Flow	200.00	953.43	955.52	954.67	955.57	0.000381	1.76	114.05	80.48	0.26
Main Channel	17371.91		Bridge									
Main Channel	17310	100-Year	3200.00	953.07	958.97		959.86	0.001237	7.59	431.03	85.65	0.58
Main Channel	17310	Low Flow	200.00	953.07	955.11		955.16	0.000442	1.84	109.22	80.73	0.28
Main Channel	17285	100-Year	3200.00	953.00	959.11		959.73	0.003665	10.92	616.18	136.56	0.78
Main Channel	17285	Low Flow	200.00	953.00	955.06		955.14	0.001590	3.48	129.79	103.63	0.43
Main Channel	17188	100-Year	3200.00	952.72	958.89		959.37	0.002973	9.91	714.01	165.55	0.70
Main Channel	17188	Low Flow	200.00	952.72	954.79		954.93	0.002653	4.51	113.57	127.56	0.55
Main Channel	17076.5	100-Year	3200.00	952.39	958.56		959.03	0.003011	9.95	712.07	166.31	0.71
Main Channel	17076.5	Low Flow	200.00	952.39	954.30		954.54	0.004531	5.58	93.17	125.92	0.71
Main Channel	16961.4	100-Year	3200.00	952.06	958.33		958.70	0.002331	8.86	795.15	181.85	0.62
Main Channel	16961.4	Low Flow	200.00	952.06	954.07		954.16	0.002028	3.86	131.04	135.38	0.48
Main Channel	16762.7	100-Year	3200.00	951.49	957.70		958.17	0.002891	9.83	725.25	174.79	0.70

HEC-RAS Plan: n 0.055 River: Buffalo Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	16762.7	Low Flow	200.00	951.49	953.51		953.68	0.002936	4.68	109.19	126.96	0.58
Main Channel	16562.9	100-Year	3200.00	950.91	957.23		957.61	0.002465	9.18	796.48	193.28	0.64
Main Channel	16562.9	Low Flow	200.00	950.91	953.04		953.16	0.002201	4.19	121.20	127.16	0.51
Main Channel	16366.6	100-Year	3200.00	950.45	956.57		957.07	0.003085	10.07	709.14	174.38	0.72
Main Channel	16366.6	Low Flow	200.00	950.45	952.42		952.62	0.003550	5.06	101.24	126.45	0.64
Main Channel	16165.7	100-Year	3200.00	949.76	956.00		956.46	0.002874	9.80	726.63	171.84	0.69
Main Channel	16165.7	Low Flow	200.00	949.76	951.80		951.96	0.002883	4.66	110.57	127.21	0.58
Main Channel	15969.0	100-Year	3200.00	949.19	955.40		955.87	0.002895	9.83	721.54	168.25	0.70
Main Channel	15969.0	Low Flow	200.00	949.19	951.24		951.39	0.002793	4.60	111.42	127.38	0.57
Main Channel	15779.9	100-Year	3200.00	948.64	954.84		955.30	0.002906	9.83	722.27	169.62	0.70
Main Channel	15779.9	Low Flow	200.00	948.64	950.66		950.83	0.003031	4.75	108.26	127.64	0.59
Main Channel	15590.8	100-Year	3200.00	948.09	954.27		954.75	0.002930	9.89	719.91	174.66	0.70
Main Channel	15590.8	Low Flow	200.00	948.09	950.12		950.28	0.002751	4.56	110.90	127.03	0.56
Main Channel	15401.8	100-Year	3200.00	947.54	953.70		954.19	0.002963	9.95	712.27	167.53	0.71
Main Channel	15401.8	Low Flow	200.00	947.54	949.56		949.74	0.002945	4.72	107.08	127.28	0.59
Main Channel	15199.3	100-Year	3200.00	946.96	953.11		953.58	0.003012	9.94	713.53	168.24	0.71
Main Channel	15199.3	Low Flow	200.00	946.96	949.00		949.15	0.002769	4.57	112.62	127.44	0.56
Main Channel	14998	100-Year	3200.00	946.37	952.43		952.94	0.003253	10.24	695.59	168.89	0.73
Main Channel	14998	Low Flow	200.00	946.37	948.42		948.58	0.002871	4.66	110.32	127.20	0.57
Main Channel	14817.3	100-Year	3200.00	945.85	951.69		952.24	0.003747	10.71	663.29	166.69	0.78
Main Channel	14817.3	Low Flow	200.00	945.85	947.89		948.03	0.002754	4.54	112.94	127.07	0.56
Main Channel	14663.1	100-Year	3200.00	945.40	951.17		951.64	0.003397	10.11	714.99	179.18	0.74
Main Channel	14663.1	Low Flow	200.00	945.40	947.50		947.62	0.002306	4.24	124.72	144.65	0.52
Main Channel	14544	100-Year	3200.00	945.06	950.20	949.51	951.04	0.006566	13.02	548.33	155.24	1.01
Main Channel	14544	Low Flow	200.00	945.06	946.94	946.94	947.21	0.004971	5.79	89.91	125.78	0.74
Main Channel	14543	100-Year	3200.00	944.06	950.49		950.91	0.002520	9.37	761.94	177.71	0.65
Main Channel	14543	Low Flow	200.00	944.06	945.94	945.94	946.21	0.004934	5.77	89.94	125.86	0.74
Main Channel	14531.42	100-Year	3200.00	944.02	950.54	947.96	950.85	0.002071	7.80	817.88	178.33	0.54
Main Channel	14531.42	Low Flow	200.00	944.02	945.70	945.43	945.82	0.004067	4.41	104.90	122.24	0.60
Main Channel	14461.42		Culvert									

HEC-RAS Plan: 0.055 River: Bullard Wash Reach: Main Channel (continued)

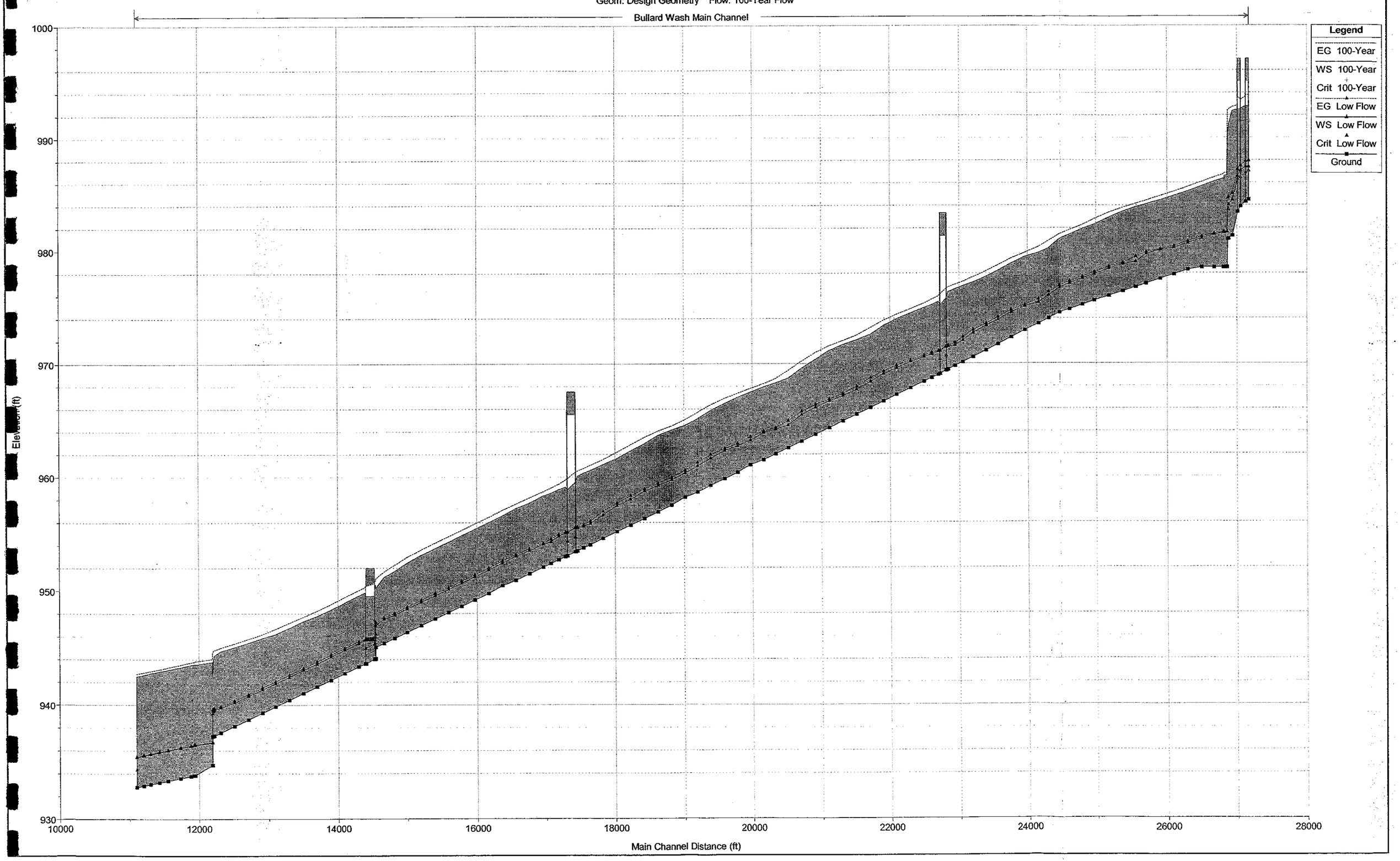
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	14391.42	100-Year	3200.00	943.62	949.82		950.30	0.003016	10.07	724.30	181.13	0.71
Main Channel	14391.42	Low Flow	200.00	943.62	945.67		945.74	0.001490	3.38	136.29	109.72	0.42
Main Channel	14298.9	100-Year	3200.00	943.35	949.55		950.02	0.002934	9.87	726.39	180.17	0.70
Main Channel	14298.9	Low Flow	200.00	943.35	945.37		945.54	0.003064	4.77	107.97	127.35	0.59
Main Channel	14096.5	100-Year	3200.00	942.76	948.92		949.41	0.002943	9.94	717.22	177.05	0.71
Main Channel	14096.5	Low Flow	200.00	942.76	944.79		944.95	0.002707	4.55	109.80	127.11	0.56
Main Channel	13894.6	100-Year	3200.00	942.18	948.31		948.80	0.003118	10.09	711.41	180.80	0.72
Main Channel	13894.6	Low Flow	200.00	942.18	944.21		944.37	0.003039	4.76	108.41	127.00	0.59
Main Channel	13694.6	100-Year	3200.00	941.60	947.76		948.21	0.002675	9.53	746.15	177.42	0.68
Main Channel	13694.6	Low Flow	200.00	941.60	943.59		943.78	0.002894	4.67	107.05	134.12	0.58
Main Channel	13494.6	100-Year	3200.00	941.02	947.30		947.69	0.002398	9.04	791.06	183.26	0.64
Main Channel	13494.6	Low Flow	200.00	941.02	943.06		943.21	0.002662	4.50	116.64	139.34	0.56
Main Channel	13294.6	100-Year	3200.00	940.44	946.73		947.17	0.002731	9.60	741.01	171.06	0.68
Main Channel	13294.6	Low Flow	200.00	940.44	942.45		942.62	0.003229	4.87	106.10	127.22	0.61
Main Channel	13095.9	100-Year	3200.00	939.86	946.18		946.64	0.002576	9.50	756.04	196.27	0.67
Main Channel	13095.9	Low Flow	200.00	939.86	941.87		942.04	0.002680	4.51	109.40	127.87	0.56
Main Channel	12908.8	100-Year	3200.00	939.32	945.83		946.16	0.002106	8.58	840.90	198.00	0.59
Main Channel	12908.8	Low Flow	200.00	939.32	941.36		941.50	0.002936	4.66	115.64	139.28	0.58
Main Channel	12708.5	100-Year	3200.00	938.73	945.41		945.75	0.002015	8.59	848.49	207.64	0.59
Main Channel	12708.5	Low Flow	200.00	938.73	940.77		940.93	0.002842	4.63	112.74	131.97	0.57
Main Channel	12508.7	100-Year	3200.00	938.15	945.03		945.34	0.001975	7.85	842.38	193.81	0.53
Main Channel	12508.7	Low Flow	200.00	938.15	940.22		940.34	0.002910	4.27	113.32	127.35	0.52
Main Channel	12315	100-Year	3200.00	937.59	944.68		944.99	0.001661	8.11	873.76	176.58	0.54
Main Channel	12315	Low Flow	200.00	937.59	939.77		939.88	0.001968	4.02	126.70	127.79	0.48
Main Channel	12220.5	100-Year	3200.00	937.32	944.27		944.78	0.002531	9.89	693.60	137.59	0.66
Main Channel	12220.5	Low Flow	200.00	937.32	939.56		939.69	0.002069	4.20	115.10	107.62	0.49
Main Channel	12209	100-Year	3200.00	937.28	943.96		944.72	0.003724	11.69	575.31	116.68	0.80
Main Channel	12209	Low Flow	200.00	937.28	939.48		939.65	0.002598	4.66	100.47	95.20	0.55
Main Channel	12197	100-Year	3200.00	937.25	942.66	942.66	944.53	0.011176	17.58	374.92	92.92	1.33
Main Channel	12197	Low Flow	200.00	937.25	939.24	939.24	939.59	0.005285	6.21	73.09	83.73	0.78

HEC-RAS Plan: n 0.055 River: Bullard Wash Reach: Main Channel (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel	12195	100-Year	3200.00	934.75	943.72		944.00	0.000512	4.21	759.48	97.15	0.27
Main Channel	12195	Low Flow	200.00	934.75	936.71		936.75	0.000579	1.57	127.50	83.09	0.22
Main Channel	11943	100-Year	3200.00	933.85	943.52		943.79	0.001512	4.15	770.30	97.33	0.26
Main Channel	11943	Low Flow	200.00	933.85	936.50		936.53	0.001362	1.46	137.39	82.96	0.20
Main Channel	11932	100-Year	3200.00	933.84	943.53		943.75	0.001291	3.75	852.33	114.76	0.24
Main Channel	11932	Low Flow	200.00	933.84	936.49		936.52	0.001240	1.40	143.26	86.59	0.19
Main Channel	11883	100-Year	3200.00	933.77	943.47		943.69	0.001288	3.75	853.12	114.79	0.24
Main Channel	11883	Low Flow	200.00	933.77	936.43		936.46	0.001216	1.39	144.14	86.63	0.19
Main Channel	11735	100-Year	3200.00	933.60	943.28		943.49	0.001299	3.76	850.52	114.70	0.24
Main Channel	11735	Low Flow	200.00	933.60	936.25		936.28	0.001245	1.40	143.07	86.58	0.19
Main Channel	11550	100-Year	3200.00	933.37	943.05		943.26	0.001229	3.60	889.31	123.42	0.24
Main Channel	11550	Low Flow	200.00	933.37	936.02		936.05	0.001234	1.38	144.54	88.24	0.19
Main Channel	11425	100-Year	3200.00	933.22	942.90		943.10	0.001231	3.60	888.82	123.40	0.24
Main Channel	11425	Low Flow	200.00	933.22	935.86		935.89	0.001246	1.39	144.10	88.21	0.19
Main Channel	11300	100-Year	3200.00	933.07	942.75		942.95	0.001233	3.60	888.27	123.38	0.24
Main Channel	11300	Low Flow	200.00	933.07	935.71		935.74	0.001263	1.39	143.51	88.18	0.19
Main Channel	11200	100-Year	3200.00	932.95	942.60		942.82	0.001314	3.78	847.31	114.59	0.24
Main Channel	11200	Low Flow	200.00	932.95	935.58		935.61	0.001292	1.41	141.43	86.51	0.19
Main Channel	11100	100-Year	3200.00	932.83	942.46	937.32	942.69	0.001320	3.78	845.89	114.54	0.25
Main Channel	11100	Low Flow	200.00	932.83	935.45	934.34	935.48	0.001321	1.42	140.47	86.46	0.20

Bullard Wash Improvements: I-10 to Lower Buckeye Road Plan: Design (n=0.055) - Final Submittal 5/4/2004

Geom: Design Geometry Flow: 100-Year Flow



APPENDIX C

Hydraulics

Section 3 – Tailwater Swale

Cross Section
Cross Section for Rectangular Channel

Project Description	
Worksheet	Tailwater n=0.025 U-C
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coeffic	0.025	
Slope	002000	ft/ft
Depth	0.75	ft
Bottom Width	9.00	ft
Discharge	13.36	cfs

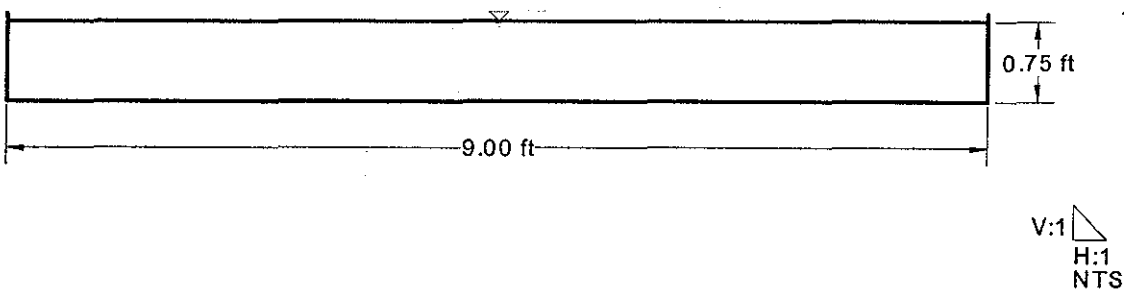


Table
Rating Table for Rectangular Channel

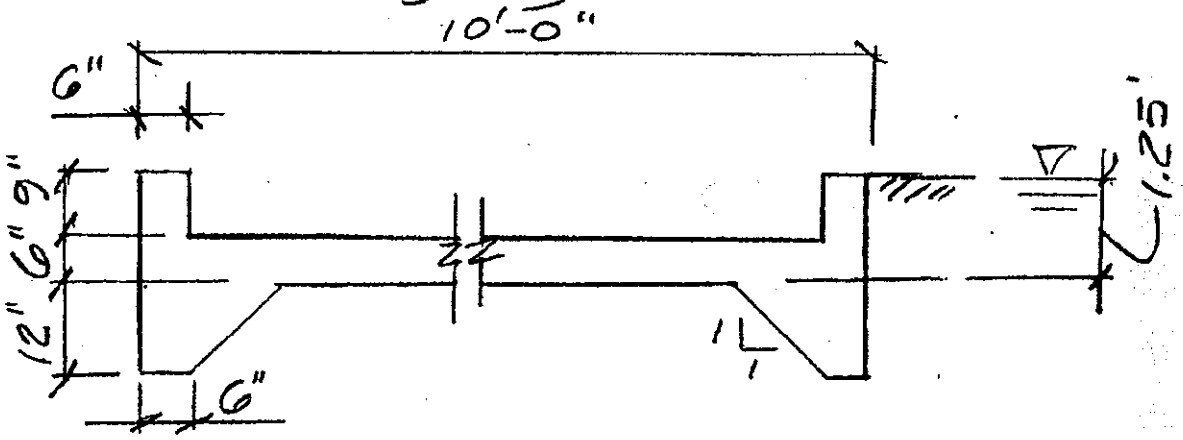
Project Description	
Worksheet	Tailwater n=0.025 U- Cl
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Mannings Coeffic	0.025
Depth	0.75 ft
Bottom Width	9.00 ft

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.002000	0.003300	0.000100

Slope (ft/ft)	Discharge (cfs)	Velocity (ft/s)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)
0.002000	13.36	1.98	6.8	10.50	9.00
0.002100	13.69	2.03	6.8	10.50	9.00
0.002200	14.02	2.08	6.8	10.50	9.00
0.002300	14.33	2.12	6.8	10.50	9.00
0.002400	14.64	2.17	6.8	10.50	9.00
0.002500	14.94	2.21	6.8	10.50	9.00
0.002600	15.24	2.26	6.8	10.50	9.00
0.002700	15.53	2.30	6.8	10.50	9.00
0.002800	15.81	2.34	6.8	10.50	9.00
0.002900	16.09	2.38	6.8	10.50	9.00
0.003000	16.37	2.42	6.8	10.50	9.00
0.003100	16.64	2.46	6.8	10.50	9.00
0.003200	16.90	2.50	6.8	10.50	9.00
0.003300	17.17	2.54	6.8	10.50	9.00

Check Buoyancy of Swale Slab



Weights

Curbs: $2 \times .15 \times .5' \times .75' = 0.113$ K/LF
Slab: $.15 \times .5' \times 10' = 0.750$ K/LF
Toe-downs: $2 \times .15 \times 1' \times 6''/12'' = 0.150$ K/LF
Fillets: $2 \times .15 \times 1^2/2 = 0.150$ K/LF
$W = 1.163$ K/LF

Buoyant Force

$B = .0624 \times 1.25' \times 10' = 0.78$ K/LF

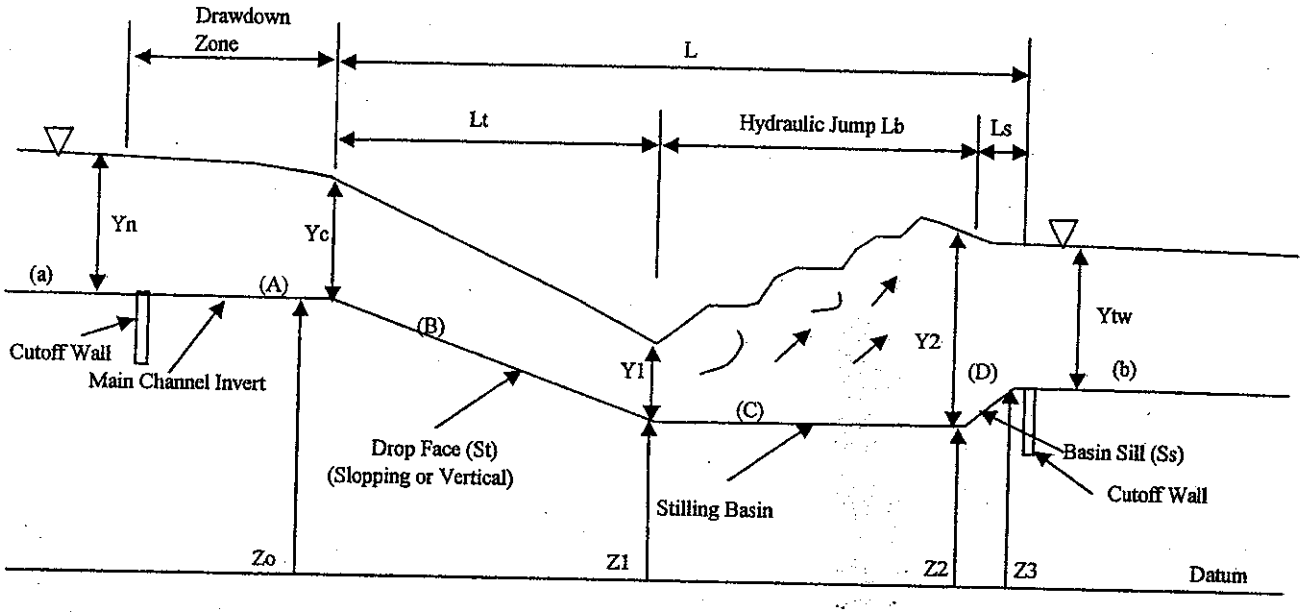
$F.S. = W/B = \underline{\underline{1.49 \approx 1.5}}$ ∴ acceptable to FCDMC

APPENDIX C

Hydraulics

Section 4 – Drop Structure Analysis
(Interim Drop South of I-10)

Typical Drop Structure Components



Where:

Yn (ft) = Normal depth in the upstream channel;
Yc (ft) = Critical flow depth at the beginning of the drop;
Y1 (ft) = Supercritical flow depth of the hydraulic jump;
Y2 (ft) = Conjugate depth of the hydraulic jump;
Ytw (ft) = Tailwater depth;
Zo (ft) = Upstream channel bottom elevation;
Z1 (ft) = Stilling basin bottom elevation at upstream;
Z2 (ft) = Stilling basin bottom elevation at downstream;
Z3 (ft) = Sill elevation;
Lt (ft) = Drop face length;
Lb (ft) = Hydraulic jump length;
Ls (ft) = Basin sill face length;
L (ft) = Total length of the drop structure;
St (H:V) = Drop face slope;
Ss (H:V) = Basin sill face slope.

Sloping Drop Structure Design Spreadsheet

Ref: FHWA, HEC No. 14, 1983. Hydraulic Design of Energy Dissipators for Culverts and Channels

Project Name: Bullard Wash **Location: I-10 Bridge**

Given Data:

Design Flow (Q)	=	[redacted]	cfs
Spillway Width (Wb)	=	[redacted]	ft
Drop Height (Zo-Z1)	=	8.5	ft
Tailwater Depth (Ytw)	=	[redacted]	ft
Spillway Crest Elevation (Zo)	=	[redacted]	ft
Basin Bottom Elevation (Z1 or Z2)	=	[redacted]	ft
Sill Elevation (Z3)	=	[redacted]	ft
Upstream Face Slope (St, H:V)	=	[redacted]	
Downstream Face Slope (Ss, H:V)	=	[redacted]	
Coefficient C1	=	[redacted]	

Solutions:

Critical Flow at Spillway Crest (depth and velocity):

Yc = 0.31433*(Q/Wb)^0.667	=	3.17 ft
Vc = Q/(Wb*Yc)	=	10.09 ft/s

Supercritical Flow of the Hydraulic Jump (depth & velocity):

Q = Y1*Wb*(2g(Zo-Z1+Yc-Y1)+Vc^2)^0.5 (Eq. IV-B-7)

Y1=Q/(Wb(2g(Zo+Yc+Vc^2/2g-Z1-Y1))^0.5) =		1.1460 ft
V1 = Q/(Wb*Y1)	=	27.92 ft/s
Froude Number: Fr1=V1/(gY1)^0.5	=	4.60

Conjugate Flow Depth of the Hydraulic Jump:

Y2 = C1*Y1((1+8*Fr1^2)^0.5 - 1)/2	=	6.90 ft

Drop Structure Lengthes:

Stilling Basin Length Lb	=	40.1 ft
Upstream Face Length Lt = (Zo-Z1)*St	=	8.5 ft
Downstream Face Length Ls = (Z3-Z1)*Ss	=	1.5 ft
Total Drop Structure Length L = Lb+Lt+Ls	=	50.1 ft

Check Tailwater Requirements:

Channel flowline	=	980.00 ft
Tailwater depth Tw	=	5.50 ft
Tailwater per channel hydraulics (WSE3)	=	985.50 ft
Basin bottom elevation	=	978.50 ft
Basin flow depth Y2	=	6.90 ft
Tailwater required for hydraulic jump (WSE2)	=	985.40 ft
Adjustment to Basin Bottom Elevation	=	0.00 ft

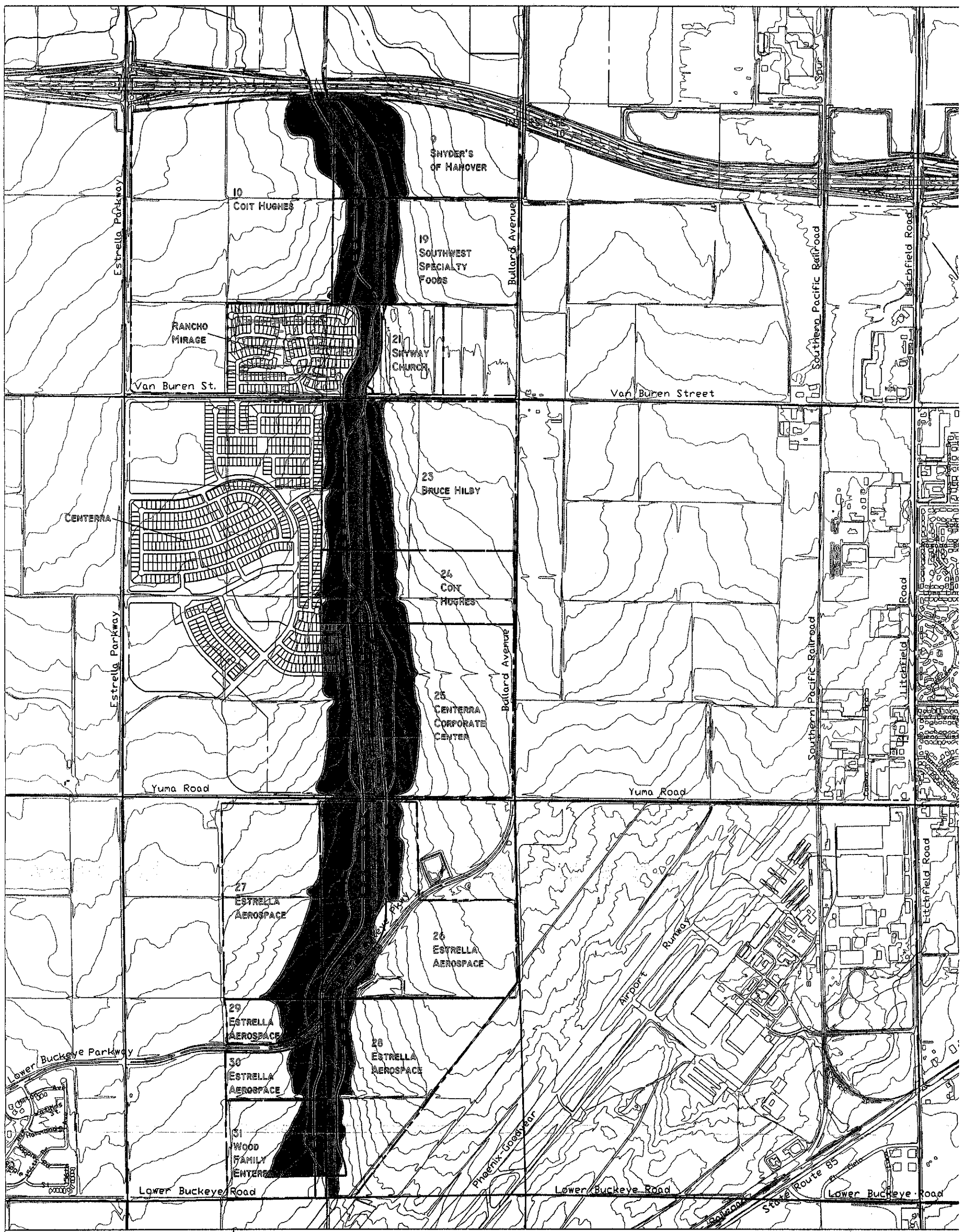
Drop Structure Cost Estimation:

Recommanded Design Parameters:

Basin Bottom Elevation Z1	=	978.5	ft
Top of Bank near Crest (Elevo)	=	991.7	ft
Top of Bank near Basin Pool (Elev1)	=	986.9	ft
Top of Bank near Tailwater Area	=	986.9	ft
Protection Length @ U/S End	=	10	ft
Protection Length @ Crest	=	5	
Protection Length @ D/S End	=	5	ft
Concrete Thickness @ High Velocity Area	=	1	ft
Concrete Thickness @ Low Velocity Area	=	1	ft
Loose Riprap Thickness	=	2	ft
Bank Side Slope (H:V)	=	3	
U/S Cutoff Wall Height (h1)	=	4	ft
U/S Cutoff Wall Thickness (t1)	=	1.00	ft
D/S Cutoff Wall Height (h2)	=	4	ft
D/S Cutoff Wall Thickness (t2)	=	1.00	ft

APPENDIX D

Floodplain and Affected Parcels Exhibit



LEGEND

- PROPERTY BOUNDARY
- CONCEPTUAL CHANNEL ROW
- FLOODPLAIN
- FLOODWAY

N

0 600 1200 2400

Scale in Feet

BULLARD WASH CHANNEL IMPROVEMENTS, PHASE II	FLOODPLAIN & AFFECTED PARCELS

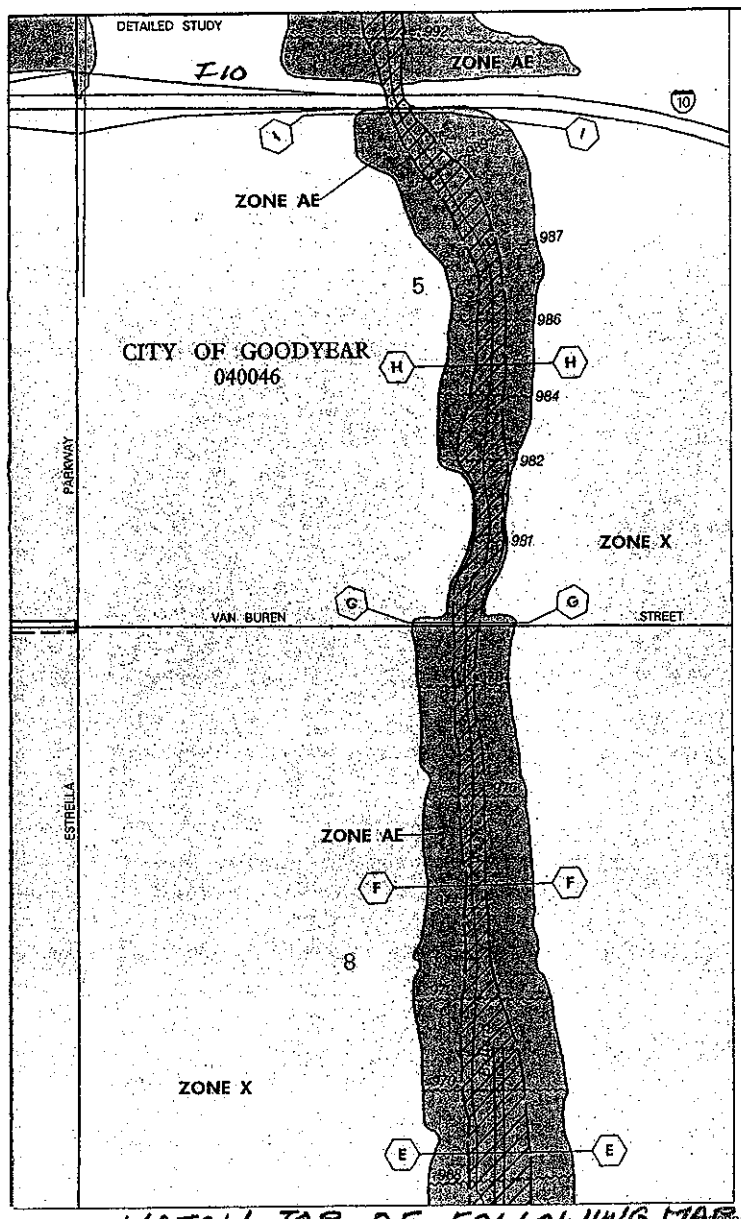
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

	BY	DATE	DRAWING NO.
DESIGNED	JDS	05/02	JDSBASE-043002c2.DWG
DRAWN	RJW	05/02	SHEET OF
CHECKED	-	-	1 1

APPENDIX E

FEMA Flood Insurance Rate Map



MATCH TOP OF FOLLOWING MAP

APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 2060 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

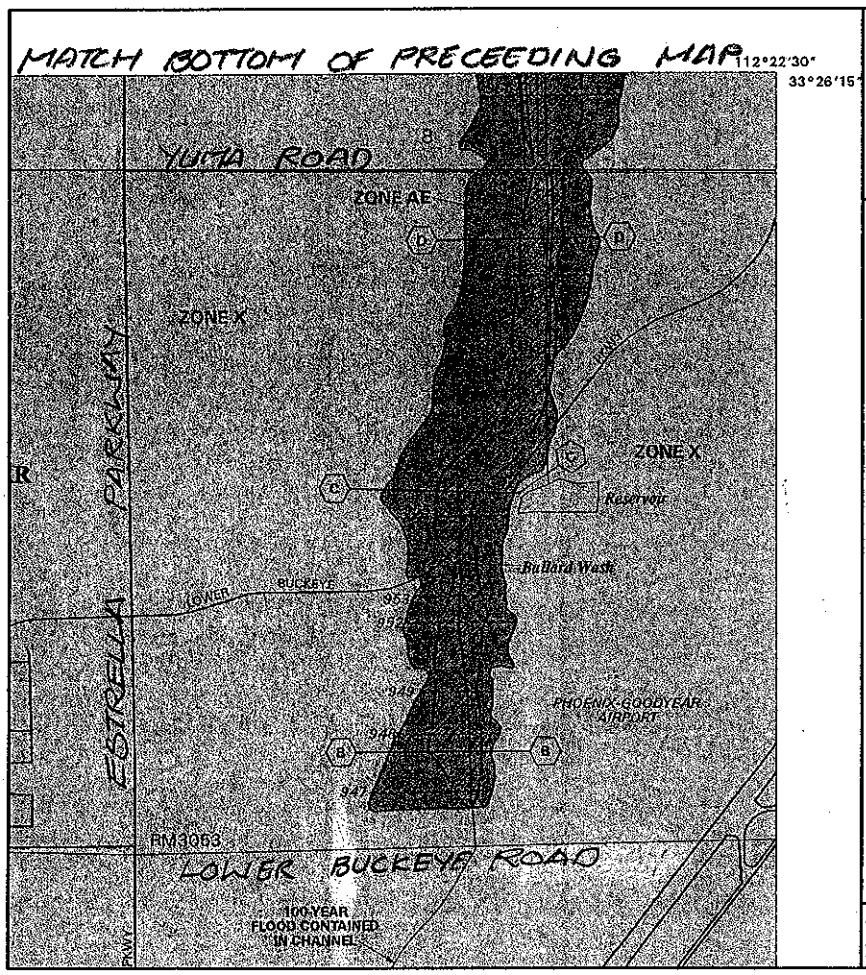
COMMUNITY	NUMBER	PANEL	SUFFIX
GOODYEAR, CITY OF	040046	2060	F
LITCHFIELD PARK, CITY OF	040128	2060	F
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	2060	F

MAP NUMBER
04013C2060 F

MAP REVISED:
JULY 19, 2001

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 2070 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY	NUMBER	PANEL	SUFFIX
GOODYEAR, CITY OF	040046	2070	G
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	2070	G

MAP NUMBER
04013C2070 G

MAP REVISED:
JULY 19, 2001

Federal Emergency Management Agency

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