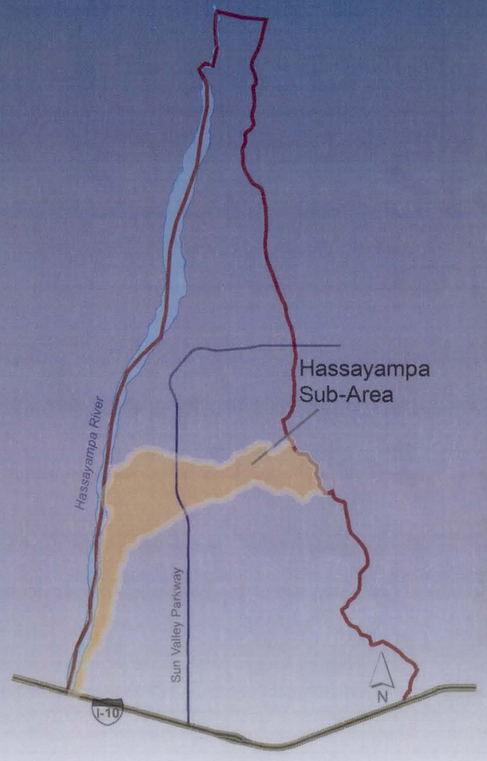
BOOK 16 OF 30

Sun Valley Area Drainage Master Plan



Step 2
Proposed Alternatives Analysis Report

Volume 4 PART 2 OF 3
HASSAYAMPA RIVER SUB-AREA

September 2006

Flood Control District of Maricopa County

A211.217

SUN VALLEY AREA DRAINAGE MASTER PLAN

STEP 2 PROPOSED ALTERNATIVES REPORT
HASSAYAMPA RIVER SUB-AREA
VOLUME 4

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

CL Williams
Consulting Engineers

LOGAN SIMPSON
DESIGN INC.

EDAW

amec

Richard H. French, Ph.D., P.E.

September 2006

TABLE OF CONTENTS

1 ABSTRACT / EXECUTIVE SUMMARY 1

2 INTRODUCTION 2

2.1 Report Organization 2

2.2 Project Background 2

2.3 Authority for Study 4

2.4 Location of Study Area 4

3 ADMP PROCESS 4

3.1 Process Overview 4

3.2 Additional Process Background for Step 2 Alternatives Formulation 6

3.3 Landscape Character Assessment 7

3.4 Stakeholder and Public Involvement 7

4 DESCRIPTION OF ALTERNATIVES 7

4.1 Areawide 8

4.2 Sub-Areas 8

4.3 Piedmont Sub-Areas Alternatives Classification 9

4.3.1 Alternative A 9

4.3.2 Alternative B 10

4.3.3 Alternative C 12

4.3.4 Alternative D 13

5 STEP 2 APPROACH 13

5.1 Data Collection 13

5.1.1 Field Survey Information 13

5.1.2 Mapping 13

5.1.3 Aerial Photographs 13

5.1.4 Existing Culvert Data at Sun Valley Parkway Crossings 13

5.1.5 Sediment Gradations 13

5.2 Process Overview and Summary of Design Criteria 13

5.3 Open Channel Design Considerations 14

5.4 Inline Sedimentation Basin and Drop Structure Design Considerations 15

5.5 On-line Detention Basin Design Considerations 15

5.6 Off-line Detention Basin Design Considerations 17

5.7 Hydrology 18

5.8 Sediment Yield 18

5.9 On-line Detention Basin Analyses 18

5.10 Open Channel Analyses 18

5.10.1 Hydraulics 18

5.10.2 Regime Theory 19

5.10.3 Allowable Velocity 22

5.10.4 Equilibrium Slope 23

5.10.5 Methodology 23

5.10.6 AMAFCA Equation 24

5.10.7 BUREC Equation 24

5.10.8 Bray Equation 25

5.10.9 Henderson Equation 25

5.10.10 Schoklitsch Equation 25

5.10.11 Meyer-Peter, Muller Equation 25

5.10.12 Shields Diagram Method 25

5.10.13 Lane's Tractive Force Method 26

5.10.14 Sediment Transport Capacity 26

5.10.15 Scour and Toe Protection 26

5.11 Off-line Detention Basins 28

6 DESIGN PROCEDURES 28

6.1 Alternative A 28

6.2 Alternative B1 28

6.3 Alternative B2 28

6.4 Alternative B3 29

6.5 Alternative B4 29
6.6 Alternative B5 29
6.7 Alternative C 29
6.8 On-line Basin Design Procedure 30
6.9 Off-line Basin Design Procedure 30
6.10 Leveed Natural Channel Design Procedure 30
6.11 Excavated Earthen Channel Design Procedure 31
6.12 Excavated Concrete Channel Design Procedure 32
7 LANDSCAPE COMPATIBILITY ENHANCEMENTS 33
7.1 Landscape Compatibility Enhancements to Leveed Channel 33
7.2 Landscape Compatibility Enhancements to Excavated Channel 33
7.3 Landscape Compatibility Enhancements to On-line/Off-line Basins 33
7.4 Landscape Compatibility Enhancements to Drop Structures 34
8 HASSAYAMPA RIVER SUB-AREA SPECIFIC DESIGN CONSIDERATIONS 34
9 STEP 2 COST ESTIMATES 34
9.1 Base Cost Estimates 34
9.1.1 Land Cost 35
9.1.2 Construction Cost 35
9.1.3 Landscaping Cost 35
9.1.4 Maintenance Cost 35
9.2 Landscape Compatibility Enhancement Costs 36
10 HASSAYAMPA RIVER SUB-AREA DESIGN SUMMARY 36
10.1 Summary 37
10.2 ALTERNATIVE A - Summary Sheet for Hassayampa River Sub-Area 38
10.2.1 Description for Alternative A 38
10.2.2 Key Features 38
10.2.3 Advantages 38
10.2.4 Disadvantages 38
10.2.5 Opportunities 38
10.3 ALTERNATIVE B2 - Summary Sheet for Hassayampa River Sub-Area 39
10.3.1 Description for Alternative B2 39
10.3.2 Key Features 39
10.3.3 Advantages 39
10.3.4 Disadvantages 39
10.3.5 Opportunities 39
10.4 ALTERNATIVE B3 - Summary Sheet for Hassayampa River Sub-Area 40
10.4.1 Description for Alternative B3 40
10.4.2 Key Features 40
10.4.3 Advantages 40
10.4.4 Disadvantages 40
10.4.5 Opportunities 40
10.5 ALTERNATIVE B4-1 - Summary Sheet for Hassayampa River Sub-Area 41
10.5.1 Description for Alternative B4-1 41
10.5.2 Key Features 41
10.5.3 Advantages 41
10.5.4 Disadvantages 41
10.5.5 Opportunities 41
10.6 ALTERNATIVE B4-2 - Summary Sheet for Hassayampa River Sub-Area 42
10.6.1 Description for Alternative B4-2 42
10.6.2 Key Features 42
10.6.3 Advantages 42
10.6.4 Disadvantages 42
10.6.5 Opportunities 42
10.7 ALTERNATIVE B4-3 - Summary Sheet for Hassayampa River Sub-Area 43
10.7.1 Description for Alternative B4-3 43
10.7.2 Key Features 43

10.7.3 Advantages *43*
10.7.4 Disadvantages *43*
10.7.5 Opportunities *43*
10.8 ALTERNATIVE C - Summary Sheet for Hassayampa River Sub-Area **44**
10.8.1 Description for Alternative C *44*
10.8.2 Key Features *44*
10.8.3 Advantages *44*
10.8.4 Disadvantages *44*
10.8.5 Opportunities *44*
10.9 ALTERNATIVE D - Summary Sheet for Hassayampa River Sub-Area **45**
10.9.1 Description for Alternative D *45*
10.9.2 Key Features *45*
10.9.3 Advantages *45*
10.9.4 Disadvantages *45*
10.9.5 Opportunities *45*
11 ALTERNATIVES EVALUATION **46**
11.1 Evaluation Criteria **46**
11.2 Evaluation Results **47**
11.2.1 Strategy Evaluation *47*
11.2.2 Sub-Area Evaluation *52*
11.2.3 Preliminary Recommended Alternative for Hassayampa River Sub-area *52*
12 RECOMMENDATIONS FOR STEP 3 FOR THE HASSAYAMPA RIVER SUB-AREA **53**
13 SUMMARY **53**
14 REFERENCES **54**

LIST OF FIGURES

Figure 1 Sun Valley Piedmont 1
Figure 2 Skyline Fan 1
Figure 3 Location of Study Area 3
Figure 4 Future developments in the ADMP study area 3
Figure 5 Alternatives development process 4
Figure 6 Aerial view of active portion Fan 36 in the FRS 1 Sub-area dated 1954 5
Figure 7 Fan Area Classification 5
Figure 8 View downstream of Fan 36 (center) and 37 (on right) 6
Figure 9 ADMP Sub-Areas 9
Figure 10 Concept Cross Section for Earthen Leveed Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale) 10
Figure 11 Concept Cross Section for Earthen Leveed Corridor with Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale) 10
Figure 12 Oblique View of Earthen Leveed Corridor with Landscape Compatibility Enhancements (Not to scale) 10
Figure 13 Concept Cross Section for Leveed Corridor with Walls (Alternatives A, B1, B2, B4, B5) (Not to scale) 11
Figure 14 Concept Cross Section for Leveed Corridor with Walls & Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale) 11
Figure 15 Oblique View of Walled Corridor with Landscape Compatibility Enhancements (Not to scale) 11
Figure 16 Concept Cross Section for Earthen Companion Channel (Alternative B3) (Not to scale) 11
Figure 17 Concept Cross Section for Earthen Companion Channel with Landscape Compatibility Enhancements (Alt B3) (Not to scale) 11
Figure 18 Oblique View of Earthen Excavated Companion Channel with Landscape Compatibility Enhancements (Not to scale) 11
Figure 19 Concept Cross Section for Concrete Companion Channel (Alternative C) (Not to scale) 12
Figure 20 Concept Profile View of Leveed Channel Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale) 15
Figure 21 Concept Profile View of Excavated Channel (Alternatives B3 and C) (Not to scale) 15
Figure 22 Concept Plan View of On-line Basins for B Alternatives (Not to scale) 16
Figure 23 Concept Plan View of On-line Basins for B Alternatives with Landscape Compatibility Enhancements (Not to scale) 16
Figure 24 Concept Profile View of On-line Basins (Not to scale) 17
Figure 25 Concept Profile View of On-line Basins with Landscape Compatibility Enhancements (Not to scale) 17
Figure 26 Concept Plan View of Off-line Basins (Not to scale) 17
Figure 27 Concept Plan View of Off-line Basins with Landscape Compatibility Enhancements (Not to scale) 17

Figure 28 Summary Map of Alternative A for the Hassayampa River Sub-Area 38
Figure 29 Summary Map of Alternative B2 for the Hassayampa River Sub-Area....39
Figure 30 Summary Map of Alternative B3 for the Hassayampa River Sub-Area....40
Figure 31 Summary Map of Alternative B4-1 for the Hassayampa River Sub-Area 41
Figure 32 Summary Map of Alternative B4-2 for the Hassayampa River Sub-Area 42
Figure 33 Summary Map of Alternative B4-3 for the Hassayampa River Sub-Area 43
Figure 34 Summary Map of Alternative C for the Hassayampa River Sub-Area....44
Figure 35 Summary Map of Alternative D for the Hassayampa River Sub-Area 45

LIST OF TABLES

Table 1 SVADMP Stakeholders 7
Table 2 Descriptions of Alternatives 9
Table 3 Design Options for Alternatives 12
Table 4 Summary of Design Criteria for Step 2 Alternatives....14
Table 5 Fortier & Scobey Table of Permissible Canal Velocities (ft/s)....22
Table 6 Suggested Maximum Permissible Mean Channel Velocities (USACOE, 1995)....23
Table 7 Corps of Engineers Erosive Velocity Data 23
Table 8 Cost Estimate Categories for Channels....34
Table 9 Summary of Unit Costs....35
Table 10 Base Cost Summary....36
Table 11 Landscape Enhanced Cost Summary....36
Table 12 Walled vs. Earth Levee Cost Comparison 37
Table 13 Step 2 Alternative Evaluation Criteria 46
Table 14 Strategy Selection Matrix 51
Table 15 Alternative Evaluation Matrix by Sub-area (Form)....52
Table 16 Alternative Evaluation Matrix by Sub-area (Function) 52
Table 17 Alternative Evaluation Matrix by Sub-area (Combined)....52

LIST OF APPENDICES

Appendix A: Design Analyses

ENCLOSED DATA CD INCLUDES:

- Digital Copy of Report in PDF Format
- GIS Shapefile Coverages of Project Elements
- Excel Files of Design Analyses
- HEC-1 Model Files

1 ABSTRACT / EXECUTIVE SUMMARY

Structural and non-structural alternatives were developed and evaluated as part of Step 2 of the Sun Valley Area Drainage Master Plan (SVADMP). This is the second of a three step process to develop a drainage master plan for the Sun Valley area. Four flood control alternative strategies were identified in Step 1 of the ADMP process. Those four strategies were further refined in Step 2. The refined alternatives included both non-structural and environmentally friendly, aesthetically compatible structural flood control measures.

In order to achieve this refinement, the area was divided into seven geographic sub-areas based on the type and nature of flooding and the distribution of alluvial fan landforms in the study area. This volume presents the results for one of those sub-areas, the Hassayampa River sub-area. Seven different flood control alternatives were developed and evaluated including apex strategy variations including avoidance, on-line and off-line detention basins, and conveyance. Earthen and concrete excavated channels were also compared with a leveed natural corridor for the downfan conveyance structures. Multiple alignment alternatives were also investigated for four of the six piedmont sub-areas. Non-structural approaches were incorporated wherever possible.

Figure 1 Sun Valley Piedmont

Figure 2 Skyline Fan

Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple alignments was expressed by the project team, stakeholders, and the public for the piedmont sub-areas including the Hassayampa River sub-area (this volume).

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates in Step 3. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

2 INTRODUCTION

2.1 Report Organization

The Step 2 Proposed Alternative Analysis Report is presented in seven (7) volumes. Volume 1 provides an overview of the ADMP, explains the ADMP process and the alternatives analysis, summarizes the Step 2 evaluation and results, and provides recommendations for the Step 3 refinements to the recommended alternative. Volume 1 also provides a discussion of general area-wide flood control issues and potential solutions as well as specific issues and potential solutions for the area north of the Central Arizona Project Canal. The so-called North of CAP sub-area is included in Volume 1 for two reasons: first, the sub-area is not dominated by large alluvial fans like the piedmont sub-areas in the remainder of the study area; second, the recommendations for the North of CAP sub-area are predominantly non-structural in nature.

Volumes 2 through 7 present the proposed alternatives for the piedmont sub-areas as follows:

2) CAP (Volume 2),

3) Wagner Wash (Volume 3),

4) Hassayampa River (this volume),

5) White Tanks Wash (Volume 5),

6) FRS #1 (Volume 6), and

7) FRS #2 & #3 (Volume 7).

The alternatives presented in Volumes 2 though 7 are primarily structural in nature. Therefore, the discussion of design methods, calculations, and results are more involved, and require additional information in their presentation. Volumes 2 through 7 also include site specific data, hydraulic analyses, and cost estimates for each of the proposed alternatives.

It is intended that each Volume of the Step 2 report be able to stand alone so that a reader, such as an interested stakeholder, unfamiliar with the ADMP, or uninterested in other sub-areas, can understand the overall study as well as the details of an individual sub-area of particular interest to them. Excessive detail associated with the design calculations are left out of Volume 1 in order to provide a more digestible document for the reader interested in the Proposed Alternatives Analysis as a whole.

The advantages of this type of report organization are:

- The reduction of reproducible materials required for interested users or stakeholders.
- It provides a condensed overview of the ADMP process and Proposed Alternatives Analyses.
- It narrows the focus to a specific sub-area while still providing an overall comprehensive summary of the Step 2 process and Alternatives descriptions.

2.2 Project Background

The Sun Valley area, located in western Maricopa County, Arizona, is presently experiencing the first stages of accelerated urbanization (Figure 3). Future development is anticipated to occur on the largely undisturbed alluvial fans and piedmont surfaces comprising the western slope of the White Tank Mountains (Figure 4). The upland areas and adjacent watershed drain to the Hassayampa River to the west and the Buckeye Flood Retarding Structure (FRS) Numbers 1, 2, & 3 along Interstate 10 to the south.

The purpose of the SVADMP is to develop a conceptual drainage plan to serve as a roadmap that jurisdictional authorities and developers can use in planning flood control measures to mitigate flood hazards up to the 100-year event. The SVADMP incorporates development plans for the area and jurisdictional drainage policies to develop a preferred regional flood control solution.

The major objectives of the project include the following:

- Plan regional flood hazard mitigation;
- Preparation of approximate alluvial fan floodplain delineations, meeting Federal Emergency Management Agency (FEMA) and Flood Control District of Maricopa County (District) standards, for those alluvial fans in the study area not previously delineated;
- Coordination between the ADMP regional flood control measures and the design of drainage features within the master planned community developments within the study area;
- Preparation of preliminary design of flood control facilities in areas not within master planned communities; and
- Design of landscape aesthetics and visual character in accordance with the District's *Landscape Aesthetics and Multi-Use Consultant Handbook (April 2003).*

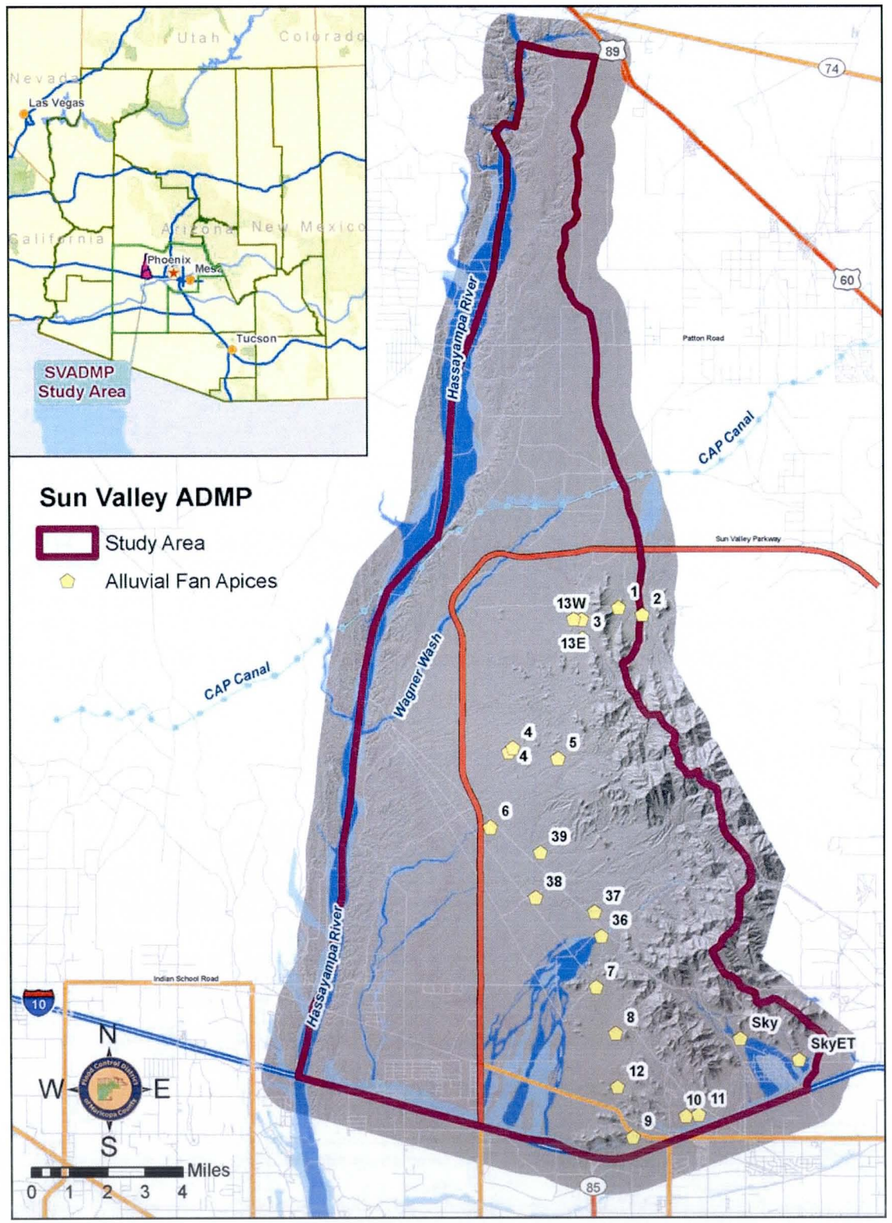


Figure 3 Location of Study Area

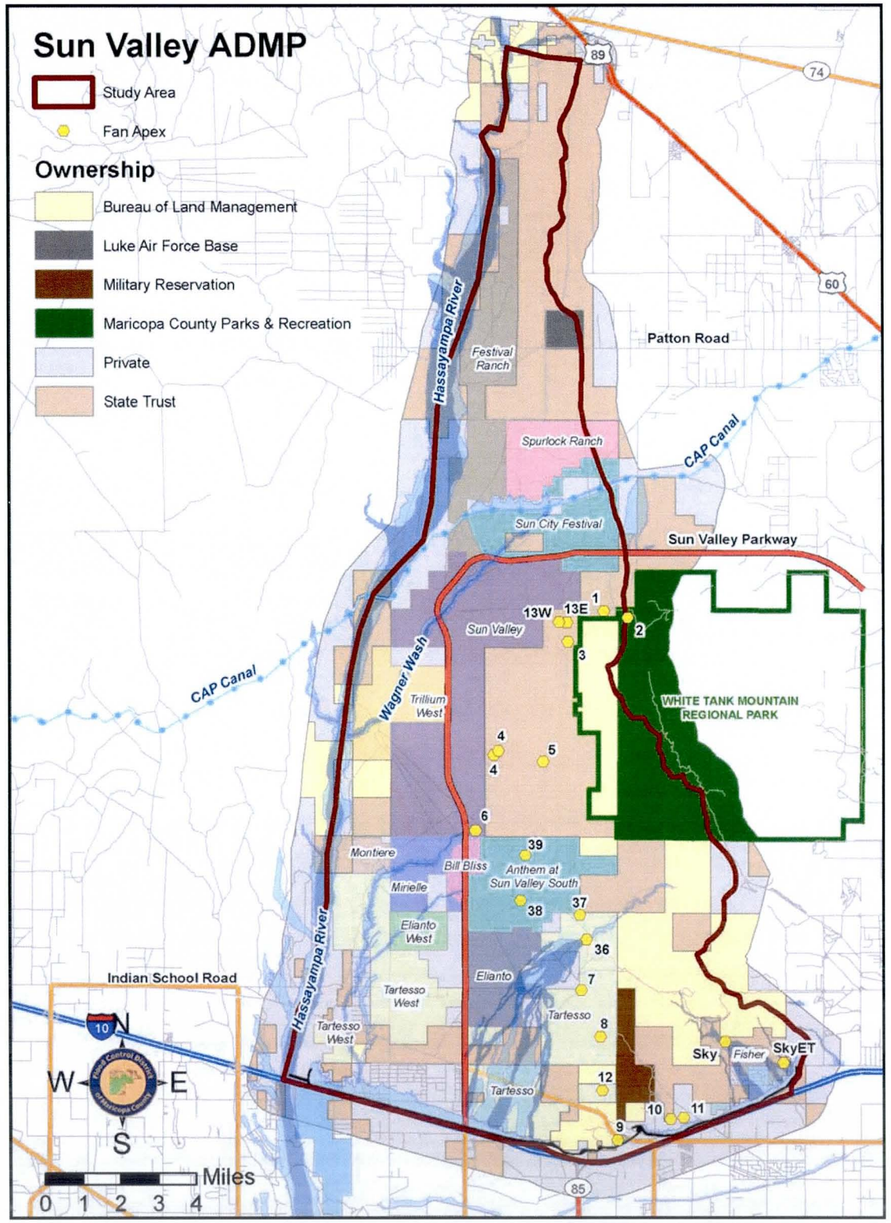


Figure 4 Future developments in the ADMP study area

Previously, the Phase I Buckeye/Sun Valley Area Drainage Master Study (ADMS), conducted by PBS&J, documented and analyzed existing conditions and identified drainage and flooding problems in the study area for the purpose of initial formulation of flood protection alternatives. The Phase II Sun Valley Area Drainage Master Plan builds on the Phase I findings by employing a 3-step process with the goal of developing a Recommended Alternative, consisting of both structural and non-structural measures, to address flood hazards in the study area. Figure 5 shows a flowchart illustrating the SVADMP alternatives development process.

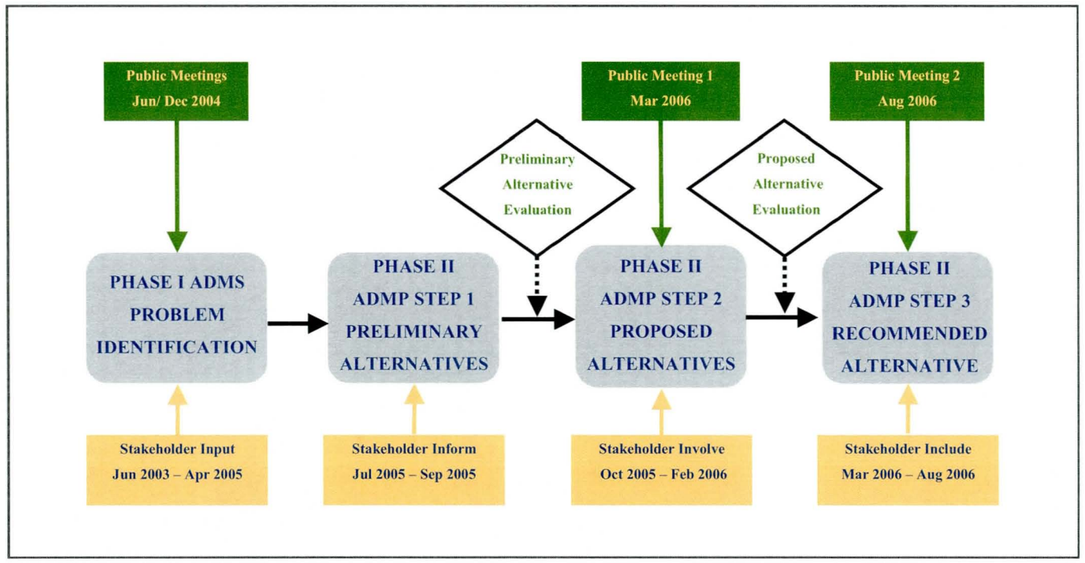


Figure 5 Alternatives development process

This report is part of the Phase II ADMP Step 2 Proposed Alternatives formulation process which focuses on further development of the recommendations of the Step 1 Preliminary Alternatives. The purpose of this study is to evaluate the Step 2 Proposed Alternatives in support of the SVADMP. The Step 2 Proposed Alternatives Report outlines the alternatives development, evaluation, and selection of the Recommended Alternative. The Recommended Alternative will be further evaluated and refined in Step 3 of the ADMP formulation process.

Based upon the recommendations resulting from Step 1, further evaluation of the Preliminary Alternatives was performed at Step 2 to determine engineering feasibility and approximate costs. The Step 1 Preliminary Alternative measures are combined to formulate the conceptual design of regional, whole-fan Step 2 Proposed Alternatives. The concept designs of the Step 2 Proposed Alternatives are presented as part of this study along with cost estimates. The cost estimates include engineering design, major construction items, right-of-way acquisition, major utility relocations, landscape compatibility aesthetic improvements, and maintenance cost for a 50-year design life.

2.3 Authority for Study

The current study was authorized by the Flood Control District of Maricopa County (District) under contract FCD 2004C049 as part of the scope of services for the SVADMP. The Town of Buckeye, Arizona was a project participant. The ADMP was performed by JE Fuller/ Hydrology & Geomorphology, Inc., with subconsultants C.L. Williams Consulting, Inc., Logan Simpson Design, Inc., AMEC Earth & Environmental, EDAW Inc., and Richard H. French, Ph.D., P.E.

2.4 Location of Study Area

The study area is located in western Maricopa County, Arizona and includes a total watershed area of 183 square miles. Figure 3 shows the location of the study area. Most of the study area is located within the Town of Buckeye. The study area is bounded by the White Tank Mountains and Trilby Wash on the east, the Hassayampa River on the west, the Buckeye Flood Retarding Structures on the south and Gates Road to the north. The watercourses within the study area are all tributaries to the Hassayampa River or the Buckeye Flood Retarding Structures, except Fan 2 which is a tributary to Trilby Wash.

3 ADMP Process

3.1 Process Overview

The highly dynamic nature of alluvial fan flooding presents significant challenges for the design of engineered flood control measures. The designed drainage infrastructure must effectively and efficiently convey 100-year discharges without creating unwanted sediment aggradation or degradation. Further complexity is added as flood hazards change in type and severity with geographic position on the fan whether the area of interest is located at the apex, mid-fan, or near the outfall; and if the flood event is less than the 100-year event.

Known problems associated with alluvial fan flooding include spatial uncertainty of the flow distribution, lack of containment within the relatively flat topographic relief laterally across the fan, avulsive movement of defined flow paths, flooding along undefined flow paths, sheet flooding, distributary flow, scour, and landform aggradation (Figure 6). In addition, steep channel slopes between fan apices and fan toes result in high flow velocities with enough energy to move significant volumes of sediment and debris during large floods (Figure 6).

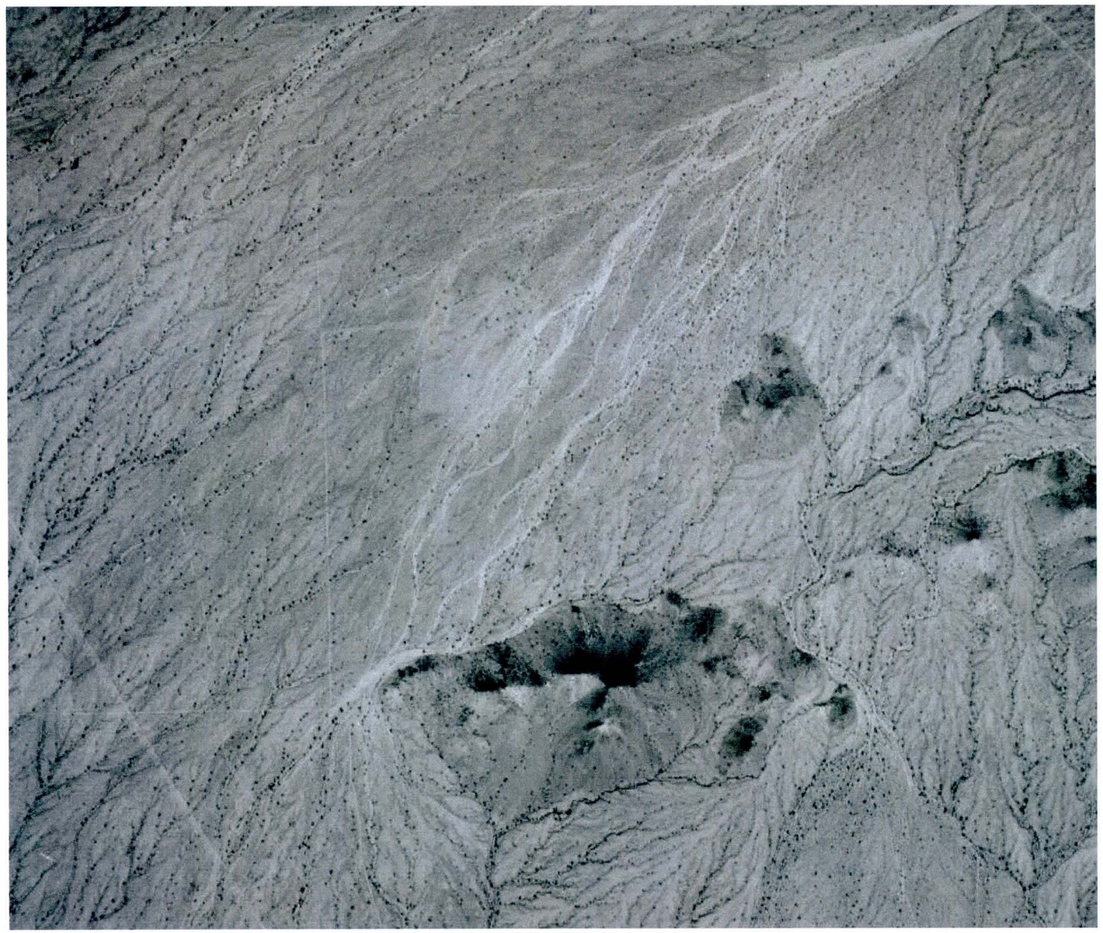


Figure 6 Aerial view of active portion Fan 36 in the FRS 1 Sub-area dated 1954

The Step 1 Preliminary Alternatives Evaluation presented the outline for the alternatives to be analyzed as part of the Step 2 Proposed Alternatives Evaluation. The Step 1 Preliminary Alternatives Evaluation process identified five areas within each fan starting from upstream to downstream: 1) Apex, 2) Up Fan 3) Parkway 4) Down Fan and 5) Outfall (Figure 7). Flooding and drainage characteristics vary for each of these component areas of the alluvial fan landform. This classification permits the design process to identify potential flood control measures specific to each of these areas which, in combination, comprise a whole-fan solution. The whole-fan solution provides a regional flood control system which acts as a major trunk drainage system for the adjacent watersheds. The trunk system is designed to convey runoff and sediment inflows from the apex plus that generated from the fan surface itself. Note that most, but not all, of the alluvial fans considered in this study have all the five component areas (Figure 8). However, the overall design considerations are similar for all the fans.

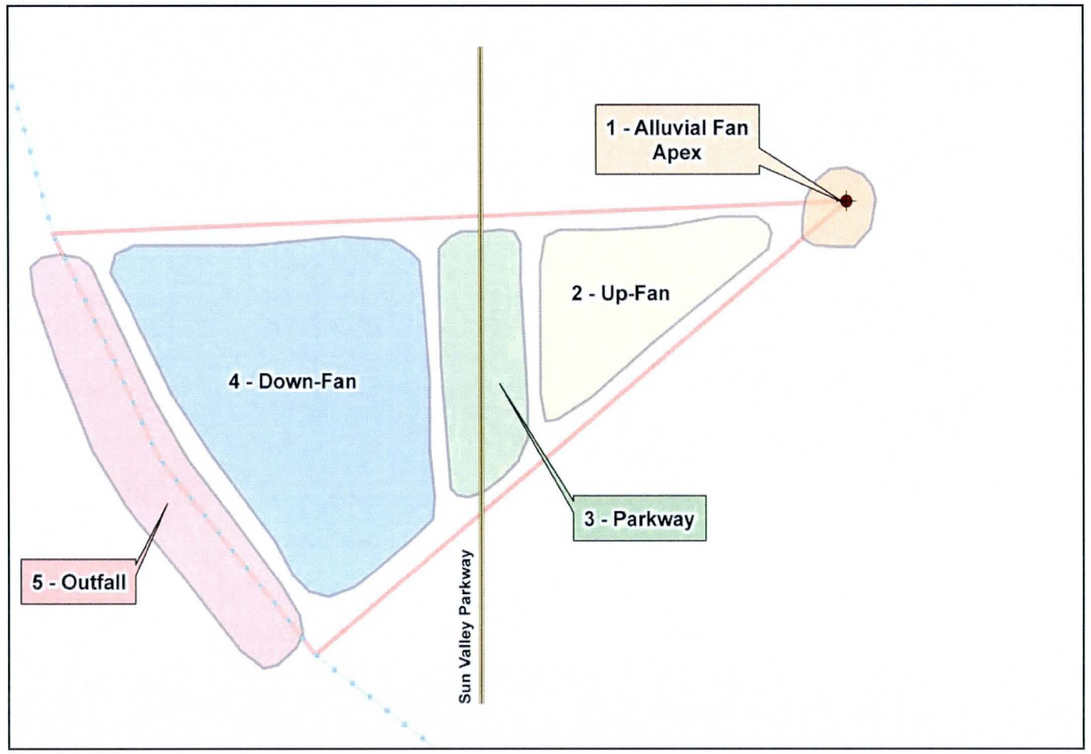


Figure 7 Fan Area Classification

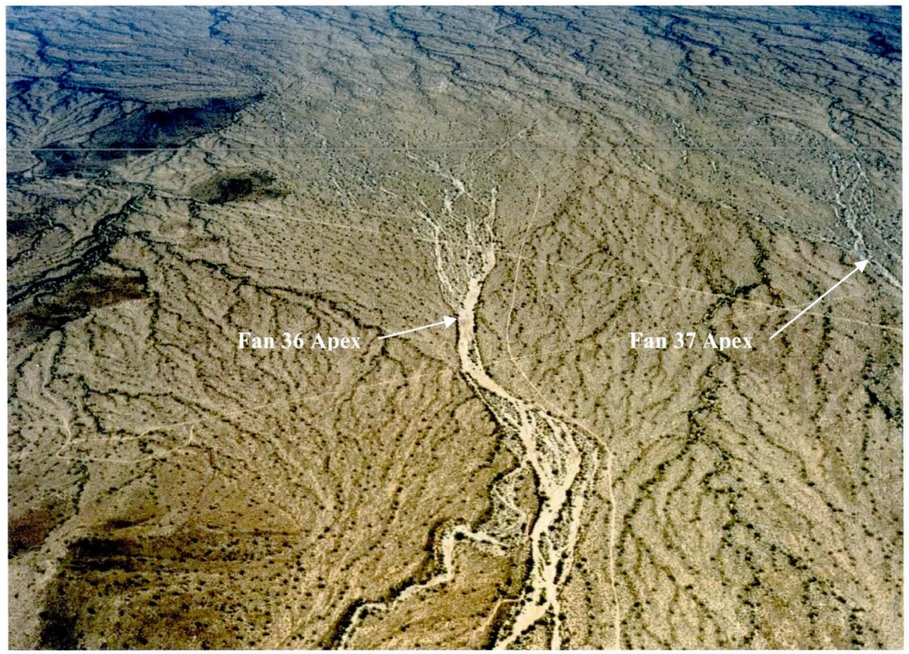


Figure 8 View downstream of Fan 36 (center) and 37 (on right)

The Step 1 process also identified the following design strategies: 1) Conveyance, 2) Storage, 3) Management, and 4) No Measure. These strategies apply to each of the five areas starting from apex to the outfall and form the basis of the Preliminary Alternatives. Four major alternatives were identified based on these strategies: Alternative A, Alternative B, Alternative C, and Alternative D. These four alternatives consist of different combinations of strategies for each of the different areas from apex to outfall. Each alternative can be described as a particular set of strategies applicable to different areas of the fan. In this study, these four alternatives are considered as part of the Step 2 Proposed Alternatives Evaluation process through refinement of the Step 1 concepts.

In order to address alluvial fan flooding hazards in the Sun Valley study area, regional whole-fan alternatives consisting of a suite of structural and non-structural measures will be required. The major structures considered in the Step 2 design approach are detention basins and open channel conveyance corridors. Detention basins reflect the Step 1 Storage strategy, while the channel corridors reflect the Step 1 Conveyance strategy.

Non-structural measures are also considered for the SVADMP alternatives. The Step 1 Management strategy includes development guidelines, floodplain delineation studies, flood detection network recommendations, and/or voluntary flood-prone property acquisition to mitigate impacts to current downstream private landowners and to prevent/mitigate impacts of future development. Management strategies are addressed in the Step 2 Proposed Alternatives Report.

The Step 1 process also defined the No Measure strategy including enforcement of existing regulations and the permitting process, allowing developers to address flood control issues within their parcel footprints in a manner compliant with existing regulations and approved by the District through permitting process. Thus, the No Measure strategy represents a non-structural solution in that no regional flood control solution is a part of this strategy.

The Alternatives A, B, C, and D formulated in the Step 2 process consist of particular combinations of detention basins, conveyance corridors, developer-planned drainage improvements, and 'no measure' options applied to different areas of the alluvial fan starting upstream at the apex to the downstream outfall. The formulation of the alternatives in terms of the specific combinations of structural and non-structural measures selected for the various portions of the alluvial fans are driven by the selection of the measures at the fan apices. For example, Alternative B includes a detention basin located at the fan apex to control flow and sediment discharges to downfan areas. Open channel corridors along multiple alignments contain and convey design discharges through the up-fan area. Off-line detention basins are considered as part of cross and/or lateral drainage improvements at Sun Valley Parkway, outletting through culverts to the down-fan area conveyance corridors to outfall structures.

During the Step 2 process, Alternative B was further subdivided into five similar, but unique alternatives named B1, B2, B3, B4, and B5. This was done primarily to evaluate the following: 1) influence of size of the apex detention basin on the design of the downfan system; 2) different channel cross-section types; and 3) various channel alignments. Further details on each alternative are presented in Section 4.3.

3.2 Additional Process Background for Step 2 Alternatives Formulation

During the initial Step 2 analyses, multiple stakeholder and team meetings were held to discuss the alternatives development. Stakeholders included in the process are listed in Table 1. The stakeholder process included Stakeholder Workgroup meetings as well as numerous individual meetings with stakeholders and the project team. Specific input was received about the potential challenges to direct impacts to existing riparian areas as a result of implementation of the alternatives. In addition, concerns were raised about the scale of proposed facilities. As a result, the so-called 'companion channel' and 'leveed corridor' alternatives were generated for evaluation in Step 2. These alternatives are described further in Section 4.3. Another result of these meetings was to limit detention basin depths to no greater than 11 feet to reduce concerns about relative scale of the basins to neighboring developed features like houses.

Table 1 SVADMP Stakeholders

Meeting No.	Date	Agency	Purpose
1	3/7/2005	MCDOT	Sun Valley Parkway Corridor Study
2	7/14/2005	Fisher/ Williams	Skyline Wash coordination
3	8/10/2005	MCDOT	Sun Valley Parkway Corridor Study and culvert analysis
4	8/16/2005	Agency and Private Sector Stakeholders	Stakeholder Working Group Meeting 1
5	8/25/2005	MCDOT	Sun Valley Parkway Corridor Study
6	8/31/2005	Town of Buckeye	Project coordination, implementation, maintenance
7	9/7/2005	AZ Game & Fish	Project coordination, implementation
8	9/28/2005	CAP	Project coordination, implementation
9	9/30/2005	FRS #1 Sub-area Developers/ Engineers	Project coordination, data collection, implementation
10	10/3/2005	Area 4 N of CAP Sub-area Developers/ Engineers	Project coordination, data collection, implementation
11	10/18/2005	Hassayampa Sub-area Developers/ Engineers	Project coordination, data collection, implementation
12	10/19/2005	Town of Buckeye	Project coordination, implementation, maintenance
13	10/24/2005	ASLD/ Consultant	Project coordination, data collection, implementation
14	11/9/2005	ASLD/ Consultant	Project coordination, data collection, implementation
15	11/9/2005	Town of Buckeye	Project coordination, implementation, maintenance
16	11/22/2005	Fisher/ Williams	Skyline Wash coordination
17	11/29/2005	Public and Private Sector Stakeholders	Stakeholder Working Group Meeting 2
18	12/16/2005	Pulte/CMX	Fan 38 coordination
19	1/26/2006	Developers/ Engineers	Feedback regarding Step 2 alternatives
20	1/26/2006	Town of Buckeye	Project coordination, implementation, maintenance
21	2/8/2006	Town of Buckeye	Project coordination, implementation, maintenance
22	2/9/2006	ASLD/ Consultant	Project coordination, data collection, implementation
23	2/28/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
24	3/8/2005	General Public	Public Meeting 1
25	3/23/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
26	3/23/2006	Lennar/ CVL	Rec Alt coordination, data collection, implementation
27	3/23/2006	Capitol Pacific Homes/ CVL	Rec Alt coordination, data collection, implementation
28	3/28/2006	Stardust/ DEA	Rec Alt coordination, data collection, implementation
29	3/30/2006	Pulte/CMX	Rec Alt coordination, data collection, implementation
30	4/5/2006	Communities Southwest/ WRG	Rec Alt coordination, data collection, implementation
31	4/12/2006	Town of Buckeye	Rec Alt coordination, data collection, implementation
32	4/20/2006	ASLD/ Consultant	Rec Alt coordination, data collection, implementation
33	4/20/2006	MCDOT/ Consultant	Rec Alt coordination, data collection, implementation
34	5/1/2006	Stardust/ DEA	Project coordination

3.3 Landscape Character Assessment

The scope of work for the ADMP specifically states that the alternatives to be developed for the ADMP in Step 2 "are environmentally friendly and blend with the natural landscape of the area following the District's *Policy for the Treatment and Landscape of Flood Control Projects*". The alternatives presented in Section 4.3 all include enhancement elements to ensure that the proposed alternatives meet these objectives. In addition, the cost estimates also include the costs associated with these landscape enhancements.

3.4 Stakeholder and Public Involvement

The District and ADMP project team conducted an extensive stakeholder and public involvement process as part of the ADMP in general, and Step 2 in particular. Numerous group and individual meetings were held with the impacted parties in the area (Table 1). Input was received and two-way communication conducted to ensure clear understanding by the project team and the stakeholders as to the nature of the proposed alternatives and project progress. Ultimately, the close interaction of the project team and stakeholders had a significant impact on the nature and the evaluation of the proposed alternatives for the SVADMP.

4 DESCRIPTION OF ALTERNATIVES

Flood control alternatives for the SVADMP area included both structural and non-structural solutions. Given the landscape compatibility assessment, non-structural solutions are generally preferred whenever possible. However, for the areas impacted by active alluvial fans, the degree, extent, and uncertainties associated with the flood hazards are considered too extreme to make fully non-structural alternatives feasible. Therefore, for the areas impacted by large active alluvial fan flooding, structural measures are central to the proposed flood control alternatives evaluated in Step 2 of the ADMP.

The study area was divided geographically into sub-areas to focus the attention of appropriate structural or non-structural flood control alternatives for each sub-area. The area north of the Central Arizona Project (CAP) Canal is not impacted by large, widespread alluvial fan flooding and was therefore addressed separately. Most of the remainder of the study area south of the CAP is impacted by large active alluvial fans along the White Tank Mountains piedmont. This area south of the CAP was the focus of most of the ADMP alternatives development and evaluation tasks. In addition to the sub-area specific flood control alternatives, be they structural or non-structural, other general flood hazard related issues exist across the study area. These issues are addressed through a category called "areawide" issues.

The following sections describe the structural and non-structural flood control alternatives evaluated in Step 2 of the SVADMP for the Wagner Wash sub-area. The North of CAP sub-area is addressed in Volume 1. Additional details on the other piedmont sub-areas are provided in Volumes 2, 3, and 5-7 of the Step 2 Proposed Alternatives Report.

4.1 Areawide

A number of general, or areawide, flood hazard related issues were identified and addressed in the Step 2 portion of the ADMP. Many apply to the Hassayampa River sub-area. Again, non-structural flood control alternatives are preferred. Therefore, many of the areawide issues are addressed with a non-structural approach. In other cases, areawide issues related to existing or potential future structural flood control measures. The following areawide items were noted:

Piecemeal solutions – Engineers do not recommend piecemeal construction of flood control projects (except for construction phasing) due to potential for conflicts in design and construction practice, inability to tie in to previously constructed sections, and the potential for permanent gaps. Other concerns with piecemeal flood control solutions include reflective scour, flanking of partial systems, first-come, first-serve inequities, landscape aesthetics, timing issues or other unplanned phasing complications, and potential changes in the regulatory environment whether it be FEMA, Section 404 Clean Water Act, or local ordinance changes. Piecemeal flood control solutions apply to any system including floodway fringe encroachments and channelization. Therefore, whenever structural solutions are proposed to address localized flood or erosion problems in the area, special attention should be paid to address the incompatibility concerns arising from piecemeal solutions.

Stock tanks - Stock tanks present several potential challenges and issues for future development in the area. Though stock tanks are structural flood control facilities of a sort, they are rarely engineered and pose a potential hazard in the event of an embankment failure. The failure of a stock tank can create a larger magnitude flood wave than had the tank not been present. Seventeen stock tanks were identified in the area. Thirteen of those are located north of the CAP Canal. As part of the SVADMP, it is therefore recommended that stock tanks be removed whenever possible as an area develops.

Other floodprone areas (i.e. non-fan floodplains) – It should be remembered that while much of the area is dominated by alluvial fans and their associated flood and sedimentation hazards, other locations within the study area are subject to riverine or sheetflooding conditions. It is recommended that floodplain management be the preferred approach to address future development in areas not specifically impacted by the large active alluvial fans in the area.

ADMS Development Guidelines – The Development Guidelines from the Buckeye / Sun Valley ADMS were reviewed as part of the ADMP proposed alternatives development. The review revealed that the suggested guidelines were focused on single lot development and were not especially applicable to master planned community development as they generally promote application of non-structural flood control measures. The SVADMP study area will be almost exclusively developed as a series of large master planned communities many directly impacted by large active alluvial fans. Therefore, the majority of the development guidelines from the ADMS are not recommended for application to the ADMP. However, the Development Guidelines from the Buckeye / Sun Valley ADMS do specifically identify a goal for flood control features for the area that provides a regional solution, controlling the apex of the active alluvial fans and conveyance of flow through the entire fan. The structural solutions in the Step 2 proposed alternatives for the piedmont sub-areas all achieve this objective.

Flood warning – Another areawide flood hazard mitigation measure could be the development of a flood warning system for the area. Instead of, or in addition to, other structural or non-structural flood control measures, flood detection technologies could be deployed in the study area to warn existing and future residents of the forecast or occurrence of severe weather. Recommendations for the placement of flood detection equipment and/or the development of a flood response plan are part of the Step 3 Recommended Alternative for the ADMP. However, a detailed flood response plan is not part of this project.

4.2 Sub-Areas

To aid the Step 2 alternatives development and evaluation beyond the areawide issues, seven sub-areas within the SVADMP study area were identified:

1) North of CAP (Volume 1)
2) CAP (Volume 2),
3) Wagner Wash (Volume 3),
4) Hassayampa River (this volume),
5) White Tank Wash (Volume 5),
6) FRS #1 (Volume 6), and
7) FRS #2 & #3 (Volume 7).

The sub-areas are based on the outfall locations and the fans discharging to a particular outfall location. For example, fans that drain to Wagner Wash are included in the Wagner Wash sub-area. The sub-areas also represent the hydrologic watershed for the particular outfall location. The sub-area boundaries and fan apices are shown in Figure 9.

This report presents the details of the Step 2 Proposed Alternatives for the CAP sub-area. Volume 1 provides an overview of the Step 2 Proposed Alternatives for the entire study area. Additional details for the other five alluvial fan sub-areas south of the CAP Canal are presented in separate companion reports (Step 2, Volumes 2, 3, and 5-7).

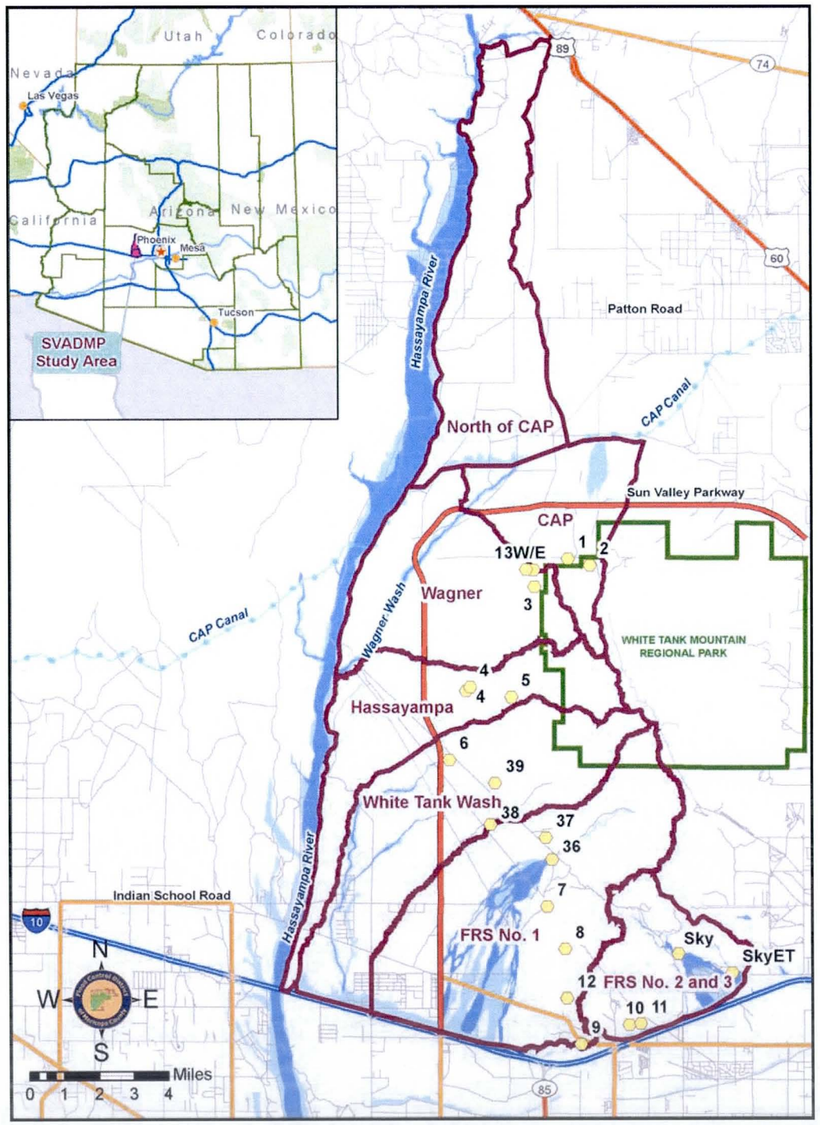


Figure 9 ADMP Sub-Areas

4.3 Piedmont Sub-Areas Alternatives Classification

The Step 1 Preliminary Alternatives Evaluation classified the Alternatives into 4 categories, namely Alternative A, Alternative B, Alternative C, and Alternative D. In this study, the concepts developed during Step 1 process were expanded and refined. Alternative B was further subcategorized into B1, B2, B3, B4, and B5 as listed below. Table 2 provides brief descriptions of the four alternatives.

Table 2 Descriptions of Alternatives

Alternative	Description
A	No measure at apex / Leveed channel section
B1	Big on-line detention basin / Small leveed channel section
B2	Small on-line detention basin / Big leveed channel section
B3	On-line detention basin / Earthen 'companion' channel
B4	On-line detention basin / Leveed channel section along different alignments
B5	Off-line detention basin / Leveed channel section
C	No measure at apex / Concrete 'companion' channel
D	No measure (Whole Fan)

Again, while the flood control alternatives for the active fans in the piedmont sub-areas focused on structural mitigation of the alluvial fan flood and sedimentation hazards, non-structural elements were included wherever possible. In addition, some of the alternatives have greater or lesser degrees of non-structural elements which varies by sub-area. The following sections provide an overview of each of the types of alternatives A-D for the piedmont sub-areas south of the CAP Canal. Additional details for all of the individual piedmont sub-areas are provided in Volumes 2, 3, and 5-7 of the Step 2 Proposed Alternatives Evaluation Report.

4.3.1 Alternative A

The area downstream of the apex represents a region of significant alluvial fan instability. The alluvial fan instability, in turn, results in the uncertainty of flow paths. The region of significant alluvial fan instability can be identified to a reasonable extent. The Step 1 process defines the Alternative A to represent "No Measure" at the apex. The main design objective of this alternative is to allow the natural geomorphic processes to occur within a designated active area downstream of the apex. This provides a largely non-structural approach to the treatment of the alluvial fan hazards near the apex. Downstream of the region of active fan processes, flows will be controlled by structural means; that is, captured via diversion levees/dikes, and collector channels. Once collected, the flows are routed downstream using leveed channel sections, culverts, and detention basins (if needed) until the flows reach the outfalls. In some cases, like Wagner and White Tanks Wash sub-areas, the outfall is a large existing riverine riparian wash

system. In these cases a non-structural, floodplain management approach is inherent to the alternative for these reaches.

The advantage of Alternative A is that it minimizes environmental impacts near the apex by preserving existing natural conditions. The main disadvantage is the cost of land set aside to allow for the natural alluvial fan processes.

4.3.2 Alternative B

Alternative B is based on a structural flood control strategy at the apex. The objective of Alternative B is to capture all of the upstream flow at the apex using on-line detention basins. The presence of a detention basin at the apex eliminates the downstream alluvial fan uncertainties. Once collected into the detention basins, flows are routed downstream using open channels, culverts, and additional detention basins (if needed) until the flows reach the outfalls. Again, for Wagner and White Tank Wash within the study area, a non-structural, floodplain management approach is included in the B alternatives for those sub-areas.

This approach increases channel stability by eliminating flow path uncertainty beginning at the apex. This alternative also offers better management of sedimentation issues by capturing incoming sediment directly into the basin. In addition, the alternative provides a continuous, comprehensive flood control trunk system which minimizes the impacts of phasing of developments in the Sun Valley Area.

Alternative B is classified into further sub-categories based on 1) sizing of structures, 2) different channel cross-section types, and 3) different alignment of channels. Alternatives B1, B2, B3, B4, B5 and C represent different combinations of these sub-categories (See Table 3 for details).

Sizing of Basins

The effect of basin size at the apex is evaluated by comparing the effects of a big excavated basin to that of a smaller basin at the apex. The variation in the sizing of the basin at the apex influences the size of the downstream structures. For example, the smaller upstream basin results in a wider channel immediately downstream. The evaluation of basin size is applied to the fans in the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. Alternatives B1 and B2 represent the big and small basin options and a comparison between these two alternatives was performed to evaluate the effects of basin size on the overall design.

Variations in Channel Cross-sections

Leveed Channel Corridor Section – The existing natural corridor is laterally contained on two sides using a levee. The levee ensures flow containment within the natural corridor while allowing the channel to naturally adjust to the higher discharges resulting from flow concentrations. Figure 10 shows a schematic of the cross-section for the earthen levee natural channel corridor. Walls could be also considered instead of earthen levees to provide flow containment for the natural channel sections. Figure 13 shows the natural channel section with walls as the alternative bank structure. The channels for the A, B1, B2, B4 and B5 alternatives are designed with an earthen leveed natural channel section.

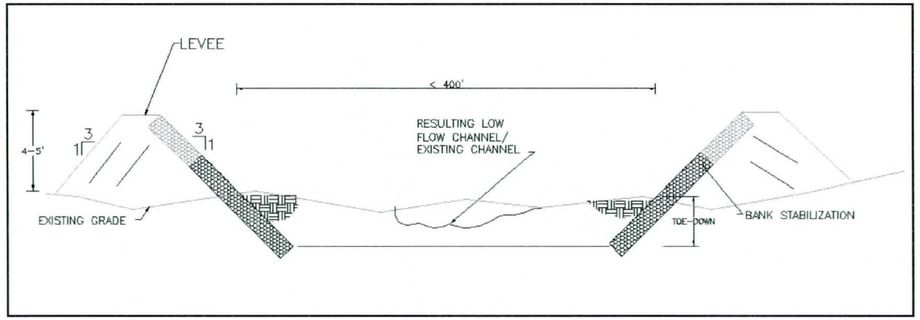


Figure 10 Concept Cross Section for Earthen Leveed Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

Figure 11 Concept Cross Section for Earthen Leveed Corridor with Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

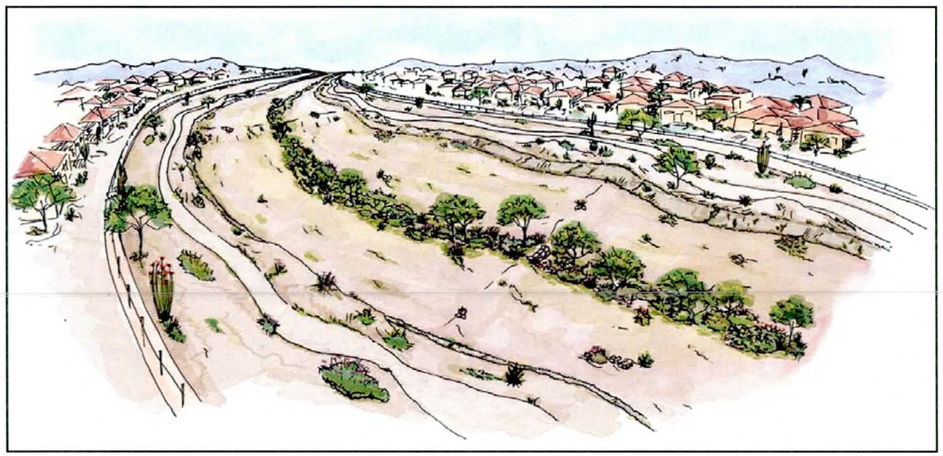


Figure 12 Oblique View of Earthen Leveed Corridor with Landscape Compatibility Enhancements (Not to scale)

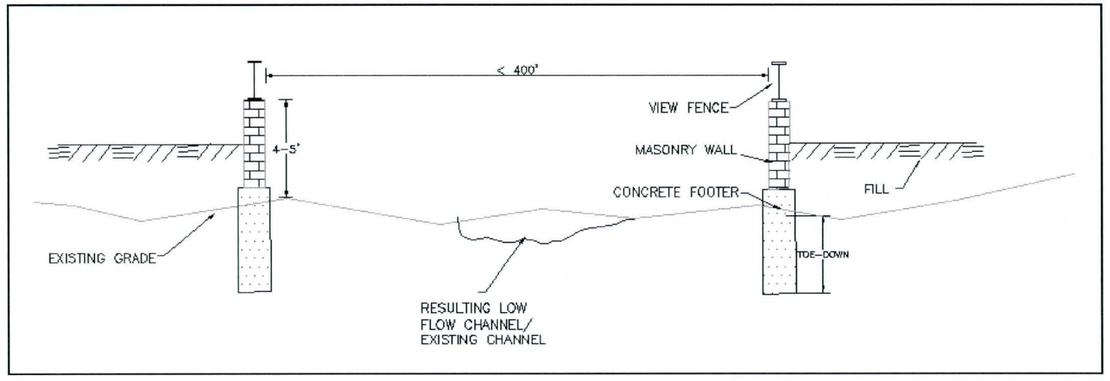


Figure 13 Concept Cross Section for Leveed Corridor with Walls (Alternatives A, B1, B2, B4, B5) (Not to scale)

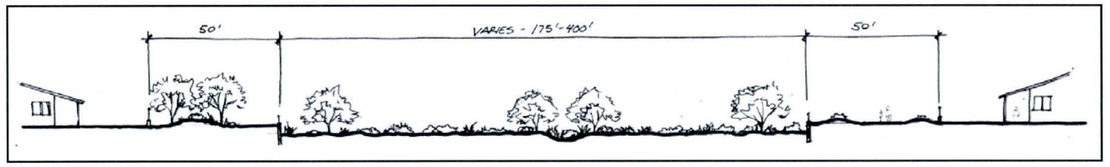


Figure 14 Concept Cross Section for Leveed Corridor with Walls & Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

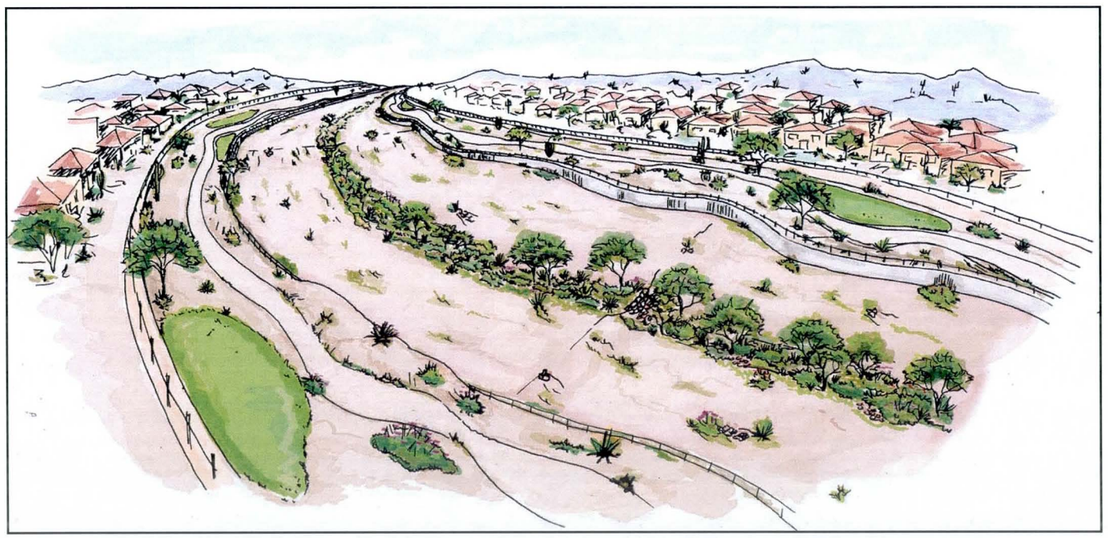


Figure 15 Oblique View of Walled Corridor with Landscape Compatibility Enhancements (Not to scale)

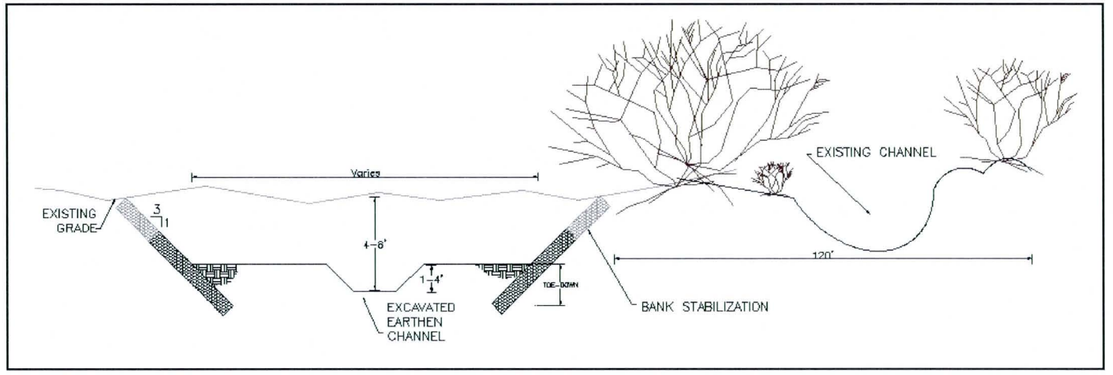


Figure 16 Concept Cross Section for Earthen Companion Channel (Alternative B3) (Not to scale)

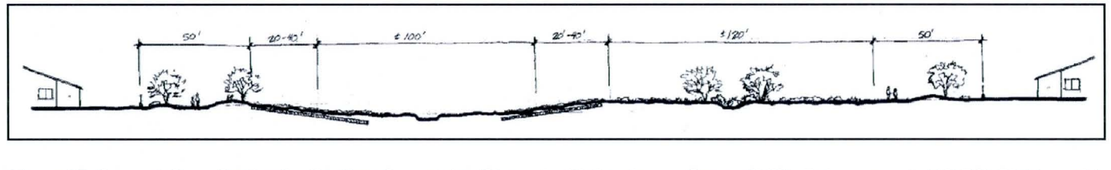


Figure 17 Concept Cross Section for Earthen Companion Channel with Landscape Compatibility Enhancements (Alt B3) (Not to scale)

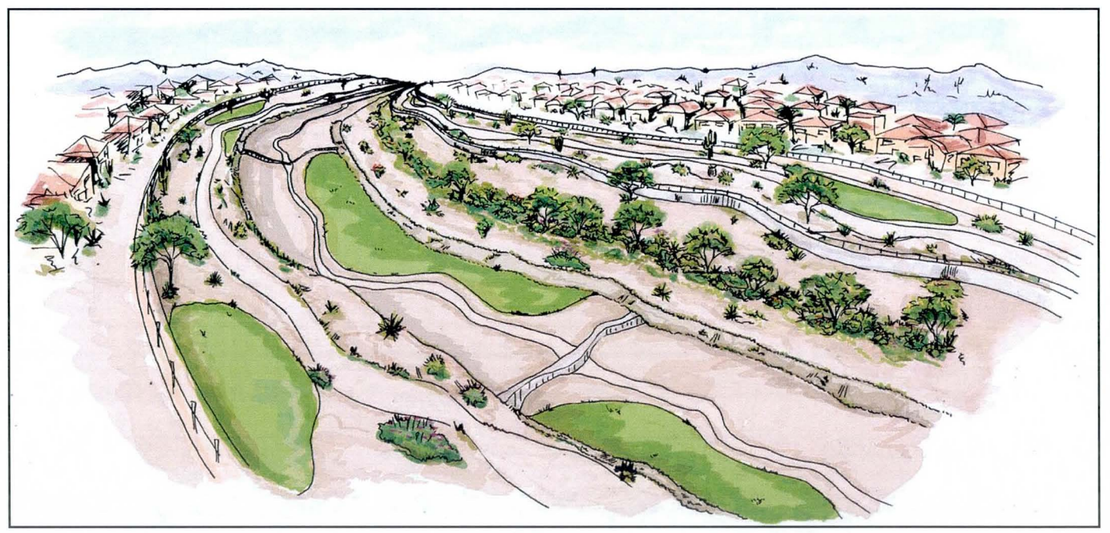


Figure 18 Oblique View of Earthen Excavated Companion Channel with Landscape Compatibility Enhancements (Not to scale)

Earthen Companion Channel – An excavated channel with earthen lining is located adjacent to the existing corridor to convey the flow. The channel is placed adjacent to the existing corridor so that the natural watercourse habitat is not disturbed. Figure 16 shows the concept cross-section for the earthen companion channel. The earthen companion channels are incorporated in Alternative B3.

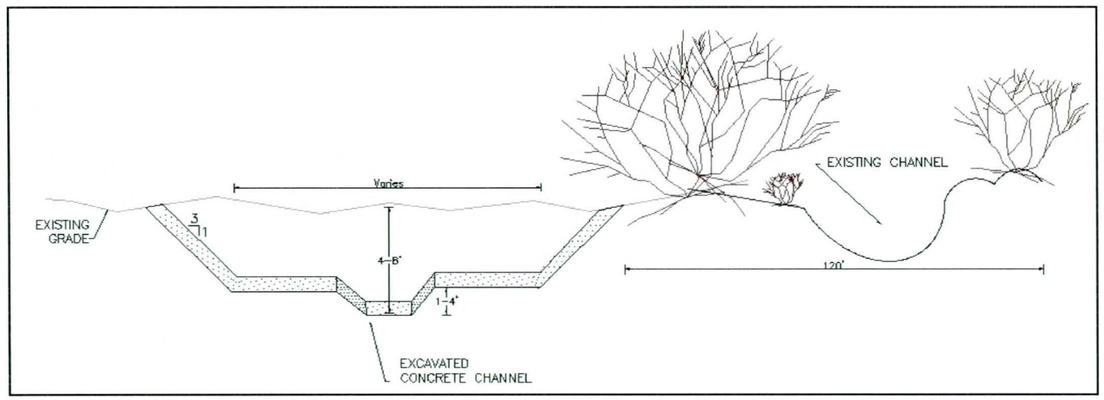


Figure 19 Concept Cross Section for Concrete Companion Channel (Alternative C) (Not to scale)

Concrete Companion Channel – An excavated channel with concrete lining is considered for the Alternative C (See Section 4.3.3. for additional information). Figure 19 shows the concept cross-section for the concrete companion channel.

Variations in Channel Alignments

The choice of the channel alignment can significantly influence the cost of the project. Longer alignments are typically more expensive. The evaluation of the different channel alignments was considered for the following areas:

1) Wagner Wash,

2) Hassayampa River,

3) FRS #1, and

4) FRS #2 & #3.

These sub-areas provide clear possibilities for channel alignment variations. To the contrary, multiple channel alignment were not considered for the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. The evaluation of the variations in channel alignment was considered as Alternative B4 which was subdivided into B4-1, B4-2 and B4-3 to represent three different channel alignment variations. The other design considerations for Alternative B4 are similar to Alternative B1. Table 3 shows the various design options chosen for each piedmont sub-area.

Table 3 Design Options for Alternatives

Subarea	A	B1	B2	B3	B4	B5	C
CAP	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	OB, LVC	BB, EXCCC
Wagner Wash	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
White Tank Wash	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	N/A	BB, EXCCC
Hassayampa River	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #1	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #2 and #3	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC

LVC - Leveed Channel, EXCEC - Excavated Earthen Channel, EXCCC - Excavated Concrete Channel
SA - Sedimentation Area, BB - Big On-line Basin, SB - Small On-line Basin, OB - Small Off-line Basin
Note: CAP and White Tank Wash have only one alignment.

Alternative B5 considers an off-line basin at the apex instead of an on-line basin. The off-line basin is designed to be a small basin with the main purpose of reducing the peak flow approximately by 10%. This alternative is similar to Alternative B2 with the only difference being the off-line basin at the apex instead of an on-line basin. Alternative B5 was considered for CAP sub-area and provides a means for evaluating the effectiveness of an off-line basin at the apex.

4.3.3 Alternative C

Alternative C is a structural flood control alternative based on the concept of an excavated concrete-lined channel from the apex to the outfall (Figure 19). No detention basin is provided at the apex. Sedimentation basins are provided throughout the system. The advantages of Alternative C include reduced land cost due to lack of a detention basin near the apex and smaller channel land areas. The concrete channels are easier to maintain as well. The disadvantages are that the concrete channels are not as aesthetically appealing and are less amenable for multi-use. Another disadvantage is the high cost of construction due to excavation and concrete lining.

4.3.4 *Alternative D*

Alternative D follows the "No Measure" strategy as defined by the Step 1 Preliminary Alternatives Evaluation. This alternative relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies, unintentional system discontinuities, and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

5 STEP 2 APPROACH

5.1 Data Collection

5.1.1 *Field Survey Information*

Refer to the Flood Control District of Maricopa County (District) for field survey information associated with the 10-foot topographic mapping used in the current study.

5.1.2 *Mapping*

The District provided 10-foot contour mapping and DTM data for use in the hydrologic and hydraulic calculations. That work was done under separate contract for the District in 2000/2001. The flight dates of that mapping were 12-16-00, 12-17-00, and 12-27-00. A triangulated irregular network (TIN) was developed in ArcGIS software using the 10-ft topographic contours. The TIN and the contours were used to obtain all the elevation data used in this study.

5.1.3 *Aerial Photographs*

The Flood Control District provided aerial photographs for use in the GIS applications.

5.1.4 *Existing Culvert Data at Sun Valley Parkway Crossings*

The as-builts for the existing culverts at the Sun Valley Parkway were obtained from MCDOT.

5.1.5 *Sediment Gradations*

Sediment gradations used in this study are based on data collected by Coe and Van Loo, Consultants Inc (CVL). These are the only set of sediment gradation data available at the time of preparation of this report. Additional sediment samples are being collected as part of this study and will be included in the Step 3 refinements of the alternatives.

Upon analyzing the CVL data, the following values were selected for the sediment gradation parameters:

D50 = 1mm D16 = 0.5 mm D65 = 0.15 mm

D90 = 5 mm D84 = 3.5 mm

5.2 Process Overview and Summary of Design Criteria

The following sections provide a brief overview of the design procedures for each structure type and each alternative. The alternatives themselves are described in Section 6 and Section 10. The design procedures vary by structure type and alternative. However, there is significant commonality between alternatives. Table 4 shows a summary of the design criteria used for each of the Step 2 alternatives. All structures are designed for the maximum peak flow or volume from the 100-year 6-hour or 24-hour event.

Using the criteria shown in Table 4, the structural elements for each sub-area were designed using the following general approach:

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Identify the set-aside area (A) or design the detention basin (B) near apex location
- Route flow from the apex to Sun Valley Parkway by designing a leveed corridor (A, B1, B2, B4, B5) or excavated channel (B3, C) along the preferred alignment.
- Design an off-line basin upstream of the culvert location at Sun Valley Parkway if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity.

- Route the flows from Sun Valley Parkway to the outfall by designing a leveed corridor or excavated channel along the preferred alignment.
- Prepare cost estimates (see section 9.1) for the land cost, construction cost, landscaping cost, and maintenance cost for the base condition and for the landscape compatibility enhancements.

Sediment is controlled at the apex for all alternatives. For the areas downstream of the alluvial fan apex, sedimentation is controlled in two ways. First, sedimentation basins are provided longitudinally along the channels based on the sediment yield from the contributing area to the design reach. Second, grade control structures are included for the leveed corridors (A, B1, B2, B4, B5) and the excavated earthen channels (B3). All earth bottom corridors also include bank and toe protection from scour.

Table 4 Summary of Design Criteria for Step 2 Alternatives

Alternative	Apex Treatment	Basin Geometry Criteria	Downstream Channel	Hydraulic Criteria
A	Active Area Set-aside	N/A	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B1	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B2	On-line Basin; 90% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B3	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	excavated earthen channel	≈ regime w, d, v
B4	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B5	Off-line Basin; 90% bypass flow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
C	Sediment Basin Only	N/A	excavated concrete channel	Fr < 0.86; 2-year < 2 ft or 5 ft/s

Note: All channels include longitudinal sediment basins based on sediment yield from contributing area.

Additional details regarding the design considerations associated with each structural element are discussed briefly in the following sections with additional details also provided in Sections 6, 7, and 8.

5.3 Open Channel Design Considerations

Open channels are used for the "conveyance" strategy as recommended by the Step 1 Preliminary Alternatives process. The channels are aligned along existing natural watercourse corridors in order to preserve the existing natural habitat. Most of the alternatives use the existing channel contained within the earthen levees for conveyance. The exceptions to this are the two alternatives where channel excavation is considered. These are the Alternative B3 (Earthen excavated channel) and Alternative C (Concrete excavated channel) which are located approximately parallel and adjacent to the natural corridor. In these cases, a portion of the flows in the excavation channel may have to be diverted into the existing watercourse corridor to preserve the natural habitat.

The channel types are classified into 1) Leveed channel corridor, 2) Excavated channel, and 3) Existing channel. The leveed channel corridor uses the existing watercourse corridor with levees on both sides to contain the flow. The excavated channel can have an earthen or concrete lining and is designed to be excavated below existing ground. The existing channel is any existing channel that is used as part of the design alternative.

The channels are designed to act as a regional flood control trunk system and are sized to convey local drainage as well as sediment from the adjacent watershed area. As part of the Step 2 design process, four discharge values are analyzed to ensure the applicability of the design to a range of flows. The four flows are simply ratios of the 100-year peak flows: 10%, 25%, 75% and 100%. The 10% flow can be expected to approximately represent the 2-year flow, the 25% represent the 10-year flow, and 75% represent the 50-year flow.

Per the District's Hydraulics Manual, minimum freeboard for the open channel is set as the greater of 1 foot and 0.25 ($y + V^2/2g$). For channels with levees, the FEMA freeboard requirement of 3 feet is applied for the concept designs.

Excavated channels are designed for subcritical flow with Froude numbers less than 0.86. Subcritical design results in flows with lower velocity and are favorable from public safety point of view. The design slopes are flatter than the existing slopes to achieve the subcritical flow.

Velocity in the leveed channel corridors is designed to be 4 to 6 ft/sec. This velocity range is expected to adequately move sediment downstream without being so large as to cause excessive erosion. The width of the leveed natural channel is also restricted to 400 ft. Flow depth in the leveed channel is restricted to 1-2 ft unless the velocity and/or width requirement could not be met simultaneously.

A side slope of 3H:1V is assumed for both the main channel as well as the low flow channel for the base design.

5.4 Inline Sedimentation Basin and Drop Structure Design Considerations

Drop structures and inline sedimentation basins are included to control sedimentation issues. The on-line detention basins collect both sediment and flow volume while the off-line basins collect only the flow volume. As a result, the on-line detention basins also function as sedimentation traps near the fan apices. Inline sedimentation basins are placed within the channels acting as sediment traps to collect any additional sediment influx exceeding the capacity of the designed channel. Excessive sediment influx is possible at all the tributary confluences as well as at confluences of any other inflow that may occur in the future. Sediment yield from the upstream reach as well as adjacent watershed provides estimates of sediments entering the channels and is used to size the inline sedimentation basins. Sedimentation basins/traps are distributed along the reach to avoid serious sedimentation problems at any specific location.

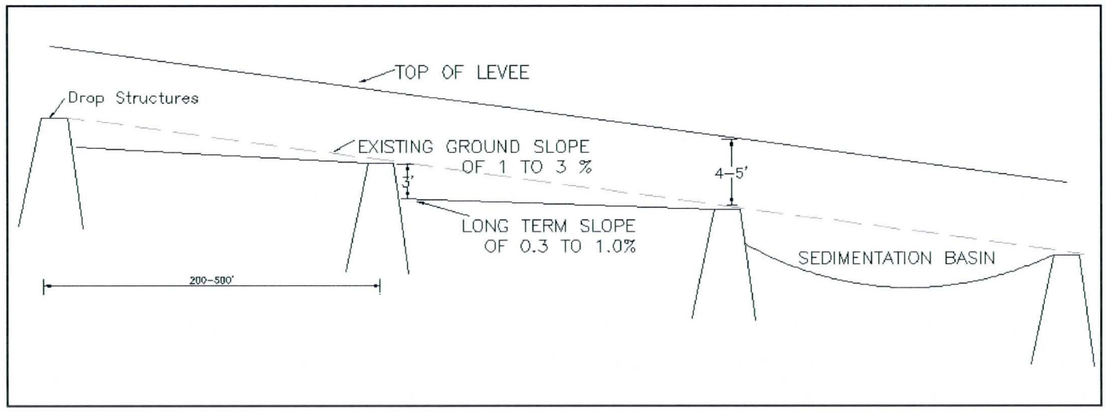


Figure 20 Concept Profile View of Leveed Channel Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

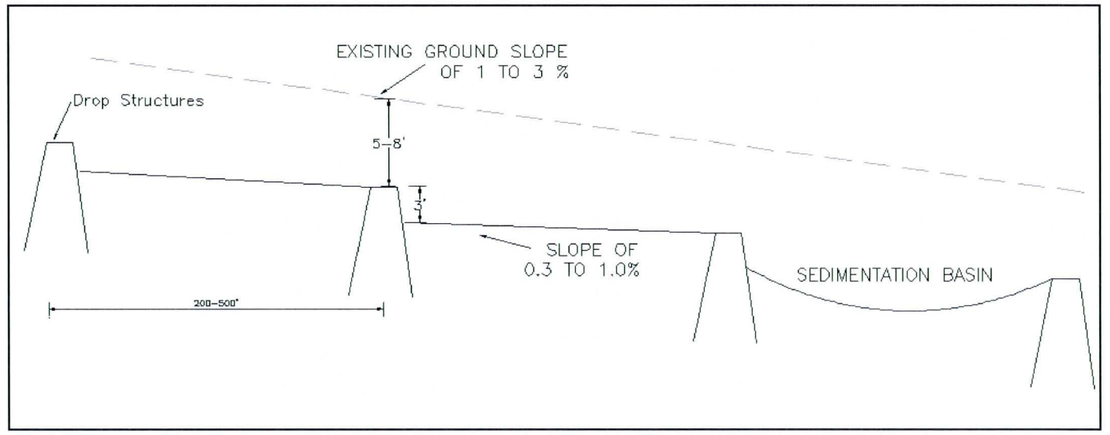


Figure 21 Concept Profile View of Excavated Channel (Alternatives B3 and C) (Not to scale)

The drop structures are designed to be 3 feet high and are spaced accordingly. The 3-foot drop provides a reasonable height from a multiple-use point of view. For the purpose of comparing alternatives considered in the Step 2 process, grade control structures for all alternatives except the concrete excavated channel were assumed to be made of riprap. The riprap is assumed to be buried. The number of drop structures was determined by using the difference between the existing slope and the design slope for excavated channels or anticipated long-term slope for the leveed corridors. The drop structures were spaced to achieve the elevation difference caused by the difference between the existing slope and the design or long-term slope. Figure 20 shows the concept profile view of the leveed channel corridor which is part of A, B1, B2, and B5 alternatives. Figure 21 shows the concept profile view of the excavated channel which is part of the B3 and C alternatives.

5.5 On-line Detention Basin Design Considerations

The on-line detention basins are located mostly at the apices to control the flow and sediment arriving at the fan apices. The basin volume is provided entirely through excavation and is designed to be entirely below existing ground. Raised embankments are not used to provide basin storage volume. Rectangular basins with constant side slopes are considered for the purpose of the base design analyses and sizing. In reality, these would be shaped differently to better fit into the natural setting depending on landscaping and other requirements. The adjustments and cost estimates for these landscape compatibility enhancements are described in Section 9.2. The rectangular basins provide an approximate idea of the required size of basin in terms of storage volume and the minimum land footprint needed to obtain that volume. Figure 22 shows the concept plan view of the on-line basins and Figure 24 shows the concept profile view. Figure 23 and Figure 25 show the basins with on-line landscape compatibility enhancements.

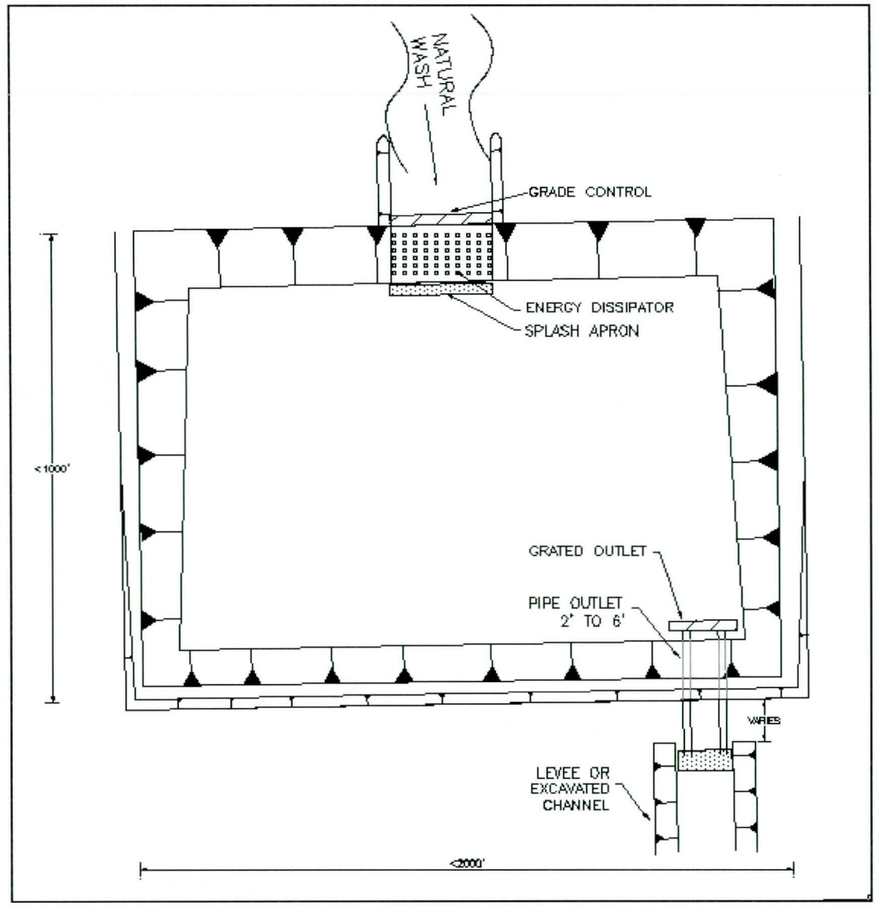


Figure 22 Concept Plan View of On-line Basins for B Alternatives (Not to scale)

Figure 23 Concept Plan View of On-line Basins for B Alternatives with Landscape Compatibility Enhancements (Not to scale)

The big basin option is designed to have a peak outflow of approximately 10% of the peak 100-year design inflow, representing approximately the 2-year flow. The small basin option is designed to have a peak outflow of approximately 90 % of the peak 100-year design inflow.

Pipe outlets are designed to drain the basins. Multiple pipes are needed when the basins are small compared to the total flow volume entering the basins. Appropriate hydraulic equations are used to determine the stage–discharge relationships. Sediment yield from the upstream watershed is used to estimate inflowing sediment volume.

The existing topographic slope was determined from the 10-ft topographic mapping contours. The existing slopes near the apices are approximately 2-3%. These steep slopes result in considerable elevation differences between the upstream and downstream ends of the basins. Basins are designed to have longer dimensions perpendicular to flow direction to minimize the cut-slope exposure on the upstream side of the basins. This gives a minimum basin dimension along the topographic slope and reduces the visual impact of the basins.

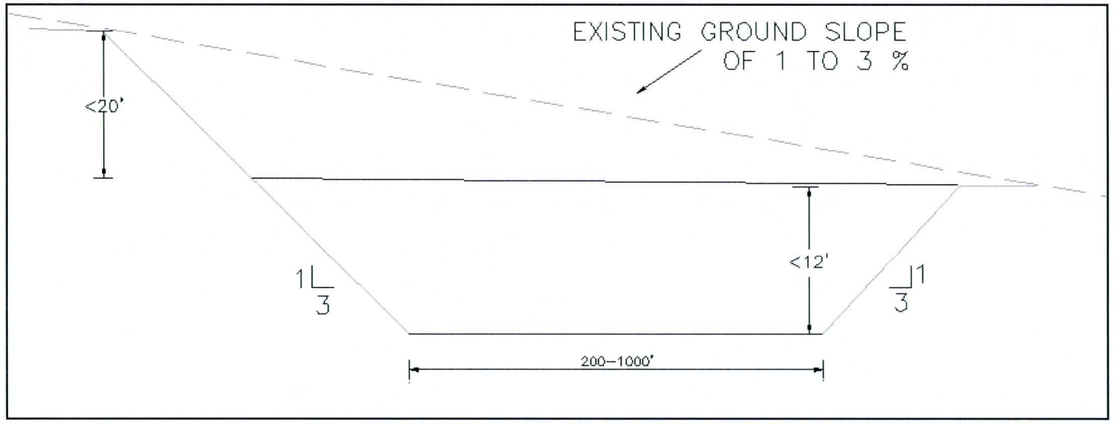


Figure 24 Concept Profile View of On-line Basins (Not to scale)

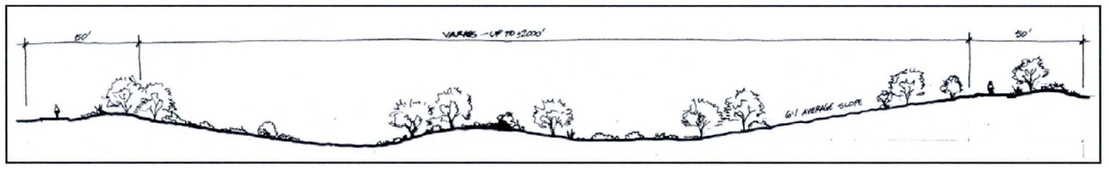


Figure 25 Concept Profile View of On-line Basins with Landscape Compatibility Enhancements (Not to scale)

The basins are designed to be up to 12 feet in depth. This depth includes a freeboard of 1 ft. An initial side slope of 3H:1V is assumed for the base design. Shallower side slopes are included in the landscape compatibility enhancements.

5.6 Off-line Detention Basin Design Considerations

Off-line detention basins are provided in locations where there is a need to reduce peak flows. These locations include: a) upstream of culverts to reduce flow to culvert hydraulic capacity, b) tributary confluences, and c) at the downstream end at outfall locations. Most of these basins will be located downstream of the apices except for Alternative B5 where an off-line basin is located near the apex.

The flow from the open channel will enter the off-line detention basins via a weir. Figure 26 shows the concept plan view of the off-line basins. Figure 27 shows the off-line basin with landscape compatibility enhancements. The Step 2 design process estimated the volume to be diverted using an inflow-outflow diversion relationship. The weirs were not sized in the Step 2 design process.

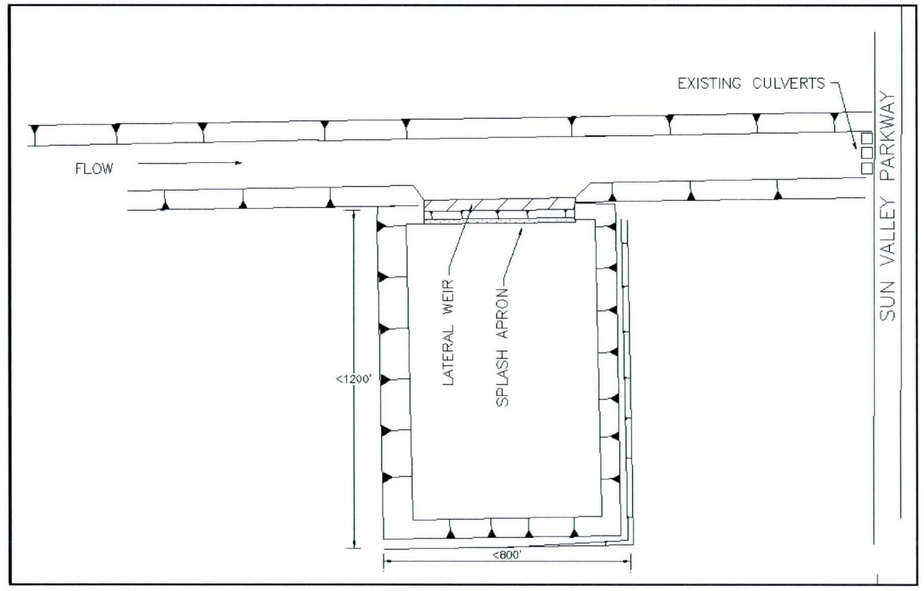


Figure 26 Concept Plan View of Off-line Basins (Not to scale)

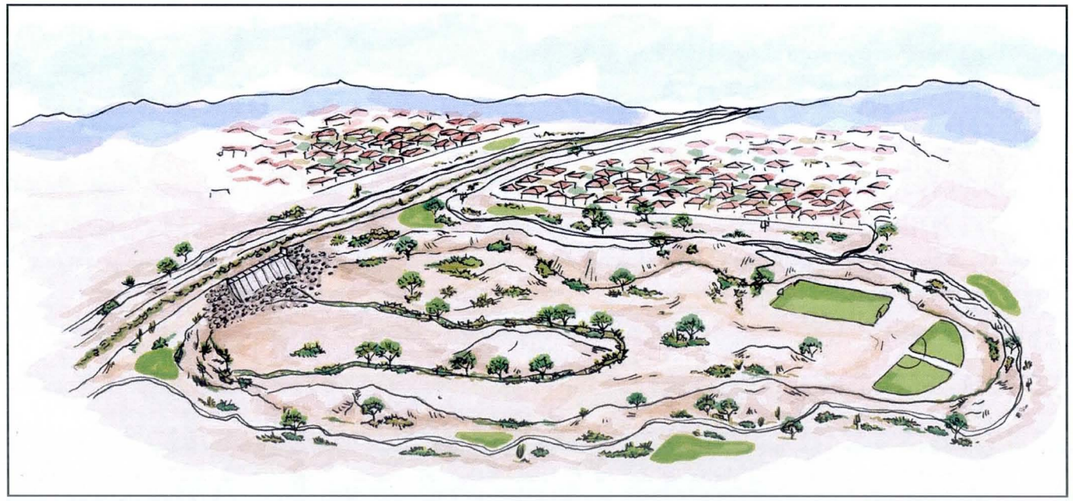


Figure 27 Concept Plan View of Off-line Basins with Landscape Compatibility Enhancements (Not to scale)

5.7 Hydrology

The design of the open channels as well as the detention basins are based on the 100-year peak discharges. HEC-1 modeling is used to determine the peak discharges as well as the flow volume passing through the designed structures. The existing conditions hydrology model is used for the estimation of the peak discharges used in the design. The flows computed from existing conditions model are higher than the future conditions model due to retention requirements. Thus, using the flows computed from the existing conditions model represents a more conservative design approach. In addition, the phasing of the developments is unknown. As a result, it is prudent to be conservative and use the existing conditions hydrology to ensure effective continuous functioning of the flood control system.

A separate HEC-1 model was developed for each sub-area for the 100-year 24-hour and 100-year 6-hour storms for each alternative. For the purpose of the design, the maximum of the values obtained from the 24-hour and 6-hour results were used to ensure adequate functionality under 6-hour and 24-hour storm scenarios. This means that the design analyses sometimes use the 6 hour value and vice-versa depending on whichever is larger.

The procedure to estimate peak flow and flow volume was iterative in nature: The iteration steps can be briefly described as follows:

- Change in structure dimensions affect HEC-1 model
- Change in HEC-1 model affects discharges/volumes
- Change in discharges affect structure dimensions

The HEC-1 models used here are based on the Area 3 HEC-1 model by PBS&J (2005) and Area 4 HEC-1 model by JE Fuller/Hydrology & Geomorphology, Inc (2005). The HEC-1 models were not refined at Step 2 to provide design peak flows at every location for all the design elements. Long open channel sections were treated as a single routing in HEC-1. In addition, some of the subbasins are large providing only a single downstream concentration point. In such situations, the design discharges and volumes were estimated using an area-ratio between the actual area affecting the design element and the entire subbasin modeled in HEC-1. This simplified procedure facilitates a more refined design of multiple channel segments within a large subbasin without the need for refining the HEC-1 model. Future HEC-1 model modifications at Step 3 will address the need for additional concentration points to generate peak flow data for concept design refinements.

5.8 Sediment Yield

Sediment contributions from the watershed adjacent to the design element were estimated using sediment yield. The sediment yield was estimated assuming a 3-year maintenance period plus a single 100-year event. An annual sediment yield of 0.3 ac-ft/sq. mi./year and a 100-year event sediment yield of 1 ac-ft/sq. mi. was assumed for this purpose. These values were derived based on examination of numerous previous studies conducted throughout Maricopa County. The total sediment volume was estimated as the sum of 3 average years' sediment volume and one 100-year event volume. The estimation of the contributing watershed area is performed using GIS. The sediment volume entering a particular design element was then estimated using the sediment contributing area and the sediment yield estimates.

5.9 On-line Detention Basin Analyses

The design considerations for the on-line detention basins are described in detail in Section 5.5. The analyses use rectangular basins with constant side slopes (3H:1V). The sediment yield estimates were used to estimate incoming sediment volume. One foot of freeboard was applied to accommodate the flow volume as well as the sediment volume. A stage-storage-discharge relationship was calculated and this relationship entered into the HEC-1 model using SE-SV-SQ records. The stage-storage relationship was determined from the basin design dimensions. The stage-discharge relationship was determined from pipe outlet equations. The HEC-1 model was then run to estimate the peak volume stored in the basin. The basin dimensions were then resized to hold this maximum volume at peak flow as predicted by HEC-1. In addition, the designed basin depth should be larger than the peak stage as predicted by HEC-1. The estimated sediment yield was added to the depth required to evaluate the adequacy of the basin design. The process was repeated in an iterative fashion until a satisfactory design was achieved.

5.10 Open Channel Analyses

5.10.1 Hydraulics

The hydraulic analyses for open channel design were performed using Manning's equation (normal-depth assumption). An 8-point cross-section is used to represent the channel cross-section dimensions. A Manning's n-value of 0.045 was used for all the alternatives except Alternative C where the designed channel has concrete lining. In places where the existing channel is used, analyses were performed to ensure adequate conveyance and freeboard for the estimated flows entering the channels.

It is anticipated that the leveed conveyance corridors, a low-flow channel will form between the levees in the long term. The low-flow channel dimensions were estimated using regime theory described in Section 5.10.2. Calculations were also performed to evaluate the hydraulic conditions expected to occur after the leveed corridor develops a low-flow channel. The earthen excavated channels (Alternative B3) were also sized to approximate the estimated regime dimensions.

5.10.2 Regime Theory

Regime theory was used to arrive at approximate estimates of gross dimensions as a function of discharge, d50 etc. The regime theory was specifically used to estimate the dimensions of the low-flow channel. The low-flow channel is expected to form in the long-term for the leveed corridors over time.

In addition, regime theory was used to design the main channel as well as the low-flow channels for the excavated earthen channels (Alternative B3). The main parameters evaluated by the regime theory are: width, depth, and velocity. The design approach aims to match the regime value estimates approximately and does not match all three parameters exactly. The values estimated by regime theory were used as guidance/starting point for the design dimensions and are interpreted as the dimension the channel wants to be or will evolve into in the long-term. The main goal is to not deviate too much from regime theory wherever possible.

Following procedures are considered to estimate the Regime Theory:

- Bray - Equation #1
- Bray - Equation #2
- Hey
- Ackers & Charlton/Lacey
- Parker
- Chang
- Kellerhals
- AMAFCA/Schumm
- Moody & Odem
- BUREC

Bray Equation #1. Bray (1979) developed equations for the geometry of alluvial gravel-bed rivers based the 2-year discharge.

$$W = 2.38\ Q_2^{0.527}$$

$$d = 0.266\ Q_2^{0.33}$$

$$V_m = 8.0\ d^{0.6}\ S_o^{0.29}$$

Where:

W = surface flow width (ft.)

Q_2 = 2-year discharge (cfs.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Bray Equation #2. Bray later modified his channel geometry relationships (Hey et. al., 1982) for gravel-bed rivers to include bankfull discharge and the bed material size.

$$W = 2.08\ Q_{bf}^{0.528}\ D_{50}^{-0.07}$$

$$d = 0.256\ Q_{bf}^{0.331}\ D_{50}^{-0.025}$$

$$V_m = 1.87\ Q_{bf}^{0.14}\ D_{50}^{0.095}$$

$$S_o = 0.0965\ Q_{bf}^{-0.334}\ D_{50}^{0.586}$$

Where:

W = surface flow width (ft.)

Q_{bf} = Bankfull discharge (cfs.)

D_{50} = medium bed sediment diameter (ft.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Hey Equation. Hey (1982) developed regime equations for gravel bed rivers in England that relate stable channel geometry to bankfull discharge and bedload transport rate.

$$WP = 2.2\ Q_{bf}^{-0.54}\ D_{50}^{-0.05}$$

$$R = 0.161\ Q_{bf}^{0.41}\ D_{50}^{-0.15}$$

$$d_{max} = 0.252\ Q_{bf}^{0.38}\ D_{50}^{-0.16}$$

$$S_o = 0.679\ Q_{bf}^{-0.53}\ Q_s^{-0.13}\ D_{50}^{0.97}$$

Where:

WP = Wetted perimeter (m)

Q_{bf} = Bankfull discharge (m)

D50 = Median sediment diameter (m.)

R = Hydraulic radius (m)

d_{max} = Maximum channel depth (m)

S_o = Channel slope (m/m)

Q_s = Bedload sediment discharge (%)

Parker Equation. Parker (1979) examined gravel bed rivers to obtain his channel geometry equations. He found that, unlike the bed material in sand bed streams, the gravel and cobble bed material in coarse bedded streams is moved only during larger flows. He also noted that the banks of gravel bed streams tended to be more stable and straighter than streams with finer bed materials (MacBroom, 1981). Parker's equations use a dimensionless discharge parameter (Q_*), as described below.

$$W_{bf} = 0.173\ Q_*^{0.5}\ D_{50}$$

$$d = 0.010\ Q_*^{0.415}\ D_{50}$$

$$S_e = 0.223\ Q_*^{-0.410}$$

Where:

W_{bf} = bankfull width, width at top of bank (ft)

$Q_* = 0.039\ V_m\ d^{-1}\ D_{50} / ((\rho_s\text{-}1)/\rho)\ g\ d)^{½})$ (dimensionless)

V_m = mean velocity (ft./sec.)

ρ_s = density of sediment (lbs/ft^2)

ρ = density of water (lbs/ft^2)

g = gravitation coefficient (32.2 ft./sec.^{2})

D_{50} = mean sediment diameter (ft.)

d = average channel depth (ft)

S_e = energy slope (ft./ft.)

Ackers & Charlton Equation. The Ackers and Charlton (1971) equations were based on data from flume studies which used sand bed materials.

$$W = K_{ac}\ Q^{0.42}$$

Where:

W = surface channel width (ft.)

Q = discharge (cfs)

K_{ac} = a coefficient varying from 3.6 for straight channels to 7.2 for meandering channels

Lacey Equation. The Lacey equation (1929) was developed to describe the geometry of silt-laden canals in India. However, Bray reported (1979) that in gravel rivers in Canada, the Lacey equation was as accurate for predicting velocity as the Manning's equation.

$$V = 0.8Q^{0.167}$$

Where V = mean channel velocity (ft./sec.)

Q = discharge (cfs)

Chang Equation. Chang's (1988) gravel bed equations for channel geometry support his FLUVIAL-12 sediment transport model, which attempts to simulate channel change from sediment continuity data using minimum stream power concepts. Chang provides equations for channel width, depth, and slope.

$$S_o = 0.000442\ D_{50}^{1.15} / Q_{bf}^{0.42}$$

$$W = [1.905 + 0.249(\ln(0.001065\ D_{50}^{1.15} / (S_o\ Q_{bf}^{0.42}))^2]\ Q_{bf}^{0.47}$$

$$d = [0.2077 + 0.0418(\ln(0.000442\ D_{50} / (S_o\ Q_{bf}^{0.42})))^{1.15}]\ Q_{bf}^{0.42}$$

Where:

S_o = channel slope (ft./ft.)

D50 = median sediment diameter (mm.)

Q_{bf} = bankfull discharge (cfs)

W = channel width (ft)

d = average channel depth (ft)

Kellerhals Equations. Kellerhals (1967) developed equations for the equilibrium channel width and depth in gravel bed rivers. The Kellerhals equations use the dominant discharge, which is also referred to as the channel-forming or effective discharge.

$$W = 1.8\ Q_{dd}^{0.5}$$

$$d = 0.166\ Q_{dd}^{0.4}\ K_n^{-0.12}$$

Where:

W = channel width (ft)

Q_{dd} = dominant discharge (cfs)

d = average channel depth (ft)

K_n = Nikuradse's sand grain roughness coefficient

Schumm Equation. Schumm (1961) preferred to examine the width/depth ratio of semi-arid streams, rather than either parameter separately. Schumm's equation is based on the percentage of fine-grained material in the channel banks.

$$F = 255\ M^{-1.08}$$

Where:

F = width/depth ratio

M = percentage of silt/clay in the bed.

AMAFCA Equations. The AMAFCA (1994) equations for width and equilibrium slope were developed from empirical and theoretical data for application to the arroyo systems of northern New Mexico.

$$W = 0.5\ F^{0.6}\ Fr^{-0.4}\ Q^{0.4}$$

$$S_o = 18.28\ n^2\ F^{0.133}\ Fr^{2.133}\ Q^{-0.133}$$

Where:

W = width of channel (ft.)

F = width/depth ratio

Fr = main channel Froude number

Q = discharge (cfs.)

S_o = channel slope (ft./ft.)

n = Manning's n value for channel

Moody & Odem Equations. Moody and Odem (1999) completed an investigation of bankfull channel geometry relationships on a variety of stream types in Arizona using Rosgen channel classification methods. Channel geometry relationships were defined for a number of regions in Arizona.

$$Q_{bf} = 52.334\ DA^{0.5766}$$

$$A = 11.428\ DA^{0.5291}$$

$$TW = 12.301\ DA^{0.3756}$$

$$d = 0.9455\ DA^{0.1506}$$

Where:

Q_{bf} = Bankfull discharge (cfs)

DA = Watershed drainage area (mi^2)

A = Section flow area at bankfull discharge (ft.)

TW = Flow width at bankfull discharge (ft.)

d = Average flow depth at bankfull discharge (ft.)

BUREC Equation. The Bureau of Reclamation (Lane and Carlson, 1953) developed relationships that describe stable channel dimensions for canals cut into coarse grained alluvium.

$$d_{max} = (Q_{bf}/2 \tan \phi)^{0.5}$$

$$A = 2\ d_{max}^2 / \tan \phi$$

$$V_m = 1/n\ (d_{max} \cos \phi / (0.5\ \pi\ (1 - \cos \phi))^{0.667}\ S_e^{0.5}$$

$$TW = d_{max}\ \pi / \tan \phi$$

Where:

d_{max} = Maximum depth of flow (ft.)

Q_{bf} = Bankfull discharge (cfs)

ϕ = Angle of repose of bank material

V_m = mean flow velocity (ft./sec.)

n = Mannings n value

S_e = Energy slope (ft./ft.)

TW = Top width of flow (ft.)

5.10.3 Allowable Velocity

Allowable velocity calculations are performed to evaluate the effectiveness of the channel lining. The allowable velocity is interpreted as the velocity below which no erosion will occur. The leveed corridors are designed to have velocities less than 6 ft/sec so that erosion does not pose a significant threat. The allowable velocity is not a factor in the alternatives with the concrete channels.

Following procedures used to estimate:

- Fortier & Scobey (as modified in Chow)
- BUREC
- Neill (gravel/cobble)
- USACE Table
- FHWA Table

Fortier & Scobey Table Fortier and Scobey (1926) published one of the first tables of permissible velocity in 1926. Their data, based on records of seasoned stable canals, was later republished by a number of federal agencies and other organizations including the FHWA, ASCE, and Chow (MacBroom, 1981). The Fortier and Scobey data (Table 5) distinguish erosion hazards for clear water, silt-laden water, and water transporting sand and gravel (bedload). Their data presumably do not account for the stabilizing effect of bank vegetation.

Table 5 Fortier & Scobey Table of Permissible Canal Velocities (ft/s)

Bank Material	Clear Water	Silt-Laden	Sand/Gravel Bedload
Sandy Loam	1.75	2.50	2.00
Firm Loam	2.50	3.50	2.25
Fine Gravel	2.50	5.00	3.75
Stiff Clay	3.75	5.00	3.00
Coarse Gravel	4.00	5.50	6.50
Cobbles	5.00	5.50	6.50

BUREC/Mavis & Laushey Equation The BUREC (1974) recommends that permissible velocity be estimated using a modification of the Mavis and Laushey equation (Jurnikis, 1971), which was developed by bridge engineers in Great Britain (MacBroom, 1981). The BUREC equation is a function of grain size, and is most applicable to bed material.

$V_b = 0.64\ D^{(4/9)}$ for D < 6.0 mm

$V_b = 0.5\ D^{1/2}$ for D > 6.0 mm

Where:

V_b = competent velocity (ft/sec)

D = particle diameter (mm)

Neill Equation Neill (1975) developed equations that are a function of flow depth and grain size for permissible velocities on gravel and cobble bed streams, with a separate equation for cohesive soils.

$V_b = 3.15\ d^{(1/3)}\ D^{(2/3)}$ (non-cohesive soils)

$V_b = 7.5\ d^{(1/6)}\ \tau_c^{1/2}$ (for cohesive soils)

Where:

V_b = competent velocity (ft/sec)

d = flow depth (ft)

D = grain size (ft)

τ_c = critical shear stress (lb/ft^2)

USACOE Permissible Velocity The Corps of Engineers (1970; 1995) has established suggested maximum velocities for design of non-scouring flood control channels, as shown in Table 6.

Table 6 Suggested Maximum Permissible Mean Channel Velocities (USACOE, 1995)

Channel Material	Mean Velocity (ft/sec)
Fine Sand	2.0
Fine Gravel	6.0
Grass-Lined Banks (< 5% Slope, Sandy Silt, Bermuda Grass)	8.0
Poor Rock (Sedimentary)	10.0
Good Rock (Igneous or Metamorphic)	20.0

The Corps of Engineers (1990) has also developed criteria relating flow depth and velocity to the beginning of movement of granular bed materials and erosion of cohesive bank materials, as summarized in Table 7.

Table 7 Corps of Engineers Erosive Velocity Data

Grain Size (mm)	Flow Depth (ft)	Velocity (ft/sec)	Cohesiveness	Flow Depth (ft)	Velocity (ft/sec)
1 (sand)	5 10	2.5 4.0	Very Soft	5 10	2.0 2.5
10 (gravel)	5 10	4.5 5.5	Average	5 10	3.5 4.0
100 (cobbles)	5 10	9.5 10.5	Very Stiff	5 10	5.5 6.0

5.10.4 Equilibrium Slope

The equilibrium slope is defined as the slope at which the channel bed is in equilibrium. It is interpreted as the slope the channel would evolve into, provided continuous flows for a long period of time and provides an idea as to what the design slope should be.

Following equations are computed:

- Schoklitsch
- MPM
- Shields
- Lane's Tractive Force
- Average BUREC
- Bray
- Henderson
- BUREC
- Simplified AMAFCA

Equilibrium slope[1] is defined as the slope which causes the channel's sediment transport capacity to equal the incoming sediment supply (ADWR, 1985). If the slope is too steep, channel velocities will be high and net erosion will occur. If the slope is too flat, channel velocities will be low and net deposition will occur. The equilibrium slope is the slope that the undisturbed, natural channel will tend towards over the long term. While there are philosophical and practical problems with applying equilibrium slope concepts to ephemeral streams with variable channel geometry and high flash flood potential, or streams where the natural hydrology has been altered by urbanization, equilibrium slope equations provide a useful order-of-magnitude assessment of the likelihood of vertical channel adjustments.

5.10.5 Methodology

Design reach-averaged data required for application of equilibrium slope equations to the study area were derived from the following sources:

- Hydraulic data – normal-depth computations
- Hydrologic data - HEC-1 modeling and area weighting

[1] Equilibrium slope is also referred to as stable slope or limiting slope.

- Topographic data – 10-foot contour data and DTM

Most equilibrium slope equations are based on the mean annual flood, the "channel-forming," or "bankfull" discharge. On many perennial alluvial streams, particularly in humid climates, the mean annual flood and the channel-forming and bankfull discharges are nearly equivalent. However, on ephemeral streams where flow events are rare, the channel-forming discharge is often difficult to determine. To account for the discrepancies in what flow rate is appropriate for equilibrium slope analyses, and to assess the trend of expected slope adjustments during floods, a range of discharges were used in the equilibrium slope equations to assess the expected slope adjustment over a range of discharges. Four ratios of the 100-year peak discharge estimate were examined: 10%, 25%, 75%, and 100%. The 10% flow was assumed to approximate the 2-5-year flood. The 25% flow was assumed to approximate the 10-year event. The 2-year event approximates the mean annual flood calculated on a probability-weighted basis. The 10-year event better approximates bankfull conditions in many ephemeral stream reaches. The following equilibrium slope equations were applied to the study reach:

- Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) Equations
- BUREC Equation
- Bray Equation
- Henderson Equation

The BUREC (Pemberton and Lara, 1984) published a manual for computing scour and channel degradation downstream of dams or other structures that interrupt the natural sediment supply to the downstream channel. The BUREC manual describes the following four approaches for estimating equilibrium slope:

- Schoklitsch Equation
- Meyer-Peter Muller Equation
- Shield's Diagram Method
- Lane's Tractive Force Method

The latter four equations listed above are zero bed sediment discharge (clear water) equations, and represent minimum slopes that would occur if sediment supply were disrupted, such as might occur downstream of a large in-stream sand and gravel mine, a dam, or an on-line detention basin.

5.10.6 AMAFCA Equation

The AMAFCA (1994) equation for the maximum equilibrium slope is based on the sediment transport characteristics of the reach.

$$S_L = \left(\frac{a}{q_s}\right)^{\frac{10}{3(c-b)}} q^{\frac{2(2b+3c)}{3(c-b)}} \left(\frac{n}{1.49}\right)$$

Where:

S_L = channel slope (ft./ft.)

q_s = unit sediment transport (cfs/ft)

q = water discharge (cfs)

n = Manning's roughness

a, b, c = power function coefficients from sediment transport function

A simplified version of the AMAFCA Equation is written for wide, rectangular channels, similar to the design channels for the ADMP study, based on the assumptions that steep, wide, rectangular alluvial streams flow at or close to critical depth and that sediment supply is transport limited.[1]

$$S_s = 18.28\ n^2\ F^{0.133}\ F_r^{2.133}\ Q_{dd}^{-0.133}$$

Where:

S_s = Stable slope (ft/ft)

n = Manning's roughness value for the channel

F = Width/depth ratio of the channel

F_r = Froude number for the channel

Q_{dd} = Dominant discharge (cfs)

5.10.7 BUREC Equation

The BUREC published an equation for stable slope based on theoretical considerations of sediment transport (MacBroom, 1981).

[1] Transport limited means that the sediment inflow equals or exceeds the reach transport capacity.

$$S_L = (0.00021\ D_{50}\ W_{bf} / Q)^{0.75}$$

Where:

S_L = Stable slope (ft/ft)
D_{50} = Bed sediment diameter (ft)
W_{bf} = Channel width (ft)
Q = Discharge (cfs)

5.10.8 Bray Equation

Bray's (1979) equation for equilibrium slope is based on regime analysis of perennial gravel bed streams in Alberta, Canada.

$$S_L = 0.965\ Q_2^{-0.344}\ D_{50}^{0.58}$$

Where:

S_L = Equilibrium slope (ft/ft)
D_{50} = Mean bed sediment diameter (ft)
Q_2 = 2-year discharge (cfs)

5.10.9 Henderson Equation

To generate an equation for the slope of stable channels, Henderson (1961) modified the Lane (1952) equations using a threshold theory of shear stress concept.

$$S_L = 0.44\ D_{90}^{1.15}\ Q^{-0.46}$$

Where:

S_L = Stable slope (ft/ft)
D_{90} = Bed sediment diameter for which 90 percent is smaller (ft)
Q = Discharge (cfs)

5.10.10 Schoklitsch Equation

The Schoklitsch (Shulits, 1935) equation is based on the concept of zero bedload transport.

$$S_L = K_s\ (D\ W_{bf}/Q)^{3/4}$$

Where:

S_L = Stable slope (ft/ft)
K_s = 0.00174
W_{bf} = Bankfull width (ft)
D = Mean bed sediment diameter (mm)
Q = Dominant discharge (cfs)

5.10.11 Meyer-Peter, Muller Equation

The Meyer-Peter, Muller (1948) equation is based on the incipient motion theory, or the point of initiation of sediment transport.

$$S_L = K_{mpm}\ (Q/Q_{bf})\ (n_s/D_{90}^{1/6})^{3/2}\ D / d$$

Where:

S_L = Stable slope (ft/ft)
K_{mpm} = 0.19
Q/Q_{bf} = Ratio of total flow to flow over the channel
Q_{bf} = Dominant discharge (cfs)
n_s = Manning's n for the stream bed
D_{90} = Bed sediment diameter for which 90 percent is smaller (mm)
D = Mean sediment diameter (mm)
d = Channel depth (ft)

5.10.12 Shields Diagram Method

The Shields diagram (1936) for determining the boundary condition for no sediment transport can be used to define an equation for stable slope.

$$R_* = U_*\ D / \upsilon$$

$$U_* = (S_L\ R\ g)^{1/2}$$

$$T_* = \tau_c / ((\gamma_s - \gamma_w)\ D)$$

Where:

S_L = Stable slope (ft/ft)

R_* = Boundary Reynold's number

U_* = Shear velocity = $(S_L\ R\ g)^{\wedge 0.5}$

D = Mean sediment diameter (mm)

υ = Kinematic velocity of water (ft/sec^2)

R = Hydraulic radius for wide channels (ft)

g = Gravitational constant = 32.2 ft/sec^2

T_* = Dimensionless shear stress

τ_c = Critical shear stress (lb/ft^2)

γ_s = Specific weight of sediment (lb/ft^3)

γ_w = Specific weight of water (lb/ft^3)

5.10.13 Lane's Tractive Force Method

Lane's equation for stable slope uses critical tractive force relationships.

$$S_L = (\tau_c/\gamma_w)\ d$$

Where:

S_L = Stable slope (ft/ft)

d = Mean flow depth (ft)

τ_c = Critical shear stress (lb/ft^2)

γ_w = Specific weight of water (lb/ft^3)

Among the equations used, AMAFCA is the only one that is for live-bed while all others are for clear water. The clear water equations predict slopes are smaller than the AMAFCA equation which generally predicts higher values of slope. The slope influences the hydraulics significantly and can directly impact the velocity in channel which affects the sedimentation issues. However, the range of equilibrium slope estimates from the equations investigated varies greatly. In order to arrive at a slope for use in the Step 2 hydraulic and design process, the average of the clear water equations (Schkoklitsch, MPM, Shields, and Lane) was taken and averaged with the results from the Simplified AMAFCA, Bray, and Henderson equations. The resulting average slope was assumed representative of the long-term slope to develop in the leveed corridors. In addition, this result was used to compute the grade control requirements for the leveed corridors. Finally, this slope was also used to for the hydraulic design of the earthen excavated channels (B3).

5.10.14Sediment Transport Capacity

The sediment transport capacity is used to estimate of the rate of sediment transport in tons/day. The sediment transport capacity can be used to ensure the adequate sediment continuity and provides channel sediment trend when compared with the inflowing sediment transport load. It can also be used to estimate sediment volume using maximum sediment concentrations and the flow volume.

The following equations are computed:

- Zeller Fullerton
- Ackers White
- Colby
- Einstein
- Engelund/Hansen
- Kalinske
- Laursen
- MPM
- Rottner
- Schoklitsch
- Toffaleti
- Yang

The calculations are performed based on procedures in Yang, 1995. It may be noted that each these equations have been developed under different circumstances and may not be entirely valid for all the conditions proposed in the design. However, the sediment transport capacity values are used as a gross estimate of sediment flux and to provide qualitative estimates of sedimentation and erosion possibilities.

5.10.15Scour and Toe Protection

The toe-down for the levee and other bank protection are estimated using the general scour estimates. The Pima County General Scour Equations are used for this purpose. It is assumed that the bend scour is negligible as

most of the designed channels have somewhat straight alignments. The long-term scour is estimated from equilibrium slope and the local scour is defined low flow channel depth.

Scour calculations in this report are performed using procedures outlined in the City of Tucson's *Standards Manual for Drainage Design and Floodplain Management* - Chapter VI - Erosion and Sedimentation (1989; hereafter, "the COT Manual"). The following equation for depth of scour in a stream is given in the COT Manual:

$$Z_t = 1.3\ (Z_{gs} + \tfrac{1}{2}\ Z_a + Z_{ls} + Z_{bs} + Z_{lft})$$

where:

Z_t = Design scour depth, excluding long-term degradation or aggradation (ft)
Z_{gs} = General scour depth (ft)
Z_a = Anti-dune trough depth (ft)
Z_{ls} = Local scour depth (ft)
Z_{bs} = Bend scour depth (ft)
Z_{lft} = Low-flow thalweg depth (ft)
1.3 = Safety factor to account for non-uniform flow distribution

General scour, Z_{gs}, is the component of scour that represents the mobile portion of the bed-material of the channel bottom. General scour was estimated using the following equation:

$$Z_{gs} = Y_{max}\ [(0.0685\ V_m^{0.8})/(Y_h^{0.4}\ S_e^{0.3})\text{-}1]$$

where:

Z_{gs} = General scour depth (ft)
V_m = Average velocity of flow at design discharge (ft/sec)
Y_{max} = Maximum depth of flow at design discharge (ft)
Y_h = Hydraulic depth of flow at design discharge, (ft)
S_e = Energy slope (ft/ft)

Where Z_{gs} was determined to be negative, the general scour component was assumed to be zero, in keeping with the recommended practice in the COT Manual.

Anti-dune trough depth, Za, is the component of scour caused by movement of dune shaped bed forms along the bottom of the channel. The anti-dune trough depth was estimated using the following equation:

$$Z_a = 0.0137\ V^2_m$$

where:

V_m = Average velocity of flow at design discharge (ft/sec)

Bend scour, Z_{bs}, occurs on the outside of bends in a stream channel, and is caused by spiral transverse currents. Bend scour was estimated using the following equation:

$$Z_{bs} = 0.0685\ Y_{max}\ V_m^{0.8}\ \ Y_h^{-0.4}\ S_e^{-0.3}\ \{2.1\ [\sin^2(\alpha/2)/\cos\alpha]^{0.2} - 1\}$$

where:

Z_{bs} = Bend-scour component of total scour depth (ft), and
= 0 when $r_c/T > 10.0$, or $\alpha < 17.8^o$
= computed value when $0.5 < r_c/T < 10.0$, or $17.8^o < \alpha < 60^o$
= computed value when $\alpha = 60^o$ when $r_c/T < 0.5$, or $\alpha > 60^o$
Y_{max} = Maximum depth of flow immediately upstream of the bend (ft)
V_m = Average velocity of flow immediately upstream of the bend (ft/sec)
Y_h = Hydraulic depth of flow immediately upstream of the bend (ft)
S_e = Energy slope immediately upstream of the bend (ft/ft)
α = Angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)
r_c = radius of curvature along centerline of channel (ft)
T = channel top width (ft)

The bend angle was computed from the arccosine of the reciprocal of the sinuosity. A sinuosity of 1.1 was assumed for all design reaches. The thalweg depth used for the scour depth calculation was set as low-flow channel depth for both the leveed corridors and the excavated earthen channel.

Scour depth below drop structures was estimated using the following equation from Schoklitsch (1935):

$$D_s = 4.75\ h^{0.2}\ q^{0.57} / d_{90}^{0.32}$$

where:

D_s = Scour depth below downstream water surface (m)
h = Drop height (m)
q = Unit discharge ($m^3/s/m$)

d_{90} = Bed material size for which 90% of the sample is finer (mm)

5.11 Off-line Detention Basins

Off-line detention basins were included in situations where the flow needs to be limited to accommodate downstream capacity of existing channels, culverts or delineated floodplains. These basins are modeled as diversions in HEC-1 using the DI/DQ records. At the culvert locations along Sun Valley Parkway, the purpose of the off-line basin is to reduce the flow capacity to the maximum capacity of the culvert. The maximum capacity of the culvert was determined using HY8 results as the flow rate that occurs when the upstream water surface elevation is 1 foot above the culvert top elevation. At other locations, flows higher than certain desired values are diverted and the inflow/outflow relations are the design parameters.

6 DESIGN PROCEDURES

The details of the design procedure for all the alternatives and structural elements are presented in this section. The alternatives are described in Section 10.

6.1 Alternative A

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Set aside adequate area for active alluvial fan processes to occur. This up-fan area is immediately downstream of the apex. The areas used were taken from delineations prepared by Ayres (2005) as part of the Buckeye/Sun Valley ADMS.
- Design collector channels downstream of the sedimentation area to collect all the flows from the upstream watershed (See section 6.11).
- Route flow from collector channels to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows to the outfall by designing leveed natural channel (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.2 Alternative B1

- This alternative is only considered for CAP and White Tank Wash sub-areas. Alternative B4 is equivalent to B1 alternative for Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas (see section 6.5).
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.3 Alternative B2

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small on-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow

- Route flow from small on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.4 Alternative B3

- Identify fan apex/upstream area location and preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.5 Alternative B4

- This alternative is only considered for Wagner, Hassayampa, FRS 1, and FRS 2 & 3 sub-areas. Alternative B1 is equivalent to B4 alternative for CAP and White Tank Wash sub-areas (see section 6.2).
- Alternatives B4-1, B4-2, and B4-3 represent the three channel alignments considered. Perform all the design procedure steps for B1 (See Section 6.2) using each of the three channel alignments.
- Select preferred alignment based on evaluation criteria such as cost, feasibility, etc.
- Perform design for Alternatives B2, B3, and C for the preferred alignment.

6.6 Alternative B5

- This alternative is only considered for CAP sub-area.
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small off-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow
- Route flow from small off-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.7 Alternative C

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Route flow from the apex to Sun Valley Parkway by designing excavated concrete channel along the preferred channel alignment (See section 6.12).

- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing excavated concrete channel along the preferred channel alignment (See section 6.12).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.8 On-line Basin Design Procedure

- Determine upstream sediment contributing area.
- Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches that bring sediment into the on-line basin. Determine sediment volume using flow volume from HEC-1 and sediment concentration at the upstream reach (sediment volume = flow volume x sediment concentration). Repeat this step for all upstream reaches.
- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- Determine outlet structure type, size/number and invert elevation. These parameters along with the basin dimensions determine stage-storage-outflow relation.
- Update the stage-storage-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the maximum peak flow volume and peak stage from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard and sediment) to see if they are adequate.
- Modify basin dimensions and outlet structure parameters and repeat the process until the basin volume and depth are adequate.

6.9 Off-line Basin Design Procedure

- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- If the off-line basin is at a location upstream of a culvert, import the HY8 results for the culvert into an inflow-outflow table (see section 5.11). If the off-line basin is at a location upstream of an outfall, then setup an inflow-outflow table to divert all flows exceeding the capacity of the channel into the off-line basin.
- Update the inflow-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the diverted flow rate and volume from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard) to see if they are adequate.
- Modify basin dimensions and repeat the process until the basin volume and depth are adequate.

6.10 Leveed Natural Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is assumed for the leveed natural channels.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.

- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the leveed channel and set up the conveyance cross-section. Depth of flow in the initial cross section is targeted at about 1 foot and velocity of the 75 percent and 100 percent flow rates are greater than 4 feet per second but less than 6 feet per second. The bottom width may not exceed 400 feet.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Set the long-term slope based on the average equilibrium slope.
- Determine the velocity, flow depth, and Froude number.
- The velocity in the initial cross section should be approximately 4-6 ft/sec. The flow depth should be in the range of 1 to 2 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine the shape of the long-term low-flow channel using hydraulics results for the long-term slope. The shape of the long-term low-flow channel is determined by the regime theory results for the 10% and 25% peak flow results for width, depth, and velocity.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope, and the long-term design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine the toe down required for bank protection. The toe down is computed based on the estimated scour depth computed (see section 5.10.15).
- Determine any additional ROW area needed. These are needed in the estimation of the land costs.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the levee area, (c) other additional right of way area, (d) toe protection using riprap, e) levee fill, f) levee lining, g) drop structures using riprap, and h) sedimentation basins.

6.11 Excavated Earthen Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is used for the earthen excavated channel.
- Determine sediment gradation parameters such as $D_{50,}$ etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.

- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the design slope based on the equilibrium slope. For the B3 Alternative, the hydraulics of only the design (long-term) slope are evaluated as the channel will be constructed to this slope.
- Determine the velocity, flow depth, and Froude number.
- The flow width and depth are approximately set based on regime theory. The flow depth should be less than 8 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, the existing slope and the design (long-term) slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to determine the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural preservation corridor, (c) other additional right of way area (d) channel excavation costs, (e) toe protection using riprap, f) drop structures using riprap, and g) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

6.12 Excavated Concrete Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.02 is used for the concrete excavated channels.
- Determine sediment gradation parameters such as $D_{50,}$ etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the slope based on the Froude number. The Froude number should be set less than 0.86. The initial slope and the long-term slope are set as the same value.
- Determine the velocity, flow depth, and Froude number.
- The flow depth should be less than 8 feet. The available freeboard must be larger than the required freeboard. Low flow channels are sized such that the 10 percent and 25 percent depth and velocity are not considered too highly dangerous for adults possibly caught within the channel based on criteria in ACER TM-11 (USBR, 1988). Generally, velocity is kept below 5 feet per second and depth less than 2 feet wherever possible. Repeat sizing width and depth of the channel until these conditions are satisfied.

- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope and the design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural corridor, (c) other additional right of way area (d) channel excavation costs, e) drop structures using concrete, and f) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

7 LANDSCAPE COMPATIBILITY ENHANCEMENTS

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the engineering design concepts are required. In 1993, the District adopted a "Policy for the Aesthetic treatment and Landscaping of Flood Control projects". This policy aims at planning and designing flood control projects that are compatible with the visual character of the adjacent landscape. In addition, the policy also aims at the integration of the recreational activities into the planning and design of the flood control facilities.

The design aspects of landscape compatibility enhancement are the enhancements imposed on a base engineering design to achieve compatibility with this policy. In particular, the enhancements require modifications to engineering structures to blend them into the landscape by integrating non-rectilinear forms, appropriate scale, etc. The landscape enhancements result in additional costs to the project when compared to the costs of the base engineering design. The details pertaining to the design aspects of the enhancements as well as the cost differential for the enhancements are presented in this section. The hydraulics and sediment transport calculations are performed only for the base engineering design and not for the landscape compatibility enhanced design. These calculations for the landscape compatibility enhanced design will be incorporated at the Step 3 design refinement process.

7.1 Landscape Compatibility Enhancements to Leveed Channel

The landscape compatibility enhancement to the levee consists of the flattening of the levee side slope, increase of the top-width of the levee as well the height of the levee. Height adjustments to earth and walled levees were also added to vary to the profile of these structures in the landscape. The levee side slope will vary between 4:1 to 8:1. The height increase in the levee will vary along the length of the levee between 0 to 2 ft. The top-width of earth levees was increased from 14 feet in the base design to 20 feet in the enhanced design. The estimation of project cost increases due to landscape compatibility enhancements were performed by using an average side slope of 6:1 and an average increase in the levee height of 1 ft. These adjustments result in increased fill volume, increased levee lining, as well as increased land area. The increase in the land area, in turn, increases the landscape and maintenance costs. The increase in the levee lining costs is a result of the increased exposed levee surface area.

If a walled corridor channel is adopted instead of a levee, an additional land buffer of 50 ft is applied to each side of the channel. In addition, an average increase of 1 foot is incorporated to the wall height to reflect the vertical variation required to provide landscape compatibility.

7.2 Landscape Compatibility Enhancements to Excavated Channel

The landscape compatibility enhancements for the excavated channel involve a decrease in the side slope of the channel and an additional 50 ft buffer area parallel to all channels. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates for the landscape compatibility enhancement components, the average side slope was decreased from 3:1 to 6:1. The decrease in the side slope increases the total land area needed which, in turn, increases the landscape and maintenance costs.

7.3 Landscape Compatibility Enhancements to On-line/Off-line Basins

The landscape compatibility enhancements for the detention basins include a decrease in the side slope, a buffer area around the basins and architectural enhancements to inlet and outlet structures. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates, the average side slopes of the basins are decreased from 3:1 to 6:1. The slope change was performed along with an adjustment to the longer dimension of the basin so there is no change in net storage volume between the base design and the enhanced design. However, due to decreased slope, the excavation volume will be higher for the enhanced design. The change in the longer dimension of the basin will also contribute to an increase in the land costs. In addition, a buffer of 50 feet was added around the

perimeter of all detention basins. This change also increases the land area resulting in increased land costs. Finally, additional costs were included for architectural enhancements to the inlet and outlet structures which are assumed to be 20% of base cost for the inlet structure and 5% for the outlet structure.

7.4 Landscape Compatibility Enhancements to Drop Structures

The landscape compatibility enhancement for the drop structures results in longer length for the drop structures. A 10% increase in the length of the drop structures was applied to achieve the enhancement. Architectural enhancements to the drop structure materials are also anticipated.

8 HASSAYAMPA RIVER SUB-AREA SPECIFIC DESIGN CONSIDERATIONS

The Hassayampa River sub-area is located on the western slope of the White Tank Mountains piedmont. Two primary alluvial fans, designated Fan 4 and Fan 5, drain from the White Tank Mountain Regional Park onto the piedmont in this sub-area. The sub-area is bisected by the Sun Valley Parkway which runs north to south across the Hassayampa River sub-area. Existing drainage facilities along the Sun Valley Parkway consist of culverts of various sizes beneath the roadway at various locations. All of the design concepts for the Hassayampa River sub-area alternatives incorporate the existing culverts without modification. Therefore, design flow rates for channels or conveyance corridors downstream of the Parkway are limited to the existing culvert capacities by offline detention facilities at or near the Sun Valley Parkway. Culvert capacities were computed assuming a headwater depth equal to one foot greater than the internal culvert height as indicated on the design plan sheets for the Parkway.

The Fan 4 Apex is composed of two separate areas of diverging channels – one at subbasin 400 and the other at subbasin 410. The design concepts for online detention basins for Fan 4 assume that the two watersheds are controlled by a single detention basin strategically located and sized to capture both primary washes.

The B4-1 Alternative combined the corridors from Fan 4 and 5 by means of an excavated channel from the Fan 5 corridor directed northwest to the Fan 4 corridor. The Fan 4 corridor was then continued across the Sun Valley Parkway to the Hassayampa River. The B4-1 Alternative was the shortest total length. Therefore, the B4-1 alignment was used to develop concept designs and costs for the B2, B3, and C Alternatives.

The B4-2 Alternative provided separate leveed conveyance corridors for Fan 4 and Fan 5. The B4-3 Alternative was similar to the B4-2 Alternative, only a different alignment was selected for the Fan 5 corridor downstream of the Sun Valley Parkway to the Hassayampa River.

The Sun Valley Parkway culverts for the B4-2 alternative are a combination of three separate, but closely located, box culverts. They provide sufficient capacity for corridor flows for the B4-2 and B4-3 Alternatives.

Diversion channels for Alternative A were assumed to be partially excavated with a downstream levee for the purposes of the cost estimation. Active alluvial fan areas were derived from the unstable delineations performed for the ADMS by Ayers (2005).

9 STEP 2 COST ESTIMATES

9.1 Base Cost Estimates

Base costs for each alternative were estimated by establishing unit costs for the various design components. The total cost for each component was obtained by multiplying the quantities involved with the unit costs. The cost components considered in the design are: 1) Land Cost, 2) Construction Cost, 3) Landscaping Cost, and 4) Maintenance Cost.

For the channels, the cost estimates are categorized into the following: (a) Levee (Alternatives A, B1, B2, B4, B5), (b) Levee Lining (Alternatives A, B1, B2, B4, B5), (c) Channel Excavation (Alternatives B3, C), (d) Channel Lining (Alternative C) (e) Toe Protection (f) Drop Structures (Alternatives A, B1, B2, B3, B4, B5), (g) Sedimentation Basins and (h) Other. The "Other" category is included for the purpose of including any other miscellaneous cost. Table 8 summarizes the channel materials selected for the purpose of cost estimation of the alternatives.

Table 8 Cost Estimate Categories for Channels

Channel Type	Channel Lining	Toe Protection	Levee Fill	Levee Lining	Drop Structures	Sedimentation Basins
Leveed Natural	None	Riprap	Yes	Riprap	Riprap	Yes
Earthen Excavated	None	Riprap	No	None	Riprap	Yes
Concrete Excavated	Concrete	None	No	None	Concrete	Yes

Similarly for the basins, the costs are categorized into: (a) basin, b) inlet, (c) outlet, and (d) other.

The four cost components are estimated for all the cost categories. A summation of all cost components provides the total cost for the particular channel or basin. The costs for all design elements (channels and basins) are totaled to provide the total cost for the particular alternative in a sub-area.

The procedures adopted in estimating the cost for each component are presented below. The details of the calculations performed as presented in Appendix A. The summary of the unit costs for all the components is presented in Table 9.

9.1.1 Land Cost

The land cost is the major cost component in most of the alternatives. The land cost is estimated using a unit cost of $100,000 per acre except for one design reach through existing homes in sub-area FRS #1. A land cost of $250,000 per acre was applied to that reach. The land areas considered in the estimates are: 1) on-line basin footprint, 2) off-line basin footprint, 3) channel area between the levees (A, B1, B2, B4, B5), 4) excavated channel area (B3, C), 5) adjacent natural preservation corridor (B3, C), 6) area occupied by levee and/or access road (A, B1, B2, B4, B5), and 7) area set-aside for natural active fan processes to occur (A).

9.1.2 Construction Cost

The construction costs are estimated mainly based on unit costs for materials and excavation costs. The unit material cost includes all costs associated with material fully constructed in place. For example, a unit cost of $75 for riprap drop structures includes the cost of material as well the cost of constructing the drop structure. A contingency cost of 25% is applied to the estimated base construction cost. Similarly, the cost for the engineering design is set at 5% of the base construction cost. The sum of the base construction cost, contingency cost and the design cost provides the total construction cost.

9.1.3 Landscaping Cost

The landscaping costs are also applied as unit costs for the cost categories where landscaping is needed. The landscaping costs are mostly based on "per area" unit cost with the areas estimated using the design parameters. A landscaping cost of $1 per square foot was assumed based on an assumption of 60% of the area landscaped at $1.50 per square foot and 40% of the area naturally seeded at $0.06 per square foot. Landscaping costs were applied only to the disturbed areas impacted by the structural elements of the alternatives. For example, the surface area of the excavated earthen channels (B3) was assumed to require landscaping. Similarly, the external slopes of the levees were assumed to require landscaping. This landscape cost is for basic reestablishment of vegetation on disturbed areas. It does not include the cost of landscape enhancements required for compatibility of the structural flood control measures with the future landscape character of the area. Landscape compatibility enhancement costs are discussed in Section 9.2.

9.1.4 Maintenance Cost

The maintenance costs are based on a 3-year maintenance cycle. The costs are estimated for a design life of 50 years. The costs include maintenance costs for a period of 50 years assuming that maintenance will be performed every 3 years.

Table 9 Summary of Unit Costs

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Levee						
Fill	cu. Yd	$ 7.00	sq. Yd	$ 9.00	sq. Yd	$ 0.70
Wall	sq. Yd	$ 215.00	sq. Yd	$ -	sq. Yd	$ 4.50
Toe Protection						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.50
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.70
Soil Cement	cu. Yd	$ 50.00	sq. Yd	$ -	sq. Yd	$ 1.50
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.35
Levee Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.25
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.50
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.80
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.00
Channel Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Drop Structure						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Basin Inlet						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Pipes						
24" RGRCP	LF	$ 55.00	sq. Yd	$ -		$ 0.55
30" & 36" RGRCP	LF	$ 82.00	sq. Yd	$ -		$ 1.20
42" & 48" RGRCP	LF	$ 160.00	sq. Yd	$ -		$ 2.40
54" & 60" RGRCP	LF	$ 183.00	sq. Yd	$ -		$ 2.75
Channel						
Excavated Channel	$ 10.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Sedimentation Basin						
Sedimentation Basi	$ 10.00	cu. Yd	sq. Yd	$ -	sq. Yd	$ 0.50
Basin						
Excavated Basin	$ 4.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Outlet Cost	Based on 100'x12' Weir					
None	EA	$ -	sq. Yd	$ -	sq. Yd	$ -
Concrete Weir	EA	$ 15,000.00	sq. Yd	$ -	sq. Yd	$ 2.50
Riprap Weir	EA	$ 10,000.00	sq. Yd	$ -	sq. Yd	$ 2.00
Pipe	LF	$ 160.00	sq. Yd	$ -	sq. Yd	$ 1.00

9.2 Landscape Compatibility Enhancement Costs

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the base engineering design concepts were required. In particular, the engineering structures require modifications to blend them into the landscape (i.e. irregular form, etc). Additional costs will be incurred to ensure that the proposed structural flood control measures conform with the future landscape character of the Sun Valley area. The additional costs were estimated based on increased land area, construction, and maintenance requirements for the enhanced structures. Details of the computation of the landscape compatibility enhancement costs are provided in Section 7.

10 HASSAYAMPA RIVER SUB-AREA DESIGN SUMMARY

The design summary of all the alternatives for the Hassayampa River sub-area is presented in the following sections. Table 10 shows a summary of the cost estimates for each alternative for the Hassayampa River sub-area. Table 11 shows a summary of the landscape enhanced costs for the Hassayampa River sub-area.

Table 10 Base Cost Summary

		Costs (in $1000)					Cost Percentages			
Alternative	Land Area	Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %
A	463	$ 46,343	$ 19,125	$ 3,952	$ 7,435	$ 76,855	60%	25%	5%	10%
B2	387	$ 38,768	$ 22,667	$ 4,963	$ 9,842	$ 76,239	51%	30%	7%	13%
B3	274	$ 27,339	$ 77,706	$ 6,670	$ 7,123	$ 118,838	23%	65%	6%	6%
B41	314	$ 31,339	$ 22,692	$ 5,408	$ 9,907	$ 69,346	45%	33%	8%	14%
B42	402	$ 40,050	$ 29,934	$ 6,623	$ 13,645	$ 90,253	44%	33%	7%	15%
B43	423	$ 42,140	$ 30,660	$ 6,869	$ 14,210	$ 93,878	45%	33%	7%	15%
C	252	$ 25,239	$ 104,359	$ 5,764	$ 10,595	$ 145,956	17%	72%	4%	7%

Table 11 Landscape Enhanced Cost Summary

		Costs (in $1000)					Percentage Cost Increase				
Alt.	Land Area (acres)	Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %	Total Cost
A	514	$ 51,390	$ 28,685	$ 6,876	$ 13,916	$ 100,868	11%	50%	74%	87%	31%
B2	451	$ 45,100	$ 35,087	$ 8,985	$ 18,899	$ 108,071	16%	55%	81%	92%	42%
B3	368	$ 36,840	$ 96,817	$ 8,852	$ 9,174	$ 151,683	35%	25%	33%	29%	28%
B41	383	$ 38,170	$ 35,137	$ 9,657	$ 19,171	$ 102,135	22%	55%	79%	94%	47%
B42	487	$ 48,510	$ 49,121	$ 12,555	$ 27,784	$ 137,971	21%	64%	90%	104%	53%
B43	512	$ 50,950	$ 50,778	$ 13,066	$ 29,033	$ 143,827	21%	66%	90%	104%	53%
C	338	$ 33,790	$ 135,141	$ 7,524	$ 16,513	$ 192,968	34%	29%	31%	56%	32%

The cost estimates reveal the following information from the alternative comparisons.

Alignment alternatives – As discussed in Section 8, three alignment alternatives were considered to control flooding on the major alluvial fans in the Hassayampa River sub-area. The B4-1 Alternative combined the corridors from Fan 4 and 5 by means of an excavated channel from the Fan 5 corridor directed northwest to the Fan 4 corridor. The B4-2 Alternative provided separate leveed conveyance corridors for Fan 4 and Fan 5. The B4-3 Alternative was

similar to the B4-2 Alternative, only a different alignment was selected for the Fan 5 corridor downstream of the Sun Valley Parkway to the Hassayampa River.

The Sun Valley Parkway culverts for the B4-2 alternative are a combination of three separate, but closely located, box culverts. They provide sufficient capacity for corridor flows for the B4-2 and B4-3 Alternatives.

The costs of the B4-2 and B4-3 Alternatives are very similar due to their similar corridor lengths. The B4-3 Alternative alignments were slightly longer and therefore somewhat more expensive. The B4-1 Alternative was the shortest total length and hence least expensive. The B4-1 Alternative was therefore selected for application of the small basin (B2) and excavated companion channel alternatives (B3 and C).

Sizing alternatives - The large on-line basin (B4-1) alternative is approximately the same cost as the small on-line basin (B2). The off-line basin (B5) was not explicitly analyzed for the Hassayampa sub-area because it was shown to have a similar cost to the small on-line basin in the CAP sub-area analysis (see Volume 2). The reasons for this result are: 1) the downstream reach peak discharges are driven by the on-fan runoff and 2) land cost is the largest portion of the total cost for the leveed corridor alternatives.

Other apex or conveyance strategies – The A alternative and excavated channel alternatives (B3 and C) are the most expensive alternatives; even more expensive than the multiple leveed corridors with apex basins. In the case of the A alternative, the land cost associated with the active alluvial fan area makes this approach much more expensive than the apex basin alternatives. The active fan area is recovered for potential development. For the excavated channel alternatives, the construction costs are much greater than the land area saved. Additionally, these alternatives include a 120-foot preservation corridor as part of the land cost which offsets some of the potential cost savings.

Landscape compatibility enhancements – The landscape compatibility enhancements include costs for additional land requirements, construction requirements (excavation and fill), increased landscaping area, and increased maintenance (due to the larger areas requiring maintenance). The increased costs for landscape compatibility enhancements average about 40 percent for all alternatives, ranging from about 30 to 55 percent. The increased costs are greatest for the B4-2 and B4-3 alternatives and least for the B3 alternative.

Wall vs. Earth Levee – The relative cost differences for the walled corridor versus the earthen levee corridor were also evaluated. A comparison of the per unit channel length was performed for an example reach. Table 12 shows the results of this comparison. The costs for the wall do not include any fill behind the wall. That is, the wall serves as the levee by itself without any backfill "uphill" of the wall. The walled levee ranges from about 45 to 80 percent less expensive than the earthen levee option depending on levee height. The cost differential is greater the taller the levee. The differences in cost are due to additional construction costs, landscape compatibility enhancement costs, and land costs associated with the earthen levee. The primary reason the cost difference increases with levee height is related to the size of the levee footprint. The earth levee footprint grows with increasing height whereas the wall footprint (and 50-foot landscape enhancement buffer) does not. The larger levee footprint results in larger construction, land, landscaping, enhancement, and maintenance costs.

Table 12 Walled vs. Earth Levee Cost Comparison

	Levee			Wall			Percentage Difference
Levee/Wall Height (ft)	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	
3.5	$ 611	$ 672	$ 1,284	$ 381	$ 512	$ 893	44%
4	$ 675	$ 734	$ 1,409	$ 421	$ 512	$ 932	51%
4.5	$ 725	$ 814	$ 1,539	$ 460	$ 512	$ 972	58%
5	$ 795	$ 876	$ 1,671	$ 499	$ 512	$ 1,011	65%
5.5	$ 847	$ 975	$ 1,822	$ 539	$ 512	$ 1,050	73%
6	$ 915	$ 1,045	$ 1,960	$ 578	$ 512	$ 1,090	80%

10.1 Summary

Engineering cost estimates for the Step 2 Proposed Alternatives were computed. The apex basin alternatives with leveed corridors are generally the least expensive alternatives compared the excavated channel alternatives or apex avoidance strategy.

In addition, the additional costs associated with meeting the landscape aesthetic requirements were also estimated. The results indicate that the landscape compatible alternatives are about 40 percent more expensive than the base engineering costs. In addition, the costs of the earthen levee were compared to a walled levee. Those calculations showed that the walled levee approach is significantly less expensive compared to the earthen levee.

The following sections provide a summary of each alternative for the Hassayampa River sub-area along with bulleted lists of the key features, advantages, disadvantages, and opportunities associated with each alternative. Additional details of the design calculations, hydrologic models, and cost estimates are provided in Appendix A for each alternative. The summary sheets are followed by the alternatives evaluation in Section 11.

10.2 ALTERNATIVE A - Summary Sheet for Hassayampa River Sub-Area

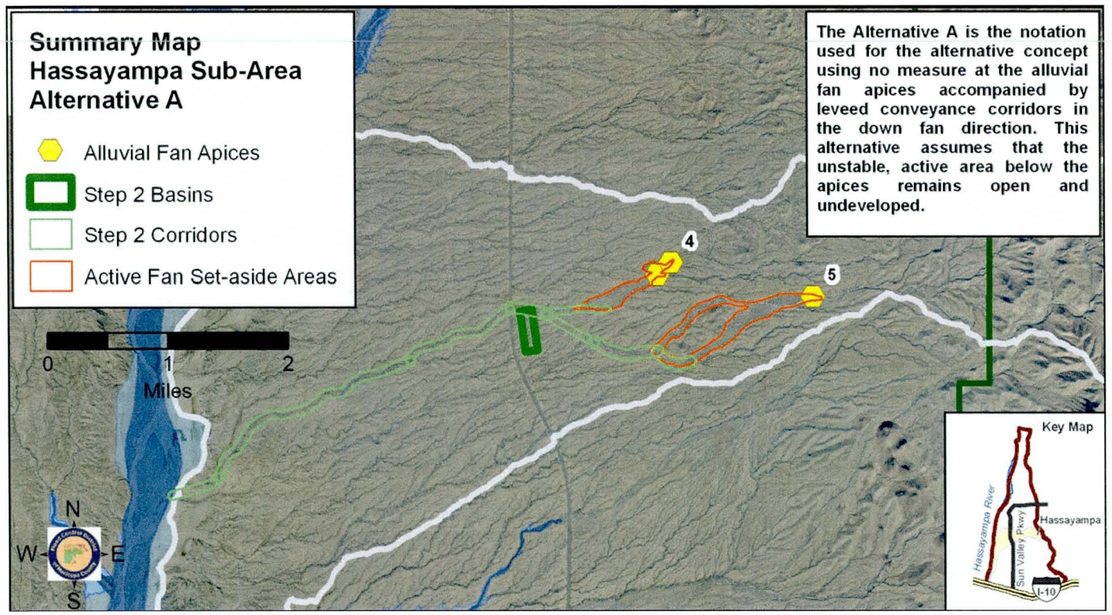


Figure 28 Summary Map of Alternative A for the Hassayampa River Sub-Area

10.2.1 Description for Alternative A

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active alluvial fan area downstream of the apex. Flood flows and sediment are controlled downstream of the region of uncertainty. The flows will be captured in the up-fan area by partially excavated collector channels. Once collected, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 5 are directed north and combined with outflows from Fan 4 via an excavated channel section in order to cross a subwatershed divide. One large off-line detention basin is required to restrict peak flow at Sun Valley Parkway to the existing culvert capacity.

10.2.2 Key Features

- $76.9 million is the estimated total cost
- One off-line basin with a total volume of 220 acre feet
- No on-line basins
- 5.5 miles of corridors, of which 1.0 miles are excavated collector channels
- 441 acres needed for right of way. This includes the right of way in the active fan areas.

10.2.3 Advantages

- Provides for continued natural fan processes near apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Achieves context sensitivity of new facilities
- Provides open space area

10.2.4 Disadvantages

- Costly structures
- Fill requirements exceed excavation volume
- Large right of way demand
- Requires excavation of one reach to cross subwatershed divides to combine outflow corridors
- Requires a large off-line basin at Sun Valley Parkway

10.2.5 Opportunities

- Provides path from Hassayampa River to near Regional Park boundary near planned connection

10.3 ALTERNATIVE B2 - Summary Sheet for Hassayampa River Sub-Area

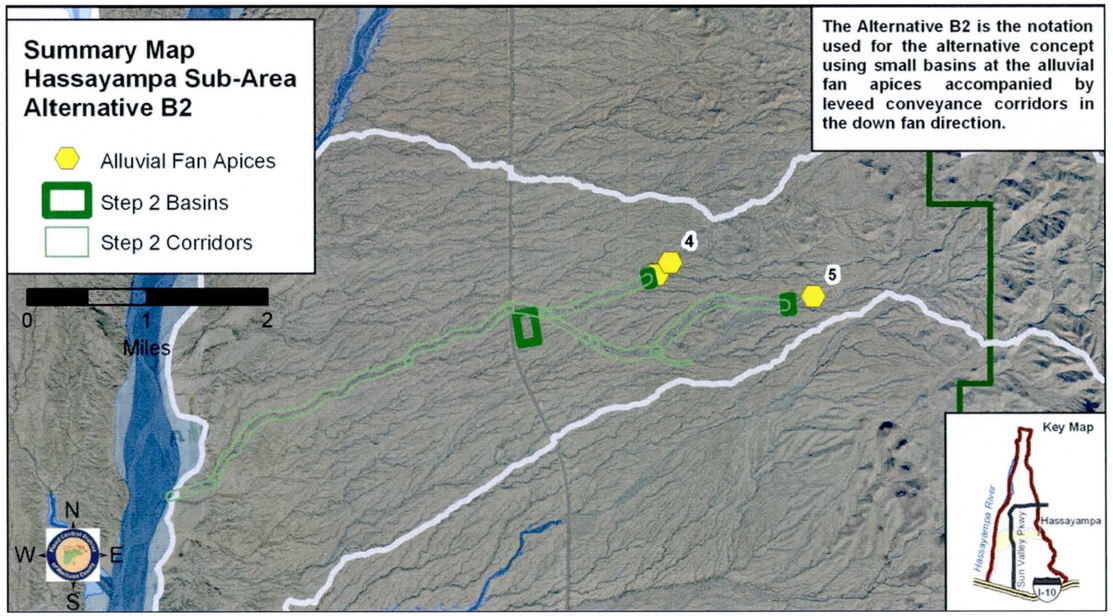


Figure 29 Summary Map of Alternative B2 for the Hassayampa River Sub-Area

10.3.1 Description for Alternative B2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the apices to the outfall at the Hassayampa River. Alternative B2 is based on using a relatively smaller on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. The B2 Alternative is based on the alignment from the B4-1 Alternative.

Once collected and controlled at the fan apices, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 5 are directed north and combined with outflows from Fan 4 via an excavated channel section in order to cross a subwatershed divide. One large off-line detention basin is required to restrict peak flow at Sun Valley Parkway to the existing culvert capacity.

10.3.2 Key Features

- $76.2 million is the estimated total cost
- Two on-line basins with a total excavation volume of 86 acre feet
- One off-line basin with a total excavation volume of 243 acre feet
- 7.4 miles of corridors
- 353 acres needed for right of way

10.3.3 Advantages

- Eliminate flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing

10.3.4 Disadvantages

- Large costly structures
- Requires excavation of one reach to cross subwatershed divides to combine outflow corridors
- Requires a large off-line basin at Sun Valley Parkway

10.3.5 Opportunities

- Provides path from Hassayampa River to near Regional Park boundary near planned connection

10.4 ALTERNATIVE B3 - Summary Sheet for Hassayampa River Sub-Area

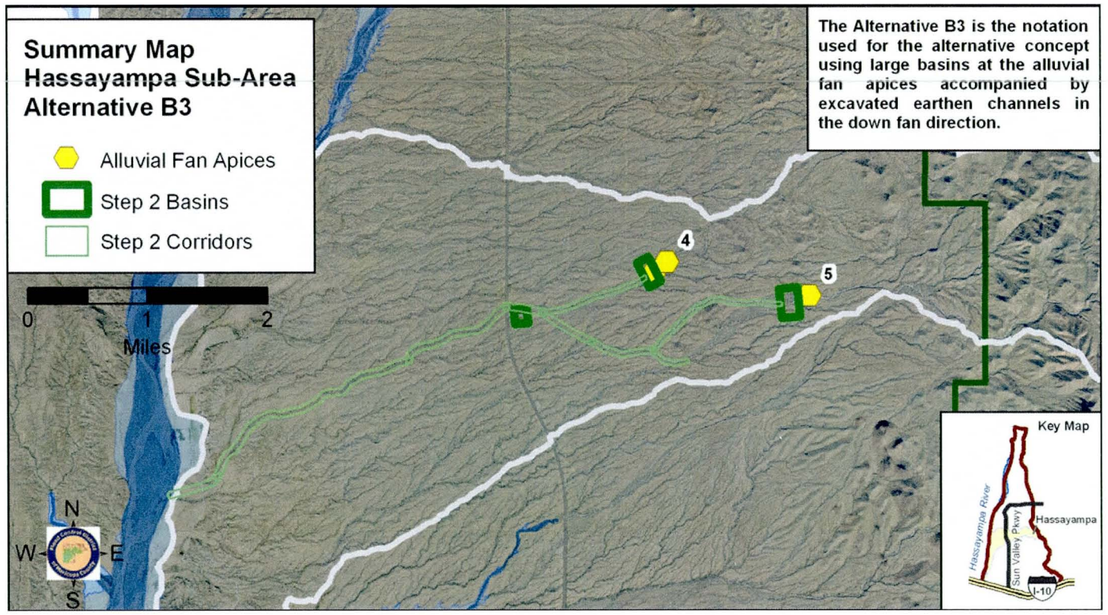


Figure 30 Summary Map of Alternative B3 for the Hassayampa River Sub-Area

10.4.1 Description for Alternative B3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the apices to the outfall at the Hassayampa River. Alternative B3 is based on using a relatively smaller on-line detention basin at the apex accompanied by excavated earthen channel sections in the down fan direction. The excavated earthen channels are complemented with a 120-foot wide adjacent riparian preservation corridor. The B3 Alternative is based on the alignment from the B4-1 Alternative.

Once collected and controlled at the fan apices, the flows are routed downstream using excavated earthen channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 5 are directed north and combined with outflows from Fan 4 via an excavated channel section in order to cross a subwatershed divide. One off-line detention basin is required to restrict peak flow at Sun Valley Parkway to the existing culvert capacity.

10.4.2 Key Features

- $118.8 million is the estimated total cost
- Two on-line basins with a total excavation volume of 658 acre feet
- One off-line basin with a total excavation volume of 50 acre feet
- 7.4 miles of corridors
- 226 acres needed for right of way, including the riparian preservation corridor

10.4.3 Advantages

- Eliminate flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk a system which minimizes the impacts of development phasing
- Preserves riparian corridor in undisturbed state

10.4.4 Disadvantages

- Large costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill
- Requires excavation of one reach to cross subwatershed divides to combine outflow corridors
- Requires an off-line basin at Sun Valley Parkway

10.4.5 Opportunities

- Provides path from Hassayampa River to near Regional Park boundary near planned connection

10.5 ALTERNATIVE B4-1 - Summary Sheet for Hassayampa River Sub-Area

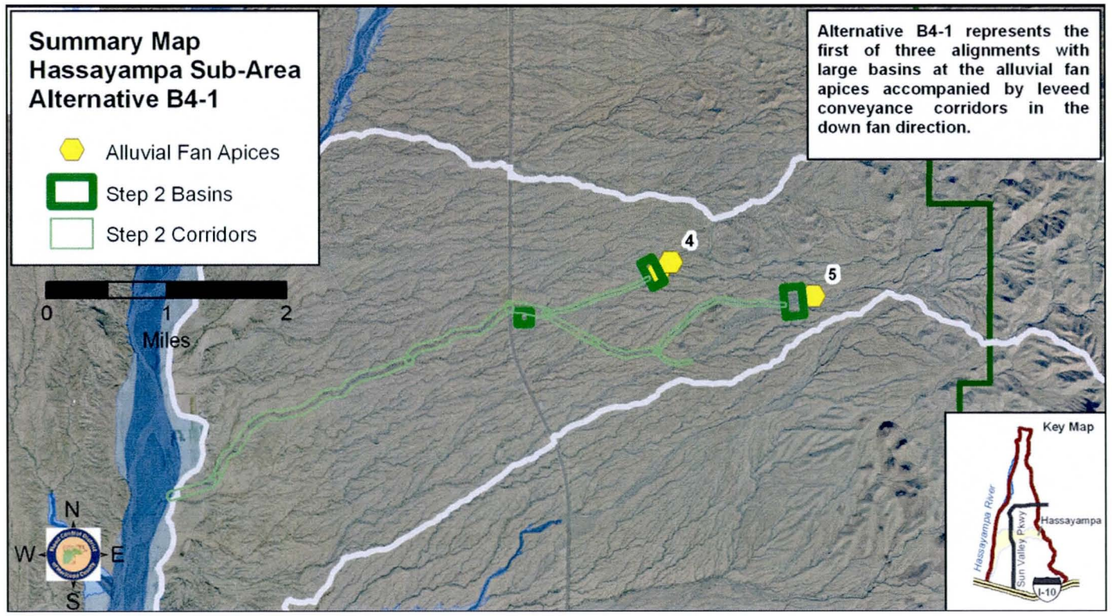


Figure 31 Summary Map of Alternative B4-1 for the Hassayampa River Sub-Area

10.5.1 Description for Alternative B4-1

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the apices to the outfall at the Hassayampa River. Alternative B4-1 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. It is the first of three corridor alignments considered as part of the Alternative B4 series.

Once collected and controlled at the fan apices, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 5 are directed north and combined with outflows from Fan 4 via an excavated channel section in order to cross a subwatershed divide. One off-line detention basin is required to restrict peak flow at Sun Valley Parkway to the existing culvert capacity.

10.5.2 Key Features

- $69.3 million is the estimated total cost
- Two on-line basins with a total volume of 658 acre feet
- One off-line basin with a total volume of 50 acre feet
- 7.4 miles of corridors
- 266 acres needed for right of way

10.5.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Nearly balanced cut & fill requirements

10.5.4 Disadvantages

- Large costly structures
- Requires excavation of one reach to cross subwatershed divides to combine outflow corridors
- Requires an off-line basin at Sun Valley Parkway

10.5.5 Opportunities

- Provides path from Hassayampa River to near Regional Park boundary near planned connection

10.6 ALTERNATIVE B4-2 - Summary Sheet for Hassayampa River Sub-Area

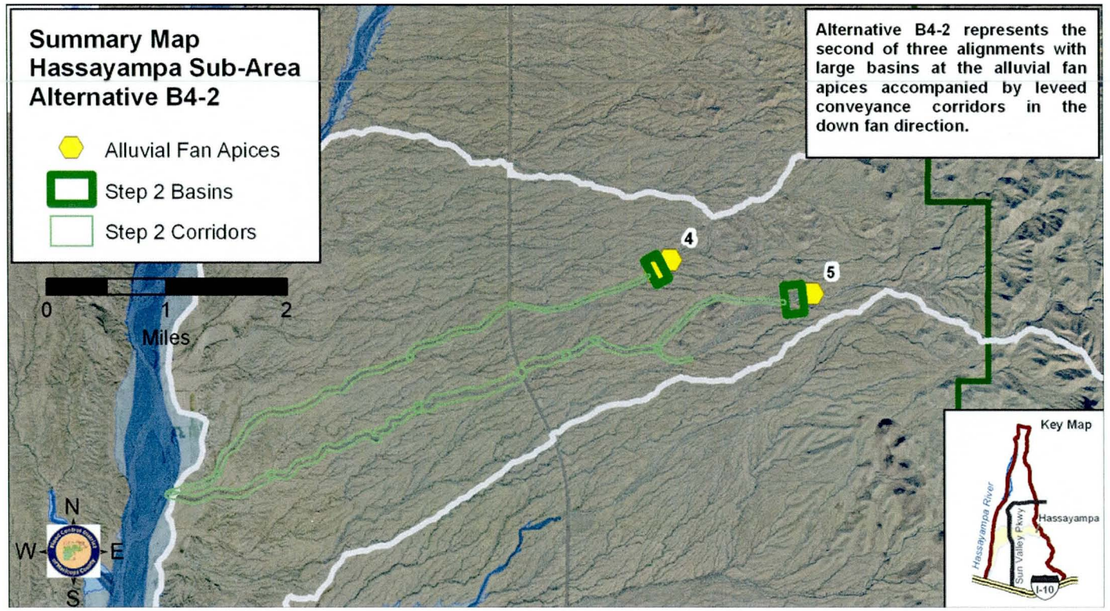


Figure 32 Summary Map of Alternative B4-2 for the Hassayampa River Sub-Area

10.6.1 Description for Alternative B4-2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the apices to the outfall at the Hassayampa River. Alternative B4-2 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. It is the second of three corridor alignments considered as part of the Alternative B4 series.

Once collected and controlled at the fan apices, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 4 and Fan 5 are directed west to the Hassayampa River via separate corridors. The existing culverts at Sun Valley Parkway have sufficient capacity to pass the 100-year peak flow.

10.6.2 Key Features

- $90.3 million is the estimated total cost
- Two on-line basins with a total excavation volume of 672 acre feet
- No off-line basins
- 10.9 miles of leveed corridors
- 361 acres needed for right of way

10.6.3 Advantages

- Eliminate flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides a trunk system which minimizes the impacts of development phasing
- Maximizes use of existing natural channel capacity

10.6.4 Disadvantages

- Large costly structures

10.6.5 Opportunities

- Provides multiple paths from Hassayampa River to near Regional Park boundary near planned connection

10.7 ALTERNATIVE B4-3 - Summary Sheet for Hassayampa River Sub-Area

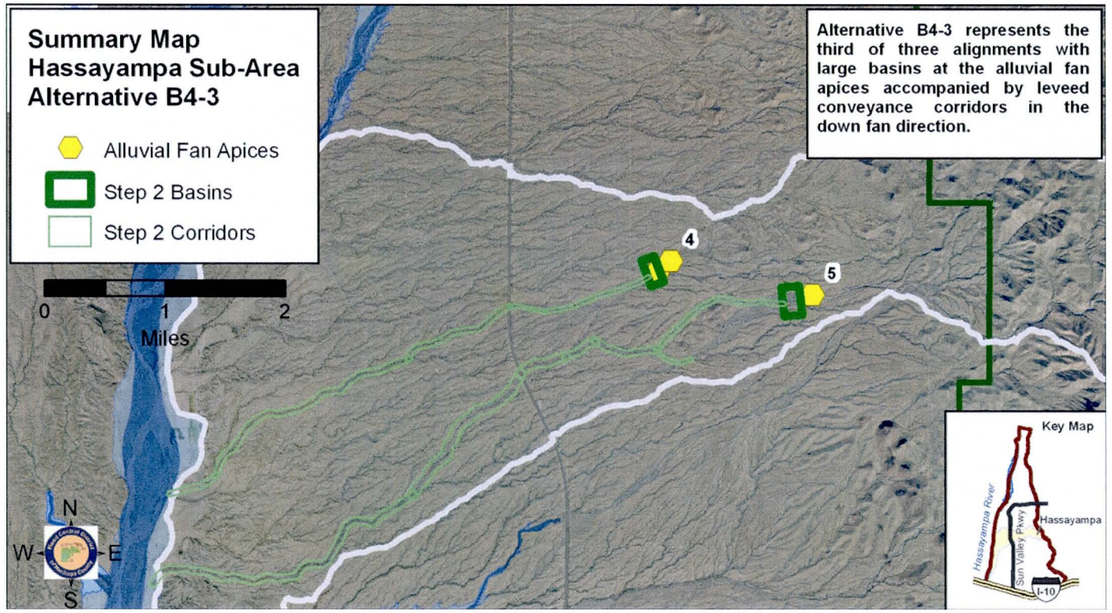


Figure 33 Summary Map of Alternative B4-3 for the Hassayampa River Sub-Area

10.7.1 Description for Alternative B4-3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the apices to the outfall at the Hassayampa River. Alternative B4-3 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. It is the third of three corridor alignments considered as part of the Alternative B4 series.

Once collected and controlled at the fan apices, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 4 and Fan 5 are directed west to the Hassayampa River via separate corridors. The existing culverts at Sun Valley Parkway have sufficient capacity to pass the 100-year peak flow.

10.7.2 Key Features

- $93.9 million is the estimated total cost
- Two on-line basins with a total excavation volume of 672 acre feet
- No off-line basins
- 11.6 miles of leveed corridors
- 382 acres needed for right of way

10.7.3 Advantages

- Eliminate flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides a trunk system which minimizes the impacts of development phasing
- Maximizes use of existing natural channel capacity

10.7.4 Disadvantages

- Large costly structures

10.7.5 Opportunities

- Provides multiple paths from Hassayampa River to near Regional Park boundary near planned connection

10.8 ALTERNATIVE C - Summary Sheet for Hassayampa River Sub-Area

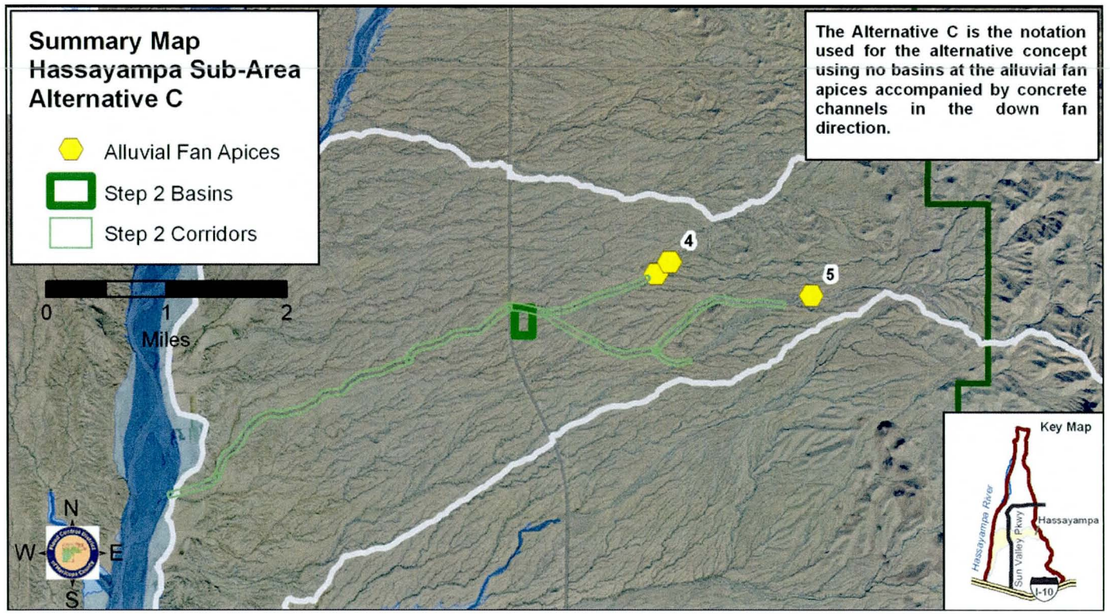


Figure 34 Summary Map of Alternative C for the Hassayampa River Sub-Area

10.8.1 Description for Alternative C

Alternative C is based on the concept of an excavated concrete-lined channel from the apex to the outfall, without providing any detention basin is at the apex. To address sedimentation associated with the alluvial fan systems, sedimentation basins are provided throughout the system. The excavated concrete channels are complemented with a 120-foot wide adjacent riparian preservation corridor. The C Alternative is based on the alignment from the B4-1 Alternative.

Once collected and controlled at the fan apices, the flows are routed downstream using excavated concrete channel sections until the flows reach the outfall along the Hassayampa River. Flows from Fan 5 are directed north and combined with outflows from Fan 4 via an excavated channel section in order to cross a subwatershed divide. One large off-line detention basin is required to restrict peak flow at Sun Valley Parkway to the existing culvert capacity.

10.8.2 Key Features

- $146.0 million is the estimated total cost
- One off-line basin at Sun Valley Parkway with an excavation volume of 210 ac-ft
- 7.4 miles of corridors
- 232 acres needed for right of way, including the riparian preservation corridor

10.8.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Preserves riparian corridor in undisturbed state

10.8.4 Disadvantages

- Costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill
- Requires excavation of one reach to cross subwatershed divides to combine outflow corridors
- Requires a large off-line basin at Sun Valley Parkway
- Potential aesthetic concerns even with architectural treatments and preservation corridor
- Potential safety concerns to persons caught in channels during flooding

10.8.5 Opportunities

- Provides path from Hassayampa River to near Regional Park boundary near planned connection

10.9 ALTERNATIVE D - Summary Sheet for Hassayampa River Sub-Area

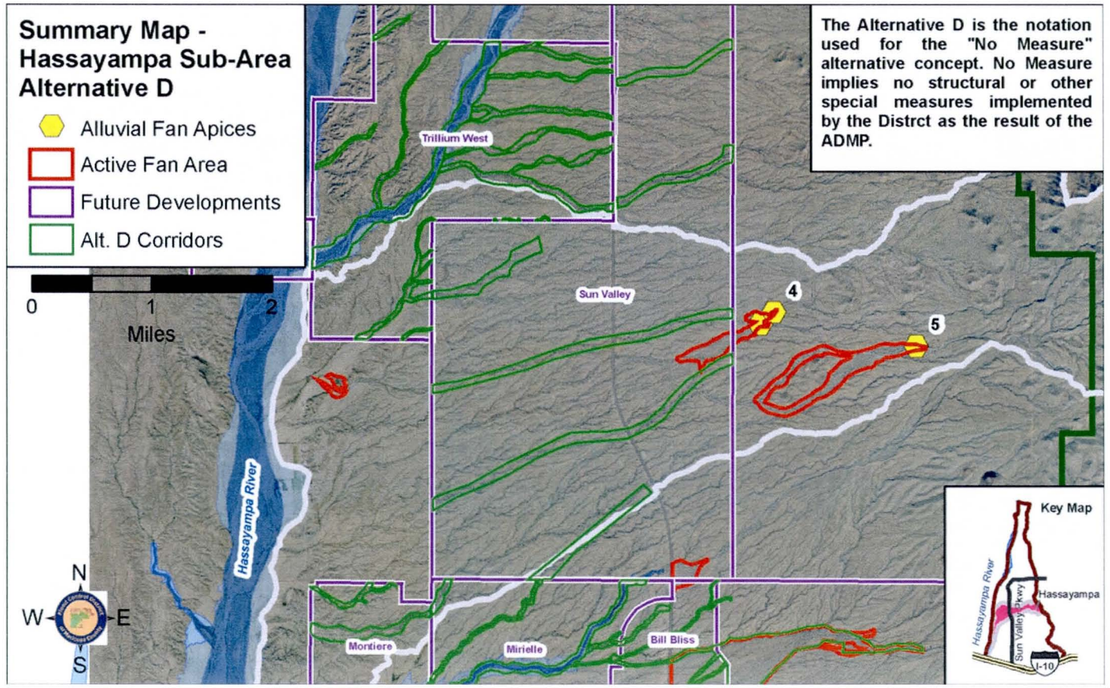


Figure 35 Summary Map of Alternative D for the Hassayampa River Sub-Area

10.9.1 Description for Alternative D

Alternative D relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

In the Hassayampa Sub-area, distributary channels from Fans 4 and 5 eventually lead to four separate outlet washes to the Hassayampa River. While the fan apices are currently on State Land, many of the logical locations for proposed flow split stabilization structures lie upstream of the Sun Valley development. Downstream of the Sun Valley development no master planned communities have been proposed to date. Therefore, the fate of these washes is uncertain.

10.9.2 Key Features

- Hazards addressed entirely by future development

10.9.3 Advantages

- Requires no direct public expenditures

10.9.4 Disadvantages

- Discontinuity of solutions across development boundaries
- Unnecessary redundancies in flood control solutions
- Long-term maintenance assurances
- Concerns with timing and phasing of development and flood control mitigation measures

10.9.5 Opportunities

- Development pays for all required drainage infrastructure

11 ALTERNATIVES EVALUATION

11.1 Evaluation Criteria

Criteria to evaluate the Step 2 alternatives were developed though a series of meetings with the project team. Table 13 shows twenty-three criteria in three broad categories that were selected for evaluation of the Step 2 alternatives. The same evaluation criteria were used for all of the ADMP piedmont sub-areas including the Hassayampa River sub-area.

Table 13 Step 2 Alternative Evaluation Criteria

Public Safety Criteria (Function)	
1) Public Safety Enhancement • Improve Public Infrastructure • Reduce Flood Level • Number of People Impacted	**2) Level of Damage Reduction** • Dollar Costs Saved/Reduced • Flood Frequency Impacted
3) Transportation Impacts • Collector or Arterial Roadway • Only Access • Number of People Impacted	**4) Upstream/Downstream Impacts** • Stand Alone • Systematic Solution
5) Relative Risk of Failure • Lower than average • Average • Greater than average	**6) Eliminates Flood Problem** • Partial Solution • Whole Solution
7) Design Certainty • Captures apex flow •	**8) Constructability** • Excavation excess •
Economic Criteria (Common)	
9) Comparative Benefit Cost • Dollars • Number of People • Regional Solution • Recoverable Flood Plain	**10) ROW Acquisition Necessary** • Existing ROW Available • Amount Needed • Private or Public Land
11) Condemnation Required • Yes • No	**12) Cost of Implementation (in $1,000)** • < than $50,000 • < than $500,000 • < than $1,000,000
13) Maintenance Cost • Lessened • Increased • Neutral • Comparative to Other Measure	**14) Potential Cost Sharing Partner** • Already Contacted • Already Willing • Possibly
Social/ Environmental/ Aesthetic/ Multi-Use Criteria (Form)	
15) Public Support • Known • Anticipated • Unknown	**16) Public Acceptance** • Known • Anticipated • Applicable • Unknown
17) Addresses Public Complaint/Concern • Response From Public • Unknown	**18) Private Acceptance** • Known • Anticipated • Applicable • Unknown
19) Environmental Impacts • Habitat • Hazmat • Cultural • 404	**20) Complexity of Environmental Permitting** • Minimal • Average • Significant
21) Visual Resource Impacts/ Aesthetic Compatibility • Incompatible • Partially Compatible • Fully Compatible	**22) Multi-Use Opportunities** • Minimal • Average • Significant
23) F.C. Method Consistency with Buckeye Recreation Master Plan • Incompatible • Partially Compatible • Fully Compatible	

11.2 Evaluation Results

Table 14 through Table 17 present the scored results of the evaluation meetings held with the project team. Table 17 presents a summary of the recommended alternative for the Hassayampa River sub-area resulting from the process.

The alternatives evaluation was divided into two steps: 1) strategy evaluation and 2) evaluation by sub-area. In each of the two steps, the evaluation criteria listed in Table 13 were used to assign a lumped score for each of the three primary categories (Public Safety, Economic, and Social/Environmental/Aesthetic/Multi-use).

11.2.1 Strategy Evaluation

The relative merits and disadvantages of the alternatives are discussed in this section without considering any Hassayampa River sub-area specific issues. The evaluation criteria are presented for the type of treatment at the apices as well as the type of channel cross-section.

Alternative A - Sedimentation Area at Apex

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active alluvial fan area downstream of the apex. This designated active alluvial fan area is the highlight of this alternative and distinguishes this alternative with other alternatives where basins are used at the apices to control alluvial fan uncertainties. Therefore, the discussion below focuses mainly on the designated alluvial fan area. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The lack of basins could result in no significant reduction in the peak discharges. Thus, the risk of failure in the downstream is not reduced due to lack of reduction in the peak discharges.
- Area set aside could be a potential hazard to public if access is not adequately restricted.
- Sediment deposition will occur in the area. Deposition within the collector channels must be handled through maintenance. If proper maintenance is not performed, channel capacity may be reduced leading to overflow.
- Area set aside may be used for other purposes. This might include transportation; though roadways are not recommended within the set aside area.
- The designated active area is not available for development. Therefore the land costs for the A Alternative can be significant, especially for the larger alluvial fans. In addition, the risk of impacts to downstream areas is higher (compared to other alternatives with the basins at the apex) due to uncertainties associated with the designated sedimentation area.

Economics:

- The set aside land area is usually large enough to significantly impact the land costs, especially for the larger alluvial fans.
- The construction cost will be significantly less compared to the basin-based alternatives where large excavation volumes can be expected to result in larger costs.
- The area required is large when compared to other alternatives.
- The peak discharges downstream of the apex region are larger compared to other alternatives where the presence of basins reduces the peak flows. The larger peak flows result in the need for larger structures downstream increasing the cost of the project.
- The lack of basins near the apex means that the fill material available from excavation is minimal. Therefore, the opportunity to re-use the excavated dirt as fill material is not present in this alternative.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The designated alluvial area is set aside to allow natural sedimentation process to occur. As a result, this area is not conducive for all types of recreational multi-use.
- This alternative is favorable from habitat preservation point of view since the existing natural corridor is mostly preserved in the designated sedimentation area. The collector channels require some disturbance to the natural habitat. However, they are not significant compared to the area of disturbance in the basin-based alternatives.
- This alternative may fair better in 404 permitting process.
- Preservation of the existing corridor as well as lack of major engineered structures provides minimal visual resources impacts. Since the existing corridor is preserved, the aesthetic compatibility is better compared to the basin-based alternatives. Cultural and hazmat impacts are also expected to be minimal applying a similar reasoning.

Alternative B - Big Basin/Small Basin/Off-line/On-line

The main objective Alternatives B2, B3, B4-1, B4-2, and B4-3 is to evaluate the effectiveness of basins at the apices as flood control measures. The B2 alternative represents the big-basin option while the B3 represents a smaller basin. Both are on-line basin options. The B4 Alternatives is a small off-line basin for water and an in-line sediment only basin. The basin at the apex is the highlight of these alternatives and distinguishes them from other alternatives where basins are not used at the apices to control alluvial fan uncertainties and/or reduce peak discharges. Therefore, the discussion below focuses mainly on the basins at the apices. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The basin alternatives provide design certainty from the flood control point of view by capturing the flows at the apices and metering them downstream in a controlled fashion.

- The on-line basins are generally preferred to off-line basins as they provide a higher degree of certainty with respect to the control of the active alluvial fan.
- The presence of the basin results in lowered peak discharges. Lower peak discharges correlate to lower risk of failure and public endangerment downstream. However, flows will last longer resulting in increased duration of flood exposure to the public. Lower peak discharges also reduce the number of people potentially impacted by a flood event.
- The failure of the basin itself could be more dangerous than a conveyance only strategy because of reduced conveyance downstream. Significant development can be anticipated to occur near the washes that carry the outflow from the basins and hence more at risk in the event of a basin failure or discharges in excess of the basin design. However, the possibility of failure of the basin is considered low. As a result, the presence of the basin at the apex can be, in overall, considered as a reduction in potential downstream flood related risks.
- The large basin (B1 Alternative) can be expected to influence the bigger flood events with significant reduction in the peak discharges. The presence of the basin may not influence smaller events and the smaller flows could go through the basins relatively unhindered. The significant reduction in the peak discharges will potentially benefit a larger area.
- For the small basin (B2 Alternative), the reduction of peak discharge at the apex is not as high as in large basins (B1 Alternative). The downstream peak flows can still be quite large compared to upstream peak flows. As a result, the potential downstream risks in terms of area of benefit as well as number of people benefited are also larger. However, a small basin will be more beneficial when compared to Alternatives A and C where there are no basins at the apices.
- Sedimentation is expected to occur within the basins requiring regular maintenance. However, if unusually high sedimentation occurs during a large flood event, the storage capacity of the basins can be reduced causing a flooding problem for the downstream properties. Risk from failure of the sedimentation capacity is greater for the off-line basin.
- There is a potential risk exposure to public if the basins are designed to accommodate recreational uses. Flood water will enter at least a portion of the basin during even smaller floods posing a potential danger to recreationists within the basins.

Economics:

- The big basins (B1) cover a larger area compared to B2 and B5 alternatives. However, the right of way (ROW) area needed will be smaller when compared to that of the A alternative where much larger area is designated as the sedimentation area.
- The basins can be designed as multi-use recreational facilities. The land area set aside for the construction of the basins could also act in lieu of the open space requirements. These multi-purpose uses of the land may reduce the apparent cost of the land.
- The land area at the apices is not presently developed. Therefore, condemnation of existing developed properties may not be needed to facilitate the construction of the basins.
- Excavation is the major part of the construction of the basins. Given the long period of deposition at the apices, the excavation process may be relatively easy. However, construction of the basins could become difficult if significant bed rock is encountered during excavation.
- The excavation excess can be potentially used as fill material for the levees. The big basin (B1) alternative will produce more excess material compared to the B2 alternative. The availability of fill material for the construction of levees can be a significant benefit in terms of construction costs.
- The big basin (B1) alternative has larger maintenance costs compared to the smaller basin (B2 or B5) alternatives. The differences are directly related to the size of the basins and volume of flows captured.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The basins provide considerable opportunity for recreational and other multiple-uses.
- Significant excavation will be needed to construct the basins. The basins will be larger for the B1 alternative and will have larger impact on the visual and aesthetic compatibility. The basins will have to be enhanced to achieve compatibility with the landscape of the area which will require additional expenditures.
- The basin excavations can be expected to impact the natural habitat as well.
- The excavations may also have cultural implications and exact excavation locations may have to be determined if cultural impacts are determined. However, native people's activities in the area were generally limited to hunting and gathering. No known habitations exist in the area.
- If developed recreational facilities are not part of a basin, the larger basins provide potential open space area for future wildlife habitat.
- Hazmat impacts at the basin locations are mostly unknown, but are not expected to be a significant limitation.
- The disturbance to the existing corridor is likely to play a key role in the 404 permitting process. Mitigation of the environmental impacts must the planned and designed to aid in the approval of the 404 permitting process.

Leveed Corridors

The leveed corridor is designed as the flow conveyance from the upstream apex to the downstream outfall. Existing washes are contained between designed earthen levees and/or walls on both sides to provide adequate conveyance.

Public Safety:

- The levees/walls provide engineered means of flow conveyance. The inclusion of adequate freeboard ensures the design certainty for flows up to the 100-year flow event. In other words, the flows (up to the 100-year event) can be expected to be conveyed from the apex to the outfall in a predictable controlled fashion as long as the levee/walls function as designed. This flow containment provides an improvement in

public safety compared to existing conditions where the naturally existing banks may or may not provide adequate flow containment or erosion protection.

- The 100-year event design flow could be significantly higher than the flow capacity of the existing channel. While the levees will contain flow within the designed channel corridor, changes can be anticipated in the channel cross-section due to the change in the flow rates. The smaller events could lead to a meandering channel as well as a flatter low flow channel slope. While the channel configuration can be expected to transform due to changes in flow conditions, flow containment will still be achieved through levees and the freeboard. The designed levees/walls satisfy the FEMA freeboard requirement of at least 3 feet above the 100-year water surface elevation.
- Drastic events such as levee failures could result in catastrophic impact to the properties adjacent to the selected conveyance paths. The conveyance relies on the successful functioning of the levees unless adequate conveyance capacity already exists.
- The presence of levees at road crossings requires an elevated bridge over the corridor to facilitate transportation requirements while in the case of excavated channels bridges need not be elevated above existing ground. A bridge could be avoided if the local topography allows for easy crossing of the levees. In such cases, a dip crossing could be used. Dip crossings can provide considerable cost savings compared to bridges. However, from public safety point of view, dip crossings are not preferred because of the risk they pose to motorists during flooding. Bridges provide higher certainty in transportation access during flood events.

Economics:

- The excavation excess material can be used to construct the levees. This presents an opportunity to avoid hauling away the excavated material as well as hauling in of fill material. This can potentially lead to significant cost savings.
- The selected conveyance paths are located along existing wash corridors with existing flood hazards. Therefore, at least part of the area may have been located in a floodway with limited development options potentially reducing land acquisition costs.
- It is possible that adequate conveyance is available based on existing topography at several locations along the selected conveyance paths. This could eliminate the need for a levee while providing the necessary flow containment. In such situations, there would be a considerable cost savings as well as reduction in risk. Channel banks may still require erosion protection but flow containment will likely be not compromised.
- The structures such as levees, walls, grade control structures, as well as, sedimentation basins will require regular maintenance to ensure continuous and proper functioning. Sedimentation basins shall be located where significant deposition is expected. Any deposited material should be removed on a periodic basis or after a significant flood event. Erosion can be expected to be contained by the grade control structures and bank protection. However, localized erosion problems may still arise requiring monitoring and repair as needed.
- It is possible that the land set aside for the leveed corridor can also be used to satisfy the open space requirements. This could result in significant cost savings.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The leveed corridor leaves most of the existing corridor undisturbed. The construction of the levee and the grade control structures can be expected to disturb only parts of the corridor. Typically, the levees are less than 5 ft tall and 200 to 400 ft apart. This makes this option visually compatible with the existing surrounding and also quite favorable from the environmental permitting and cultural point of view.
- The top of levees presents the possibility of use as a trail. Other multi-use opportunities will be very limited in nature since the existing corridor is relatively not influenced by the design.
- The walled corridor option includes parallel buffer areas that could also provide multiple use opportunities adjacent to the conveyance area.

Excavated Channel – Earthen (B3) and Concrete (C)

The excavated channel is designed as a companion channel to the existing wash corridor which is preserved. Two types of excavated channels were evaluated: an earthen excavated channel (B3), and a concrete excavated channel (C).

Public Safety:

- The entire flood conveyance channel is below ground and is designed to have a freeboard of at least 1 ft for the 100 year event. The channel, thus, has adequate conveyance for all flows up to the 100-year flow. The conveyance as designed could be reduced by significant deposition or increase in vegetation. However, these changes must be quite dramatic to pose a significant risk of overflow.
- The excavated channels will deliver flow faster than the channel with natural cross-section. Faster flows pose a more serious public safety problem if people or animals get caught in the flow.
- The banks of the earthen excavated channel (B3) are protected from failure through bank and toe protection. In the event of bank protection failure, the channel may shift location and cause damage to adjacent property. While this scenario represents a structural failure, flow is likely to be still contained. Therefore, such a potential failure does not pose a widespread, significant public safety problem.
- The concrete channel (C) could also experience a lining failure, but is considered less likely than for an earthen channel.
- The channel is designed to a slope that is flatter than the existing slope. The designed slope is maintained by grade control. Grade control failure could lead to similar channel location changes as in B3. Another consequence of failure could be damage to underground utilities. Again, the concrete channel would be expected to have a lower chance of experiencing drop structure failure.

Economics:

- The excavation volume is exorbitantly high and represents a significant portion of the total cost of the excavated channel alternatives. Hauling away of the excavated excess could be major obstacle. Concrete channels, in addition, require concrete lining of the entire channel cross-section. The establishment of concrete lining is also very expensive and could form a significant portion of the total project cost.
- The land needed for the excavated channel and the adjacent existing corridor is generally similar to the levee/wall corridor needs. Therefore, the excavated channels do not significantly lower land costs.

- The excavated channels provide the opportunity to avoid the construction of the bridges at road crossings. The conveyance is below ground and could be handled by structures such as box culverts. The adjacent preserved wash would also need to be crossed in some fashion.
- Sedimentation basins will be located in places where significant deposition is anticipated. Periodic maintenance is needed to clear the collected sediment deposits.
- The earthen excavated channel may encounter localized erosion while this is not a problem in concrete channels. Monitoring and erosion maintenance of the excavated channels will be needed to ensure long-term functionality of the channels.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The excavated channel is located adjacent to an existing wash corridor. This will leave the existing corridor completely undisturbed. This is favorable for habitat preservation. The visual impacts can be significant since the excavated channel, particularly with concrete lining, is considered less aesthetically pleasing than the levee/wall corridor.
- The environmental impacts could be minimal since the channel is located separately from the corridor. However, the existing corridor must be provided with an irrigation mechanism to ensure sustainability of the natural habitat. Flow could come from the flood channel or adjacent tributary areas.
- The excavated channel provides possibilities for multiple-use such as trails.

Alternative D

The "No Measure" alternative relies on existing drainage and floodplain regulations to manage the alluvial fan flood and sedimentation hazards. Individual developments would provide flood hazard mitigation measures for their own properties.

Public Safety:

- Hazards will be addressed entirely by future development. Local communities will have to review and approve all proposed drainage facilities.
- The potential for a discontinuity of solutions across development boundaries exists.
- Long-term maintenance of any constructed facilities is potentially less certain.

Economics:

- Developers would pay for their own improvements. Costs are likely to be passed on to the individual residential and commercial property buyers.
- Because of the distribution of land ownership and the timing/phasing of individual development, there exists the potential for some unnecessary redundancies in future flood control solutions.
- Long-term maintenance assurances needed for some facilities may require public expenditures.
- Depending on the phasing of development and the selected flood control solutions, the potential exists for large areas of development to be constructed within FEMA floodplains.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- Continuity of trails and other multiple-use elements of flood control facilities is not assured.
- Aesthetic treatment will be left to individual developments.
- The cumulative impacts of development may not be recognized in environmental permitting or mitigation requirements.

Outcome

Public Safety

Alternative A has a designated sedimentation area at the apices compared to other alternatives which have basins. The presence of the basins provides design certainty aiding in the control of the flows coming down the hills at the apices. This key advantage makes the basin based alternatives more preferable over Alternative A. Alternative C represents the concrete channel option without any detention at the apex. This alternative is favored slightly better compared to Alternatives A and D as it would have higher design certainty due to the concrete channels starting all the way from the apex. Alternative B5 represents the off-line basin option at the apex. This alternative ranks lower than the on-line basin alternatives. This is mainly due to uncertainties related to the functionality of the side-weirs/gates to split and let the larger flows enter the off-line basins. The on-line basins, on the other hand, have a well defined inlet taking the flow into the basins. In addition, the longer dimension of the on-line basins is perpendicular to the flow direction. This reduces the uncertainty of flow not entering the on-line basin.

For the purpose of discussing public safety aspects, the types of channel cross-sections can be categorized as leveed corridors or excavated channels. The excavated channel can have earthen or concrete lining. All the alternatives except C and D are ranked similarly. Alternative C represents the concrete channel option is ranked lower. The concrete channels tend to be narrower and deeper than the other alternatives with higher velocities. The higher velocities have negative influence on public safety with the possibility of larger damage when some type failure occurs. In addition, there is higher probability of people getting stuck in the flood waters. These factors resulted in a lowered ranking for the concrete channel.

Alternative D represents the developer initiated flood control measure. This alternative has a considerable uncertainty over the implementation of adequate and reliable system-wide flood control as it leaves the development of solutions to third parties. The continuity of the design certainty from an upstream development and the immediately downstream development may not be well determined due differences in developer priorities, phasing,

and other issues. As a result, Alternative D ranks lower than the leveed corridor while it still ranks higher than the concrete channel alternative (C). In conclusion, the leveed corridor arises as the preferred alternative from the channel cross-section point of view.

Economics

The cost estimates for the various alternatives were used to determine the relative merits of each alternative in terms of economics. Land cost, excavation cost, levee-fill cost, and the channel-lining cost represent the major cost contributors. Alternatives B3 and C represent excavated earthen and concrete channels. The channel excavation costs for these alternatives are significantly higher than the levee-fill costs for the leveed-corridor alternatives. This is a direct result of the large lengths of the channels to convey the flow from the apices to the outfall. This makes the excavated channel alternatives less favorable compared to leveed corridor alternatives from the cost point of view. In addition to the excavation costs, Alternative C also involves the channel lining cost even though Alternative C has not only a sedimentation basin at the apex. The motivating notion behind Alternative C is to avoid having a basin at the apex and, instead, conveying the flow quickly through the concrete channel. Due to large lengths of the channels, lining the channel with concrete is significantly more expensive than placing a basin at the apex. These factors makes Alternative C economically less favorable compared the earthen excavated channel or the other alternatives where a basin is present at the apices.

Alternative A represents the non-structural solution at the apex with the designated sedimentation area. As the designated sedimentation is not amenable for any other use, the cost of land set aside is not subsidized by additional usage. The designated sedimentation areas are significantly large due to hydraulic and sedimentation uncertainties at the apices. As a result, Alternative A fairs unfavorably with regards to cost. In conclusion, the alternatives with basins at the apices and leveed-corridors as the means of conveyance represent the preferred alternative in terms of cost.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

The on-line basins and the excavated channel alternatives scored lower than the other alternatives for the social, environmental, aesthetic, and multi-use criteria. Excavation was viewed as having a greater environmental and aesthetic impact than the alternatives without excavation. The D Alternative was viewed as having a relatively higher score because of the perception that a greater number of corridors would be provided than compared to the regional facilities proposed in the other alternatives. However, this scoring did not reflect the fact that the "extra" corridors would be required for preservation as part of the development plan with or without the regional facility.

Summary

Table 14 shows the weighted scoring results from the strategy evaluation process. The result was a clear preference for the basin alternatives at the apices with the levee/wall corridors as the conveyance mechanism downstream (alternatives B1, B2, B4, & B5). The B4 alternatives represent the alignment variations which were evaluated in the sub-area specific evaluation described in Section 11 and are strategically similar to the B1 alternative. The B5 alternative, though scoring the same as B1 and B2, is considered less preferable due to the potential public safety and performance concerns. Therefore, the sub-area specific evaluation focused on the B1 and B2 options with an emphasis on the relative strengths and weaknesses of the various alignments. The D Alternative was carried forward to the sub-area evaluation as a requirement of the ADMP process.

Table 14 Strategy Selection Matrix

Alternative Measure		Evaluation Criteria			Ranking
Alternative Measure	**Alternative**	**Public Safety**	**Economic**	**Social/Environmental**	**Total Score**
Example (Rank 1-3 where 1 = least preferred)	**A**	**3**	**2**	**1**	**6 of possible 9**
APEX	A	1	1	3	5
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	2	3	3	8
	C	2	1	1	4
	D	1	2	3	6
CROSS SECTION	A	3	1	2	6
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	3	3	2	8
	C	2	1	1	4
	D	2	2	3	7
Combined Score for Apex and Cross Section	A				11
	B1/B2				16
	B3				12
	B4				16
	B5				16
	C				8
	D				13
Primary Preferred Alternative	B1/B2/B5/B4				
Secondary Preferred Alternative	D				

11.2.2 Sub-Area Evaluation

The Hassayampa River sub-area was primarily an alignment variation alternative evaluation. In addition to the alignments, the small basin (B2) and off-line basin (B5) apex strategies were also carried over to the sub-area evaluation for the Hassayampa sub-area.

During the sub-area evaluation process, the nine "Form" criteria were lumped into four related categories: Environmental, Permitting, Visual/Aesthetic, & Recreation/Multiple Use which were used to assess the preferred alternative for the sub-area. Table 15 shows the results of the social, environmental, aesthetic, and multi-use criteria evaluation using the four "Form" categories. Table 16 shows the results of the public safety and economic criteria evaluation. Table 17 shows the results preferred alternative for each sub-area based on the outcome from the evaluation of both "Form" and "Function" by the project team.

The B4-3 alternative was selected as the preferred alternative according to the Form criteria. The important merits were the larger basin size and connectivity opportunities to the Regional Park. A larger basin was felt to provide greater recreational and/or habitat opportunities than the smaller basin alternatives. The B4-1 alternatives were preferred according to the Function evaluation due to its lower cost.

Table 15 Alternative Evaluation Matrix by Sub-area (Form)

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria				Ranking	
Alternative Measure	Alt.	Public Safety	Economic	Environmental	Permitting	Visual/ Aesthetic	Recreation / Multi-Use	Total Score	Preferred Alternative
Example (Rank from 1-3; 1 = least preferred)	B5	3	3	3	2	1	1	7 of possible 12	
Hassayampa Sub-Area	B4-1			2	1	1	1	5	B4-3
	B4-2			2	1	2	2	7	
	B4-3			3	1	3	3	10	
	B5			3	1	3	2	9	
	D			3	3	1	1	8	

Table 16 Alternative Evaluation Matrix by Sub-area (Function)

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria	Ranking	
Alternative Measure	Alternative	Public Safety	Economic	Social/ Environmental	Total Score	Preferred Alternative
Example (Rank from 1-3 where 1 = least preferred)	B1	3	2	1	6 of possible 9	
Hassayampa Sub-Area	B2	1	3		4	B4-1/B4-3
	B5	1	3		4	
	B4-1	2	3		5	
	B4-2	3	2		5	
	B4-3	3	2		5	
	D	1	1		2	

Table 17 Alternative Evaluation Matrix by Sub-area (Combined)

Alternative Measure		Preferred Alternative		Preliminary Recommended Alternative
Alternative Measure	Alternative	Form	Function	
Hassayampa Sub-Area	B2	B4-3	B4-1/B4-3	B4-3
	B5			
	B4-1			
	B4-2			
	B4-3			
	D			

11.2.3 Preliminary Recommended Alternative for Hassayampa River Sub-area

The B4-3 alternative was selected as the recommended alternative for the Hassayampa River sub-area. Non-structural elements also comprise portions of the recommended alternative and will be emphasized through the incorporation of existing wash capacity in Step 3 (see Section 12 also).

12 RECOMMENDATIONS FOR STEP 3 FOR THE HASSAYAMPA RIVER SUB-AREA

Based on the outcome of the Step 2 alternatives evaluation a number of items for consideration in the refinement of the recommended alterative are suggested for Step 3 for the Hassayampa River sub-area. These recommendations are based on input received during the development of the proposed alternatives, the team evaluation process, and input from stakeholders and the public.

- On-line big basins are the preferred solution to control alluvial fan uncertainties at the apices.
- Multiple downstream levee/wall corridors are preferred whenever possible.
- There is a need to balance earthwork by project. For Step 3, a project will be considered the apex-to-outfall system for an individual alluvial fan (or fan complex if hydraulically connected).
- Existing channel conveyance should be quantified and incorporated into the recommended alternative designs. This could result in the elimination of some levee/wall reaches where the existing conveyance is adequate or natural lateral containment exists on one or more sides of the corridor. This will also maximize the use of non-structural or nearly non-structural reach management elements.
- The required landscape compatibility enhancements should be included explicitly in the hydrologic and hydraulic design.
- Incorporate the specific sediment data collected in Step 2 into the design calculations.
- Identify the area benefited using the Stage 3 delineations.
- Refine the design details including riprap sizing calculations and the evaluation of basin inlet structures (e.g., energy dissipaters, collection dikes/ ditches, off-line basin outlet structures, etc.)
- Refine the hydrologic models to include more HEC-1 subreaches, ideally one subreach per design reach.
- Discretize the quantities and costs by individual fan system (by "project")

13 SUMMARY

The proposed alternatives for the Hassayampa River sub-area of SVADMP were developed and evaluated in Step 2 of the ADMP process. The alternatives included both non-structural and environmentally friendly and aesthetically compatible structural flood control measures. Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple corridors was expressed by the project team, stakeholders, and the public.

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

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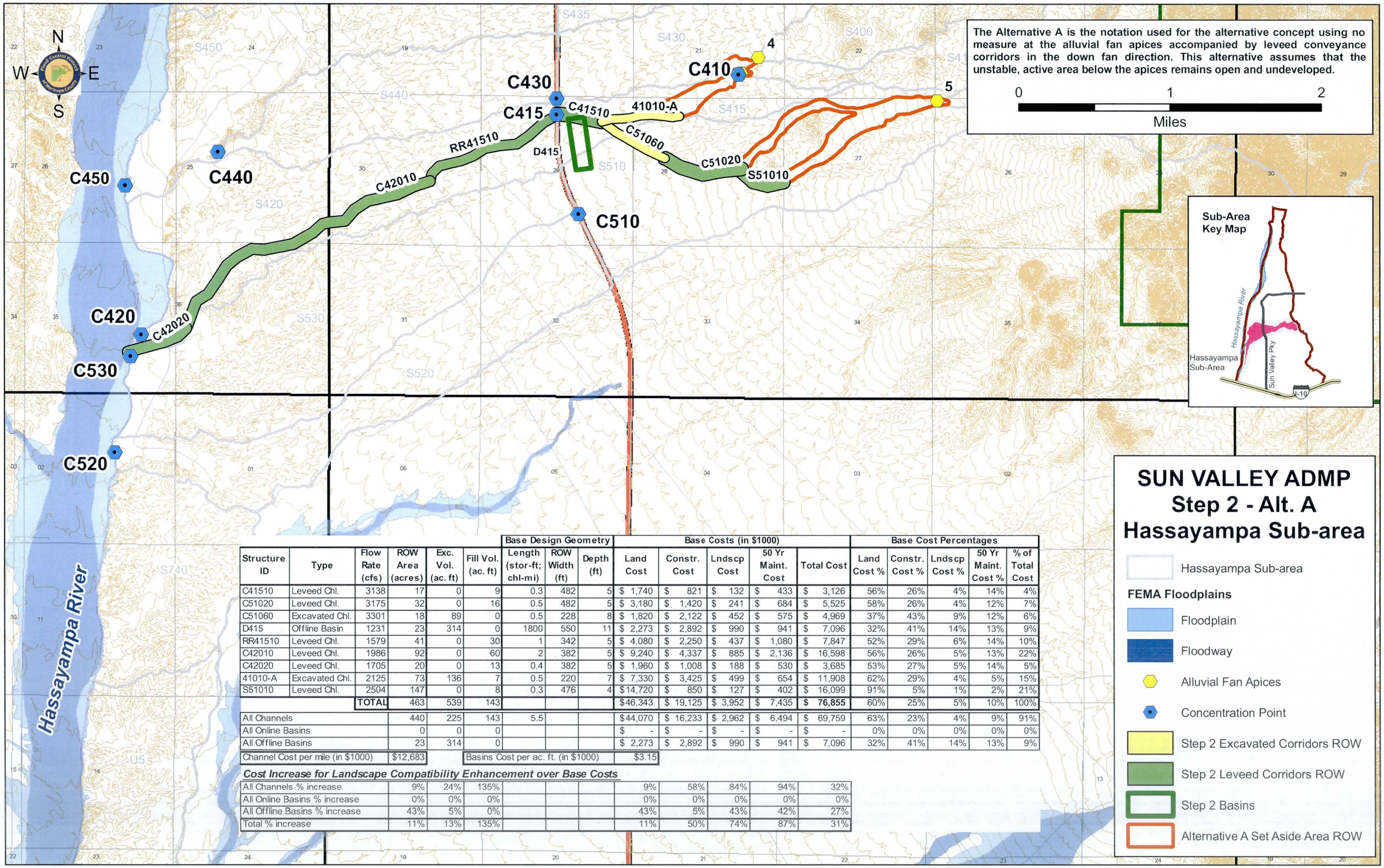
Appendix A

Design Analyses



						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
C41510	Leveed Chl.	3138	17	0	9	0.3	482	5	$ 1,740	$ 821	$ 132	$ 433	$ 3,126	56%	26%	4%	14%	4%
C51020	Leveed Chl.	3175	32	0	16	0.5	482	5	$ 3,180	$ 1,420	$ 241	$ 684	$ 5,525	58%	26%	4%	12%	7%
C51060	Excavated Chl.	3301	18	89	0	0.5	228	8	$ 1,820	$ 2,122	$ 452	$ 575	$ 4,969	37%	43%	9%	12%	6%
D415	Offline Basin	1231	23	314	0	1800	550	11	$ 2,273	$ 2,892	$ 990	$ 941	$ 7,096	32%	41%	14%	13%	9%
RR41510	Leveed Chl.	1579	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	10%
C42010	Leveed Chl.	1986	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	22%
C42020	Leveed Chl.	1705	20	0	13	0.4	382	5	$ 1,960	$ 1,008	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
41010-A	Excavated Chl.	2125	73	136	7	0.5	220	7	$ 7,330	$ 3,425	$ 499	$ 654	$ 11,908	62%	29%	4%	5%	15%
S51010	Leveed Chl.	2504	147	0	8	0.3	476	4	$14,720	$ 850	$ 127	$ 402	$ 16,099	91%	5%	1%	2%	21%
		TOTAL	463	539	143				$46,343	$ 19,125	$ 3,952	$ 7,435	**$ 76,855**	60%	25%	5%	10%	100%
All Channels			440	225	143	5.5			$44,070	$ 16,233	$ 2,962	$ 6,494	$ 69,759	63%	23%	4%	9%	91%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			23	314	0				$ 2,273	$ 2,892	$ 990	$ 941	$ 7,096	32%	41%	14%	13%	9%
Channel Cost per mile (in $1000)			$12,683		Basins Cost per ac. ft. (in $1000)				$3.15									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	9%	24%	135%				9%	58%	84%	94%	32%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	43%	5%	0%				43%	5%	43%	42%	27%
Total % increase	11%	13%	135%				11%	50%	74%	87%	31%

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SUN VALLEY AREA DRAINAGE MASTER PLAN

Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
C41510	Leveed Chl.	3138	17	0	9	0.3	482	5	$ 1,740	$ 821	$ 132	$ 433	$ 3,126	56%	26%	4%	14%	4%
C51020	Leveed Chl.	3175	32	0	16	0.5	482	5	$ 3,180	$ 1,420	$ 241	$ 684	$ 5,525	58%	26%	4%	12%	7%
C51060	Excavated Chl.	3301	18	89	0	0.5	228	8	$ 1,820	$ 2,122	$ 452	$ 575	$ 4,969	37%	43%	9%	12%	6%
D415	Offline Basin	1231	23	314	0	1800	550	11	$ 2,273	$ 2,892	$ 990	$ 941	$ 7,096	32%	41%	14%	13%	9%
RR41510	Leveed Chl.	1579	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	10%
C42010	Leveed Chl.	1986	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	22%
C42020	Leveed Chl.	1705	20	0	13	0.4	382	5	$ 1,960	$ 1,008	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
41010-A	Excavated Chl.	2125	73	136	7	0.5	220	7	$ 7,330	$ 3,425	$ 499	$ 654	$ 11,908	62%	29%	4%	5%	15%
S51010	Leveed Chl.	2504	147	0	8	0.3	476	4	$ 14,720	$ 850	$ 127	$ 402	$ 16,099	91%	5%	1%	2%	21%
	TOTAL	463	539	143					$ 46,343	$ 19,125	$ 3,952	$ 7,435	**$ 76,855**	60%	25%	5%	10%	100%
All Channels		440	225	143	5.5				$ 44,070	$ 16,233	$ 2,962	$ 6,494	$ 69,759	63%	23%	4%	9%	91%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		23	314	0					$ 2,273	$ 2,892	$ 990	$ 941	$ 7,096	32%	41%	14%	13%	9%
Channel Cost per mile (in $1000)		$12,683		Basins Cost per ac. ft. (in $1000)					$3.15									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
C41510	Leveed Chl.	3138	19	0	21	0.3	533	5	$ 1,920	$ 1,346	$ 273	$ 801	$ 4,339	44%	31%	6%	18%	4%
C51020	Leveed Chl.	3175	35	0	39	0.5	533	5	$ 3,520	$ 2,386	$ 500	$ 1,359	$ 7,765	45%	31%	6%	18%	8%
C51060	Excavated Chl.	3301	24	109	0	0.5	410	8	$ 2,390	$ 2,552	$ 574	$ 689	$ 6,205	39%	41%	9%	11%	6%
D415	Offline Basin	1231	33	330	0	2180	650	11	$ 3,250	$ 3,028	$ 1,417	$ 1,341	$ 9,036	36%	34%	16%	15%	9%
RR41510	Leveed Chl.	1579	47	0	70	1	393	5	$ 4,690	$ 3,962	$ 904	$ 2,298	$ 11,854	40%	33%	8%	19%	12%
C42010	Leveed Chl.	1986	105	0	141	2	433	5	$ 10,470	$ 7,786	$ 1,833	$ 4,601	$ 24,690	42%	32%	7%	19%	24%
C42020	Leveed Chl.	1705	22	0	30	0.4	433	5	$ 2,220	$ 1,745	$ 389	$ 1,054	$ 5,408	41%	32%	7%	19%	5%
41010-A	Excavated Chl.	2125	80	169	16	0.5	403	7	$ 8,030	$ 4,540	$ 720	$ 1,033	$ 14,323	56%	32%	5%	7%	14%
S51010	Leveed Chl.	2504	149	0	19	0.3	524	4	$ 14,900	$ 1,343	$ 265	$ 740	$ 17,247	86%	8%	2%	4%	17%
	TOTAL	514	608	336					$ 51,390	$ 28,685	$ 6,876	$ 13,916	**$ 100,868**	51%	28%	7%	14%	100%
All Channels		481	278	336	5.5				$ 48,140	$ 25,658	$ 5,459	$ 12,575	$ 91,832	52%	28%	6%	14%	91%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		33	330	0					$ 3,250	$ 3,028	$ 1,417	$ 1,341	$ 9,036	36%	34%	16%	15%	9%
Channel Cost per mile (in $1000)		$16,697		Basins Cost per ac. ft. (in $1000)					$4.29									
All Channels % increase		9%	24%	135%					9%	58%	84%	94%	32%					
All Online Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
All Offline Basins % increase		43%	5%	0%					43%	5%	43%	42%	27%					
Total % increase		11%	13%	135%					11%	50%	74%	87%	31%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
R410A	ROUTE	1237	101.6	34.9	4.7	2.18	262	66	22	9	1.116	1.12	1.12	1.12	130	130	130	130
410415	ROUTE	1235	100.9	12.53	4.8	2.18	262	66	22	9	1.116	1.12	1.12	1.12	130	130	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415R	COMBINE	1232			4.8	2.63	302	76	25	11	1.066	1.07	1.07	1.07	150	150	150	150
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
R500A	ROUTE	1713	101.8	33.61	4.9	3.64	453	115	38	17	1.157	1.171	1.171	1.171	224	227	227	227
500415	ROUTE	1691	100.8	33.42	5	3.64	452	115	38	17	1.156	1.171	1.171	1.171	224	227	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C415L	COMBINE	1690			5	5.48	601	152	51	22	1.021	1.032	1.032	1.032	298	301	301	301
C415	COMBINE	2435			5	8.11	801	202	67	29	0.918	0.928	0.928	0.928	397	401	401	401
D415	DIVERT	1231			4.1	8.11	587	149	50	21	0.673	0.682	0.682	0.682	291	295	295	295
415420	ROUTE	1231	101	129.2	5.9	8.11	563	149	50	21	0.646	0.682	0.682	0.682	279	295	295	295
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1252			5.5	9.88	676	182	61	26	0.636	0.685	0.685	0.685	335	361	361	361
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
R410A	ROUTE	1334	101.7	36.82	12.7	2.18	262	67	23	10	1.114	1.15	1.15	1.15	130	134	134	134
410415	ROUTE	1333	100.9	13.15	12.8	2.18	262	67	23	10	1.114	1.149	1.15	1.15	130	134	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415R	COMBINE	1353			12.8	2.63	309	79	26	11	1.091	1.12	1.121	1.121	153	157	157	157
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
R500A	ROUTE	1989	101.9	36.93	12.9	3.64	476	129	43	19	1.216	1.321	1.323	1.323	236	256	257	257
500415	ROUTE	1940	101	37.15	13	3.64	476	129	43	19	1.216	1.321	1.323	1.323	236	256	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C415L	COMBINE	2094			12.2	5.48	680	180	60	26	1.154	1.225	1.226	1.226	337	358	358	358
C415	COMBINE	3138			13	8.11	978	257	86	37	1.121	1.177	1.179	1.179	485	509	510	510
D415	DIVERT	1231			12	8.11	615	166	56	24	0.705	0.762	0.764	0.764	305	330	330	330
415420	ROUTE	1231	101	129.2	14	8.11	592	166	56	24	0.679	0.761	0.764	0.764	294	329	330	330
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1705			12.3	9.88	765	214	71	31	0.72	0.805	0.807	0.807	379	424	425	425
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
C41510	Leveed	0.0137	0.0050	0.30	3	4.5	0.045	3138	409.6	616.1	1.5	1.5	1.5	3.0	409	5.1	0.73	0.48
C51020	Leveed	0.0153	0.0055	0.50	3	4.5	0.045	3175	409.4	600.1	1.5	1.5	1.5	3.0	409	5.3	0.77	0.51
C51060	Excavated	0.0055	0.0030	0.50	3	8.0	0.045	3301	171.3	707.3	4.1	4.2	6.5	1.5	169	4.7	0.40	1.22
RR41510	Leveed	0.0162	0.0060	1.00	3	4.5	0.045	1579	267.9	327.7	1.2	1.2	1.2	3.3	267	4.8	0.77	0.47
C42010	Leveed	0.0120	0.0050	2.00	3	4.5	0.045	1986	309.1	436.0	1.4	1.4	1.4	3.1	309	4.6	0.68	0.45
C42020	Leveed	0.0139	0.0055	0.40	3	4.5	0.045	1705	307.9	379.8	1.2	1.2	1.3	3.2	308	4.5	0.71	0.43
41010-A	Excavated	0.0128	0.0050	0.50	3	6.5	0.045	2125	136.7	425.6	3.1	3.2	5.0	1.5	135	5.0	0.50	1.56
S51010	Leveed	0.0171	0.0060	0.30	3	4.0	0.045	2504	407.9	503.0	1.2	1.2	1.2	2.8	407	5.0	0.79	0.47

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
D415	Offline Basin	0.0150	1800	550	11.0	198.2	180.0	180.0	1907	0	4.5	6.5

Open Channel

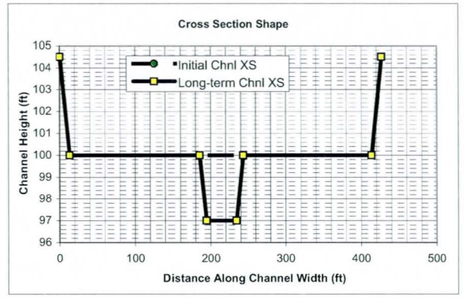
Structure ID	C41510	HEC1 ID	410415

Longitudal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

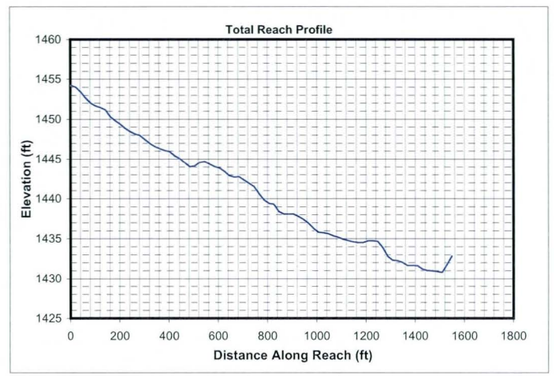
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	172	3	40	7.5	3	170	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	185.5	194.5	234.5	243.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	3138									3138
Weighting Factor	1.00									
Flow into Channel	3138									3138

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_41010-A	500415_C51060							TOTAL
Flow Volume (ac. ft)	134.00	257.00							391
Sediment Conc. (ppm)	2130	1146							
Sediment Volume (ac. ft)	0.11	0.11							0.22
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.11	0.11							0.22

Hydrology

Drainage Area	1.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3138	cfs	
Long-term Max. Chnl Capacity	13143	cfs	
Q2 Channel	314	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
314	402.4	153.7	0.4	100.0	100.4	2.0	0.4	402.3	0.4	0.12	0.58
785	404.2	266.7	0.7	100.0	100.7	2.9	0.7	404.0	0.7	0.21	0.64
2354	408.1	517.7	1.3	100.0	101.3	4.5	1.3	407.7	1.3	0.40	0.71
3138	409.6	616.1	1.5	100.0	101.5	5.1	1.5	409.1	1.5	0.48	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
314	52.7	92.2	1.8	97.0	99.0	3.4	2.0	52.0	1.8	0.63	0.45
785	404.3	361.2	0.9	97.0	100.5	2.2	3.5	403.2	0.9	1.10	0.40
2354	409.7	702.0	1.7	97.0	101.4	3.4	4.4	408.2	1.7	1.36	0.45
3138	411.7	836.0	2.0	97.0	101.7	3.8	4.7	410.2	2.0	1.47	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_41010-A	500415_C51060								
314	792	667								1459
785	1929	1603								3533
2354	8294	6896								15190
3138	12203	10197								22400

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
314	1.74	1.0988	1.0439	Erosive	Erosive	Erosive	0.2	Stable	6.5	Stable	Stable
785	1.74	1.2674	1.2040	Erosive	Erosive	Erosive	0.3	Stable	7.7	Stable	Stable
2354	1.74	1.4691	1.3956	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable
3138	1.74	1.5217	1.4456	Erosive	Erosive	Erosive	0.4	Stable	10.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	314	785	2354	3138	314	785	2354	3138	314	785	2354	3138
Bray - Equation #1	49	80	142	166	1.8	2.4	3.5	3.9	3.5	4.0	4.7	4.9
Bray - Equation #2	65	105	187	218	2.0	2.7	3.9	4.2	2.4	2.8	3.2	3.4
Hey	15	25	47	54	5.7	8.1	12.3	13.7				
Ackers & Charlton/Lacey	40	59	94	106					2.1	2.4	2.9	3.1
Parker	122	192	333	385	1.5	2.2	3.5	3.9				
Chang	87	152	294	350	0.1	-0.2	-0.8	-1.0				
Kellerhals	32	50	87	101	2.7	3.9	6.1	6.8	3.6	4.0	4.4	4.6
AMAFCA/Schumm	52	404	409	411								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	22.9	32.3	48.8	54.4	6	9	13	15	3.5	4.4	5.8	6.2
Average	50	111	166	186	2.6	3.6	5.3	5.9	3.0	3.5	4.2	4.4
Values As Designed	52	403	408	410	2.0	3.5	4.4	4.7	3.4	2.2	3.4	3.8
Difference with Design	-2	-292	-243	-224	0.6	0.1	0.9	1.2	-0.4	1.3	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
314	2443	1514	3068	4488	6351	719	640	408	8750	690	2671	2886
785	10100	4916	9146	21252	9403	3028	2087	2044	23024	2459	11152	8965
2354	54927	17837	27742	136652	14261	14299	6805	10345	70609	12035	53185	38063
3138	85536	24663	36280	222287	15806	21286	9091	15354	94403	18329	78617	56514

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
314	2889	1790	3628	5306	7508	850	757	482	10345	816	3157	3412
785	4777	2325	4325	10050	4447	1432	987	967	10889	1163	5274	4240
2354	8659	2812	4373	21542	2248	2254	1073	1631	11131	1897	8384	6000
3138	10113	2916	4289	26281	1869	2517	1075	1815	11161	2167	9295	6682

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
314	1811	782	1109	3540	1193	358	249	438	2008	374	2121	1271
785	2481	1289	2137	4017	5623	444	425	511	4581	543	2821	2261
2354	13472	5616	8356	25773	9173	2664	1885	3248	15033	2753	15767	9431
3138	20962	8026	11524	41886	10309	4043	2622	4994	20259	4244	24088	13905

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
314	2141	925	1311	4186	1411	423	295	517	2374	442	2508	1503
785	1173	610	1010	1900	2659	210	201	242	2166	257	1334	1069
2354	2124	885	1317	4063	1446	420	297	512	2370	434	2485	1487
3138	2478	949	1362	4952	1219	478	310	590	2395	502	2848	1644

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
314	0.0021	0.0032	135	0.41	0.047	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0016	0.0051	0.0003	0.0022	0.0137	0.0052
785	0.0011	0.0018	177	0.54	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0051	0.0002	0.0011	0.0137	0.0050
2354	0.0005	0.0010	246	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0005	0.0137	0.0049
3138	0.0004	0.0008	268	0.82	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0004	0.0137	0.0048

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	13.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.20	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		8.77	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
314	1.1	-0.6	0.2	24.6	2.0	1.8	3.4	0.0050	0.2	0.0	3.0	4.3
785	1.1	-1.2	0.1	24.6	3.5	0.9	2.2	0.0050	0.4	0.0	3.0	4.4
2354	1.1	-1.3	0.2	24.6	4.4	1.7	3.4	0.0050	0.5	0.0	3.0	4.6
3138	1.1	-1.3	0.2	24.6	4.7	2.0	3.8	0.0050	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1333	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.42	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.34	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2007.8	2007.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	522	sq. Yd
Volume	1393	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1567	1567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	7313	15148
Left Levee Volume (cu. Yd)	7197	16947
Right Levee Length (ft)	1567	1567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	7313	15148
Right Levee Volume (cu. Yd)	7197	16947
Total Levee Surface Area (sq. Yd)	14626	30296
Total Levee Volume (cu. Yd)	14394	33894

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2438	5746
Left Levee Lining Volume (cu. Yd)	1219	2873
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2438	5746
Right Levee Lining Volume (cu. Yd)	1219	2873
Total Lining Area (sq. Yd)	4875	11491
Total Lining Volume (cu. Yd)	2438	5746

Drop Structures	Riprap	
Structure Type	(Riprap, Gabions, Soil cement, Concrete,None)	
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.5	ft
Structure Height	10.5	ft
Number of Structures	5	
Volume per structure	499	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 37,425	
Area per structure	142	sq. Yd
Total Area	712	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14149	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 56,596	
Other Cost	$ -	
Total cost per basin	$ 56,596	
Area per basin	14,870	sq. Yd
Total Area	14,870	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,394	cu. Yd	$ 7.00	$ 100,758	14,626	sq. Yd	$ 9.00	$ 131,634	14,626	sq. Yd	$ 11.67	$ 170,637
Levee - LC Enhancement	Fill	19,500	cu. Yd	$ 7.00	$ 136,500	15,670	sq. Yd	$ 9.00	$ 141,030	19,500	sq. Yd	$ 11.67	$ 227,500
Levee Lining	Riprap	2,438	cu. Yd	$ 75.00	$ 182,850	4,875	sq. Yd	$ -	$ -	4,875	sq. Yd	$ 20.83	$ 101,565
Levee Lining -LC Enhancement	Riprap	3,308	cu. Yd	$ 75.00	$ 248,100	6,616	sq. Yd	$ -	$ -	6,616	sq. Yd	$ 20.83	$ 137,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,393	cu. Yd	$ 75.00	$ 104,475	522	sq. Yd	$ -	$ -	522	sq. Yd	$ 25.00	$ 13,050
Drop Structures	Riprap	5	EA	$ 37,425.00	$ 187,125	712	sq. Yd	$ -	$ -	712	sq. Yd	$ 33.33	$ 23,733
Drop Str. - LC Enhancement	Riprap	5	EA	$ 3,742.50	$ 18,713	71	sq. Yd	$ -	$ -	71	sq. Yd	$ 33.33	$ 2,373
Sedimentation Basins		1	EA	$ 56,596.00	$ 56,596	14,870	sq. Yd	$ -	$ -	14,870	sq. Yd	$ 8.33	$ 123,917
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 131,634	Base Maintenance Cost			$ 432,901
						LC Enhancement Cost			$ 141,030	LC Enhancement Cost			$ 367,711
						Total Landscape Cost			$ 272,664	Total Maintenance Cost			$ 800,613

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 631,804	$ 403,313	$ 1,035,117
Contingency Cost (25% of Construction Cost)	$ 157,951	$ 100,828	$ 258,779
Engineering Design Cost (5% of Construction Cost)	$ 31,590	$ 20,166	$ 51,756
Total Construction Cost	$ 821,345	$ 524,306	$ 1,345,651

Land Cost

Channel Length	1567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	15.4	$100,000	$ 1,540,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2	$100,000	$ 200,000
Levee LC Enhancement	51	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	533	19.2		$ 1,920,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.4	$100,000	$ 1,740,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	19.2	$100,000	$ 1,920,000

Total Cost

Base Total Cost	$ 3,125,881
Total Landscape Enhancement Cost	$ 1,213,048
Total Cost Including LC Enh.	$ 4,338,928

Open Channel

Structure ID	C51020

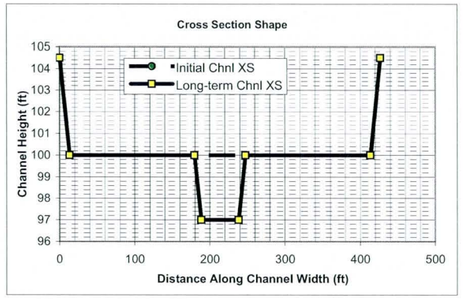
HEC1 ID	500415

Longitudnal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

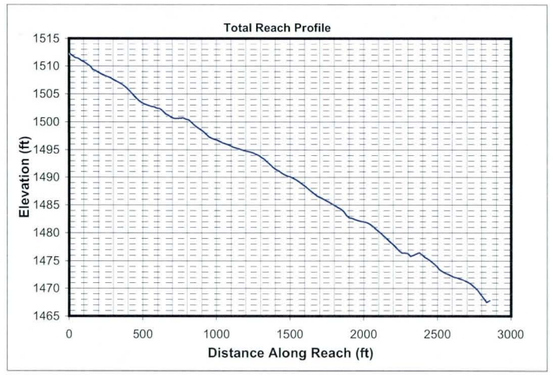
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	166	3	50	7.5	3	166	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	179.5	188.5	238.5	247.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S500	S510							TOTAL
HEC1 Peak-Flow	2063	2099							4162
Weighting Factor	1.00	0.53							
Flow into Channel	2063	1112							3175

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_S51010								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	1950								
Sediment Volume (ac. ft)	0.19								0.19
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	4.44	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3175	cfs	
Long-term Max. Chnl Capacity	14130	cfs	
Q2 Channel	318	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
318	402.4	149.8	0.4	100.0	100.4	2.1	0.4	402.2	0.4	0.13	0.61
794	404.1	259.8	0.6	100.0	100.6	3.1	0.6	403.9	0.6	0.22	0.67
2381	407.9	504.2	1.2	100.0	101.2	4.7	1.2	407.5	1.2	0.43	0.75
3175	409.4	600.1	1.5	100.0	101.5	5.3	1.5	408.9	1.5	0.51	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
318	61.0	95.7	1.6	97.0	98.7	3.3	1.7	60.4	1.6	0.59	0.46
794	403.8	353.3	0.9	97.0	100.4	2.2	3.4	402.6	0.9	1.18	0.42
2381	409.0	686.5	1.7	97.0	101.3	3.5	4.3	407.6	1.7	1.46	0.47
3175	411.0	817.5	2.0	97.0	101.6	3.9	4.6	409.5	2.0	1.57	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
	500415_S51010								
318	1259								1259
794	2179								2179
2381	8956								8956
3175	13160								13160

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
318	1.74	1.0908	1.0363	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
794	1.74	1.2594	1.1964	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
2381	1.74	1.4611	1.3881	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable
3175	1.74	1.5137	1.4381	Erosive	Erosive	Erosive	0.4	Stable	10.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	318	794	2381	3175	318	794	2381	3175	318	794	2381	3175
Bray - Equation #1	50	80	143	167	1.8	2.5	3.5	3.9	3.5	4.0	4.7	4.9
Bray - Equation #2	65	105	188	219	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	25	47	55	5.8	8.1	12.4	13.8				
Ackers & Charlton/Lacey	40	59	94	106					2.1	2.4	2.9	3.1
Parker	122	194	335	387	1.5	2.2	3.5	3.9				
Chang	90	157	305	363	0.0	-0.2	-0.9	-1.2				
Kellerhals	32	51	88	101	2.7	3.9	6.1	6.8	3.6	4.0	4.4	4.6
AMAFCA/Schumm	60	403	408	410								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	22.6	31.9	48.2	53.7	6	9	13	14	3.6	4.6	6.0	6.5
Average	52	113	168	188	2.6	3.6	5.3	5.9	3.1	3.6	4.3	4.5
Values As Designed	60	403	408	409	1.7	3.4	4.3	4.6	3.3	2.2	3.5	3.9
Difference with Design	-8	-290	-240	-221	0.9	0.2	1.1	1.3	-0.2	1.3	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2900	1778	3730	5494	6768	913	783	499	10584	828	3183	3405
794	11986	5660	10699	26020	9938	3716	2452	2402	27632	2939	13023	10588
2381	65207	20279	31555	167344	14979	17389	7848	11894	84460	14296	61110	45124
3175	101559	27977	41475	272231	16583	25879	10455	17590	112875	21739	90013	67125

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	3389	2077	4359	6420	7909	1066	915	583	12368	968	3720	3979
794	5602	2645	5001	12162	4645	1737	1146	1123	12915	1374	6087	4949
2381	10159	3159	4916	26072	2334	2709	1223	1853	13159	2227	9521	7030
3175	11867	3269	4846	31810	1938	3024	1222	2055	13189	2540	10518	7844

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	1951	859	1254	3810	1370	402	282	462	2343	408	2276	1402
794	2885	1487	2534	4801	5957	559	517	600	5446	638	3307	2612
2381	15672	6347	9585	30805	9625	3194	2177	3700	17648	3235	18134	10920
3175	24384	9039	13245	50067	10797	4828	3007	5663	23749	4984	27599	16124

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2280	1004	1466	4452	1601	469	330	540	2738	477	2659	1638
794	1349	695	1184	2244	2785	261	242	281	2546	298	1546	1221
2381	2442	989	1493	4799	1500	498	339	576	2750	504	2825	1701
3175	2849	1056	1548	5850	1262	564	351	662	2775	582	3225	1884

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
318	0.0021	0.0033	141	0.43	0.047	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0016	0.0051	0.0003	0.0022	0.0153	0.0056
794	0.0010	0.0019	185	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0009	0.0051	0.0002	0.0011	0.0153	0.0054
2381	0.0005	0.0010	256	0.78	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0051	0.0001	0.0005	0.0153	0.0052
3175	0.0004	0.0008	279	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0004	0.0153	0.0052

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	28.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	287	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.59	sq. mi
Total Sediment Yield Volume	1.12	ac ft

Sedimentation Basins

Length	287 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		8.02	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
318	1.1	-0.5	0.2	24.6	1.7	1.6	3.3	0.0055	0.2	0.0	1.0	1.6
794	1.1	-1.2	0.1	24.6	3.4	0.9	2.2	0.0055	0.3	0.0	1.0	1.8
2381	1.1	-1.2	0.2	24.6	4.3	1.7	3.5	0.0055	0.5	0.0	1.0	2.0
3175	1.1	-1.2	0.2	24.6	4.6	2.0	3.9	0.0055	0.5	0.0	1.0	2.1

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1940	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.12	ac. ft
Outflowing Sediment Volume	0.18	ac. ft
Deposited(+)/Eroded(-) Volume	0.94	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2037.8	2037.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	958	sq. Yd
Volume	1916	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2874	2874
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13412	27782
Left Levee Volume (cu. Yd)	13199	31082
Right Levee Length (ft)	2874	2874
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13412	27782
Right Levee Volume (cu. Yd)	13199	31082
Total Levee Surface Area (sq. Yd)	26824	55564
Total Levee Volume (cu. Yd)	26398	62164

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4471	10538
Left Levee Lining Volume (cu. Yd)	2235	5269
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4471	10538
Right Levee Lining Volume (cu. Yd)	2235	5269
Total Lining Area (sq. Yd)	8941	21076
Total Lining Volume (cu. Yd)	4470	10538

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.6	ft
Structure Height	10.6	ft
Number of Structures	10	
Volume per structure	502	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 37,650	
Area per structure	142	sq. Yd
Total Area	1,423	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12939	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 51,756	
Other Cost	$ -	
Total cost per basin	$ 51,756	
Area per basin	13,635	sq. Yd
Total Area	13,635	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	26,398	cu. Yd	$ 7.00	$ 184,786	26,824	sq. Yd	$ 9.00	$ 241,416	26,824	sq. Yd	$ 11.67	$ 312,947
Levee - LC Enhancement	Fill	35,766	cu. Yd	$ 7.00	$ 250,362	28,740	sq. Yd	$ 9.00	$ 258,660	35,766	sq. Yd	$ 11.67	$ 417,270
Levee Lining	Riprap	4,470	cu. Yd	$ 75.00	$ 335,250	8,941	sq. Yd	$ -	$ -	8,941	sq. Yd	$ 20.83	$ 186,278
Levee Lining -LC Enhancement	Riprap	6,068	cu. Yd	$ 75.00	$ 455,100	12,135	sq. Yd	$ -	$ -	12,135	sq. Yd	$ 20.83	$ 252,806
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,916	cu. Yd	$ 75.00	$ 143,700	958	sq. Yd	$ -	$ -	958	sq. Yd	$ 25.00	$ 23,950
Drop Structures	Riprap	10	EA	$ 37,650.00	$ 376,500	1,423	sq. Yd	$ -	$ -	1,423	sq. Yd	$ 33.33	$ 47,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,765.00	$ 37,650	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,743
Sedimentation Basins		1	EA	$ 51,756.00	$ 51,756	13,635	sq. Yd	$ -	$ -	13,635	sq. Yd	$ 8.33	$ 113,625
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 241,416	Base Maintenance Cost			$ 684,233
						LC Enhancement Cost			$ 258,660	LC Enhancement Cost			$ 674,819
						Total Landscape Cost			$ 500,076	Total Maintenance Cost			$ 1,359,052

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,091,992	$ 743,112	$ 1,835,104
Contingency Cost (25% of Construction Cost)	$ 272,998	$ 185,778	$ 458,776
Engineering Design Cost (5% of Construction Cost)	$ 54,600	$ 37,156	$ 91,755
Total Construction Cost	$ 1,419,590	$ 966,046	$ 2,385,635

Land Cost

Channel Length	2874	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	28.2	$100,000	$ 2,820,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	533	35.2		$ 3,520,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31.8	$100,000	$ 3,180,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	35.2	$100,000	$ 3,520,000

Total Cost

Base Total Cost	$	5,525,238
Total Landscape Enhancement Cost	$	2,239,524
Total Cost Including LC Enh.	$	7,764,763

Open Channel

Structure ID	C51060

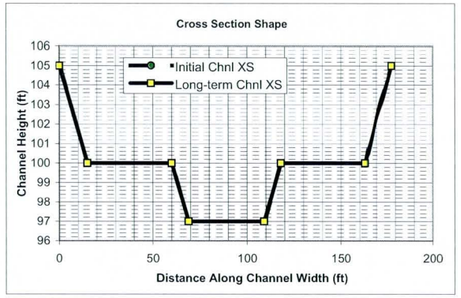
HEC1 ID	500415

Longitudinal Geometry

Length	2541.7	ft
U/S Elev	1468.2	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0055	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

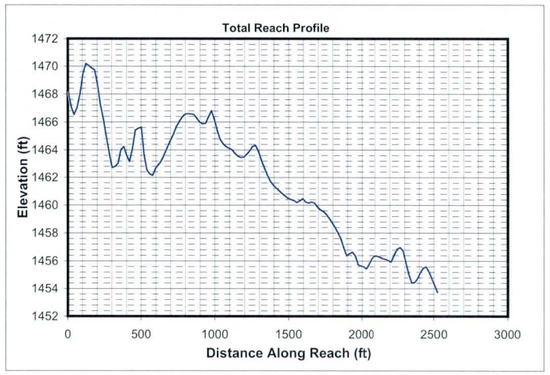
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	45	3	40	8	3	45	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	60	69	109	118	163	178
Y	105	100	100	97	97	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	45	3	40	8	3	45	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	60	69	109	118	163	178
Y	105	100	100	97	97	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S500	S510								TOTAL
HEC1 Peak-Flow	2063	2099								4162
Weighting Factor	1.00	0.59								
Flow into Channel	2063	1238								3301

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51020									TOTAL
Flow Volume (ac. ft)	257.00									257
Sediment Conc. (ppm)	1884									
Sediment Volume (ac. ft)	0.18									0.18
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.18									0.18

Hydrology

Drainage Area	4.54	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3301	cfs	
Long-term Max. Chnl Capacity	5321	cfs	
Q2 Channel	330	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	178	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
330	55.1	112.9	2.0	97.0	99.4	2.9	2.4	54.4	2.1	0.45	0.36
825	155.2	295.9	1.9	97.0	101.0	2.8	4.0	153.9	1.9	0.75	0.35
2476	166.8	588.9	3.5	97.0	102.8	4.2	5.8	164.9	3.6	1.09	0.39
3301	171.3	707.3	4.1	97.0	103.5	4.7	6.5	169.2	4.2	1.22	0.40

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
330	55.1	112.9	2.0	97.0	99.4	2.9	2.4	54.4	2.1	0.45	0.36
825	155.2	295.9	1.9	97.0	101.0	2.8	4.0	153.9	1.9	0.75	0.35
2476	166.8	588.9	3.5	97.0	102.8	4.2	5.8	164.9	3.6	1.09	0.39
3301	171.3	707.3	4.1	97.0	103.5	4.7	6.5	169.2	4.2	1.22	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
	500415_C51020								
330	1402								1402
825	2612								2612
2476	10920								10920
3301	16124								16124

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
330	1.74	1.6208	1.5397	Erosive	Erosive	Erosive	0.4	Stable	5.7	Stable	Stable
825	1.74	1.5970	1.5172	Erosive	Erosive	Erosive	0.4	Stable	7.2	Stable	Stable
2476	1.74	1.7883	1.6989	Erosive	Erosive	Erosive	0.5	Stable	9.7	Stable	Stable
3301	1.74	1.8494	1.7570	Erosive	Erosive	Erosive	0.5	Stable	10.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	330	825	2476	3301	330	825	2476	3301	330	825	2476	3301
Bray - Equation #1	51	82	146	170	1.8	2.5	3.6	3.9	3.6	4.0	4.7	4.9
Bray - Equation #2	66	108	192	224	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	26	48	56	5.8	8.3	12.6	14.0				
Ackers & Charlton/Lacey	41	60	96	108					2.1	2.5	3.0	3.1
Parker	125	197	342	395	1.5	2.2	3.5	4.0				
Chang	75	132	258	307	0.3	0.2	-0.3	-0.4				
Kellerhals	33	52	90	103	2.8	4.0	6.2	6.9	3.6	4.0	4.5	4.6
AMAFCA/Schumm	54	154	165	169								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	25.7	36.3	54.8	61.0	7	10	15	16	2.9	3.7	4.9	5.2
Average	51	87	141	162	2.8	3.9	5.7	6.3	2.9	3.4	4.0	4.2
Values As Designed	54	154	165	169	2.4	4.0	5.8	6.5	2.9	2.8	4.2	4.7
Difference with Design	-4	-67	-24	-8	0.4	-0.1	-0.2	-0.3	0.0	0.6	-0.2	-0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	939	503	805	3983	1467	211	124	252	2440	360	2015	1191
825	2216	1187	2014	9135	3955	489	300	587	6072	851	4759	2870
2476	11624	4589	6694	56305	6176	2628	1135	3015	18700	3917	23131	12538
3301	17858	6414	8714	90181	6936	3962	1549	4476	25016	4210	34294	18510

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	1056	566	905	4476	1649	237	140	283	2743	405	2264	1338
825	996	534	905	4107	1778	220	135	264	2730	382	2139	1290
2476	1742	688	1003	8438	926	394	170	452	2802	587	3466	1879
3301	2007	721	979	10135	780	445	174	503	2812	473	3854	2080

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	939	451	603	1610	975	151	124	252	943	153	1136	667
825	2216	1060	1446	3694	2610	352	300	587	2330	371	2669	1603
2476	11624	4205	5023	22768	4280	1799	1135	3015	7427	968	13611	6896
3301	17858	5903	6945	36466	4850	2678	1549	4476	9978	1051	20419	10197

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	1056	507	678	1810	1096	170	140	283	1059	172	1277	750
825	996	477	650	1661	1173	158	135	264	1047	167	1200	721
2476	1742	630	753	3412	641	270	170	452	1113	145	2040	1033
3301	2007	663	781	4098	545	301	174	503	1121	118	2295	1146

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
330	0.0004	0.0006	197	0.60	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0050	0.0003	0.0011	0.0029	0.0021
825	0.0005	0.0006	190	0.58	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0050	0.0002	0.0006	0.0030	0.0021
2476	0.0002	0.0003	259	0.79	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0050	0.0001	0.0002	0.0030	0.0021
3301	0.0002	0.0003	280	0.85	0.054	0.0001	32	0.036	0.0000	0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	6.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	847	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.10	sq. mi
Total Sediment Yield Volume	0.19	ac ft

Sedimentation Basins

Length	847 ft	Depth	3 ft
Width	178 ft	Side slope	3 ft/ft
Total Volume per Basin		9.76	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
330	1.1	-0.7	0.1	24.6	2.4	2.1	2.9	0.0030	0.3	0.0	1.0	1.7
825	1.1	-1.3	0.1	24.6	4.0	1.9	2.8	0.0030	0.4	0.0	1.0	1.9
2476	1.1	-1.5	0.2	24.6	5.8	3.6	4.2	0.0030	0.7	0.0	1.0	2.3
3301	1.1	-1.6	0.3	24.6	6.5	4.2	4.7	0.0030	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1940	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	6.5	ft
Channel Depth as designed	8.0	ft
Available Freeboard	1.5	ft
Required Freeboard	1.7	ft

Sediment Volume

Inflowing Sediment Volume	0.37	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.26	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2542	2542
Side Slope (?H:1V)	3	6
Channel Width (ft)	178	226
Channel XS Area (sq. ft)	962	1154
Channel Perimeter (ft)	181	228

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	143527	175884
Excavated Area (sq. Yd)	50275	63832

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2542	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	424	sq. Yd
Volume	847	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2542	2542
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2542	2542
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	178	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	12.8	ft
Structure Height	15.8	ft
Number of Structures	3	
Volume per structure	313	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 23,475	
Area per structure	59	sq. Yd
Total Area	178	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15746	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 62,984	
Other Cost	$ -	
Total cost per basin	$ 62,984	
Area per basin	16,756	sq. Yd
Total Area	16,756	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	143,527	cu. Yd	$ 10.00	$ 1,435,270	50,275	sq. Yd	$ 9.00	$ 452,475	50,275	sq. Yd	$ 8.33	$ 418,958
Exc. Chl - LC Enhancement	Excavated	32,357	cu. Yd	$ 10.00	$ 323,570	13,557	sq. Yd	$ 9.00	$ 122,013	13,557	sq. Yd	$ 8.33	$ 112,975
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	847	cu. Yd	$ 75.00	$ 63,525	424	sq. Yd	$ -	$ -	424	sq. Yd	$ 25.00	$ 10,600
Drop Structures	Riprap	3	EA	$ 23,475.00	$ 70,425	178	sq. Yd	$ -	$ -	178	sq. Yd	$ 33.33	$ 5,933
Drop Str. - LC Enhancement	Riprap	3	EA	$ 2,347.50	$ 7,043	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 593
Sedimentation Basins		1	EA	$ 62,984.00	$ 62,984	16,756	sq. Yd	$ -	$ -	16,756	sq. Yd	$ 8.33	$ 139,633
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 452,475	Base Maintenance Cost			$ 575,125
						LC Enhancement Cost			$ 122,013	LC Enhancement Cost			$ 113,568
						Total Landscape Cost			$ 574,488	Total Maintenance Cost			$ 688,693

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,632,204	$ 330,613	$ 1,962,817
Contingency Cost (25% of Construction Cost)	$ 408,051	$ 82,653	$ 490,704
Engineering Design Cost (5% of Construction Cost)	$ 81,610	$ 16,531	$ 98,141
Total Construction Cost	$ 2,121,865	$ 429,796	$ 2,551,661

Land Cost

Channel Length	2542	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	7.8	$100,000	$ 780,000
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	178	10.4	$100,000	$ 1,040,000
Channel LC Enhancement	48	2.8	$100,000	$ 280,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	410	23.9		$ 2,390,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	18.2	$100,000	$ 1,820,000
LC Enhancement Cost	acre	5.7	$100,000	$ 570,000
Total Land Cost	acre	23.9	$100,000	$ 2,390,000

Total Cost

Base Total Cost	$	4,969,465
Total Landscape Enhancement Cost	$	1,235,378
Total Cost Including LC Enh.	$	6,204,843

Offline Basin

HEC1 ID	D415

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

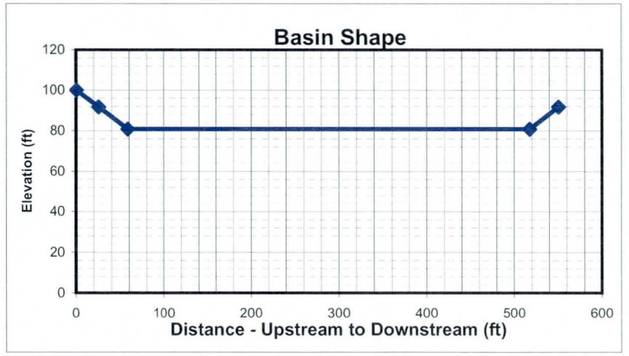
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1800	2080
Basin Width (ft)	550	550
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	525.25	500.5
Top Area (acres)	22.7	26.3
U/S-D/S Height Difference (ft)	8.3	8.3
Excess Area on Upstream (acres)	1.1	2.4

			Base	LC Enhanced
Bottom Length (ft)	1734	Allocated Storage Volume (ac. ft)	198.2	197.8
Bottom Width (ft)	459.25	Total Available Volume (ac. ft) (incl. Freeboard)	219.7	221.3
		Total Excavation Volume (ac. ft)	313.5	329.7

Stage-Storage-Discharge

Stage (ft)	0										
Inflow (cfs)	0	200	400	600	800	1000	1231	1400	2000	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	169	769	1769	2769



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2435	3138	3138
Peak flow after diversion (cfs)	1231	1231	1231
Diverted Peak Flow (cfs)	1204	1907	1907
Total Diverted Flow Volume (ac. ft)	106.0	180	180.0
Peak Stage	4.5	ft	

Volume Check			***Stage Check***	
Total Volume needed	180.0	ac. ft	Depth Needed	5.5
Total Volume Provided	198.2	ac. ft	Depth Provided	11

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 512+67

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	427000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1800	ft
Base Total ROW Width	550	ft
LC Enh. Total ROW Length	2180	ft
LC Enh. Total ROW Length	650	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	505780	531916
Excavated Area (sq. Yd)	110000	157444

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	61	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	678	sq. Yd
Material Volume	339	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	1100	ft
Unit Cost	160	per ft
Cost per outlet	$176,000	
Other Cost	$ -	
Total Cost	$176,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		505,780	cu. Yd	$ 4.00	$ 2,023,120	110,000	sq. Yd	$ 9.00	$ 990,000	110,000	sq. Yd	$ 8.33	$ 916,667	
Basin - LC Enhanced		26,136	cu. Yd	$ 4.00	$ 104,544	47,444	sq. Yd	$ 9.00	$ 426,996	47,444	sq. Yd	$ 8.33	$ 395,367	
Inlet	Riprap	339	sq. Yd	$ 75.00	$ 25,425	678	sq. Yd	$ -	$ -	678	sq. Yd	$ 33.33	$ 22,600	
Inlet - LC Enhanced (20%Total)					$ 5,085				$ -				$ 4,520	
Outlet	Pipe	1	EA	$ 176,000	$ 176,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhanced (5%Total)					$ 8,800				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 990,000	Base Maintenance Cost			$ 941,483	
						LC Enh. Landscape Cost			$ 426,996	LC Enh. Maintenance Cost			$ 399,998	
						Total Landscape Cost			$1,416,996	Total Maintenance Cost			$ 1,341,481	

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 2,224,545	$ 104,544	$ 2,329,089
Contingency Cost (25% of Construction Cost)	$ 556,136	$ 26,136	$ 582,272
Engineering Design Cost (5% of Construction Cost)	$ 111,227	$ 5,227	$ 116,454
Total Construction Cost	$ 2,891,909	$ 135,907	$ 3,027,816

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	9.8	$100,000	$ 980,257
Basin	22.7	$100,000	$ 2,270,000
Other		$100,000	$ -
Total	32.5	$100,000	$ 3,250,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	22.7	$100,000	$ 2,272,727
LC Enhancement Cost	acre	9.8	$100,000	$ 977,273
Total Land Cost	acre	32.5	$100,000	$ 3,250,000

Total Cost

Base Total Cost	$ 7,096,119
Total LC Enhancement Cost	$ 1,940,173
Total Cost Including LC Enh.	$ 9,036,293

Open Channel

Structure ID	RR41510

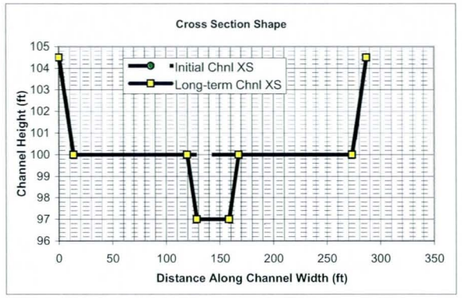
HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

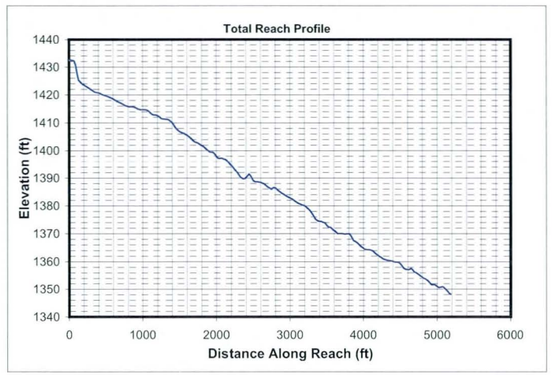
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	260	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	273.5	273.5	273.5	287
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	106	3	30	7.5	3	106	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	119.5	128.5	158.5	167.5	273.5	287
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420								TOTAL
HEC1 Peak-Flow	1231	1740								2971
Weighting Factor	1.00	0.20								
Flow into Channel	1231	348								1579

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	8.11	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1579	cfs	
Long-term Max. Chnl Capacity	9639	cfs	
Q2 Channel	158	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	287	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	262.0	81.6	0.3	100.0	100.3	1.9	0.3	261.9	0.3	0.12	0.61
395	263.4	141.6	0.5	100.0	100.5	2.8	0.5	263.2	0.5	0.20	0.67
1184	266.6	275.2	1.0	100.0	101.0	4.3	1.0	266.3	1.0	0.39	0.75
1579	267.9	327.7	1.2	100.0	101.2	4.8	1.2	267.5	1.2	0.47	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	39.4	51.5	1.3	97.0	98.5	3.1	1.5	39.0	1.3	0.56	0.47
395	46.0	94.9	2.1	97.0	99.5	4.2	2.5	45.2	2.1	0.95	0.51
1184	267.1	370.9	1.4	97.0	101.0	3.2	4.0	265.8	1.4	1.48	0.48
1579	268.8	441.9	1.6	97.0	101.2	3.6	4.2	267.4	1.7	1.58	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
158										0
395										0
1184										0
1579										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble) Non-cohesive		Neill (gravel/cobble) Cohesive		USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
158	1.74	1.0360	0.9842	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
395	1.74	1.2043	1.1441	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1184	1.74	1.4056	1.3353	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
1579	1.74	1.4581	1.3852	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	158	395	1184	1579	158	395	1184	1579	158	395	1184	1579
Bray - Equation #1	34	56	99	115	1.4	1.9	2.8	3.1	3.2	3.6	4.3	4.4
Bray - Equation #2	45	73	130	152	1.6	2.1	3.1	3.4	2.2	2.5	2.9	3.0
Hey	10	17	32	37	4.4	6.2	9.5	10.6				
Ackers & Charlton/Lacey	30	44	70	79					1.9	2.2	2.6	2.7
Parker	86	136	236	273	1.1	1.7	2.6	2.9				
Chang	61	106	206	245	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	36	62	72	2.1	3.0	4.6	5.2	3.4	3.7	4.1	4.3
AMAFCA/Schumm	39	45	266	268								
Moody & Odem	27	27	27	27	1.3	1.3	1.3	1.3				
BUREC	17.1	24.2	36.5	40.6	5	6	10	11	3.2	4.0	5.2	5.6
Average	37	56	117	131	2.1	2.8	4.1	4.6	2.8	3.2	3.8	4.0
Values As Designed	39	45	266	267	1.5	2.5	4.0	4.2	3.1	4.2	3.2	3.6
Difference with Design	-2	11	-149	-137	0.6	0.3	0.2	0.3	-0.3	-1.0	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	1341	864	1821	2474	4011	417	378	209	5616	411	1434	1725
395	5541	2824	5528	11707	5966	1789	1259	1092	14809	1416	6080	5274
1184	30089	10283	16990	75154	9090	8484	4142	5644	45454	6770	29162	21933
1579	46819	14223	22157	122171	10087	12627	5540	8400	60777	10265	43122	32381

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	3150	2029	4279	5812	9425	979	888	490	13195	965	3369	4053
395	5207	2654	5195	11002	5607	1682	1183	1027	13918	1331	5714	4956
1184	9426	3221	5323	23544	2848	2658	1298	1768	14240	2121	9136	6871
1579	11001	3342	5206	28705	2370	2967	1302	1974	14280	2412	10132	7608

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	944	440	679	1822	829	204	150	220	1319	203	1105	719
395	3559	1286	1852	7794	1299	715	412	802	3384	745	3941	2345
1184	7560	3237	5166	14625	5867	1619	1161	1759	9937	1599	8798	5575
1579	11756	4635	7117	23749	6602	2461	1618	2722	13393	2454	13449	8178

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	2219	1034	1594	4281	1948	478	352	516	3099	476	2597	1691
395	3345	1209	1740	7325	1221	672	387	754	3181	700	3704	2203
1184	2368	1014	1618	4582	1838	507	364	551	3113	501	2756	1747
1579	2762	1089	1672	5580	1551	578	380	639	3147	577	3160	1921

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
158	0.0025	0.0039	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0064	0.0004	0.0027	0.0161	0.0062
395	0.0013	0.0023	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0064	0.0002	0.0014	0.0162	0.0060
1184	0.0006	0.0012	241	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0002	0.0006	0.0162	0.0058
1579	0.0005	0.0010	262	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0001	0.0005	0.0162	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	52.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	289	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	289 ft	Depth	3 ft
Width	287 ft	Side slope	3 ft/ft
Total Volume per Basin		5.36	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
158	1.1	-0.5	0.1	24.6	1.5	1.3	3.1	0.0060	0.2	0.0	3.0	4.2
395	1.1	-0.7	0.2	24.6	2.5	2.1	4.2	0.0060	0.3	0.0	3.0	4.4
1184	1.1	-1.2	0.1	24.6	4.0	1.4	3.2	0.0060	0.4	0.0	3.0	4.5
1579	1.1	-1.2	0.2	24.6	4.2	1.7	3.6	0.0060	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.27	ac. ft
Deposited(+)/Eroded(-) Volume	0.40	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	3
Channel Width (ft)	287	287
Channel XS Area (sq. ft)	1347.8	1347.8
Channel Perimeter (ft)	289	289

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1733	sq. Yd
Volume	4620	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5198	5198
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24257	50247
Left Levee Volume (cu. Yd)	23872	56215
Right Levee Length (ft)	5198	5198
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24257	50247
Right Levee Volume (cu. Yd)	23872	56215
Total Levee Surface Area (sq. Yd)	48514	100494
Total Levee Volume (cu. Yd)	47744	112430

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8086	19059
Left Levee Lining Volume (cu. Yd)	4043	9530
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8086	19059
Right Levee Lining Volume (cu. Yd)	4043	9530
Total Lining Area (sq. Yd)	16172	38119
Total Lining Volume (cu. Yd)	8086	19060

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	287	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	18	
Volume per structure	303	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,725	
Area per structure	96	sq. Yd
Total Area	1,722	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8647	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 34,588	
Other Cost	$ -	
Total cost per basin	$ 34,588	
Area per basin	9,209	sq. Yd
Total Area	9,209	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	47,744	cu. Yd	$ 7.00	$ 334,208	48,514	sq. Yd	$ 9.00	$ 436,626	48,514	sq. Yd	$ 11.67	$ 565,997	
Levee - LC Enhancement	Fill	64,686	cu. Yd	$ 7.00	$ 452,802	51,980	sq. Yd	$ 9.00	$ 467,820	64,686	sq. Yd	$ 11.67	$ 754,670	
Levee Lining	Riprap	8,086	cu. Yd	$ 75.00	$ 606,450	16,172	sq. Yd	$ -	$ -	16,172	sq. Yd	$ 20.83	$ 336,907	
Levee Lining -LC Enhancement	Riprap	10,974	cu. Yd	$ 75.00	$ 823,050	21,947	sq. Yd	$ -	$ -	21,947	sq. Yd	$ 20.83	$ 457,231	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	4,620	cu. Yd	$ 75.00	$ 346,500	1,733	sq. Yd	$ -	$ -	1,733	sq. Yd	$ 25.00	$ 43,325	
Drop Structures	Riprap	18	EA	$ 22,725.00	$ 409,050	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 33.33	$ 57,400	
Drop Str. - LC Enhancement	Riprap	18	EA	$ 2,272.50	$ 40,905	172	sq. Yd	$ -	$ -	172	sq. Yd	$ 33.33	$ 5,740	
Sedimentation Basins		1	EA	$ 34,588.00	$ 34,588	9,209	sq. Yd	$ -	$ -	9,209	sq. Yd	$ 8.33	$ 76,742	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 436,626	Base Maintenance Cost			$ 1,080,371	
						LC Enhancement Cost			$ 467,820	LC Enhancement Cost			$ 1,217,641	
						Total Landscape Cost			$ 904,446	Total Maintenance Cost			$ 2,298,012	

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,730,796	$ 1,316,757	$ 3,047,553
Contingency Cost (25% of Construction Cost)	$ 432,699	$ 329,189	$ 761,888
Engineering Design Cost (5% of Construction Cost)	$ 86,540	$ 65,838	$ 152,378
Total Construction Cost	$ 2,250,035	$ 1,711,784	$ 3,961,819

Land Cost

Channel Length	5198 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	287	34.2	$100,000	$ 3,420,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.6	$100,000	$ 660,000
Levee LC Enhancement	51	6.1	$100,000	$ 610,000
Other	0	0	$100,000	$ -
Total	393	46.9		$ 4,690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	40.8	$100,000	$ 4,080,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	46.9	$100,000	$ 4,690,000

Total Cost

Base Total Cost	$ 7,847,032
Total Landscape Enhancement Cost	$ 4,007,246
Total Cost Including LC Enh.	$ 11,854,277

Open Channel

Structure ID	C42010

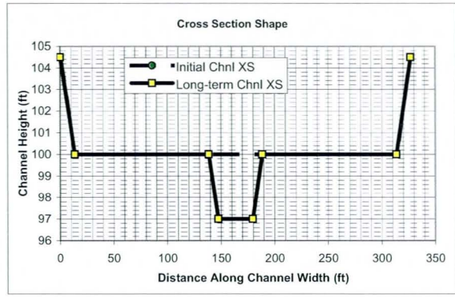
HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

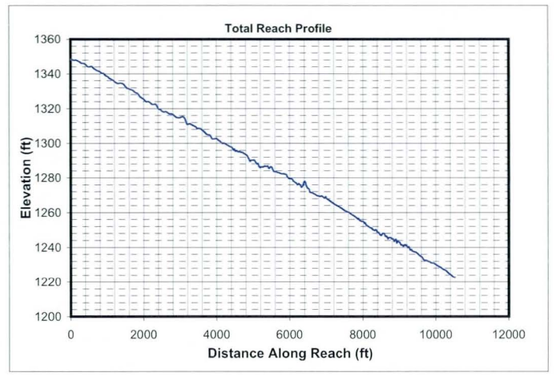
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	1231	1740							2971
Weighting Factor	1.00	0.43							
Flow into Channel	1231	755							1986

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	330.00								330
Sediment Conc. (ppm)	2203								
Sediment Volume (ac. ft)	0.27								0.27
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.27								0.27

Hydrology

Drainage Area	8.877	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1986	cfs	
Long-term Max. Chnl Capacity	10012	cfs	
Q2 Channel	199	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	302.3	108.6	0.4	100.0	100.4	1.8	0.4	302.2	0.4	0.11	0.54
497	303.9	188.5	0.6	100.0	100.6	2.6	0.6	303.7	0.6	0.19	0.59
1490	307.6	366.2	1.2	100.0	101.2	4.1	1.2	307.2	1.2	0.38	0.66
1986	309.1	436.0	1.4	100.0	101.4	4.6	1.4	308.6	1.4	0.45	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	43.0	64.6	1.5	97.0	98.7	3.1	1.7	42.4	1.5	0.54	0.44
497	50.5	119.5	2.4	97.0	99.9	4.2	2.9	49.6	2.4	0.91	0.47
1490	308.3	476.2	1.5	97.0	101.2	3.1	4.2	307.0	1.6	1.30	0.44
1986	310.2	567.2	1.8	97.0	101.5	3.5	4.5	308.8	1.8	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
199	719									719
497	2345									2345
1490	5575									5575
1986	8178									8178

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
199	1.74	1.0800	1.0260	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
497	1.74	1.2483	1.1859	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1490	1.74	1.4496	1.3771	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1986	1.74	1.5020	1.4269	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	199	497	1490	1986	199	497	1490	1986	199	497	1490	1986
Bray - Equation #1	39	63	112	130	1.5	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	147	171	1.7	2.3	3.3	3.6	2.3	2.6	3.0	3.1
Hey	12	20	36	42	4.8	6.8	10.4	11.5				
Ackers & Charlton/Lacey	33	49	77	87					1.9	2.3	2.7	2.8
Parker	97	153	265	306	1.2	1.8	2.9	3.2				
Chang	65	115	223	266	0.1	0.0	-0.5	-0.7				
Kellerhals	25	40	69	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	42	50	307	309								
Moody & Odem	28	28	28	28	1.3	1.3	1.3	1.3				
BUREC	19.3	27.2	41.1	45.8	5	7	11	12	3.1	3.9	5.2	5.6
Average	41	63	131	147	2.3	3.1	4.6	5.0	2.8	3.3	3.9	4.1
Values As Designed	42	50	307	309	1.7	2.9	4.2	4.5	3.1	4.2	3.1	3.5
Difference with Design	-1	13	-176	-162	0.5	0.2	0.4	0.6	-0.3	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1162	741	1455	2006	4076	291	285	170	4334	334	1224	1462
497	4804	2535	4793	9493	6172	1385	1053	964	11677	1181	5413	4497
1490	26077	9502	15478	60943	9528	6742	3624	5208	36157	5769	26857	18717
1986	40587	13214	20032	99073	10598	10055	4879	7809	48398	8793	40016	27587

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	2171	1385	2718	3747	7615	544	532	317	8096	625	2287	2731
497	3589	1895	3582	7094	4612	1035	787	720	8725	882	4045	3361
1490	6495	2367	3855	15180	2373	1679	903	1297	9006	1437	6689	4662
1986	7582	2469	3742	18508	1980	1878	911	1459	9041	1643	7475	5153

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	996	464	687	1876	878	199	150	240	1256	208	1179	739
497	3739	1360	1860	7979	1386	703	416	874	3230	661	4215	2402
1490	7746	3389	5209	14455	6431	1546	1151	1866	9436	1596	9130	5632
1986	12046	4869	7132	23476	7251	2363	1617	2897	12743	2456	14017	8261

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1861	866	1283	3505	1640	373	280	449	2346	389	2202	1381
497	2794	1016	1390	5962	1036	526	311	653	2414	494	3149	1795
1490	1929	844	1298	3600	1602	385	287	465	2350	398	2274	1403
1986	2250	910	1332	4385	1354	441	302	541	2380	459	2618	1543

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
199	0.0024	0.0034	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0060	0.0003	0.0025	0.0119	0.0050
497	0.0012	0.0020	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0060	0.0002	0.0013	0.0120	0.0048
1490	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0060	0.0001	0.0006	0.0119	0.0046
1986	0.0004	0.0009	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0005	0.0119	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	73.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	25	
Distance between structs.	421	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	421 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		9.03	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
199	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	0.0	3.0	4.2
497	1.1	-0.8	0.2	24.6	2.9	2.4	4.2	0.0050	0.3	0.0	3.0	4.5
1490	1.1	-1.2	0.1	24.6	4.2	1.6	3.1	0.0050	0.4	0.0	3.0	4.6
1986	1.1	-1.3	0.2	24.6	4.5	1.8	3.5	0.0050	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.06	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	0.83	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	3512	sq. Yd
Volume	9364	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10535	10535
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	49163	101838
Left Levee Volume (cu. Yd)	48383	113934
Right Levee Length (ft)	10535	10535
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	49163	101838
Right Levee Volume (cu. Yd)	48383	113934
Total Levee Surface Area (sq. Yd)	98326	203676
Total Levee Volume (cu. Yd)	96766	227868

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16388	38628
Left Levee Lining Volume (cu. Yd)	8194	19314
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16388	38628
Right Levee Lining Volume (cu. Yd)	8194	19314
Total Lining Area (sq. Yd)	32776	77257
Total Lining Volume (cu. Yd)	16388	38628

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.8	ft
Structure Height	9.8	ft
Number of Structures	25	
Volume per structure	357	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 26,775	
Area per structure	109	sq. Yd
Total Area	2,725	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14568	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 58,272	
Other Cost	$ -	
Total cost per basin	$ 58,272	
Area per basin	15,311	sq. Yd
Total Area	15,311	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	96,766	cu. Yd	$ 7.00	$ 677,362	98,326	sq. Yd	$ 9.00	$ 884,934	98,326	sq. Yd	$ 11.67	$ 1,147,137
Levee - LC Enhancement	Fill	131,102	cu. Yd	$ 7.00	$ 917,714	105,350	sq. Yd	$ 9.00	$ 948,150	131,102	sq. Yd	$ 11.67	$ 1,529,523
Levee Lining	Riprap	16,388	cu. Yd	$ 75.00	$ 1,229,100	32,776	sq. Yd	$ -	$ -	32,776	sq. Yd	$ 20.83	$ 682,824
Levee Lining -LC Enhancement	Riprap	22,240	cu. Yd	$ 75.00	$ 1,668,000	44,481	sq. Yd	$ -	$ -	44,481	sq. Yd	$ 20.83	$ 926,690
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	9,364	cu. Yd	$ 75.00	$ 702,300	3,512	sq. Yd	$ -	$ -	3,512	sq. Yd	$ 25.00	$ 87,800
Drop Structures	Riprap	25	EA	$ 26,775.00	$ 669,375	2,725	sq. Yd	$ -	$ -	2,725	sq. Yd	$ 33.33	$ 90,833
Drop Str. - LC Enhancement	Riprap	25	EA	$ 2,677.50	$ 66,938	273	sq. Yd	$ -	$ -	273	sq. Yd	$ 33.33	$ 9,083
Sedimentation Basins		1	EA	$ 58,272.00	$ 58,272	15,311	sq. Yd	$ -	$ -	15,311	sq. Yd	$ 8.33	$ 127,592
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 884,934	Base Maintenance Cost			$ 2,136,186
						LC Enhancement Cost			$ 948,150	LC Enhancement Cost			$ 2,465,296
						Total Landscape Cost			$ 1,833,084	Total Maintenance Cost			$ 4,601,482

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,336,409	$ 2,652,652	$ 5,989,061
Contingency Cost (25% of Construction Cost)	$ 834,102	$ 663,163	$ 1,497,265
Engineering Design Cost (5% of Construction Cost)	$ 166,820	$ 132,633	$ 299,453
Total Construction Cost	$ 4,337,332	$ 3,448,447	$ 7,785,779

Land Cost

Channel Length	10535	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	79.1	$100,000	$ 7,910,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.3	$100,000	$ 1,330,000
Levee LC Enhancement	51	12.3	$100,000	$ 1,230,000
Other	0	0	$100,000	$ -
Total	433	104.7		$ 10,470,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	92.4	$100,000	$ 9,240,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	104.7	$100,000	$ 10,470,000

Total Cost

Base Total Cost	$	16,598,451
Total Landscape Enhancement Cost	$	8,091,893
Total Cost Including LC Enh.	$	24,690,345

Open Channel

Structure ID	C42020

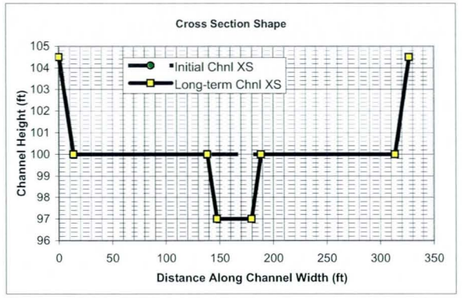
HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

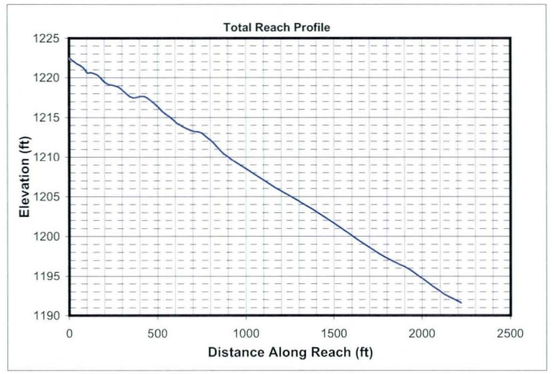
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1705									1705
Weighting Factor	1.00									
Flow into Channel	1705									1705

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	330.00									330
Sediment Conc. (ppm)	1795									
Sediment Volume (ac. ft)	0.22									0.22
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.22									0.22

Hydrology

Drainage Area	9.88	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1705	cfs	
Long-term Max. Chnl Capacity	10501	cfs	
Q2 Channel	171	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	302.0	94.7	0.3	100.0	100.3	1.8	0.3	301.9	0.3	0.11	0.57
426	303.4	164.3	0.5	100.0	100.5	2.6	0.5	303.3	0.5	0.19	0.62
1279	306.7	319.1	1.0	100.0	101.1	4.0	1.1	306.3	1.0	0.36	0.69
1705	307.9	379.8	1.2	100.0	101.3	4.5	1.3	307.5	1.2	0.43	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	41.8	56.7	1.4	97.0	98.5	3.0	1.5	41.3	1.4	0.53	0.45
426	48.5	104.3	2.1	97.0	99.6	4.1	2.6	47.7	2.2	0.90	0.49
1279	307.2	421.6	1.4	97.0	101.0	3.0	4.0	305.9	1.4	1.37	0.46
1705	308.9	502.2	1.6	97.0	101.2	3.4	4.2	307.5	1.6	1.46	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
171	739									739
426	2402									2402
1279	5632									5632
1705	8261									8261

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
171	1.74	1.0380	0.9861	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
426	1.74	1.2065	1.1461	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1279	1.74	1.4080	1.3376	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1705	1.74	1.4606	1.3875	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	171	426	1279	1705	171	426	1279	1705	171	426	1279	1705
Bray - Equation #1	36	58	103	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	136	158	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.5	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	73	82					1.9	2.2	2.6	2.8
Parker	90	142	246	284	1.2	1.7	2.7	3.0				
Chang	62	108	210	250	0.1	-0.1	-0.5	-0.6				
Kellerhals	24	37	64	74	2.1	3.1	4.8	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	41	48	306	308								
Moody & Odem	29	29	29	29	1.3	1.3	1.3	1.3				
BUREC	17.9	25.3	38.2	42.5	5	7	10	11	3.1	3.9	5.2	5.6
Average	39	59	124	139	2.1	2.9	4.3	4.7	2.8	3.2	3.9	4.0
Values As Designed	41	48	306	307	1.5	2.6	4.0	4.2	3.0	4.1	3.0	3.4
Difference with Design	-3	11	-182	-169	0.6	0.3	0.3	0.5	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1130	737	1500	1984	4119	305	296	159	4687	345	1179	1495
426	4674	2506	4904	9392	6224	1434	1083	917	12582	1190	5219	4557
1279	25405	9358	15769	60354	9587	6968	3713	4980	38902	5724	25828	18781
1705	39548	13003	20418	98150	10657	10392	4994	7471	52063	8699	38444	27622

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	2460	1603	3264	4316	8963	664	644	347	10200	750	2565	3252
426	4068	2181	4268	8174	5417	1248	943	798	10951	1036	4542	3966
1279	7371	2715	4575	17510	2782	2022	1077	1445	11287	1661	7493	5449
1705	8605	2829	4443	21357	2319	2261	1087	1626	11329	1893	8365	6010

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	914	432	659	1727	849	190	144	216	1244	194	1076	695
426	3451	1271	1786	7404	1332	675	400	795	3200	716	3870	2264
1279	6995	3110	4988	13084	6309	1455	1095	1649	9335	1468	8219	5246
1705	10883	4477	6813	21259	7114	2229	1543	2574	12610	2255	12638	7672

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1988	939	1435	3759	1847	414	312	469	2706	422	2342	1512
426	3003	1106	1555	6444	1159	588	348	692	2785	623	3369	1970
1279	2029	902	1447	3796	1830	422	318	478	2708	426	2384	1522
1705	2368	974	1482	4626	1548	485	336	560	2744	491	2750	1669

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
171	0.0027	0.0039	123	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0028	0.0139	0.0056
426	0.0013	0.0022	161	0.49	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0063	0.0002	0.0014	0.0139	0.0054
1279	0.0006	0.0012	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0006	0.0139	0.0052
1705	0.0005	0.0010	244	0.74	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0139	0.0052

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	18.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		6.81	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
171	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0055	0.2	0.0	3.0	4.2
426	1.1	-0.7	0.2	24.6	2.6	2.2	4.1	0.0055	0.3	0.0	3.0	4.4
1279	1.1	-1.2	0.1	24.6	4.0	1.4	3.0	0.0055	0.4	0.0	3.0	4.5
1705	1.1	-1.2	0.2	24.6	4.2	1.6	3.4	0.0055	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.12	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	1.88	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	746	sq. Yd
Volume	1989	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2238	2238
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	10444	21634
Left Levee Volume (cu. Yd)	10278	24204
Right Levee Length (ft)	2238	2238
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	10444	21634
Right Levee Volume (cu. Yd)	10278	24204
Total Levee Surface Area (sq. Yd)	20888	43268
Total Levee Volume (cu. Yd)	20556	48408

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3481	8206
Left Levee Lining Volume (cu. Yd)	1741	4103
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3481	8206
Right Levee Lining Volume (cu. Yd)	1741	4103
Total Lining Area (sq. Yd)	6963	16412
Total Lining Volume (cu. Yd)	3482	8206

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	7	
Volume per structure	337	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,275	
Area per structure	109	sq. Yd
Total Area	763	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10987	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,948	
Other Cost	$ -	
Total cost per basin	$ 43,948	
Area per basin	11,615	sq. Yd
Total Area	11,615	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	20,556	cu. Yd	$ 7.00	$ 143,892	20,888	sq. Yd	$ 9.00	$ 187,992	20,888	sq. Yd	$ 11.67	$ 243,693	
Levee - LC Enhancement	Fill	27,852	cu. Yd	$ 7.00	$ 194,964	22,380	sq. Yd	$ 9.00	$ 201,420	27,852	sq. Yd	$ 11.67	$ 324,940	
Levee Lining	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	6,963	sq. Yd	$ -	$ -	6,963	sq. Yd	$ 20.83	$ 145,056	
Levee Lining -LC Enhancement	Riprap	4,724	cu. Yd	$ 75.00	$ 354,300	9,449	sq. Yd	$ -	$ -	9,449	sq. Yd	$ 20.83	$ 196,861	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	1,989	cu. Yd	$ 75.00	$ 149,175	746	sq. Yd	$ -	$ -	746	sq. Yd	$ 25.00	$ 18,650	
Drop Structures	Riprap	7	EA	$ 25,275.00	$ 176,925	763	sq. Yd	$ -	$ -	763	sq. Yd	$ 33.33	$ 25,433	
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,527.50	$ 17,693	76	sq. Yd	$ -	$ -	76	sq. Yd	$ 33.33	$ 2,543	
Sedimentation Basins		1	EA	$ 43,948.00	$ 43,948	11,615	sq. Yd	$ -	$ -	11,615	sq. Yd	$ 8.33	$ 96,792	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 187,992	Base Maintenance Cost			$ 529,624	
						LC Enhancement Cost			$ 201,420	LC Enhancement Cost			$ 524,344	
						Total Landscape Cost			$ 389,412	Total Maintenance Cost			$ 1,053,968	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 775,090	$ 566,957	$ 1,342,047
Contingency Cost (25% of Construction Cost)	$ 193,773	$ 141,739	$ 335,512
Engineering Design Cost (5% of Construction Cost)	$ 38,755	$ 28,348	$ 67,102
Total Construction Cost	$ 1,007,617	$ 737,043	$ 1,744,660

Land Cost

Channel Length	2238 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	16.8	$100,000	$ 1,680,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2.8	$100,000	$ 280,000
Levee LC Enhancement	51	2.6	$100,000	$ 260,000
Other	0	0	$100,000	$ -
Total	433	22.2		$ 2,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.6	$100,000	$ 1,960,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	22.2	$100,000	$ 2,220,000

Total Cost

Base Total Cost	$ 3,685,233
Total Landscape Enhancement Cost	$ 1,722,808
Total Cost Including LC Enh.	$ 5,408,041

Open Channel

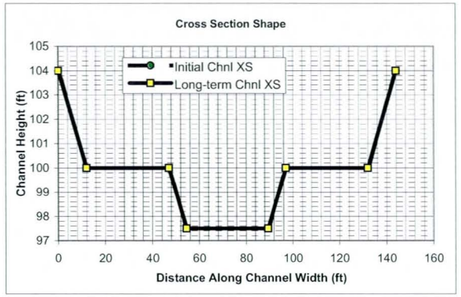
Structure ID	41010-A	HEC1 ID	41010-A

Longitudal Geometry

Length	2729.4	ft
U/S Elev	1489.1	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0128	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

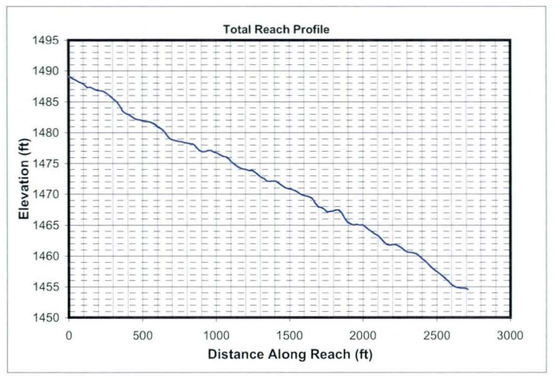
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	35	6.5	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	54.5	89.5	97	132	144
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	35	6.5	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	54.5	89.5	97	132	144
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C410	S415							TOTAL
HEC1 Peak-Flow	1524	791							2315
Weighting Factor	1.00	0.76							
Flow into Channel	1524	601							2125

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	2.523	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2125	cfs	
Long-term Max. Chnl Capacity	3952	cfs	
Q2 Channel	213	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	144	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
213	45.9	69.1	1.5	97.5	99.2	3.1	1.7	45.3	1.5	0.54	0.44
531	124.6	178.5	1.4	97.5	100.6	3.0	3.1	123.6	1.4	0.96	0.44
1594	133.3	354.6	2.7	97.5	102.0	4.5	4.5	131.8	2.7	1.39	0.48
2125	136.7	425.6	3.1	97.5	102.5	5.0	5.0	135.0	3.2	1.56	0.50

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
213	45.9	69.1	1.5	97.5	99.2	3.1	1.7	45.3	1.5	0.54	0.44
531	124.6	178.5	1.4	97.5	100.6	3.0	3.1	123.6	1.4	0.96	0.44
1594	133.3	354.6	2.7	97.5	102.0	4.5	4.5	131.8	2.7	1.39	0.48
2125	136.7	425.6	3.1	97.5	102.5	5.0	5.0	135.0	3.2	1.56	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
213										0
531										0
1594										0
2125										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
213	1.74	1.5254	1.4492	Erosive	Erosive	Erosive	0.4	Stable	5.9	Stable	Stable
531	1.74	1.5089	1.4334	Erosive	Erosive	Erosive	0.4	Stable	7.8	Stable	Stable
1594	1.74	1.7005	1.6155	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable
2125	1.74	1.7401	1.6531	Erosive	Erosive	Erosive	0.5	Stable	11.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	213	531	1594	2125	213	531	1594	2125	213	531	1594	2125
Bray - Equation #1	40	65	116	135	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	53	85	152	177	1.7	2.4	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	38	44	4.9	7.0	10.6	11.8				
Ackers & Charlton/Lacey	34	50	80	90					2.0	2.3	2.7	2.9
Parker	100	158	274	317	1.3	1.9	3.0	3.3				
Chang	68	120	233	277	0.1	-0.1	-0.5	-0.7				
Kellerhals	26	41	72	83	2.3	3.3	5.2	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	45	124	132	135								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	19.8	27.9	42.2	47.0	5	7	11	13	3.2	4.0	5.3	5.7
Average	42	71	116	132	2.3	3.2	4.6	5.1	2.9	3.3	4.0	4.1
Values As Designed	45	124	132	135	1.7	3.1	4.5	5.0	3.1	3.0	4.5	5.0
Difference with Design	-4	-53	-16	-3	0.6	0.1	0.2	0.1	-0.2	0.3	-0.5	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1069	581	1128	8220	1692	377	161	258	5707	535	2868	2054
531	2568	1378	2805	19357	4471	901	396	616	14249	1293	6934	4997
1594	13502	5094	8550	119670	6772	5333	1372	3075	43197	6020	31472	22187
2125	20762	7064	11174	191873	7560	8580	1849	4544	57673	8972	45921	33270

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1866	1015	1970	14351	2954	659	280	450	9964	934	5007	3586
531	1793	962	1959	13518	3123	629	277	430	9951	903	4842	3490
1594	3143	1186	1990	27857	1576	1241	319	716	10056	1401	7326	5165
2125	3625	1233	1951	33499	1320	1498	323	793	10069	1566	8017	5809

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1069	497	736	2010	938	214	161	258	1344	223	1264	792
531	2568	1176	1839	4734	2464	514	396	616	3343	535	3038	1929
1594	13502	4487	6036	29264	3945	2468	1372	3075	10412	1816	14855	8294
2125	20762	6258	7802	46921	4449	3655	1849	4544	13949	1966	22077	12203

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1866	868	1285	3510	1638	374	280	450	2346	390	2207	1383
531	1793	821	1284	3306	1721	359	277	430	2334	374	2122	1347
1594	3143	1045	1405	6812	918	575	319	716	2424	423	3458	1931
2125	3625	1093	1362	8192	777	638	323	793	2435	343	3854	2130

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
213	0.0005	0.0008	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0013	0.0049	0.0029
531	0.0006	0.0008	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0007	0.0050	0.0029
1594	0.0003	0.0005	343	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0049	0.0028
2125	0.0002	0.0004	372	1.13	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0049	0.0028

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	21.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	8	
Distance between structs.	341	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	341 ft	Depth	3 ft
Width	144 ft	Side slope	3 ft/ft
Total Volume per Basin		3.09	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
213	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	0.0	1.0	1.6
531	1.1	-0.9	0.1	24.6	3.1	1.4	3.0	0.0050	0.3	0.0	1.0	1.8
1594	1.1	-1.1	0.3	24.6	4.5	2.7	4.5	0.0050	0.5	0.0	1.0	2.2
2125	1.1	-1.2	0.3	24.6	5.0	3.2	5.0	0.0050	0.6	0.0	1.0	2.3

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1334	cfs
Stage at Peak Flow	101.7	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.54	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2729	2729
Side Slope (?H:1V)	3	6
Channel Width (ft)	144	183
Channel XS Area (sq. ft)	634.2	760.95
Channel Perimeter (ft)	146	184

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	218729	273419
Excavated Area (sq. Yd)	43664	55490

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2729	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	455	sq. Yd
Volume	910	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2729	2729
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	11826	24561
Left Levee Volume (cu. Yd)	10512	25269
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	0	0
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	0	0
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	11826	24561
Total Levee Volume (cu. Yd)	10512	25269

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2729	2729
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3942	9097
Left Levee Lining Volume (cu. Yd)	1971	4548
Right Levee Length (ft)	0	2729
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	1.5
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	3942	9097
Total Lining Volume (cu. Yd)	1971	4548

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	144	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.4	ft	
Structure Height	14.4	ft	
Number of Structures	8		
Volume per structure	230	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 17,250		
Area per structure	48	sq. Yd	
Total Area	384	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4985	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 19,940	
Other Cost	$ -	
Total cost per basin	$ 19,940	
Area per basin	5,459	sq. Yd
Total Area	5,459	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	10,512	cu. Yd	$ 7.00	$ 73,584	11,826	sq. Yd	$ 9.00	$ 106,434	11,826	sq. Yd	$ 11.67	$ 137,970
Levee - LC Enhancement	Fill	14,757	cu. Yd	$ 7.00	$ 103,299	12,735	sq. Yd	$ 9.00	$ 114,615	14,757	sq. Yd	$ 11.67	$ 172,165
Levee Lining	Riprap	1,971	cu. Yd	$ 75.00	$ 147,825	3,942	sq. Yd	$ -	$ -	3,942	sq. Yd	$ 20.83	$ 82,123
Levee Lining -LC Enhancement	Riprap	2,577	cu. Yd	$ 75.00	$ 193,275	5,155	sq. Yd	$ -	$ -	5,155	sq. Yd	$ 20.83	$ 107,391
Excavated Channel	Excavated	218,729	cu. Yd	$ 10.00	$ 2,187,290	43,664	sq. Yd	$ 9.00	$ 392,976	43,664	sq. Yd	$ 8.33	$ 363,867
Exc. Chl - LC Enhancement	Excavated	54,690	cu. Yd	$ 10.00	$ 546,900	11,826	sq. Yd	$ 9.00	$ 106,434	11,826	sq. Yd	$ 8.33	$ 98,550
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	910	cu. Yd	$ 75.00	$ 68,250	455	sq. Yd	$ -	$ -	455	sq. Yd	$ 25.00	$ 11,375
Drop Structures	Riprap	8	EA	$ 17,250.00	$ 138,000	384	sq. Yd	$ -	$ -	384	sq. Yd	$ 33.33	$ 12,800
Drop Str. - LC Enhancement	Riprap	8	EA	$ 1,725.00	$ 13,800	38	sq. Yd	$ -	$ -	38	sq. Yd	$ 33.33	$ 1,280
Sedimentation Basins		1	EA	$ 19,940.00	$ 19,940	5,459	sq. Yd	$ -	$ -	5,459	sq. Yd	$ 8.33	$ 45,492
Other					$ -				$ -				$ -

Base Landscape Cost	$ 499,410	Base Maintenance Cost	$ 653,626
LC Enhancement Cost	$ 221,049	LC Enhancement Cost	$ 379,386
Total Landscape Cost	$ 720,459	Total Maintenance Cost	$ 1,033,012

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,634,889	$ 857,274	$ 3,492,163
Contingency Cost (25% of Construction Cost)	$ 658,722	$ 214,319	$ 873,041
Engineering Design Cost (5% of Construction Cost)	$ 131,744	$ 42,864	$ 174,608
Total Construction Cost	$ 3,425,356	$ 1,114,456	$ 4,539,812

Land Cost

Channel Length	2729 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	120	7.5	$100,000	$ 750,000
LC Enhancement Buffer	50	3.1	$100,000	$ 310,000
Channel	144	9	$100,000	$ 900,000
Channel LC Enhancement	39	2.4	$100,000	$ 240,000
Levee	26	1.6	$100,000	$ 160,000
Levee LC Enhancement	24	1.5	$100,000	$ 150,000
Active fan area set aside for Fan 4	0	55.2	$100,000	$ 5,520,000
Total	403	80.3		$ 8,030,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	73.3	$100,000	$ 7,330,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	80.3	$100,000	$ 8,030,000

Total Cost

Base Total Cost	$ 11,908,392
Total Landscape Enhancement Cost	$ 2,414,891
Total Cost Including LC Enh.	$ 14,323,283

Open Channel

Structure ID	S51010

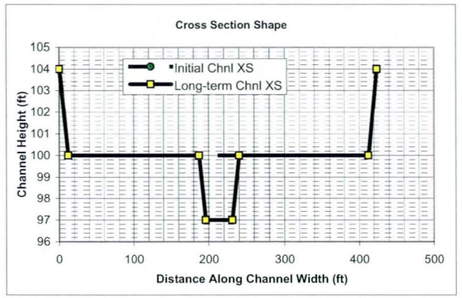
HEC1 ID	S51010

Longitundal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

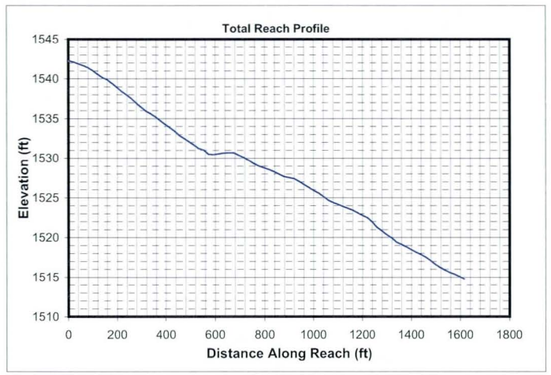
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	400	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	412	412	412	424
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	175	3	35	7	3	172	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	187	196	231	240	412	424
Y	104	100	100	97	97	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510	S500								TOTAL
HEC1 Peak-Flow	2099	2063								4162
Weighting Factor	0.21	1.00								
Flow into Channel	441	2063								2504

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	4.033	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2504	cfs	
Long-term Max. Chnl Capacity	11838	cfs	
Q2 Channel	250	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	424	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
250	402.0	125.7	0.3	100.0	100.3	2.0	0.3	401.9	0.3	0.12	0.63
626	403.4	217.9	0.5	100.0	100.5	2.9	0.5	403.3	0.5	0.20	0.69
1878	406.6	422.7	1.0	100.0	101.0	4.4	1.0	406.3	1.0	0.39	0.77
2504	407.9	503.0	1.2	100.0	101.2	5.0	1.2	407.5	1.2	0.47	0.79

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
250	46.3	72.5	1.6	97.0	98.8	3.5	1.8	45.8	1.6	0.67	0.48
626	403.6	298.4	0.7	97.0	100.4	2.1	3.4	402.5	0.7	1.28	0.43
1878	408.0	579.5	1.4	97.0	101.1	3.2	4.1	406.7	1.4	1.54	0.48
2504	409.7	689.8	1.7	97.0	101.4	3.6	4.4	408.3	1.7	1.64	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
250										0
626										0
1878										0
2504										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
250	1.74	1.0370	0.9852	Erosive	Erosive	Erosive	0.2	Stable	6.6	Stable	Stable
626	1.74	1.2057	1.1454	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1878	1.74	1.4077	1.3373	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable
2504	1.74	1.4604	1.3874	Erosive	Erosive	Erosive	0.3	Stable	10.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	250	626	1878	2504	250	626	1878	2504	250	626	1878	2504
Bray - Equation #1	44	71	126	147	1.7	2.3	3.3	3.6	3.4	3.9	4.5	4.7
Bray - Equation #2	57	93	166	193	1.8	2.5	3.6	3.9	2.4	2.7	3.1	3.2
Hey	13	22	41	48	5.3	7.4	11.3	12.6				
Ackers & Charlton/Lacey	37	54	85	96					2.0	2.3	2.8	3.0
Parker	109	172	298	344	1.4	2.0	3.2	3.6				
Chang	80	140	272	323	0.0	-0.2	-0.8	-1.0				
Kellerhals	28	45	78	90	2.5	3.6	5.5	6.2	3.5	3.9	4.3	4.5
AMAFCA/Schumm	46	403	407	409								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	20.4	28.7	43.4	48.3	5	8	12	13	3.5	4.5	5.9	6.3
Average	46	105	154	172	2.4	3.3	4.9	5.4	3.0	3.5	4.1	4.3
Values As Designed	46	402	407	408	1.8	3.4	4.1	4.4	3.5	2.1	3.2	3.6
Difference with Design	0	-298	-253	-236	0.6	-0.1	0.7	1.0	-0.5	1.4	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
250	2335	1491	3196	4393	6435	757	669	376	9756	715	2516	2967
626	9664	4811	9449	20818	9505	3168	2163	1905	25583	2466	10510	9095
1878	52611	17375	28456	134018	14380	14936	7021	9680	78341	11796	49900	38047
2504	81950	24001	37240	218096	15928	22235	9371	14371	104721	17889	73646	56314

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
250	3460	2210	4735	6509	9535	1122	991	557	14455	1059	3727	4396
626	5727	2852	5600	12338	5633	1878	1282	1129	15162	1462	6229	5390
1878	10393	3432	5621	26475	2841	2951	1387	1912	15476	2330	9858	7516
2504	12142	3556	5518	32314	2360	3294	1388	2129	15516	2651	10912	8344

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
250	1764	750	1109	3565	1099	373	251	411	2118	373	2034	1259
626	2256	1183	2100	3703	5582	434	417	434	4818	517	2531	2179
1878	12262	5187	8239	23789	9104	2619	1859	2853	15782	2583	14238	8956
2504	19093	7423	11362	38686	10227	3979	2587	4410	21265	3970	21763	13160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
250	2614	1111	1643	5282	1628	552	371	608	3139	553	3014	1865
626	1337	701	1244	2194	3308	257	247	257	2855	306	1500	1292
1878	2422	1025	1628	4700	1798	517	367	564	3118	510	2813	1769
2504	2829	1100	1683	5732	1515	590	383	653	3151	588	3224	1950

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
250	0.0025	0.0039	136	0.41	0.047	0.0008	30	0.036	0.0006	0.0159	0.0008	0.0019	0.0055	0.0003	0.0026	0.0171	0.0062
626	0.0013	0.0022	179	0.55	0.050	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0055	0.0002	0.0013	0.0171	0.0060
1878	0.0006	0.0012	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0055	0.0001	0.0006	0.0171	0.0058
2504	0.0004	0.0010	270	0.82	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0055	0.0001	0.0005	0.0171	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	18.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	233	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.80	sq. mi
Total Sediment Yield Volume	1.53	ac ft

Sedimentation Basins

Length	233 ft	Depth	3 ft
Width	424 ft	Side slope	3 ft/ft
Total Volume per Basin		6.42	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
250	1.1	-0.5	0.2	24.6	1.8	1.6	3.5	0.0060	0.2	0.0	3.0	4.3
626	1.1	-1.2	0.1	24.6	3.4	0.7	2.1	0.0060	0.3	0.0	3.0	4.4
1878	1.1	-1.2	0.1	24.6	4.1	1.4	3.2	0.0060	0.4	0.0	3.0	4.6
2504	1.1	-1.2	0.2	24.6	4.4	1.7	3.6	0.0060	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	2063	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.8	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.53	ac. ft
Outflowing Sediment Volume	0.19	ac. ft
Deposited(+)/Eroded(-) Volume	1.34	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	3
Channel Width (ft)	424	424
Channel XS Area (sq. ft)	1780	1780
Channel Perimeter (ft)	426	426

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	545	sq. Yd
Volume	1452	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1634	1634
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	7081	14706
Left Levee Volume (cu. Yd)	6294	15130
Right Levee Length (ft)	1634	1634
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	7081	14706
Right Levee Volume (cu. Yd)	6294	15130
Total Levee Surface Area (sq. Yd)	14162	29412
Total Levee Volume (cu. Yd)	12588	30260

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1634	1634
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2360	5447
Left Levee Lining Volume (cu. Yd)	1180	2723
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2360	5447
Right Levee Lining Volume (cu. Yd)	1180	2723
Total Lining Area (sq. Yd)	4720	10893
Total Lining Volume (cu. Yd)	2360	5446

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	424	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.6	ft	
Structure Height	9.6	ft	
Number of Structures	7		
Volume per structure	454	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 34,050		
Area per structure	141	sq. Yd	
Total Area	989	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10358	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 41,432	
	-	
Other Cost	$ -	
Total cost per basin	$ 41,432	
Area per basin	10,995	sq. Yd
Total Area	10,995	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	12,588	cu. Yd	$ 7.00	$ 88,116	14,162	sq. Yd	$ 9.00	$ 127,458	14,162	sq. Yd	$ 11.67	$ 165,223
Levee - LC Enhancement	Fill	17,672	cu. Yd	$ 7.00	$ 123,704	15,250	sq. Yd	$ 9.00	$ 137,250	17,672	sq. Yd	$ 11.67	$ 206,173
Levee Lining	Riprap	2,360	cu. Yd	$ 75.00	$ 177,000	4,720	sq. Yd	$ -	$ -	4,720	sq. Yd	$ 20.83	$ 98,343
Levee Lining -LC Enhancement	Riprap	3,086	cu. Yd	$ 75.00	$ 231,450	6,173	sq. Yd	$ -	$ -	6,173	sq. Yd	$ 20.83	$ 128,602
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,452	cu. Yd	$ 75.00	$ 108,900	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 25.00	$ 13,625
Drop Structures	Riprap	7	EA	$ 34,050.00	$ 238,350	989	sq. Yd	$ -	$ -	989	sq. Yd	$ 33.33	$ 32,967
Drop Str. - LC Enhancement	Riprap	7	EA	$ 3,405.00	$ 23,835	99	sq. Yd	$ -	$ -	99	sq. Yd	$ 33.33	$ 3,297
Sedimentation Basins		1	EA	$ 41,432.00	$ 41,432	10,995	sq. Yd	$ -	$ -	10,995	sq. Yd	$ 8.33	$ 91,625
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 127,458	Base Maintenance Cost			$ 401,783
						LC Enhancement Cost			$ 137,250	LC Enhancement Cost			$ 338,072
						Total Landscape Cost			$ 264,708	Total Maintenance Cost			$ 739,854

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 653,798	$ 378,989	$ 1,032,787
Contingency Cost (25% of Construction Cost)	$ 163,450	$ 94,747	$ 258,197
Engineering Design Cost (5% of Construction Cost)	$ 32,690	$ 18,949	$ 51,639
Total Construction Cost	$ 849,937	$ 492,686	$ 1,342,623

Land Cost

Channel Length	1634	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	424	15.9	$100,000	$ 1,590,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2	$100,000	$ 200,000
Levee LC Enhancement	48	1.8	$100,000	$ 180,000
Active fan area set aside for Fan 5	0	129.3	$100,000	$ 12,930,000
Total	524	149		$ 14,900,000

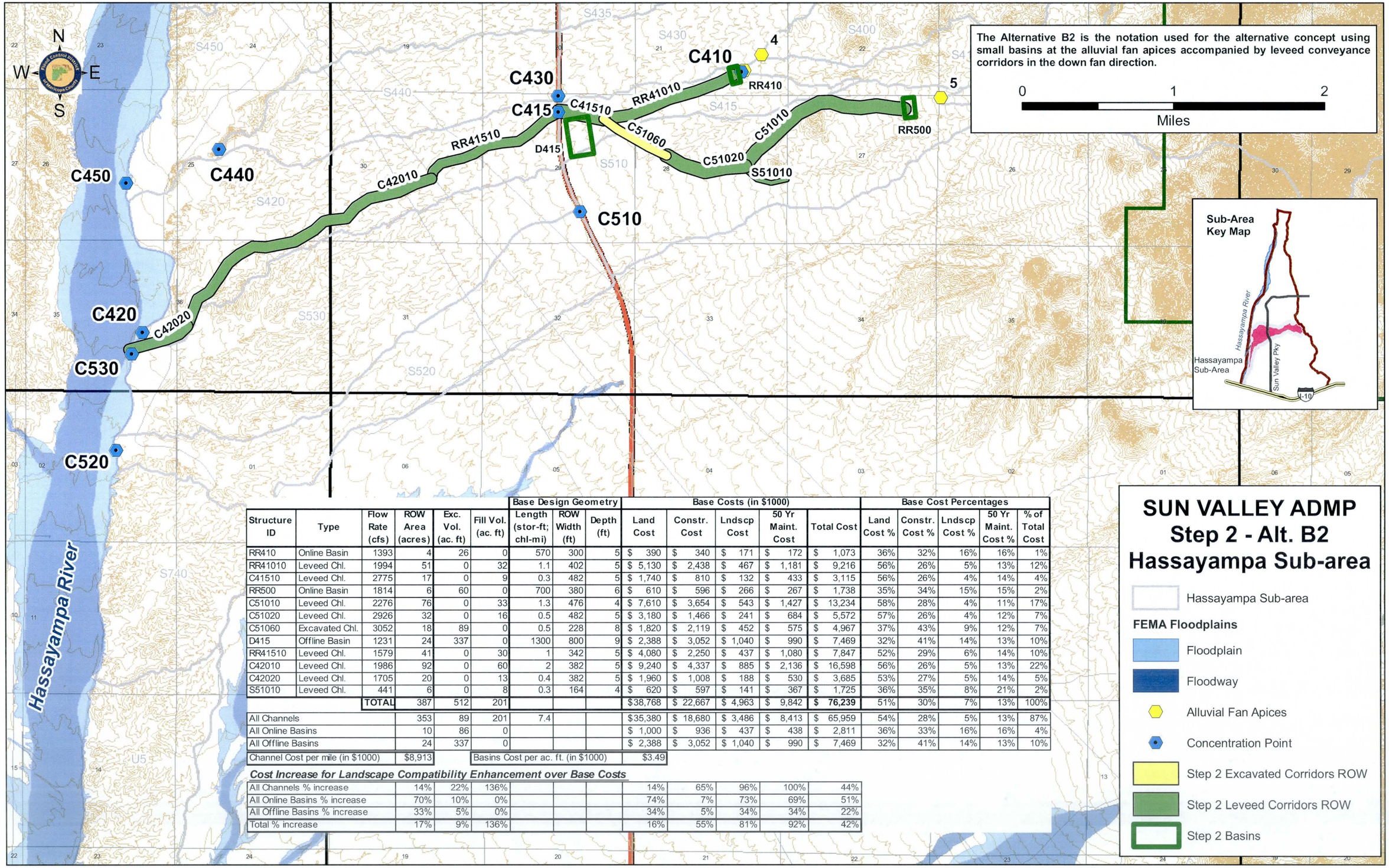
Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	147.2	$100,000	$ 14,720,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	149	$100,000	$ 14,900,000

Total Cost

Base Total Cost	$	16,099,178
Total Landscape Enhancement Cost	$	1,148,008
Total Cost Including LC Enh.	$	17,247,186



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR410	Online Basin	1393	4	26	0	570	300	5	$ 390	$ 340	$ 171	$ 172	$ 1,073	36%	32%	16%	16%	1%
RR41010	Leveed Chl.	1994	51	0	32	1.1	402	5	$ 5,130	$ 2,438	$ 467	$ 1,181	$ 9,216	56%	26%	5%	13%	12%
C41510	Leveed Chl.	2775	17	0	9	0.3	482	5	$ 1,740	$ 810	$ 132	$ 433	$ 3,115	56%	26%	4%	14%	4%
RR500	Online Basin	1814	6	60	0	700	380	6	$ 610	$ 596	$ 266	$ 267	$ 1,738	35%	34%	15%	15%	2%
C51010	Leveed Chl.	2276	76	0	33	1.3	476	4	$ 7,610	$ 3,654	$ 543	$ 1,427	$ 13,234	58%	28%	4%	11%	17%
C51020	Leveed Chl.	2926	32	0	16	0.5	482	5	$ 3,180	$ 1,466	$ 241	$ 684	$ 5,572	57%	26%	4%	12%	7%
C51060	Excavated Chl.	3052	18	89	0	0.5	228	8	$ 1,820	$ 2,119	$ 452	$ 575	$ 4,967	37%	43%	9%	12%	7%
D415	Offline Basin	1231	24	337	0	1300	800	9	$ 2,388	$ 3,052	$ 1,040	$ 990	$ 7,469	32%	41%	14%	13%	10%
RR41510	Leveed Chl.	1579	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	10%
C42010	Leveed Chl.	1986	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	22%
C42020	Leveed Chl.	1705	20	0	13	0.4	382	5	$ 1,960	$ 1,008	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
S51010	Leveed Chl.	441	6	0	8	0.3	164	4	$ 620	$ 597	$ 141	$ 367	$ 1,725	36%	35%	8%	21%	2%
	TOTAL	387	512	201					$38,768	$ 22,667	$ 4,963	$ 9,842	**$ 76,239**	51%	30%	7%	13%	100%
All Channels		353	89	201	7.4				$35,380	$ 18,680	$ 3,486	$ 8,413	$ 65,959	54%	28%	5%	13%	87%
All Online Basins		10	86	0					$ 1,000	$ 936	$ 437	$ 438	$ 2,811	36%	33%	16%	16%	4%
All Offline Basins		24	337	0					$ 2,388	$ 3,052	$ 1,040	$ 990	$ 7,469	32%	41%	14%	13%	10%
Channel Cost per mile (in $1000)		$8,913		Basins Cost per ac. ft. (in $1000)					$3.49									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	14%	22%	136%				14%	65%	96%	100%	44%
All Online Basins % increase	70%	10%	0%				74%	7%	73%	69%	51%
All Offline Basins % increase	33%	5%	0%				34%	5%	34%	34%	22%
Total % increase	17%	9%	136%				16%	55%	81%	92%	42%

SUN VALLEY ADMP
Step 2 - Alt. B2
Hassayampa Sub-area

Hassayampa Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Excavated Corridors ROW

Step 2 Leveed Corridors ROW

Step 2 Basins

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SUN VALLEY AREA DRAINAGE MASTER PLAN

Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR410	Online Basin	1393	4	26	0	570	300	5	$ 390	$ 340	$ 171	$ 172	$ 1,073	36%	32%	16%	16%	1%
RR41010	Leveed Chl.	1994	51	0	32	1.1	402	5	$ 5,130	$ 2,438	$ 467	$ 1,181	$ 9,216	56%	26%	5%	13%	12%
C41510	Leveed Chl.	2775	17	0	9	0.3	482	5	$ 1,740	$ 810	$ 132	$ 433	$ 3,115	56%	26%	4%	14%	4%
RR500	Online Basin	1814	6	60	0	700	380	6	$ 610	$ 596	$ 266	$ 267	$ 1,738	35%	34%	15%	15%	2%
C51010	Leveed Chl.	2276	76	0	33	1.3	476	4	$ 7,610	$ 3,654	$ 543	$ 1,427	$ 13,234	58%	28%	4%	11%	17%
C51020	Leveed Chl.	2926	32	0	16	0.5	482	5	$ 3,180	$ 1,466	$ 241	$ 684	$ 5,572	57%	26%	4%	12%	7%
C51060	Excavated Chl.	3052	18	89	0	0.5	228	8	$ 1,820	$ 2,119	$ 452	$ 575	$ 4,967	37%	43%	9%	12%	7%
D415	Offline Basin	1231	24	337	0	1300	800	9	$ 2,388	$ 3,052	$ 1,040	$ 990	$ 7,469	32%	41%	14%	13%	10%
RR41510	Leveed Chl.	1579	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	10%
C42010	Leveed Chl.	1986	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	22%
C42020	Leveed Chl.	1705	20	0	13	0.4	382	5	$ 1,960	$ 1,008	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
S51010	Leveed Chl.	441	6	0	8	0.3	164	4	$ 620	$ 597	$ 141	$ 367	$ 1,725	36%	35%	8%	21%	2%
	TOTAL	387	512	201					$ 38,768	$ 22,667	$ 4,963	$ 9,842	**$ 76,239**	51%	30%	7%	13%	100%
All Channels		353	89	201	7.4				$ 35,380	$ 18,680	$ 3,486	$ 8,413	$ 65,959	54%	28%	5%	13%	87%
All Online Basins		10	86	0					$ 1,000	$ 936	$ 437	$ 438	$ 2,811	36%	33%	16%	16%	4%
All Offline Basins		24	337	0					$ 2,388	$ 3,052	$ 1,040	$ 990	$ 7,469	32%	41%	14%	13%	10%
Channel Cost per mile (in $1000)		$8,913		Basins Cost per ac. ft. (in $1000)					$3.49									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RR410	Online Basin	1393	7	28	0	760	400	5	$ 700	$ 354	$ 304	$ 297	$ 1,655	42%	21%	18%	18%	2%
RR41010	Leveed Chl.	1994	58	0	75	1.1	453	5	$ 5,780	$ 4,277	$ 968	$ 2,484	$ 13,509	43%	32%	7%	18%	13%
C41510	Leveed Chl.	2775	19	0	21	0.3	533	5	$ 1,920	$ 1,333	$ 273	$ 801	$ 4,327	44%	31%	6%	19%	4%
RR500	Online Basin	1814	10	67	0	940	480	6	$ 1,040	$ 649	$ 451	$ 442	$ 2,582	40%	25%	17%	17%	2%
C51010	Leveed Chl.	2276	84	0	80	1.3	524	4	$ 8,380	$ 5,776	$ 1,128	$ 2,871	$ 18,154	46%	32%	6%	16%	17%
C51020	Leveed Chl.	2926	35	0	39	0.5	533	5	$ 3,520	$ 2,431	$ 500	$ 1,359	$ 7,810	45%	31%	6%	17%	7%
C51060	Excavated Chl.	3052	24	109	0	0.5	410	8	$ 2,390	$ 2,548	$ 574	$ 689	$ 6,202	39%	41%	9%	11%	6%
D415	Offline Basin	1231	32	355	0	1550	900	9	$ 3,200	$ 3,197	$ 1,395	$ 1,324	$ 9,116	35%	35%	15%	15%	8%
RR41510	Leveed Chl.	1579	47	0	70	1	393	5	$ 4,690	$ 3,962	$ 904	$ 2,298	$ 11,854	40%	33%	8%	19%	11%
C42010	Leveed Chl.	1986	105	0	141	2	433	5	$ 10,470	$ 7,786	$ 1,833	$ 4,601	$ 24,690	42%	32%	7%	19%	23%
C42020	Leveed Chl.	1705	22	0	30	0.4	433	5	$ 2,220	$ 1,745	$ 389	$ 1,054	$ 5,408	41%	32%	7%	19%	5%
S51010	Leveed Chl.	441	8	0	19	0.3	208	4	$ 790	$ 1,030	$ 265	$ 680	$ 2,765	29%	37%	10%	25%	3%
	TOTAL	451	559	475					$ 45,100	$ 35,087	$ 8,985	$ 18,899	**$ 108,071**	42%	32%	8%	17%	100%
All Channels		402	109	475	7.4				$ 40,160	$ 30,888	$ 6,835	$ 16,837	$ 94,719	42%	33%	7%	18%	88%
All Online Basins		17	95	0					$ 1,740	$ 1,002	$ 755	$ 739	$ 4,236	41%	24%	18%	17%	4%
All Offline Basins		32	355	0					$ 3,200	$ 3,197	$ 1,395	$ 1,324	$ 9,116	35%	35%	15%	15%	8%
Channel Cost per mile (in $1000)		$12,800		Basins Cost per ac. ft. (in $1000)					$4.78									
All Channels % increase		14%	22%	136%					14%	65%	96%	100%	44%					
All Online Basins % increase		70%	10%	0%					74%	7%	73%	69%	51%					
All Offline Basins % increase		33%	5%	0%					34%	5%	34%	34%	22%					
Total % increase		17%	9%	136%					16%	55%	81%	92%	42%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
RR410	STORAGE	1288	2.3	7.7	4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
410415	ROUTE	1245	100.9	56.75	4.9	2.18	262	66	22	9	1.116	1.12	1.12	1.12	130	130	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415R	COMBINE	1245			4.9	2.63	304	76	25	11	1.074	1.078	1.078	1.078	151	151	151	151
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
RR500	STORAGE	1619	2.9	14.77	4.9	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
500415	ROUTE	1557	100.4	57.89	5.3	3.64	453	115	38	17	1.157	1.171	1.171	1.171	224	227	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C415L	COMBINE	1520			4.5	5.48	607	153	51	22	1.031	1.041	1.041	1.041	301	304	304	304
C415	COMBINE	2323			5	8.11	802	202	67	29	0.919	0.928	0.928	0.928	398	401	401	401
D415	DIVERT	1231			4.1	8.11	608	154	51	22	0.696	0.705	0.705	0.705	301	305	305	305
415420	ROUTE	1231	101	129.2	5.9	8.11	584	154	51	22	0.669	0.705	0.705	0.705	289	305	305	305
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1253			5.5	9.88	696	187	62	27	0.655	0.704	0.704	0.704	345	371	371	371
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
RR410	STORAGE	1393	2.7	9.05	12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
410415	ROUTE	1327	100.9	59.08	12.9	2.18	262	67	23	10	1.114	1.15	1.15	1.15	130	134	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415R	COMBINE	1339			12.9	2.63	309	79	26	11	1.091	1.12	1.121	1.121	153	157	157	157
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
RR500	STORAGE	1814	3.7	18.79	12.9	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
500415	ROUTE	1711	100.5	62.85	13.3	3.64	476	129	43	19	1.216	1.321	1.323	1.323	236	256	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C415L	COMBINE	2112			12.2	5.48	680	180	60	26	1.155	1.225	1.226	1.226	337	358	358	358
C415	COMBINE	2775			13	8.11	978	257	86	37	1.121	1.178	1.179	1.179	485	509	510	510
D415	DIVERT	1231			12	8.11	636	171	57	25	0.729	0.785	0.787	0.787	315	340	340	340
415420	ROUTE	1231	101	129.2	14	8.11	612	171	57	25	0.702	0.784	0.787	0.787	304	339	340	340
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1705			12.3	9.88	784	219	73	32	0.738	0.824	0.826	0.826	389	434	435	435
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Leveed	0.0143	0.0050	1.10	3	4.5	0.045	1994	328.3	424.8	1.3	1.3	1.3	3.2	328	4.7	0.73	0.41
C41510	Leveed	0.0137	0.0050	0.30	3	4.5	0.045	2775	408.9	571.9	1.4	1.4	1.4	3.1	408	4.9	0.72	0.44
C51010	Leveed	0.0222	0.0070	1.30	3	4.0	0.045	2276	406.9	438.9	1.1	1.1	1.1	2.9	407	5.2	0.88	0.48
C51020	Leveed	0.0153	0.0055	0.50	3	4.5	0.045	2926	408.9	571.2	1.4	1.4	1.4	3.1	408	5.1	0.76	0.48
C51060	Excavated	0.0055	0.0030	0.50	3	8.0	0.045	3052	170.0	672.7	4.0	4.0	6.3	1.7	168	4.5	0.40	1.18
RR41510	Leveed	0.0162	0.0060	1.00	3	4.5	0.045	1579	267.9	327.7	1.2	1.2	1.2	3.3	267	4.8	0.77	0.47
C42010	Leveed	0.0120	0.0050	2.00	3	4.5	0.045	1986	309.1	436.0	1.4	1.4	1.4	3.1	309	4.6	0.68	0.45
C42020	Leveed	0.0139	0.0055	0.40	3	4.5	0.045	1705	307.9	379.8	1.2	1.2	1.3	3.2	308	4.5	0.71	0.43
S51010	Leveed	0.0171	0.0070	0.30	3	4.0	0.045	441	88.3	96.2	1.1	1.1	1.1	2.9	88	4.6	0.77	0.50

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR410	Online Basin	0.0150	570	300	5.0	13.6	9.1	134.0	1524	1393	2.7	2.3
RR500	Online Basin	0.0250	700	380	6.0	25.8	18.8	257.0	2063	1814	3.7	2.3
D415	Offline Basin	0.0150	1300	800	9.0	171.2	170.0	170.0	1544	0	3.9	5.1

Online Basin

HEC1 ID	RR410

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.2	sq. mi
Total Sediment Yield Volume	4.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	4.1	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	570	660
Basin Width (ft)	300	300
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	287	273
Top Area (acres)	3.9	4.5
U/S-D/S Height Difference (ft)	4.5	4.5
Excess Area on Upstream (acres)	0.2	0.4

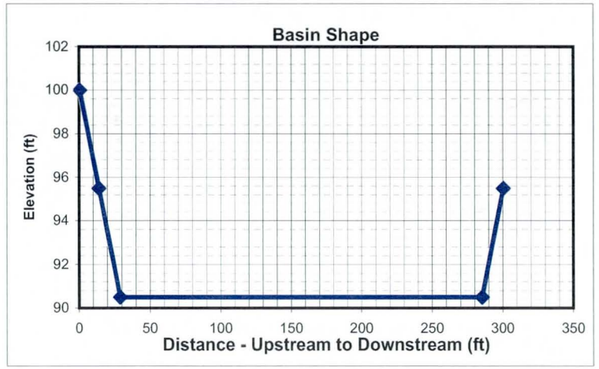
			Base	LC Enhanced
Bottom Length (ft)	540	Allocated Storage Volume (ac. ft)	13.6	13.6
Bottom Width (ft)	257	Total Available Volume (ac. ft) (incl. Freeboard)	17.3	17.6
		Total Excavation Volume (ac. ft)	26.2	27.8

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	9	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	9
Volume	0.00	3.24	6.59	10.06	13.64	17.34	21.15	25.09	29.14	33.32
Outflow	0.0	850.9	1203.3	1473.8	1701.8	1902.6	2084.2	2251.2	2406.6	2552.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	130.0	134	134.0
Peak Inflow (cfs)	1372	1524	1524.0
Peak Outflow (cfs)	1288	1393	1393.0
Stage at Peak Outflow (ft)	2.3	2.7	2.7
Volume at Peak Outflow (ac. ft)	7.7	9.05	9.1

Volume Check

Total Volume needed	13.2	ac. ft
Total Volume Provided	13.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.7	ft
Depth Provided	5	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	133000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	570	ft
Base Total ROW Width	300	ft
LC Enh. Total ROW Length	760	ft
LC Enh. Total ROW Length	400	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	42269	44851
Excavated Area (sq. Yd)	19000	33778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	30	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	334	sq. Yd
Material Volume	167	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	500	ft
Unit Cost	160	per ft
Cost per outlet	$80,000	
Other Cost	$ -	
Total Cost	$80,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		42,269	cu. Yd	$ 4.00	$ 169,076	19,000	sq. Yd	$ 9.00	$ 171,000	19,000	sq. Yd	$ 8.33	$ 158,333
Basin - LC Enhancement		2,582	cu. Yd	$ 4.00	$ 10,328	14,778	sq. Yd	$ 9.00	$ 133,002	14,778	sq. Yd	$ 8.33	$ 123,150
Inlet	Riprap	167	sq. Yd	$ 75.00	$ 12,525	334	sq. Yd	$ -	$ -	334	sq. Yd	$ 33.33	$ 11,133
Inlet - LC Enhancement (20%Inlet)					$ 2,505				$ -				$ 2,227
Outlet	Pipe	1	EA	$ 80,000	$ 80,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,000				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 171,000	Base Maintenance Cost			$ 171,683
						LC Enh. Landscape Cost			$ 133,002	LC Enh. Maintenance Cost			$ 125,488
						Total Landscape Cost			$ 304,002	Total Maintenance Cost			$ 297,171

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 261,601	$ 10,328	$ 271,929
Contingency Cost (25% of Construction Cost)	$ 65,400	$ 2,582	$ 67,982
Engineering Design Cost (5% of Construction Cost)	$ 13,080	$ 516	$ 13,596
Total Construction Cost	$ 340,081	$ 13,426	$ 353,508

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	3.1	$100,000	$ 310,000
Basin	3.9	$100,000	$ 390,000
Other		$100,000	$ -
Total	7.0	$100,000	$ 700,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	3.9	$100,000	$ 390,000
LC Enhancement Cost	acre	3.1	$100,000	$ 310,000
Total Land Cost	acre	7	$100,000	$ 700,000

Total Cost

Base Total Cost	$ 1,072,765
Total LC Enhancement Cost	$ 581,916
Total Cost Including LC Enh.	$ 1,654,681

Open Channel

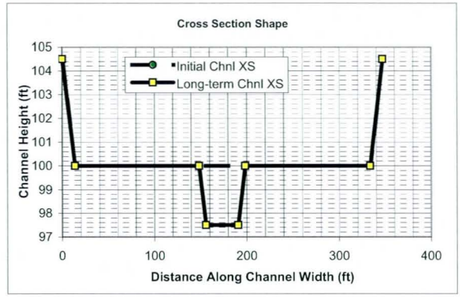
Structure ID	RR41010	HEC1 ID	410415

Longitudinal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

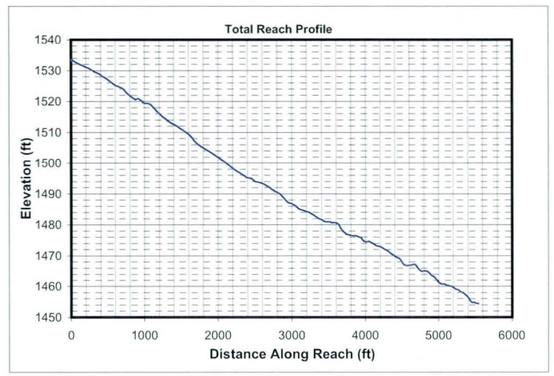
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	320	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	333.5	333.5	333.5	347
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	135	3	35	7	3	135	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	148.5	156	191	198.5	333.5	347
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR410	S415							TOTAL
HEC1 Peak-Flow	1393	791							2184
Weighting Factor	1.00	0.76							
Flow into Channel	1393	601							1994

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.343	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1994	cfs	
Long-term Max. Chnl Capacity	10408	cfs	
Q2 Channel	199	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	347	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	322.1	105.9	0.3	100.0	100.3	1.9	0.3	322.0	0.3	0.10	0.58
499	323.6	183.8	0.6	100.0	100.6	2.7	0.6	323.4	0.6	0.18	0.63
1496	327.0	356.9	1.1	100.0	101.1	4.2	1.1	326.6	1.1	0.34	0.71
1994	328.3	424.8	1.3	100.0	101.3	4.7	1.3	327.9	1.3	0.41	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	45.5	66.3	1.5	97.5	99.2	3.0	1.7	44.9	1.5	0.52	0.44
499	323.7	251.7	0.8	97.5	100.5	2.0	3.0	322.7	0.8	0.92	0.40
1496	328.3	489.4	1.5	97.5	101.2	3.1	3.7	327.1	1.5	1.15	0.44
1994	330.1	583.0	1.8	97.5	101.5	3.4	4.0	328.8	1.8	1.24	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
199										0
499										0
1496										0
1994										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
199	1.74	1.0527	1.0001	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
499	1.74	1.2212	1.1601	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
1496	1.74	1.4228	1.3516	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1994	1.74	1.4753	1.4015	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	199	499	1496	1994	199	499	1496	1994	199	499	1496	1994
Bray - Equation #1	39	63	112	130	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	147	171	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	42	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	153	266	307	1.2	1.8	2.9	3.2				
Chang	66	115	224	266	0.1	0.0	-0.5	-0.7				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	45	323	328	329								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	19.4	27.3	41.2	45.9	5	7	11	12	3.1	3.9	5.2	5.6
Average	40	88	131	147	2.2	3.1	4.5	5.0	2.8	3.3	3.9	4.1
Values As Designed	45	323	327	329	1.7	3.0	3.7	4.0	3.0	2.0	3.1	3.4
Difference with Design	-5	-235	-196	-182	0.6	0.1	0.8	1.0	-0.2	1.3	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1441	927	1894	2581	4659	411	385	217	5780	431	1532	1842
499	5956	3092	5944	12221	6981	1838	1340	1182	15375	1500	6621	5641
1496	32378	11405	18742	78548	10685	8815	4495	6240	47363	7243	32264	23471
1994	50416	15816	24356	127748	11864	13135	6030	9322	63357	11010	47883	34631

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	2681	1725	3523	4803	8668	765	717	404	10754	802	2850	3426
499	4433	2301	4424	9096	5195	1368	997	880	11443	1116	4928	4198
1496	8032	2829	4649	19486	2651	2187	1115	1548	11750	1797	8004	5823
1994	9380	2943	4532	23769	2207	2444	1122	1734	11788	2049	8909	6443

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	974	460	689	1815	909	195	149	234	1257	204	1153	731
499	1389	737	1155	2172	4017	220	227	259	2804	312	1526	1347
1496	7538	3364	5218	13923	6685	1507	1142	1812	9443	1556	8896	5553
1994	11723	4842	7117	22621	7541	2310	1610	2824	12764	2393	13688	8130

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1812	856	1281	3376	1692	363	277	436	2339	379	2145	1360
499	1034	548	860	1616	2989	164	169	193	2087	232	1135	1002
1496	1870	835	1294	3454	1658	374	283	450	2343	386	2207	1378
1994	2181	901	1324	4209	1403	430	300	525	2375	445	2547	1513

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
199	0.0025	0.0037	127	0.39	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0060	0.0003	0.0026	0.0142	0.0056
499	0.0013	0.0021	168	0.51	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0060	0.0002	0.0013	0.0143	0.0054
1496	0.0006	0.0011	232	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0060	0.0001	0.0006	0.0142	0.0052
1994	0.0004	0.0009	253	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0005	0.0142	0.0052

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	51.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	309	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	309 ft	Depth	3 ft
Width	347 ft	Side slope	3 ft/ft
Total Volume per Basin		6.98	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
199	1.1	-0.5	0.1	24.6	1.7	1.5	3.0	0.0050	0.2	0.0	2.5	3.6
499	1.1	-1.1	0.1	24.6	3.0	0.8	2.0	0.0050	0.3	0.0	2.5	3.7
1496	1.1	-1.1	0.1	24.6	3.7	1.5	3.1	0.0050	0.4	0.0	2.5	3.8
1994	1.1	-1.1	0.2	24.6	4.0	1.8	3.4	0.0050	0.4	0.0	2.5	3.9

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	1327	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.57	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	3
Channel Width (ft)	347	347
Channel XS Area (sq. ft)	1607	1607
Channel Perimeter (ft)	349	349

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1854	sq. Yd
Volume	4325	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5561	5561
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25951	53756
Left Levee Volume (cu. Yd)	25539	60141
Right Levee Length (ft)	5561	5561
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25951	53756
Right Levee Volume (cu. Yd)	25539	60141
Total Levee Surface Area (sq. Yd)	51902	107512
Total Levee Volume (cu. Yd)	51078	120282

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8650	20390
Left Levee Lining Volume (cu. Yd)	4325	10195
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8650	20390
Right Levee Lining Volume (cu. Yd)	4325	10195
Total Lining Area (sq. Yd)	17301	40781
Total Lining Volume (cu. Yd)	8650	20390

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	347	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.6	ft	
Structure Height	9.6	ft	
Number of Structures	18		
Volume per structure	370	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 27,750		
Area per structure	116	sq. Yd	
Total Area	2,082	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	11261	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 45,044	
Other Cost	$ -	
Total cost per basin	$ 45,044	
Area per basin	11,913	sq. Yd
Total Area	11,913	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	51,078	cu. Yd	$ 7.00	$ 357,546	51,902	sq. Yd	$ 9.00	$ 467,118	51,902	sq. Yd	$ 11.67	$ 605,523
Levee - LC Enhancement	Fill	69,204	cu. Yd	$ 7.00	$ 484,428	55,610	sq. Yd	$ 9.00	$ 500,490	69,204	sq. Yd	$ 11.67	$ 807,380
Levee Lining	Riprap	8,650	cu. Yd	$ 75.00	$ 648,750	17,301	sq. Yd	$ -	$ -	17,301	sq. Yd	$ 20.83	$ 360,435
Levee Lining -LC Enhancement	Riprap	11,740	cu. Yd	$ 75.00	$ 880,500	23,480	sq. Yd	$ -	$ -	23,480	sq. Yd	$ 20.83	$ 489,162
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,325	cu. Yd	$ 75.00	$ 324,375	1,854	sq. Yd	$ -	$ -	1,854	sq. Yd	$ 25.00	$ 46,350
Drop Structures	Riprap	18	EA	$ 27,750.00	$ 499,500	2,082	sq. Yd	$ -	$ -	2,082	sq. Yd	$ 33.33	$ 69,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 2,775.00	$ 49,950	208	sq. Yd	$ -	$ -	208	sq. Yd	$ 33.33	$ 6,940
Sedimentation Basins		1	EA	$ 45,044.00	$ 45,044	11,913	sq. Yd	$ -	$ -	11,913	sq. Yd	$ 8.33	$ 99,275
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 467,118	Base Maintenance Cost			$ 1,180,984
						LC Enhancement Cost			$ 500,490	LC Enhancement Cost			$ 1,303,482
						Total Landscape Cost			$ 967,608	Total Maintenance Cost			$ 2,484,466

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,875,215	$ 1,414,878	$ 3,290,093
Contingency Cost (25% of Construction Cost)	$ 468,804	$ 353,720	$ 822,523
Engineering Design Cost (5% of Construction Cost)	$ 93,761	$ 70,744	$ 164,505
Total Construction Cost	$ 2,437,780	$ 1,839,341	$ 4,277,121

Land Cost

Channel Length	5561 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	347	44.3	$100,000	$ 4,430,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7	$100,000	$ 700,000
Levee LC Enhancement	51	6.5	$100,000	$ 650,000
Other	0	0	$100,000	$ -
Total	453	57.8		$ 5,780,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	51.3	$100,000	$ 5,130,000
LC Enhancement Cost	acre	6.5	$100,000	$ 650,000
Total Land Cost	acre	57.8	$100,000	$ 5,780,000

Total Cost

Base Total Cost	$ 9,215,881
Total Landscape Enhancement Cost	$ 4,293,313
Total Cost Including LC Enh.	$ 13,509,194

Open Channel

Structure ID	C41510

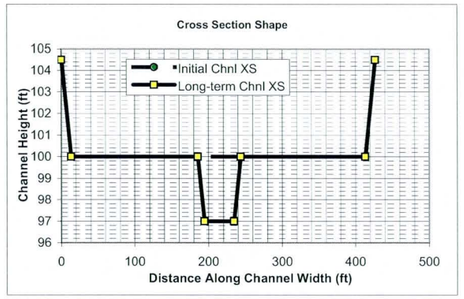
HEC1 ID	410415

Longitundal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

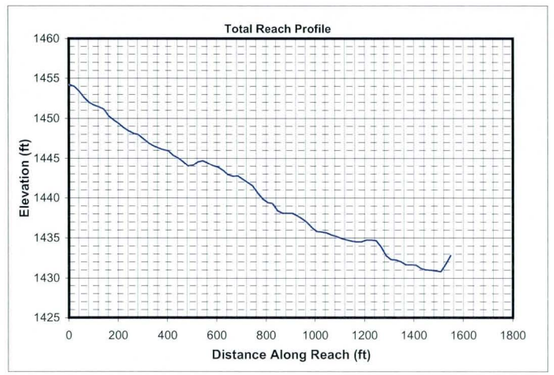
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	172	3	40	7.5	3	170	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	185.5	194.5	234.5	243.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	2775									2775
Weighting Factor	1.00									
Flow into Channel	2775									2775

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR41010	500415_C51060								TOTAL
Flow Volume (ac. ft)	134.00	257.00								391
Sediment Conc. (ppm)	1513	1114								
Sediment Volume (ac. ft)	0.08	0.11								0.18
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.08	0.11								0.18

Hydrology

Drainage Area	1.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2775	cfs	
Long-term Max. Chnl Capacity	13143	cfs	
Q2 Channel	278	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
278	402.3	142.8	0.4	100.0	100.4	1.9	0.4	402.1	0.4	0.11	0.57
694	403.9	247.7	0.6	100.0	100.6	2.8	0.6	403.7	0.6	0.19	0.63
2081	407.5	480.6	1.2	100.0	101.2	4.3	1.2	407.1	1.2	0.37	0.70
2775	408.9	571.9	1.4	100.0	101.4	4.9	1.4	408.5	1.4	0.44	0.72

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
278	51.8	85.1	1.6	97.0	98.9	3.3	1.9	51.2	1.7	0.58	0.45
694	403.9	335.4	0.8	97.0	100.5	2.1	3.5	402.8	0.8	1.08	0.40
2081	408.9	651.6	1.6	97.0	101.2	3.2	4.2	407.5	1.6	1.33	0.45
2775	410.8	775.7	1.9	97.0	101.6	3.6	4.6	409.3	1.9	1.42	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR4101 0	500415_C5106 0								
278	731	603								1334
694	1347	1446								2793
2081	5553	6204								11757
2775	8130	9162								17292

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
278	1.74	1.0762	1.0224	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
694	1.74	1.2448	1.1825	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
2081	1.74	1.4466	1.3743	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
2775	1.74	1.4992	1.4243	Erosive	Erosive	Erosive	0.4	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	278	694	2081	2775	278	694	2081	2775	278	694	2081	2775
Bray - Equation #1	46	75	133	155	1.7	2.3	3.4	3.7	3.5	3.9	4.6	4.8
Bray - Equation #2	61	98	175	204	1.9	2.6	3.7	4.1	2.4	2.7	3.2	3.3
Hey	14	24	43	51	5.5	7.7	11.8	13.1				
Ackers & Charlton/Lacey	38	56	89	101					2.0	2.4	2.9	3.0
Parker	114	181	313	362	1.4	2.1	3.3	3.7				
Chang	80	141	273	325	0.1	-0.1	-0.7	-0.9				
Kellerhals	30	47	82	95	2.6	3.7	5.8	6.5	3.6	3.9	4.4	4.5
AMAFCA/Schumm	51	403	408	410								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	21.9	30.9	46.6	51.9	6	8	12	14	3.4	4.3	5.6	6.1
Average	47	107	158	177	2.5	3.5	5.1	5.6	3.0	3.5	4.1	4.3
Values As Designed	51	403	407	409	1.9	3.5	4.2	4.6	3.3	2.1	3.2	3.6
Difference with Design	-4	-296	-250	-232	0.6	0.0	0.8	1.1	-0.3	1.4	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
278	2020	1279	2587	3642	5998	578	532	319	7649	586	2175	2488
694	8351	4226	7976	17252	8947	2527	1807	1677	20272	2066	9282	7671
2081	45448	15507	24808	110986	13639	12056	6002	8712	62352	10057	44913	32226
2775	70787	21485	32309	180568	15130	17961	8038	12984	83393	15311	66577	47686

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
278	2701	1711	3459	4869	8018	773	712	426	10227	783	2908	3326
694	4466	2260	4265	9226	4784	1351	966	897	10841	1105	4964	4102
2081	8101	2764	4422	19784	2431	2149	1070	1553	11115	1793	8006	5744
2775	9464	2872	4320	24141	2023	2401	1075	1736	11149	2047	8901	6375

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
278	1513	675	970	2906	1125	301	216	366	1768	314	1780	1085
694	2052	1077	1776	3262	5293	347	345	403	3977	455	2295	1935
2081	11150	4808	7307	20939	8717	2220	1629	2689	13219	2290	13118	8008
2775	17363	6900	10042	34041	9811	3389	2283	4166	17841	3527	20122	11771

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
278	2022	902	1297	3885	1504	402	289	489	2363	419	2380	1450
694	1097	576	950	1744	2831	186	184	216	2127	243	1227	1035
2081	1988	857	1302	3733	1554	396	290	479	2356	408	2338	1427
2775	2321	922	1343	4551	1312	453	305	557	2385	472	2690	1574

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
278	0.0023	0.0034	130	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0053	0.0003	0.0024	0.0137	0.0053
694	0.0012	0.0020	171	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0053	0.0002	0.0012	0.0137	0.0051
2081	0.0005	0.0010	237	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0053	0.0001	0.0005	0.0137	0.0049
2775	0.0004	0.0009	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0001	0.0004	0.0137	0.0049

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	13.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.20	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft	
Width	427 ft	Side slope	3 ft/ft	
Total Volume per Basin		8.77	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
278	1.1	-0.6	0.1	24.6	1.9	1.7	3.3	0.0050	0.2	0.0	3.0	4.3
694	1.1	-1.2	0.1	24.6	3.5	0.8	2.1	0.0050	0.3	0.0	3.0	4.4
2081	1.1	-1.3	0.1	24.6	4.2	1.6	3.2	0.0050	0.5	0.0	3.0	4.6
2775	1.1	-1.3	0.2	24.6	4.6	1.9	3.6	0.0050	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1327	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.39	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.31	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2007.8	2007.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	522	sq. Yd
Volume	1393	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1567	1567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	7313	15148
Left Levee Volume (cu. Yd)	7197	16947
Right Levee Length (ft)	1567	1567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	7313	15148
Right Levee Volume (cu. Yd)	7197	16947
Total Levee Surface Area (sq. Yd)	14626	30296
Total Levee Volume (cu. Yd)	14394	33894

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2438	5746
Left Levee Lining Volume (cu. Yd)	1219	2873
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2438	5746
Right Levee Lining Volume (cu. Yd)	1219	2873
Total Lining Area (sq. Yd)	4875	11491
Total Lining Volume (cu. Yd)	2438	5746

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	5	
Volume per structure	476	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 35,700	
Area per structure	142	sq. Yd
Total Area	712	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14149	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 56,596	
Other Cost	$ -	
Total cost per basin	$ 56,596	
Area per basin	14,870	sq. Yd
Total Area	14,870	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,394	cu. Yd	$ 7.00	$ 100,758	14,626	sq. Yd	$ 9.00	$ 131,634	14,626	sq. Yd	$ 11.67	$ 170,637
Levee - LC Enhancement	Fill	19,500	cu. Yd	$ 7.00	$ 136,500	15,670	sq. Yd	$ 9.00	$ 141,030	19,500	sq. Yd	$ 11.67	$ 227,500
Levee Lining	Riprap	2,438	cu. Yd	$ 75.00	$ 182,850	4,875	sq. Yd	$ -	$ -	4,875	sq. Yd	$ 20.83	$ 101,565
Levee Lining -LC Enhancement	Riprap	3,308	cu. Yd	$ 75.00	$ 248,100	6,616	sq. Yd	$ -	$ -	6,616	sq. Yd	$ 20.83	$ 137,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,393	cu. Yd	$ 75.00	$ 104,475	522	sq. Yd	$ -	$ -	522	sq. Yd	$ 25.00	$ 13,050
Drop Structures	Riprap	5	EA	$ 35,700.00	$ 178,500	712	sq. Yd	$ -	$ -	712	sq. Yd	$ 33.33	$ 23,733
Drop Str. - LC Enhancement	Riprap	5	EA	$ 3,570.00	$ 17,850	71	sq. Yd	$ -	$ -	71	sq. Yd	$ 33.33	$ 2,373
Sedimentation Basins		1	EA	$ 56,596.00	$ 56,596	14,870	sq. Yd	$ -	$ -	14,870	sq. Yd	$ 8.33	$ 123,917
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 131,634	Base Maintenance Cost			$ 432,901
						LC Enhancement Cost			$ 141,030	LC Enhancement Cost			$ 367,711
						Total Landscape Cost			$ 272,664	Total Maintenance Cost			$ 800,613

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 623,179	$ 402,450	$ 1,025,629
Contingency Cost (25% of Construction Cost)	$ 155,795	$ 100,613	$ 256,407
Engineering Design Cost (5% of Construction Cost)	$ 31,159	$ 20,123	$ 51,281
Total Construction Cost	$ 810,133	$ 523,185	$ 1,333,318

Land Cost

Channel Length	1567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	15.4	$100,000	$ 1,540,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2	$100,000	$ 200,000
Levee LC Enhancement	51	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	533	19.2		$ 1,920,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.4	$100,000	$ 1,740,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	19.2	$100,000	$ 1,920,000

Total Cost

Base Total Cost	$ 3,114,668
Total Landscape Enhancement Cost	$ 1,211,926
Total Cost Including LC Enh.	$ 4,326,594

Online Basin

HEC1 ID	RR500

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.6	sq. mi
Total Sediment Yield Volume	6.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	6.9	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	700	840
Basin Width (ft)	380	380
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	352	323
Top Area (acres)	6.1	7.3
U/S-D/S Height Difference (ft)	9.5	9.5
Excess Area on Upstream (acres)	0.5	1.1

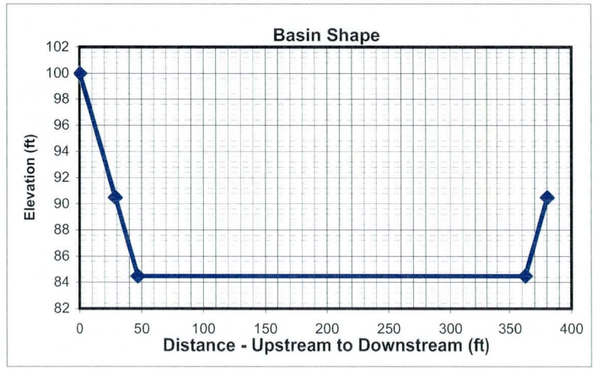
			Base	LC Enhanced
Bottom Length (ft)	664	Allocated Storage Volume (ac. ft)	25.8	25.8
Bottom Width (ft)	316	Total Available Volume (ac. ft) (incl. Freeboard)	31.4	31.8
		Total Excavation Volume (ac. ft)	60.4	66.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	10	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	9
Volume	0.00	4.88	9.91	15.07	20.37	25.81	31.39	37.12	43.00	49.02
Outflow	0.0	945.4	1337.0	1637.5	1890.8	2114.0	2315.8	2501.3	2674.0	2836.3



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	227.0	257	257.0
Peak Inflow (cfs)	1743	2063	2063.0
Peak Outflow (cfs)	1619	1814	1814.0
Stage at Peak Outflow (ft)	2.9	3.7	3.7
Volume at Peak Outflow (ac. ft)	14.8	18.79	18.8

Volume Check

Total Volume needed	25.7	ac. ft
Total Volume Provided	25.8	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	4.7	ft
Depth Provided	6	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	185200	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	700	ft
Base Total ROW Width	380	ft
LC Enh. Total ROW Length	940	ft
LC Enh. Total ROW Length	480	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	97445	107609
Excavated Area (sq. Yd)	29556	50133

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	49	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	545	sq. Yd
Material Volume	273	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	300	ft
Unit Cost	160	per ft
Cost per outlet	$48,000	
Other Cost	$ -	
Total Cost	$48,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		97,445	cu. Yd	$ 4.00	$ 389,780	29,556	sq. Yd	$ 9.00	$ 266,004	29,556	sq. Yd	$ 8.33	$ 246,300
Basin - LC Enhancement		10,164	cu. Yd	$ 4.00	$ 40,656	20,577	sq. Yd	$ 9.00	$ 185,193	20,577	sq. Yd	$ 8.33	$ 171,475
Inlet	Riprap	273	sq. Yd	$ 75.00	$ 20,475	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 33.33	$ 18,167
Inlet - LC Enhancement (20%Inlet)					$ 4,095				$ -				$ 3,633
Outlet	Pipe	1	EA	$ 48,000	$ 48,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 266,004	Base Maintenance Cost			$ 266,683
						LC Enh. Landscape Cost			$ 185,193	LC Enh. Maintenance Cost			$ 175,219
						Total Landscape Cost			$ 451,197	Total Maintenance Cost			$ 441,903

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 458,255	$ 40,656	$ 498,911
Contingency Cost (25% of Construction Cost)	$ 114,564	$ 10,164	$ 124,728
Engineering Design Cost (5% of Construction Cost)	$ 22,913	$ 2,033	$ 24,946
Total Construction Cost	$ 595,732	$ 52,853	$ 648,584

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.3	$100,000	$ 430,000
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	10.4	$100,000	$ 1,040,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 610,000
LC Enhancement Cost	acre	4.3	$100,000	$ 430,000
Total Land Cost	acre	10.4	$100,000	$ 1,040,000

Total Cost

Base Total Cost	$ 1,738,419
Total LC Enhancement Cost	$ 843,265
Total Cost Including LC Enh.	$ 2,581,684

Open Channel

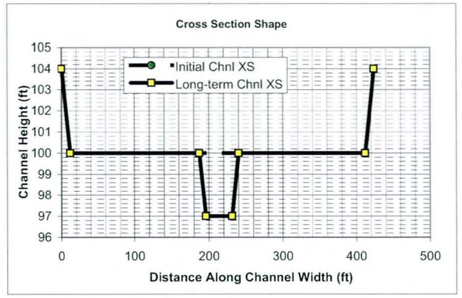
Structure ID	C51010	HEC1 ID	500415

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

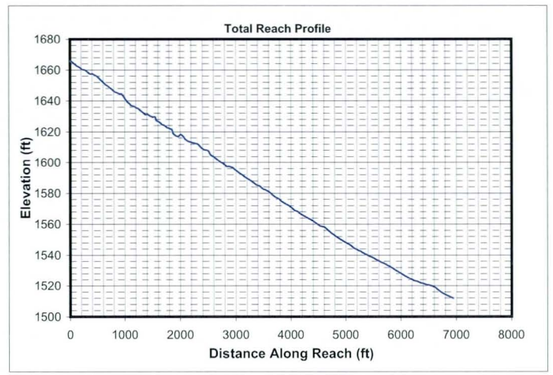
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	400	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	412	412	412	424
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	175	3	35	7	3	172	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	187	196	231	240	412	424
Y	104	100	100	97	97	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	1814	2099							3913
Weighting Factor	1.00	0.22							
Flow into Channel	1814	462							2276

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.409	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2276	cfs	
Long-term Max. Chnl Capacity	12787	cfs	
Q2 Channel	228	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	424	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
228	401.7	109.7	0.3	100.0	100.3	2.1	0.3	401.6	0.3	0.12	0.70
569	403.0	190.4	0.5	100.0	100.5	3.0	0.5	402.8	0.5	0.21	0.77
1707	405.8	368.9	0.9	100.0	100.9	4.6	0.9	405.5	0.9	0.40	0.85
2276	406.9	438.9	1.1	100.0	101.1	5.2	1.1	406.5	1.1	0.48	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
228	45.3	64.7	1.4	97.0	98.6	3.5	1.6	44.7	1.4	0.71	0.52
569	52.4	118.9	2.3	97.0	99.7	4.8	2.7	51.5	2.3	1.20	0.55
1707	407.1	522.0	1.3	97.0	101.0	3.3	4.0	405.8	1.3	1.73	0.51
2276	408.6	621.3	1.5	97.0	101.2	3.7	4.2	407.3	1.5	1.84	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
228										0
569										0
1707										0
2276										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
228	1.74	0.9954	0.9456	Erosive	Erosive	Erosive	0.2	Stable	6.7	Stable	Stable
569	1.74	1.1643	1.1061	Erosive	Erosive	Erosive	0.2	Stable	9.5	Stable	Stable
1707	1.74	1.3663	1.2980	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable
2276	1.74	1.4191	1.3481	Erosive	Erosive	Erosive	0.3	Stable	10.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	228	569	1707	2276	228	569	1707	2276	228	569	1707	2276
Bray - Equation #1	42	67	120	140	1.6	2.2	3.2	3.5	3.4	3.8	4.5	4.7
Bray - Equation #2	55	88	158	184	1.8	2.4	3.5	3.8	2.3	2.6	3.1	3.2
Hey	13	21	39	46	5.1	7.2	10.9	12.2				
Ackers & Charlton/Lacey	35	52	82	93					2.0	2.3	2.8	2.9
Parker	104	164	284	328	1.3	1.9	3.0	3.4				
Chang	80	139	269	320	0.0	-0.3	-0.9	-1.1				
Kellerhals	27	43	74	86	2.4	3.4	5.3	6.0	3.5	3.8	4.3	4.4
AMAFCA/Schumm	45	52	406	408								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	19.1	26.9	40.6	45.3	5	7	11	12	3.7	4.6	6.1	6.5
Average	43	66	148	166	2.3	3.1	4.6	5.1	3.0	3.5	4.1	4.4
Values As Designed	45	51	406	407	1.6	2.7	4.0	4.2	3.5	4.8	3.3	3.7
Difference with Design	-2	15	-258	-242	0.6	0.4	0.6	0.9	-0.5	-1.3	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
228	2889	1843	4263	5739	7061	1072	895	484	13336	941	3102	3784
569	11921	5763	11888	27192	10308	4272	2729	2309	34585	3149	12582	11518
1707	65156	20456	34406	175232	15444	19953	8659	11398	105418	14754	58317	48108
2276	101527	28157	45361	285244	17075	29699	11514	16832	140836	22271	85580	71281

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
228	4710	3004	6948	9355	11510	1747	1460	788	21738	1533	5057	6168
569	7773	3758	7751	17730	6721	2785	1780	1506	22550	2053	8204	7510
1707	14161	4446	7478	38085	3357	4337	1882	2477	22912	3207	12675	10456
2276	16549	4590	7394	46496	2783	4841	1877	2744	22957	3630	13950	11619

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
228	1910	799	1223	3972	1120	426	277	431	2437	411	2169	1380
569	7227	2272	3063	17069	1723	1461	728	1507	6196	1248	7517	4546
1707	13114	5468	9050	26122	9405	2969	2053	2964	18159	2821	15045	9743
2276	20423	7811	12499	42490	10549	4498	2844	4575	24440	4328	22934	14308

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
228	3114	1303	1994	6474	1826	695	452	703	3973	671	3536	2249
569	4712	1482	1997	11129	1123	953	475	983	4040	814	4901	2964
1707	2850	1189	1967	5677	2044	645	446	644	3947	613	3270	2117
2276	3329	1273	2037	6926	1720	733	464	746	3984	705	3738	2332

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
228	0.0027	0.0044	145	0.44	0.048	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0057	0.0003	0.0028	0.0221	0.0076
569	0.0013	0.0026	191	0.58	0.050	0.0006	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0057	0.0002	0.0014	0.0221	0.0073
1707	0.0006	0.0013	264	0.81	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0057	0.0001	0.0006	0.0222	0.0072
2276	0.0005	0.0011	288	0.88	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0057	0.0001	0.0005	0.0222	0.0071

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	105.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	36	
Distance between structs.	193	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	193	ft	Depth	3 ft
Width	424	ft	Side slope	3 ft/ft
Total Volume per Basin			5.27	ac. ft.
Basin Trap Efficiency			0.6	
No. of Basins			1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
228	1.1	-0.5	0.2	24.6	1.6	1.4	3.5	0.0070	0.2	0.0	3.0	4.2
569	1.1	-0.7	0.3	24.6	2.7	2.3	4.8	0.0070	0.3	0.0	3.0	4.5
1707	1.1	-1.2	0.1	24.6	4.0	1.3	3.3	0.0070	0.4	0.0	3.0	4.6
2276	1.1	-1.2	0.2	24.6	4.2	1.5	3.7	0.0070	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1711	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.29	ac. ft
Deposited(+)/Eroded(-) Volume	0.49	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	3
Channel Width (ft)	424	424
Channel XS Area (sq. ft)	1780	1780
Channel Perimeter (ft)	426	426

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2321	sq. Yd
Volume	6190	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6964	6964
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	30177	62676
Left Levee Volume (cu. Yd)	26824	64481
Right Levee Length (ft)	6964	6964
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	30177	62676
Right Levee Volume (cu. Yd)	26824	64481
Total Levee Surface Area (sq. Yd)	60354	125352
Total Levee Volume (cu. Yd)	53648	128962

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10059	23213
Left Levee Lining Volume (cu. Yd)	5030	11607
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10059	23213
Right Levee Lining Volume (cu. Yd)	5030	11607
Total Lining Area (sq. Yd)	20118	46427
Total Lining Volume (cu. Yd)	10060	23214

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	424	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	36	
Volume per structure	438	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 32,850	
Area per structure	141	sq. Yd
Total Area	5,088	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8502	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 34,008	
Other Cost	$ -	
Total cost per basin	$ 34,008	
Area per basin	9,113	sq. Yd
Total Area	9,113	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	53,648	cu. Yd	$ 7.00	$ 375,536	60,354	sq. Yd	$ 9.00	$ 543,186	60,354	sq. Yd	$ 11.67	$ 704,130
Levee - LC Enhancement	Fill	75,314	cu. Yd	$ 7.00	$ 527,198	64,998	sq. Yd	$ 9.00	$ 584,982	75,314	sq. Yd	$ 11.67	$ 878,663
Levee Lining	Riprap	10,060	cu. Yd	$ 75.00	$ 754,500	20,118	sq. Yd	$ -	$ -	20,118	sq. Yd	$ 20.83	$ 419,130
Levee Lining -LC Enhancement	Riprap	13,154	cu. Yd	$ 75.00	$ 986,550	26,308	sq. Yd	$ -	$ -	26,308	sq. Yd	$ 20.83	$ 548,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,190	cu. Yd	$ 75.00	$ 464,250	2,321	sq. Yd	$ -	$ -	2,321	sq. Yd	$ 25.00	$ 58,025
Drop Structures	Riprap	36	EA	$ 32,850.00	$ 1,182,600	5,088	sq. Yd	$ -	$ -	5,088	sq. Yd	$ 33.33	$ 169,600
Drop Str. - LC Enhancement	Riprap	36	EA	$ 3,285.00	$ 118,260	509	sq. Yd	$ -	$ -	509	sq. Yd	$ 33.33	$ 16,960
Sedimentation Basins		1	EA	$ 34,008.00	$ 34,008	9,113	sq. Yd	$ -	$ -	9,113	sq. Yd	$ 8.33	$ 75,942
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 543,186	Base Maintenance Cost			$ 1,426,826
						LC Enhancement Cost			$ 584,982	LC Enhancement Cost			$ 1,443,716
						Total Landscape Cost			$ 1,128,168	Total Maintenance Cost			$ 2,870,542

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,810,894	$ 1,632,008	$ 4,442,902
Contingency Cost (25% of Construction Cost)	$ 702,724	$ 408,002	$ 1,110,726
Engineering Design Cost (5% of Construction Cost)	$ 140,545	$ 81,600	$ 222,145
Total Construction Cost	$ 3,654,162	$ 2,121,610	$ 5,775,773

Land Cost

Channel Length	6964 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	424	67.8	$100,000	$ 6,780,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.3	$100,000	$ 830,000
Levee LC Enhancement	48	7.7	$100,000	$ 770,000
Other	0	0	$100,000	$ -
Total	524	83.8		$ 8,380,000

Total Cost

Base Total Cost	$ 13,234,174
Total Landscape Enhancement Cost	$ 4,920,308
Total Cost Including LC Enh.	$ 18,154,483

Right of Way

Preservation Corridor Width	0 ft
Maintenance Access	0 ft
Landscape Enhancement Buffer	0 ft
Other	0 ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	76.1	$100,000	$ 7,610,000
LC Enhancement Cost	acre	7.7	$100,000	$ 770,000
Total Land Cost	acre	83.8	$100,000	$ 8,380,000

Open Channel

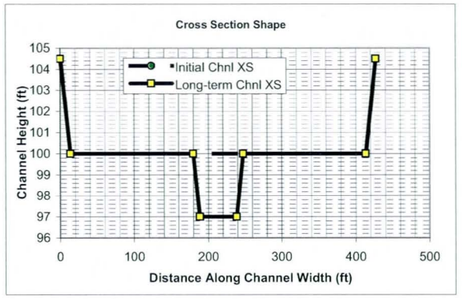
Structure ID	C51020	HEC1 ID	500415

Longitundal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

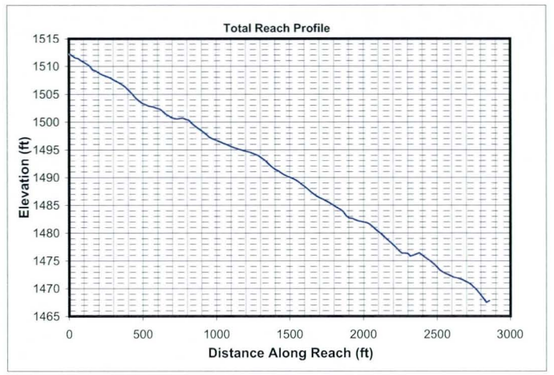
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	166	3	50	7.5	3	166	4.5	3
		0							

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	179.5	188.5	238.5	247.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	1814	2099							3913
Weighting Factor	1.00	0.53							
Flow into Channel	1814	1112							2926

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51010	500415_S5101 0							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	2964	2250							
Sediment Volume (ac. ft)	0.29	0.22							0.51
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.29	0.22							0.51

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2926	cfs	
Long-term Max. Chnl Capacity	14130	cfs	
Q2 Channel	293	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
293	402.2	142.6	0.4	100.0	100.4	2.1	0.4	402.1	0.4	0.12	0.61
732	403.9	247.3	0.6	100.0	100.6	3.0	0.6	403.7	0.6	0.21	0.67
2195	407.5	479.9	1.2	100.0	101.2	4.6	1.2	407.1	1.2	0.41	0.74
2926	408.9	571.2	1.4	100.0	101.4	5.1	1.4	408.5	1.4	0.48	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
293	60.5	90.8	1.5	97.0	98.7	3.2	1.7	59.9	1.5	0.57	0.46
732	67.8	164.8	2.4	97.0	99.8	4.4	2.8	66.9	2.5	0.97	0.50
2195	408.4	653.3	1.6	97.0	101.2	3.4	4.2	407.1	1.6	1.43	0.47
2926	410.4	778.0	1.9	97.0	101.5	3.8	4.5	408.9	1.9	1.54	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51010	500415_S51010								
293	1380	200								1580
732	4546	613								5160
2195	9743	1836								11579
2926	14308	2674								16983

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
293	1.74	1.0758	1.0220	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
732	1.74	1.2444	1.1821	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
2195	1.74	1.4462	1.3739	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
2926	1.74	1.4988	1.4239	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	293	732	2195	2926	293	732	2195	2926	293	732	2195	2926
Bray - Equation #1	47	77	137	160	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	101	180	210	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	45	52	5.6	7.9	12.0	13.4				
Ackers & Charlton/Lacey	39	57	91	103					2.1	2.4	2.9	3.0
Parker	118	186	322	372	1.5	2.1	3.4	3.8				
Chang	86	150	291	345	0.0	-0.2	-0.8	-1.1				
Kellerhals	31	49	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	60	67	408	409								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	21.9	30.9	46.7	52.0	6	8	12	14	3.6	4.5	5.9	6.4
Average	49	75	162	181	2.5	3.5	5.1	5.7	3.0	3.5	4.2	4.4
Values As Designed	60	67	407	409	1.7	2.8	4.2	4.5	3.2	4.4	3.4	3.8
Difference with Design	-11	8	-245	-228	0.9	0.7	0.9	1.2	-0.2	-0.9	0.9	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
293	2556	1594	3329	4783	6523	795	698	426	9693	743	2786	3084
732	10566	5127	9763	22654	9621	3301	2234	2112	25403	2618	11548	9541
2195	57500	18494	29255	145742	14548	15531	7227	10626	77774	12695	54684	40371
2926	89557	25544	38334	237116	16114	23118	9642	15754	103961	19299	80692	59921

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
293	3240	2021	4221	6064	8270	1009	884	540	12290	942	3532	3910
732	5359	2600	4951	11490	4880	1674	1133	1071	12884	1328	5857	4839
2195	9721	3127	4946	24639	2459	2626	1222	1796	13148	2146	9245	6825
2926	11355	3239	4861	30065	2043	2931	1223	1997	13182	2447	10231	7598

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
293	1728	778	1147	3335	1319	357	257	410	2152	362	2023	1261
732	6658	2278	3084	14641	2012	1267	701	1495	5516	1067	7290	4183
2195	13825	5733	8753	26835	9310	2836	1981	3270	16212	2863	16070	9790
2926	21507	8182	12077	43620	10454	4297	2747	5025	21835	4408	24517	14425

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
293	2191	987	1454	4229	1672	453	326	519	2729	459	2565	1599
732	3377	1155	1564	7426	1020	642	355	758	2798	541	3697	2121
2195	2337	969	1480	4537	1574	479	335	553	2741	484	2717	1655
2926	2727	1037	1531	5531	1326	545	348	637	2769	559	3109	1829

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
293	0.0022	0.0034	137	0.42	0.047	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0017	0.0052	0.0003	0.0023	0.0153	0.0056
732	0.0011	0.0020	180	0.55	0.050	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0052	0.0002	0.0012	0.0153	0.0054
2195	0.0005	0.0010	250	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0052	0.0001	0.0005	0.0153	0.0053
2926	0.0004	0.0009	272	0.83	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0052	0.0001	0.0004	0.0153	0.0053

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	28.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	287	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	287 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		8.02	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
293	1.1	-0.5	0.1	24.6	1.7	1.5	3.2	0.0055	0.2	0.0	3.0	4.2
732	1.1	-0.7	0.3	24.6	2.8	2.5	4.4	0.0055	0.3	0.0	3.0	4.5
2195	1.1	-1.2	0.2	24.6	4.2	1.6	3.4	0.0055	0.5	0.0	3.0	4.6
2926	1.1	-1.2	0.2	24.6	4.5	1.9	3.8	0.0055	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1711	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	0.64	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2037.8	2037.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	958	sq. Yd
Volume	2555	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2874	2874
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13412	27782
Left Levee Volume (cu. Yd)	13199	31082
Right Levee Length (ft)	2874	2874
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13412	27782
Right Levee Volume (cu. Yd)	13199	31082
Total Levee Surface Area (sq. Yd)	26824	55564
Total Levee Volume (cu. Yd)	26398	62164

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4471	10538
Left Levee Lining Volume (cu. Yd)	2235	5269
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4471	10538
Right Levee Lining Volume (cu. Yd)	2235	5269
Total Lining Area (sq. Yd)	8941	21076
Total Lining Volume (cu. Yd)	4470	10538

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	10	
Volume per structure	486	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 36,450	
Area per structure	142	sq. Yd
Total Area	1,423	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12939	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 51,756	
Other Cost	$ -	
Total cost per basin	$ 51,756	
Area per basin	13,635	sq. Yd
Total Area	13,635	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	26,398	cu. Yd	$ 7.00	$ 184,786	26,824	sq. Yd	$ 9.00	$ 241,416	26,824	sq. Yd	$ 11.67	$ 312,947
Levee - LC Enhancement	Fill	35,766	cu. Yd	$ 7.00	$ 250,362	28,740	sq. Yd	$ 9.00	$ 258,660	35,766	sq. Yd	$ 11.67	$ 417,270
Levee Lining	Riprap	4,470	cu. Yd	$ 75.00	$ 335,250	8,941	sq. Yd	$ -	$ -	8,941	sq. Yd	$ 20.83	$ 186,278
Levee Lining -LC Enhancement	Riprap	6,068	cu. Yd	$ 75.00	$ 455,100	12,135	sq. Yd	$ -	$ -	12,135	sq. Yd	$ 20.83	$ 252,806
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,555	cu. Yd	$ 75.00	$ 191,625	958	sq. Yd	$ -	$ -	958	sq. Yd	$ 25.00	$ 23,950
Drop Structures	Riprap	10	EA	$ 36,450.00	$ 364,500	1,423	sq. Yd	$ -	$ -	1,423	sq. Yd	$ 33.33	$ 47,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,645.00	$ 36,450	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,743
Sedimentation Basins		1	EA	$ 51,756.00	$ 51,756	13,635	sq. Yd	$ -	$ -	13,635	sq. Yd	$ 8.33	$ 113,625
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 241,416	Base Maintenance Cost			$ 684,233
						LC Enhancement Cost			$ 258,660	LC Enhancement Cost			$ 674,819
						Total Landscape Cost			$ 500,076	Total Maintenance Cost			$ 1,359,052

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,127,917	$ 741,912	$ 1,869,829
Contingency Cost (25% of Construction Cost)	$ 281,979	$ 185,478	$ 467,457
Engineering Design Cost (5% of Construction Cost)	$ 56,396	$ 37,096	$ 93,491
Total Construction Cost	$ 1,466,292	$ 964,486	$ 2,430,778

Land Cost

Channel Length	2874	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	28.2	$100,000	$ 2,820,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	533	35.2		$ 3,520,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31.8	$100,000	$ 3,180,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	35.2	$100,000	$ 3,520,000

Total Cost

Base Total Cost	$ 5,571,941
Total Landscape Enhancement Cost	$ 2,237,964
Total Cost Including LC Enh.	$ 7,809,905

Open Channel

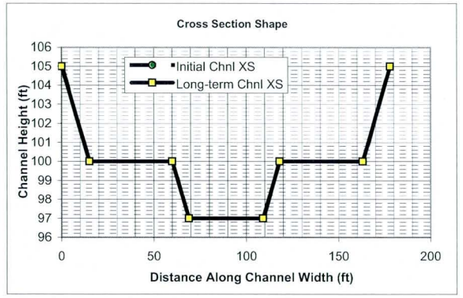
Structure ID	C51060	HEC1 ID	500415

Longitudal Geometry

Length	2541.7	ft
U/S Elev	1468.2	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0055	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

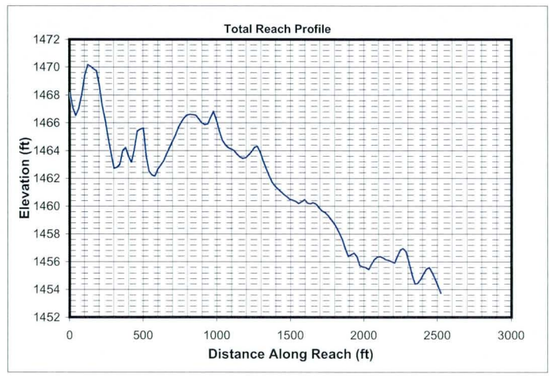
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	45	3	40	8	3	45	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	60	69	109	118	163	178
Y	105	100	100	97	97	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	45	3	40	8	3	45	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	60	69	109	118	163	178
Y	105	100	100	97	97	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	1814	2099							3913
Weighting Factor	1.00	0.59							
Flow into Channel	1814	1238							3052

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51020								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	2121								
Sediment Volume (ac. ft)	0.21								0.21
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.21								0.21

Hydrology

Drainage Area	1.08	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3052	cfs	
Long-term Max. Chnl Capacity	5321	cfs	
Q2 Channel	305	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	178	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
305	54.5	107.2	2.0	97.0	99.3	2.8	2.3	53.7	2.0	0.43	0.36
763	154.6	281.9	1.8	97.0	100.9	2.7	3.9	153.4	1.8	0.73	0.35
2289	165.7	560.3	3.4	97.0	102.7	4.1	5.7	163.9	3.4	1.06	0.39
3052	170.0	672.7	4.0	97.0	103.3	4.5	6.3	168.0	4.0	1.18	0.40

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
305	54.5	107.2	2.0	97.0	99.3	2.8	2.3	53.7	2.0	0.43	0.36
763	154.6	281.9	1.8	97.0	100.9	2.7	3.9	153.4	1.8	0.73	0.35
2289	165.7	560.3	3.4	97.0	102.7	4.1	5.7	163.9	3.4	1.06	0.39
3052	170.0	672.7	4.0	97.0	103.3	4.5	6.3	168.0	4.0	1.18	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51020									
305	1261									1261
763	4183									4183
2289	9790									9790
3052	14425									14425

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
305	1.74	1.6084	1.5280	Erosive	Erosive	Erosive	0.4	Stable	5.5	Stable	Stable
763	1.74	1.5832	1.5040	Erosive	Erosive	Erosive	0.4	Stable	7.1	Stable	Stable
2289	1.74	1.7715	1.6830	Erosive	Erosive	Erosive	0.5	Stable	9.5	Stable	Stable
3052	1.74	1.8329	1.7412	Erosive	Erosive	Erosive	0.5	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	305	763	2289	3052	305	763	2289	3052	305	763	2289	3052
Bray - Equation #1	49	79	140	163	1.8	2.4	3.5	3.8	3.5	4.0	4.7	4.9
Bray - Equation #2	64	103	184	215	2.0	2.7	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	25	46	54	5.7	8.0	12.2	13.6				
Ackers & Charlton/Lacey	40	58	93	105					2.1	2.4	2.9	3.1
Parker	120	190	329	380	1.5	2.2	3.4	3.9				
Chang	71	126	246	293	0.3	0.2	-0.2	-0.4				
Kellerhals	31	50	86	99	2.7	3.9	6.0	6.7	3.6	4.0	4.4	4.5
AMAFCA/Schumm	54	154	164	168								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	25.0	35.2	53.2	59.2	7	9	14	16	2.9	3.6	4.8	5.1
Average	48	83	135	155	2.7	3.7	5.5	6.1	2.9	3.4	4.0	4.2
Values As Designed	54	153	164	168	2.3	3.9	5.7	6.3	2.8	2.7	4.1	4.5
Difference with Design	-6	-70	-29	-13	0.4	-0.2	-0.2	-0.2	0.1	0.6	-0.1	-0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
305	838	457	743	3515	1413	186	112	223	2251	323	1800	1078
763	1967	1072	1845	8015	3829	428	269	517	5596	758	4227	2593
2289	10336	4184	6125	49499	5984	2346	1041	2702	17271	3762	20750	11273
3052	15888	5858	8126	79333	6720	3545	1425	4023	23110	4128	30825	16635

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
305	1019	555	903	4272	1718	227	137	272	2736	392	2188	1311
763	957	521	897	3897	1862	208	131	251	2721	369	2055	1261
2289	1675	678	993	8023	970	380	169	438	2799	610	3363	1827
3052	1931	712	988	9644	817	431	173	489	2809	502	3747	2022

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
305	838	408	543	1421	936	134	112	223	866	139	1012	603
763	1967	955	1299	3241	2514	309	269	517	2138	336	2362	1446
2289	10336	3828	4602	20015	4136	1612	1041	2702	6850	948	12170	6204
3052	15888	5385	6355	32079	4688	2405	1425	4023	9208	1027	18295	9162

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
305	1019	496	660	1728	1138	163	137	272	1053	169	1230	733
763	957	464	631	1576	1223	150	131	251	1039	164	1148	703
2289	1675	621	746	3244	670	261	169	438	1110	154	1972	1005
3052	1931	655	773	3900	570	292	173	489	1119	125	2224	1114

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
305	0.0005	0.0006	193	0.59	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0052	0.0003	0.0012	0.0029	0.0022
763	0.0005	0.0007	186	0.57	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0004	0.0052	0.0002	0.0006	0.0030	0.0022
2289	0.0002	0.0004	254	0.77	0.053	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0052	0.0001	0.0003	0.0030	0.0021
3052	0.0002	0.0003	274	0.84	0.054	0.0001	32	0.036	0.0000	0.0159	0.0001	0.0002	0.0052	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	6.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	847	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.10	sq. mi
Total Sediment Yield Volume	0.19	ac ft

Sedimentation Basins

Length	847 ft	Depth	3 ft
Width	178 ft	Side slope	3 ft/ft
Total Volume per Basin		9.76	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
305	1.1	-0.7	0.1	24.6	2.3	2.0	2.8	0.0030	0.2	0.0	1.0	1.7
763	1.1	-1.2	0.1	24.6	3.9	1.8	2.7	0.0030	0.4	0.0	1.0	1.9
2289	1.1	-1.5	0.2	24.6	5.7	3.4	4.1	0.0030	0.6	0.0	1.0	2.3
3052	1.1	-1.6	0.3	24.6	6.3	4.0	4.5	0.0030	0.7	0.0	1.0	2.4

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1711	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	6.3	ft
Channel Depth as designed	8.0	ft
Available Freeboard	1.7	ft
Required Freeboard	1.7	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.29	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2542	2542
Side Slope (?H:1V)	3	6
Channel Width (ft)	178	226
Channel XS Area (sq. ft)	962	1154
Channel Perimeter (ft)	181	228

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	143527	175884
Excavated Area (sq. Yd)	50275	63832

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2542	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	424	sq. Yd
Volume	847	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2542	2542
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2542	2542
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	178	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	12.3	ft
Structure Height	15.3	ft
Number of Structures	3	
Volume per structure	303	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,725	
Area per structure	59	sq. Yd
Total Area	178	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15746	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 62,984	
Other Cost	$ -	
Total cost per basin	$ 62,984	
Area per basin	16,756	sq. Yd
Total Area	16,756	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	143,527	cu. Yd	$ 10.00	$ 1,435,270	50,275	sq. Yd	$ 9.00	$ 452,475	50,275	sq. Yd	$ 8.33	$ 418,958
Exc. Chl - LC Enhancement	Excavated	32,357	cu. Yd	$ 10.00	$ 323,570	13,557	sq. Yd	$ 9.00	$ 122,013	13,557	sq. Yd	$ 8.33	$ 112,975
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	847	cu. Yd	$ 75.00	$ 63,525	424	sq. Yd	$ -	$ -	424	sq. Yd	$ 25.00	$ 10,600
Drop Structures	Riprap	3	EA	$ 22,725.00	$ 68,175	178	sq. Yd	$ -	$ -	178	sq. Yd	$ 33.33	$ 5,933
Drop Str. - LC Enhancement	Riprap	3	EA	$ 2,272.50	$ 6,818	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 593
Sedimentation Basins		1	EA	$ 62,984.00	$ 62,984	16,756	sq. Yd	$ -	$ -	16,756	sq. Yd	$ 8.33	$ 139,633
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 452,475	Base Maintenance Cost			$ 575,125
						LC Enhancement Cost			$ 122,013	LC Enhancement Cost			$ 113,568
						Total Landscape Cost			$ 574,488	Total Maintenance Cost			$ 688,693

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,629,954	$ 330,388	$ 1,960,342
Contingency Cost (25% of Construction Cost)	$ 407,489	$ 82,597	$ 490,085
Engineering Design Cost (5% of Construction Cost)	$ 81,498	$ 16,519	$ 98,017
Total Construction Cost	$ 2,118,940	$ 429,504	$ 2,548,444

Land Cost

Channel Length	2542	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	7.8	$100,000	$ 780,000
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	178	10.4	$100,000	$ 1,040,000
Channel LC Enhancement	48	2.8	$100,000	$ 280,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	410	23.9		$ 2,390,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	18.2	$100,000	$ 1,820,000
LC Enhancement Cost	acre	5.7	$100,000	$ 570,000
Total Land Cost	acre	23.9	$100,000	$ 2,390,000

Total Cost

Base Total Cost	$ 4,966,540
Total Landscape Enhancement Cost	$ 1,235,085
Total Cost Including LC Enh.	$ 6,201,625

Offline Basin

HEC1 ID	D415

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

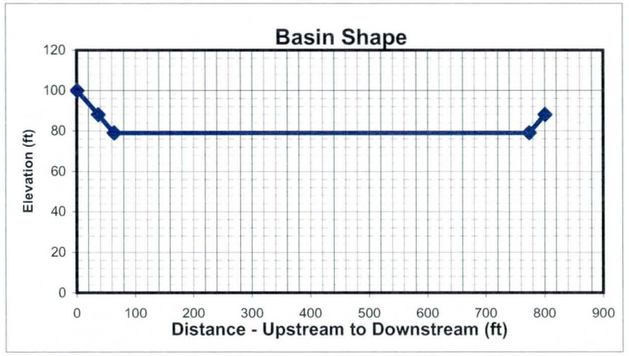
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1300	1450
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	764	728
Top Area (acres)	23.9	26.6
U/S-D/S Height Difference (ft)	12.0	12.0
Excess Area on Upstream (acres)	1.1	2.4

			Base	LC Enhanced
Bottom Length (ft)	1246	Allocated Storage Volume (ac. ft)	171.2	170.7
Bottom Width (ft)	710	Total Available Volume (ac. ft) (incl. Freeboard)	193.9	194.6
		Total Excavation Volume (ac. ft)	337.2	354.5

Stage-Storage-Discharge

Stage (ft)	0										
Inflow (cfs)	0	200	400	600	800	1000	1231	1400	2000	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	169	769	1769	2769



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2323	2775	2775
Peak flow after diversion (cfs)	1231	1231	1231
Diverted Peak Flow (cfs)	1092	1544	1544
Total Diverted Flow Volume (ac. ft)	96.0	170	170.0
Peak Stage	3.9	ft	

Volume Check			***Stage Check***	
Total Volume needed	170.0	ac. ft	Depth Needed	4.9
Total Volume Provided	171.2	ac. ft	Depth Provided	9

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 512+67

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	355000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1300	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	1550	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	544016	571927
Excavated Area (sq. Yd)	115556	155000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	66	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	738	sq. Yd
Material Volume	369	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	900	ft
Unit Cost	160	per ft
Cost per outlet	$144,000	
Other Cost	$ -	
Total Cost	$144,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		544,016	cu. Yd	$ 4.00	$ 2,176,064	115,556	sq. Yd	$ 9.00	$ 1,040,004	115,556	sq. Yd	$ 8.33	$ 962,967
Basin - LC Enhanced		27,911	cu. Yd	$ 4.00	$ 111,644	39,444	sq. Yd	$ 9.00	$ 354,996	39,444	sq. Yd	$ 8.33	$ 328,700
Inlet	Riprap	369	sq. Yd	$ 75.00	$ 27,675	738	sq. Yd	$ -	$ -	738	sq. Yd	$ 33.33	$ 24,600
Inlet - LC Enhanced (20%Total)					$ 5,535				$ -				$ 4,920
Outlet	Pipe	1	EA	$ 144,000	$ 144,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 7,200				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$1,040,004	Base Maintenance Cost			$ 989,783
						LC Enh. Landscape Cost			$ 354,996	LC Enh. Maintenance Cost			$ 333,731
						Total Landscape Cost			$1,395,000	Total Maintenance Cost			$ 1,323,514

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 2,347,739	$ 111,644	$ 2,459,383
Contingency Cost (25% of Construction Cost)	$ 586,935	$ 27,911	$ 614,846
Engineering Design Cost (5% of Construction Cost)	$ 117,387	$ 5,582	$ 122,969
Total Construction Cost	$ 3,052,061	$ 145,137	$ 3,197,198

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	8.1	$100,000	$ 814,968
Basin	23.9	$100,000	$ 2,390,000
Other		$100,000	$ -
Total	32.0	$100,000	$ 3,200,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.9	$100,000	$ 2,387,511
LC Enhancement Cost	acre	8.1	$100,000	$ 812,489
Total Land Cost	acre	32	$100,000	$ 3,200,000

Total Cost

Base Total Cost	$ 7,469,360
Total LC Enhancement Cost	$ 1,646,353
Total Cost Including LC Enh.	$ 9,115,712

Open Channel

Structure ID	RR41510

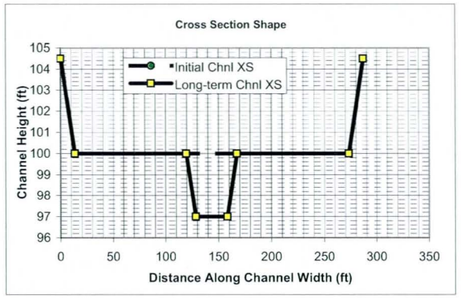
HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

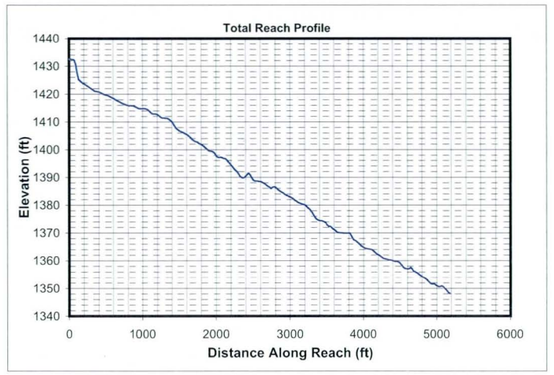
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	260	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	273.5	273.5	273.5	287
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	106	3	30	7.5	3	106	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	119.5	128.5	158.5	167.5	273.5	287
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420								TOTAL
HEC1 Peak-Flow	1231	1740								2971
Weighting Factor	1.00	0.20								
Flow into Channel	1231	348								1579

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.645	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1579	cfs	
Long-term Max. Chnl Capacity	9639	cfs	
Q2 Channel	158	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	287	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	262.0	81.6	0.3	100.0	100.3	1.9	0.3	261.9	0.3	0.12	0.61
395	263.4	141.6	0.5	100.0	100.5	2.8	0.5	263.2	0.5	0.20	0.67
1184	266.6	275.2	1.0	100.0	101.0	4.3	1.0	266.3	1.0	0.39	0.75
1579	267.9	327.7	1.2	100.0	101.2	4.8	1.2	267.5	1.2	0.47	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	39.4	51.5	1.3	97.0	98.5	3.1	1.5	39.0	1.3	0.56	0.47
395	46.0	94.9	2.1	97.0	99.5	4.2	2.5	45.2	2.1	0.95	0.51
1184	267.1	370.9	1.4	97.0	101.0	3.2	4.0	265.8	1.4	1.48	0.48
1579	268.8	441.9	1.6	97.0	101.2	3.6	4.2	267.4	1.7	1.58	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
158										0
395										0
1184										0
1579										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
158	1.74	1.0360	0.9842	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
395	1.74	1.2043	1.1441	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1184	1.74	1.4056	1.3353	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
1579	1.74	1.4581	1.3852	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	158	395	1184	1579	158	395	1184	1579	158	395	1184	1579
Bray - Equation #1	34	56	99	115	1.4	1.9	2.8	3.1	3.2	3.6	4.3	4.4
Bray - Equation #2	45	73	130	152	1.6	2.1	3.1	3.4	2.2	2.5	2.9	3.0
Hey	10	17	32	37	4.4	6.2	9.5	10.6				
Ackers & Charlton/Lacey	30	44	70	79					1.9	2.2	2.6	2.7
Parker	86	136	236	273	1.1	1.7	2.6	2.9				
Chang	61	106	206	245	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	36	62	72	2.1	3.0	4.6	5.2	3.4	3.7	4.1	4.3
AMAFCA/Schumm	39	45	266	268								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.1	24.2	36.5	40.6	5	6	10	11	3.2	4.0	5.2	5.6
Average	36	56	116	130	2.1	2.8	4.1	4.6	2.8	3.2	3.8	4.0
Values As Designed	39	45	266	267	1.5	2.5	4.0	4.2	3.1	4.2	3.2	3.6
Difference with Design	-3	10	-150	-137	0.6	0.3	0.2	0.3	-0.3	-1.0	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	1341	864	1821	2474	4011	417	378	209	5616	411	1434	1725
395	5541	2824	5528	11707	5966	1789	1259	1092	14809	1416	6080	5274
1184	30089	10283	16990	75154	9090	8484	4142	5644	45454	6770	29162	21933
1579	46819	14223	22157	122171	10087	12627	5540	8400	60777	10265	43122	32381

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	3150	2029	4279	5812	9425	979	888	490	13195	965	3369	4053
395	5207	2654	5195	11002	5607	1682	1183	1027	13918	1331	5714	4956
1184	9426	3221	5323	23544	2848	2658	1298	1768	14240	2121	9136	6871
1579	11001	3342	5206	28705	2370	2967	1302	1974	14280	2412	10132	7608

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	944	440	679	1822	829	204	150	220	1319	203	1105	719
395	3559	1286	1852	7794	1299	715	412	802	3384	745	3941	2345
1184	7560	3237	5166	14625	5867	1619	1161	1759	9937	1599	8798	5575
1579	11756	4635	7117	23749	6602	2461	1618	2722	13393	2454	13449	8178

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	2219	1034	1594	4281	1948	478	352	516	3099	476	2597	1691
395	3345	1209	1740	7325	1221	672	387	754	3181	700	3704	2203
1184	2368	1014	1618	4582	1838	507	364	551	3113	501	2756	1747
1579	2762	1089	1672	5580	1551	578	380	639	3147	577	3160	1921

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
158	0.0025	0.0039	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0064	0.0004	0.0027	0.0161	0.0062
395	0.0013	0.0023	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0064	0.0002	0.0014	0.0162	0.0060
1184	0.0006	0.0012	241	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0002	0.0006	0.0162	0.0058
1579	0.0005	0.0010	262	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0001	0.0005	0.0162	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	52.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	289	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	289 ft	Depth	3 ft
Width	287 ft	Side slope	3 ft/ft
Total Volume per Basin		5.36	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
158	1.1	-0.5	0.1	24.6	1.5	1.3	3.1	0.0060	0.2	0.0	3.0	4.2
395	1.1	-0.7	0.2	24.6	2.5	2.1	4.2	0.0060	0.3	0.0	3.0	4.4
1184	1.1	-1.2	0.1	24.6	4.0	1.4	3.2	0.0060	0.4	0.0	3.0	4.5
1579	1.1	-1.2	0.2	24.6	4.2	1.7	3.6	0.0060	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	340.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.28	ac. ft
Deposited(+)/Eroded(-) Volume	0.39	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	3
Channel Width (ft)	287	287
Channel XS Area (sq. ft)	1347.8	1347.8
Channel Perimeter (ft)	289	289

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1733	sq. Yd
Volume	4620	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5198	5198
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24257	50247
Left Levee Volume (cu. Yd)	23872	56215
Right Levee Length (ft)	5198	5198
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24257	50247
Right Levee Volume (cu. Yd)	23872	56215
Total Levee Surface Area (sq. Yd)	48514	100494
Total Levee Volume (cu. Yd)	47744	112430

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8086	19059
Left Levee Lining Volume (cu. Yd)	4043	9530
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8086	19059
Right Levee Lining Volume (cu. Yd)	4043	9530
Total Lining Area (sq. Yd)	16172	38119
Total Lining Volume (cu. Yd)	8086	19060

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	287	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	18	
Volume per structure	303	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,725	
Area per structure	96	sq. Yd
Total Area	1,722	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8647	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 34,588	
Other Cost	$ -	
Total cost per basin	$ 34,588	
Area per basin	9,209	sq. Yd
Total Area	9,209	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,744	cu. Yd	$ 7.00	$ 334,208	48,514	sq. Yd	$ 9.00	$ 436,626	48,514	sq. Yd	$ 11.67	$ 565,997
Levee - LC Enhancement	Fill	64,686	cu. Yd	$ 7.00	$ 452,802	51,980	sq. Yd	$ 9.00	$ 467,820	64,686	sq. Yd	$ 11.67	$ 754,670
Levee Lining	Riprap	8,086	cu. Yd	$ 75.00	$ 606,450	16,172	sq. Yd	$ -	$ -	16,172	sq. Yd	$ 20.83	$ 336,907
Levee Lining -LC Enhancement	Riprap	10,974	cu. Yd	$ 75.00	$ 823,050	21,947	sq. Yd	$ -	$ -	21,947	sq. Yd	$ 20.83	$ 457,231
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,620	cu. Yd	$ 75.00	$ 346,500	1,733	sq. Yd	$ -	$ -	1,733	sq. Yd	$ 25.00	$ 43,325
Drop Structures	Riprap	18	EA	$ 22,725.00	$ 409,050	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 33.33	$ 57,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 2,272.50	$ 40,905	172	sq. Yd	$ -	$ -	172	sq. Yd	$ 33.33	$ 5,740
Sedimentation Basins		1	EA	$ 34,588.00	$ 34,588	9,209	sq. Yd	$ -	$ -	9,209	sq. Yd	$ 8.33	$ 76,742
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 436,626	Base Maintenance Cost			$ 1,080,371
						LC Enhancement Cost			$ 467,820	LC Enhancement Cost			$ 1,217,641
						Total Landscape Cost			$ 904,446	Total Maintenance Cost			$ 2,298,012

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,730,796	$ 1,316,757	$ 3,047,553
Contingency Cost (25% of Construction Cost)	$ 432,699	$ 329,189	$ 761,888
Engineering Design Cost (5% of Construction Cost)	$ 86,540	$ 65,838	$ 152,378
Total Construction Cost	$ 2,250,035	$ 1,711,784	$ 3,961,819

Land Cost

Channel Length	5198 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	287	34.2	$100,000	$ 3,420,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.6	$100,000	$ 660,000
Levee LC Enhancement	51	6.1	$100,000	$ 610,000
Other	0	0	$100,000	$ -
Total	393	46.9		$ 4,690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	40.8	$100,000	$ 4,080,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	46.9	$100,000	$ 4,690,000

Total Cost

Base Total Cost	$ 7,847,032
Total Landscape Enhancement Cost	$ 4,007,246
Total Cost Including LC Enh.	$ 11,854,277

Open Channel

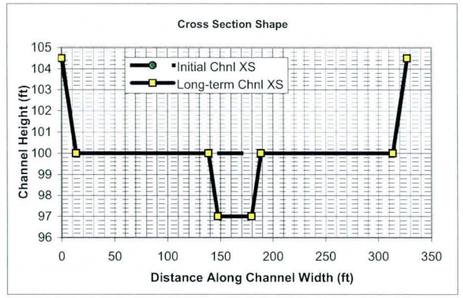
Structure ID	C42010	HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

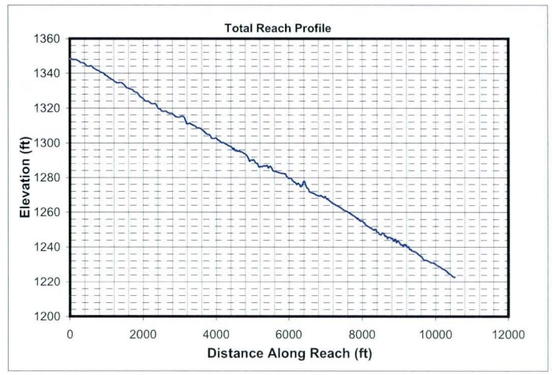
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	1231	1740							2971
Weighting Factor	1.00	0.43							
Flow into Channel	1231	755							1986

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	340.00								340
Sediment Conc. (ppm)	2203								
Sediment Volume (ac. ft)	0.28								0.28
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.28								0.28

Hydrology

Drainage Area	3.057	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1986	cfs	
Long-term Max. Chnl Capacity	10012	cfs	
Q2 Channel	199	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	302.3	108.6	0.4	100.0	100.4	1.8	0.4	302.2	0.4	0.11	0.54
497	303.9	188.5	0.6	100.0	100.6	2.6	0.6	303.7	0.6	0.19	0.59
1490	307.6	366.2	1.2	100.0	101.2	4.1	1.2	307.2	1.2	0.38	0.66
1986	309.1	436.0	1.4	100.0	101.4	4.6	1.4	308.6	1.4	0.45	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	43.0	64.6	1.5	97.0	98.7	3.1	1.7	42.4	1.5	0.54	0.44
497	50.5	119.5	2.4	97.0	99.9	4.2	2.9	49.6	2.4	0.91	0.47
1490	308.3	476.2	1.5	97.0	101.2	3.1	4.2	307.0	1.6	1.30	0.44
1986	310.2	567.2	1.8	97.0	101.5	3.5	4.5	308.8	1.8	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
	415420_RR41510								
199	719								719
497	2345								2345
1490	5575								5575
1986	8178								8178

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
199	1.74	1.0800	1.0260	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
497	1.74	1.2483	1.1859	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1490	1.74	1.4496	1.3771	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1986	1.74	1.5020	1.4269	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	199	497	1490	1986	199	497	1490	1986	199	497	1490	1986
Bray - Equation #1	39	63	112	130	1.5	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	147	171	1.7	2.3	3.3	3.6	2.3	2.6	3.0	3.1
Hey	12	20	36	42	4.8	6.8	10.4	11.5				
Ackers & Charlton/Lacey	33	49	77	87					1.9	2.3	2.7	2.8
Parker	97	153	265	306	1.2	1.8	2.9	3.2				
Chang	65	115	223	266	0.1	0.0	-0.5	-0.7				
Kellerhals	25	40	69	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	42	50	307	309								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	19.3	27.2	41.1	45.8	5	7	11	12	3.1	3.9	5.2	5.6
Average	40	62	130	146	2.3	3.1	4.5	5.0	2.8	3.3	3.9	4.1
Values As Designed	42	50	307	309	1.7	2.9	4.2	4.5	3.1	4.2	3.1	3.5
Difference with Design	-2	12	-177	-163	0.5	0.2	0.4	0.6	-0.3	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1162	741	1455	2006	4076	291	285	170	4334	334	1224	1462
497	4804	2535	4793	9493	6172	1385	1053	964	11677	1181	5413	4497
1490	26077	9502	15478	60943	9528	6742	3624	5208	36157	5769	26857	18717
1986	40587	13214	20032	99073	10598	10055	4879	7809	48398	8793	40016	27587

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	2171	1385	2718	3747	7615	544	532	317	8096	625	2287	2731
497	3589	1895	3582	7094	4612	1035	787	720	8725	882	4045	3361
1490	6495	2367	3855	15180	2373	1679	903	1297	9006	1437	6689	4662
1986	7582	2469	3742	18508	1980	1878	911	1459	9041	1643	7475	5153

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	996	464	687	1876	878	199	150	240	1256	208	1179	739
497	3739	1360	1860	7979	1386	703	416	874	3230	661	4215	2402
1490	7746	3389	5209	14455	6431	1546	1151	1866	9436	1596	9130	5632
1986	12046	4869	7132	23476	7251	2363	1617	2897	12743	2456	14017	8261

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1861	866	1283	3505	1640	373	280	449	2346	389	2202	1381
497	2794	1016	1390	5962	1036	526	311	653	2414	494	3149	1795
1490	1929	844	1298	3600	1602	385	287	465	2350	398	2274	1403
1986	2250	910	1332	4385	1354	441	302	541	2380	459	2618	1543

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
199	0.0024	0.0034	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0060	0.0003	0.0025	0.0119	0.0050
497	0.0012	0.0020	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0060	0.0002	0.0013	0.0120	0.0048
1490	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0060	0.0001	0.0006	0.0119	0.0046
1986	0.0004	0.0009	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0005	0.0119	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	73.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	25	
Distance between structs.	421	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	421 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		9.03	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
199	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	0.0	3.0	4.2
497	1.1	-0.8	0.2	24.6	2.9	2.4	4.2	0.0050	0.3	0.0	3.0	4.5
1490	1.1	-1.2	0.1	24.6	4.2	1.6	3.1	0.0050	0.4	0.0	3.0	4.6
1986	1.1	-1.3	0.2	24.6	4.5	1.8	3.5	0.0050	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	340.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.07	ac. ft
Outflowing Sediment Volume	0.23	ac. ft
Deposited(+)/Eroded(-) Volume	0.84	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	3512	sq. Yd
Volume	9364	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10535	10535
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	49163	101838
Left Levee Volume (cu. Yd)	48383	113934
Right Levee Length (ft)	10535	10535
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	49163	101838
Right Levee Volume (cu. Yd)	48383	113934
Total Levee Surface Area (sq. Yd)	98326	203676
Total Levee Volume (cu. Yd)	96766	227868

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16388	38628
Left Levee Lining Volume (cu. Yd)	8194	19314
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16388	38628
Right Levee Lining Volume (cu. Yd)	8194	19314
Total Lining Area (sq. Yd)	32776	77257
Total Lining Volume (cu. Yd)	16388	38628

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.8	ft
Structure Height	9.8	ft
Number of Structures	25	
Volume per structure	357	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 26,775	
Area per structure	109	sq. Yd
Total Area	2,725	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14568	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 58,272	
Other Cost	$ -	
Total cost per basin	$ 58,272	
Area per basin	15,311	sq. Yd
Total Area	15,311	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	96,766	cu. Yd	$ 7.00	$ 677,362	98,326	sq. Yd	$ 9.00	$ 884,934	98,326	sq. Yd	$ 11.67	$ 1,147,137	
Levee - LC Enhancement	Fill	131,102	cu. Yd	$ 7.00	$ 917,714	105,350	sq. Yd	$ 9.00	$ 948,150	131,102	sq. Yd	$ 11.67	$ 1,529,523	
Levee Lining	Riprap	16,388	cu. Yd	$ 75.00	$ 1,229,100	32,776	sq. Yd	$ -	$ -	32,776	sq. Yd	$ 20.83	$ 682,824	
Levee Lining -LC Enhancement	Riprap	22,240	cu. Yd	$ 75.00	$ 1,668,000	44,481	sq. Yd	$ -	$ -	44,481	sq. Yd	$ 20.83	$ 926,690	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	9,364	cu. Yd	$ 75.00	$ 702,300	3,512	sq. Yd	$ -	$ -	3,512	sq. Yd	$ 25.00	$ 87,800	
Drop Structures	Riprap	25	EA	$ 26,775.00	$ 669,375	2,725	sq. Yd	$ -	$ -	2,725	sq. Yd	$ 33.33	$ 90,833	
Drop Str. - LC Enhancement	Riprap	25	EA	$ 2,677.50	$ 66,938	273	sq. Yd	$ -	$ -	273	sq. Yd	$ 33.33	$ 9,083	
Sedimentation Basins		1	EA	$ 58,272.00	$ 58,272	15,311	sq. Yd	$ -	$ -	15,311	sq. Yd	$ 8.33	$ 127,592	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 884,934	Base Maintenance Cost			$ 2,136,186	
						LC Enhancement Cost			$ 948,150	LC Enhancement Cost			$ 2,465,296	
						Total Landscape Cost			$ 1,833,084	Total Maintenance Cost			$ 4,601,482	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,336,409	$ 2,652,652	$ 5,989,061
Contingency Cost (25% of Construction Cost)	$ 834,102	$ 663,163	$ 1,497,265
Engineering Design Cost (5% of Construction Cost)	$ 166,820	$ 132,633	$ 299,453
Total Construction Cost	$ 4,337,332	$ 3,448,447	$ 7,785,779

Land Cost

Channel Length	10535	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	79.1	$100,000	$ 7,910,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.3	$100,000	$ 1,330,000
Levee LC Enhancement	51	12.3	$100,000	$ 1,230,000
Other	0	0	$100,000	$ -
Total	433	104.7		$ 10,470,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	92.4	$100,000	$ 9,240,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	104.7	$100,000	$ 10,470,000

Total Cost

Base Total Cost	$	16,598,451
Total Landscape Enhancement Cost	$	8,091,893
Total Cost Including LC Enh.	$	24,690,345

Open Channel

Structure ID	C42020

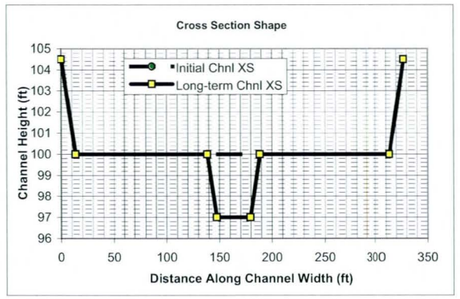
HEC1 ID	415420

Longitudinal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

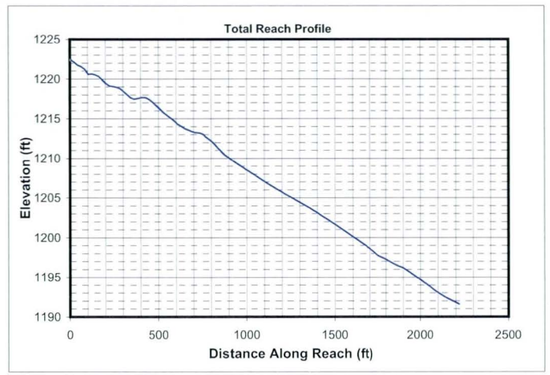
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1705									1705
Weighting Factor	1.00									
Flow into Channel	1705									1705

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	340.00									340
Sediment Conc. (ppm)	1795									
Sediment Volume (ac. ft)	0.23									0.23
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.23									0.23

Hydrology

Drainage Area	4.058	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1705	cfs	
Long-term Max. Chnl Capacity	10501	cfs	
Q2 Channel	171	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	302.0	94.7	0.3	100.0	100.3	1.8	0.3	301.9	0.3	0.11	0.57
426	303.4	164.3	0.5	100.0	100.5	2.6	0.5	303.3	0.5	0.19	0.62
1279	306.7	319.1	1.0	100.0	101.1	4.0	1.1	306.3	1.0	0.36	0.69
1705	307.9	379.8	1.2	100.0	101.3	4.5	1.3	307.5	1.2	0.43	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	41.8	56.7	1.4	97.0	98.5	3.0	1.5	41.3	1.4	0.53	0.45
426	48.5	104.3	2.1	97.0	99.6	4.1	2.6	47.7	2.2	0.90	0.49
1279	307.2	421.6	1.4	97.0	101.0	3.0	4.0	305.9	1.4	1.37	0.46
1705	308.9	502.2	1.6	97.0	101.2	3.4	4.2	307.5	1.6	1.46	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
171	739									739
426	2402									2402
1279	5632									5632
1705	8261									8261

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
171	1.74	1.0380	0.9861	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
426	1.74	1.2065	1.1461	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1279	1.74	1.4080	1.3376	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1705	1.74	1.4606	1.3875	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	171	426	1279	1705	171	426	1279	1705	171	426	1279	1705
Bray - Equation #1	36	58	103	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	136	158	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.5	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	73	82					1.9	2.2	2.6	2.8
Parker	90	142	246	284	1.2	1.7	2.7	3.0				
Chang	62	108	210	250	0.1	-0.1	-0.5	-0.6				
Kellerhals	24	37	64	74	2.1	3.1	4.8	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	41	48	306	308								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.9	25.3	38.2	42.5	5	7	10	11	3.1	3.9	5.2	5.6
Average	38	58	123	138	2.1	2.9	4.3	4.7	2.8	3.2	3.9	4.0
Values As Designed	41	48	306	307	1.5	2.6	4.0	4.2	3.0	4.1	3.0	3.4
Difference with Design	-3	10	-183	-170	0.6	0.3	0.3	0.5	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1130	737	1500	1984	4119	305	296	159	4687	345	1179	1495
426	4674	2506	4904	9392	6224	1434	1083	917	12582	1190	5219	4557
1279	25405	9358	15769	60354	9587	6968	3713	4980	38902	5724	25828	18781
1705	39548	13003	20418	98150	10657	10392	4994	7471	52063	8699	38444	27622

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	2460	1603	3264	4316	8963	664	644	347	10200	750	2565	3252
426	4068	2181	4268	8174	5417	1248	943	798	10951	1036	4542	3966
1279	7371	2715	4575	17510	2782	2022	1077	1445	11287	1661	7493	5449
1705	8605	2829	4443	21357	2319	2261	1087	1626	11329	1893	8365	6010

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	914	432	659	1727	849	190	144	216	1244	194	1076	695
426	3451	1271	1786	7404	1332	675	400	795	3200	716	3870	2264
1279	6995	3110	4988	13084	6309	1455	1095	1649	9335	1468	8219	5246
1705	10883	4477	6813	21259	7114	2229	1543	2574	12610	2255	12638	7672

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1988	939	1435	3759	1847	414	312	469	2706	422	2342	1512
426	3003	1106	1555	6444	1159	588	348	692	2785	623	3369	1970
1279	2029	902	1447	3796	1830	422	318	478	2708	426	2384	1522
1705	2368	974	1482	4626	1548	485	336	560	2744	491	2750	1669

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
171	0.0027	0.0039	123	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0028	0.0139	0.0056
426	0.0013	0.0022	161	0.49	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0063	0.0002	0.0014	0.0139	0.0054
1279	0.0006	0.0012	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0006	0.0139	0.0052
1705	0.0005	0.0010	244	0.74	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0139	0.0052

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	18.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		6.81	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
171	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0055	0.2	0.0	3.0	4.2
426	1.1	-0.7	0.2	24.6	2.6	2.2	4.1	0.0055	0.3	0.0	3.0	4.4
1279	1.1	-1.2	0.1	24.6	4.0	1.4	3.0	0.0055	0.4	0.0	3.0	4.5
1705	1.1	-1.2	0.2	24.6	4.2	1.6	3.4	0.0055	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1231	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	340.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.13	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	1.88	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	746	sq. Yd
Volume	1989	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2238	2238
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	10444	21634
Left Levee Volume (cu. Yd)	10278	24204
Right Levee Length (ft)	2238	2238
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	10444	21634
Right Levee Volume (cu. Yd)	10278	24204
Total Levee Surface Area (sq. Yd)	20888	43268
Total Levee Volume (cu. Yd)	20556	48408

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3481	8206
Left Levee Lining Volume (cu. Yd)	1741	4103
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3481	8206
Right Levee Lining Volume (cu. Yd)	1741	4103
Total Lining Area (sq. Yd)	6963	16412
Total Lining Volume (cu. Yd)	3482	8206

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	7	
Volume per structure	337	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,275	
Area per structure	109	sq. Yd
Total Area	763	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10987	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,948	
Other Cost	$ -	
Total cost per basin	$ 43,948	
Area per basin	11,615	sq. Yd
Total Area	11,615	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	20,556	cu. Yd	$ 7.00	$ 143,892	20,888	sq. Yd	$ 9.00	$ 187,992	20,888	sq. Yd	$ 11.67	$ 243,693	
Levee - LC Enhancement	Fill	27,852	cu. Yd	$ 7.00	$ 194,964	22,380	sq. Yd	$ 9.00	$ 201,420	27,852	sq. Yd	$ 11.67	$ 324,940	
Levee Lining	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	6,963	sq. Yd	$ -	$ -	6,963	sq. Yd	$ 20.83	$ 145,056	
Levee Lining -LC Enhancement	Riprap	4,724	cu. Yd	$ 75.00	$ 354,300	9,449	sq. Yd	$ -	$ -	9,449	sq. Yd	$ 20.83	$ 196,861	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	1,989	cu. Yd	$ 75.00	$ 149,175	746	sq. Yd	$ -	$ -	746	sq. Yd	$ 25.00	$ 18,650	
Drop Structures	Riprap	7	EA	$ 25,275.00	$ 176,925	763	sq. Yd	$ -	$ -	763	sq. Yd	$ 33.33	$ 25,433	
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,527.50	$ 17,693	76	sq. Yd	$ -	$ -	76	sq. Yd	$ 33.33	$ 2,543	
Sedimentation Basins		1	EA	$ 43,948.00	$ 43,948	11,615	sq. Yd	$ -	$ -	11,615	sq. Yd	$ 8.33	$ 96,792	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 187,992	Base Maintenance Cost			$ 529,624	
						LC Enhancement Cost			$ 201,420	LC Enhancement Cost			$ 524,344	
						Total Landscape Cost			$ 389,412	Total Maintenance Cost			$ 1,053,968	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 775,090	$ 566,957	$ 1,342,047
Contingency Cost (25% of Construction Cost)	$ 193,773	$ 141,739	$ 335,512
Engineering Design Cost (5% of Construction Cost)	$ 38,755	$ 28,348	$ 67,102
Total Construction Cost	$ 1,007,617	$ 737,043	$ 1,744,660

Land Cost

Channel Length	2238 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	16.8	$100,000	$ 1,680,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2.8	$100,000	$ 280,000
Levee LC Enhancement	51	2.6	$100,000	$ 260,000
Other	0	0	$100,000	$ -
Total	433	22.2		$ 2,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.6	$100,000	$ 1,960,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	22.2	$100,000	$ 2,220,000

Total Cost

Base Total Cost	$ 3,685,233
Total Landscape Enhancement Cost	$ 1,722,808
Total Cost Including LC Enh.	$ 5,408,041

Open Channel

Structure ID	S51010

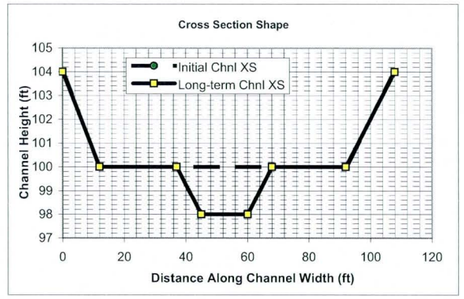
HEC1 ID	S51010

Longitudnal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

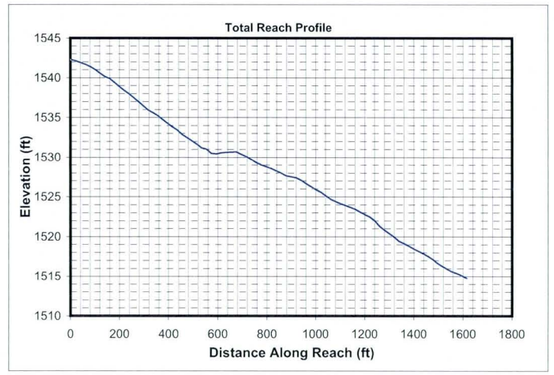
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	4	80	4	4	0	4	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	92	92	92	108
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	4	15	6	4	24	4	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	45	60	68	92	108
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510									TOTAL
HEC1 Peak-Flow	2099									2099
Weighting Factor	0.21									
Flow into Channel	441									441

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	2871	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	82.1	23.5	0.3	100.0	100.3	1.9	0.3	82.0	0.3	0.13	0.62
110	83.7	41.0	0.5	100.0	100.5	2.7	0.5	83.5	0.5	0.22	0.68
331	87.0	80.5	0.9	100.0	101.0	4.1	1.0	86.8	0.9	0.42	0.75
441	88.3	96.2	1.1	100.0	101.1	4.6	1.1	88.0	1.1	0.50	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	23.0	18.5	0.8	98.0	99.0	2.4	1.0	22.8	0.8	0.43	0.47
110	28.3	34.7	1.2	98.0	99.6	3.2	1.6	27.9	1.2	0.71	0.50
331	85.7	104.5	1.2	98.0	100.7	3.2	2.7	85.0	1.2	1.18	0.50
441	87.4	125.3	1.4	98.0	101.0	3.5	3.0	86.7	1.4	1.29	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
44										0
110										0
331										0
441										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.0098	0.9593	Erosive	Erosive	Erosive	0.2	Stable	4.7	Stable	Stable
110	1.74	1.1758	1.1170	Erosive	Erosive	Erosive	0.2	Stable	6.5	Stable	Stable
331	1.74	1.3723	1.3037	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
441	1.74	1.4229	1.3518	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	44	110	331	441	44	110	331	441	44	110	331	441
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	29	51	100	119	0.1	0.1	-0.1	-0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	23	28	85	87								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	10.3	14.5	22.0	24.5	3	4	6	7	2.4	3.1	4.0	4.3
Average	19	29	55	62	1.3	1.8	2.6	2.8	2.3	2.7	3.2	3.3
Values As Designed	23	28	85	87	1.0	1.6	2.7	3.0	2.4	3.2	3.2	3.5
Difference with Design	-4	1	-30	-24	0.3	0.1	-0.1	-0.1	-0.1	-0.5	0.0	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	379	248	531	698	1227	119	109	57	1696	121	400	508
110	1554	814	1632	3273	1845	516	370	303	4481	407	1705	1536
331	8304	2963	5092	20616	2869	2432	1226	1571	13767	1904	8147	6263
441	12848	4097	6624	33280	3207	3607	1643	2336	18411	2867	12022	9176

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	3187	2089	4466	5870	10324	1001	920	477	14267	1016	3368	4271
110	5230	2739	5490	11013	6209	1736	1244	1018	15078	1371	5738	5170
331	9314	3323	5711	23125	3218	2728	1376	1762	15442	2135	9138	7025
441	10808	3446	5573	27997	2698	3034	1382	1965	15489	2412	10114	7720

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	219	119	204	391	381	49	42	45	448	50	252	200
110	802	361	574	1610	633	183	129	182	1170	176	926	613
331	2414	1051	1729	4789	1911	550	389	546	3508	525	2785	1836
441	3722	1497	2378	7702	2168	830	540	839	4722	798	4222	2674

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1839	998	1719	3291	3209	415	357	383	3770	424	2124	1684
110	2700	1214	1930	5417	2130	616	433	611	3937	591	3118	2063
331	2707	1179	1939	5372	2144	617	436	612	3935	589	3124	2060
441	3132	1259	2001	6480	1824	698	454	706	3973	672	3552	2250

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0028	0.0042	130	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0021	0.0099	0.0007	0.0034	0.0170	0.0074
110	0.0014	0.0025	170	0.52	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0099	0.0004	0.0017	0.0171	0.0071
331	0.0006	0.0013	234	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0099	0.0003	0.0008	0.0170	0.0069
441	0.0005	0.0011	254	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0099	0.0002	0.0006	0.0170	0.0069

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	16.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	272	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	272 ft	Depth	3 ft
Width	108 ft	Side slope	3 ft/ft
Total Volume per Basin		1.80	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	-0.3	0.1	24.6	1.0	0.8	2.4	0.0070	0.1	0.0	2.0	2.8
110	1.1	-0.5	0.1	24.6	1.6	1.2	3.2	0.0070	0.2	0.0	2.0	2.9
331	1.1	-0.8	0.1	24.6	2.7	1.2	3.2	0.0070	0.3	0.0	2.0	3.1
441	1.1	-0.8	0.2	24.6	3.0	1.4	3.5	0.0070	0.3	0.0	2.0	3.1

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	2063	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	422	422
Channel Perimeter (ft)	110	110

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	545	sq. Yd
Volume	1271	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1634	1634
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	7081	14706
Left Levee Volume (cu. Yd)	6294	15130
Right Levee Length (ft)	1634	1634
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	4	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8533	14706
Right Levee Volume (cu. Yd)	7262	15130
Total Levee Surface Area (sq. Yd)	15614	29412
Total Levee Volume (cu. Yd)	13556	30260

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1634	1634
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2360	5447
Left Levee Lining Volume (cu. Yd)	1180	2723
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	16	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2905	5447
Right Levee Lining Volume (cu. Yd)	1452	2723
Total Lining Area (sq. Yd)	5265	10893
Total Lining Volume (cu. Yd)	2632	5446

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	108	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	6	
Volume per structure	108	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,100	
Area per structure	36	sq. Yd
Total Area	216	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2904	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,616	
Other Cost	$ -	
Total cost per basin	$ 11,616	
Area per basin	3,267	sq. Yd
Total Area	6,534	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	13,556	cu. Yd	$ 7.00	$ 94,892	15,614	sq. Yd	$ 9.00	$ 140,526	15,614	sq. Yd	$ 11.67	$ 182,163
Levee - LC Enhancement	Fill	16,704	cu. Yd	$ 7.00	$ 116,928	13,798	sq. Yd	$ 9.00	$ 124,182	16,704	sq. Yd	$ 11.67	$ 194,880
Levee Lining	Riprap	2,632	cu. Yd	$ 75.00	$ 197,400	5,265	sq. Yd	$ -	$ -	5,265	sq. Yd	$ 20.83	$ 109,690
Levee Lining -LC Enhancement	Riprap	2,814	cu. Yd	$ 75.00	$ 211,050	5,628	sq. Yd	$ -	$ -	5,628	sq. Yd	$ 20.83	$ 117,255
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,271	cu. Yd	$ 75.00	$ 95,325	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 25.00	$ 13,625
Drop Structures	Riprap	6	EA	$ 8,100.00	$ 48,600	216	sq. Yd	$ -	$ -	216	sq. Yd	$ 33.33	$ 7,200
Drop Str. - LC Enhancement	Riprap	6	EA	$ 810.00	$ 4,860	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 33.33	$ 720
Sedimentation Basins		2	EA	$ 11,616.00	$ 23,232	6,534	sq. Yd	$ -	$ -	6,534	sq. Yd	$ 8.33	$ 54,450
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 140,526	Base Maintenance Cost			$ 367,128
						LC Enhancement Cost			$ 124,182	LC Enhancement Cost			$ 312,855
						Total Landscape Cost			$ 264,708	Total Maintenance Cost			$ 679,983

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 459,449	$ 332,838	$ 792,287
Contingency Cost (25% of Construction Cost)	$ 114,862	$ 83,210	$ 198,072
Engineering Design Cost (5% of Construction Cost)	$ 22,972	$ 16,642	$ 39,614
Total Construction Cost	$ 597,284	$ 432,689	$ 1,029,973

Land Cost

Channel Length	1634 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	108	4.1	$100,000	$ 410,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	56	2.1	$100,000	$ 210,000
Levee LC Enhancement	44	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	208	7.9		$ 790,000

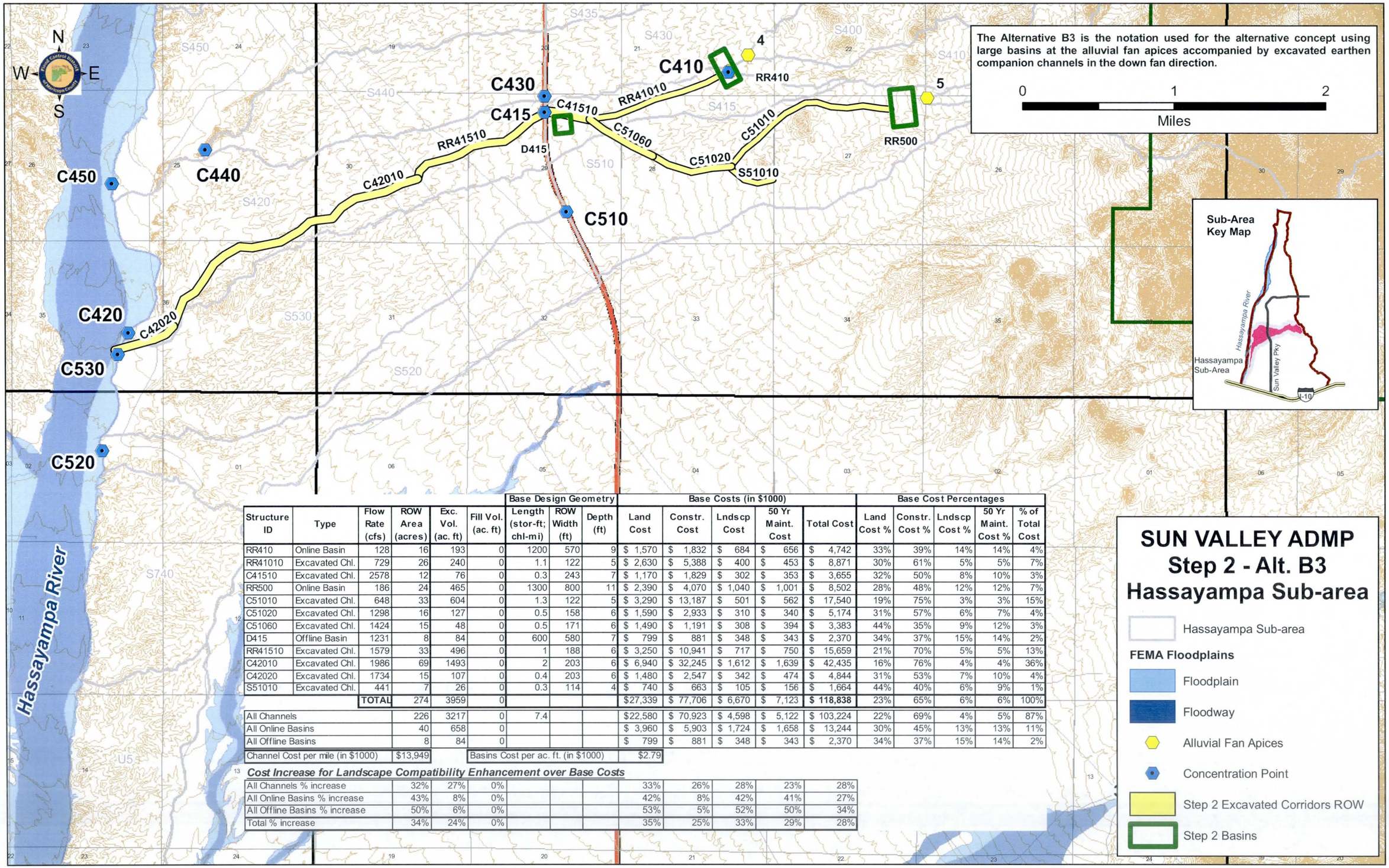
Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.2	$100,000	$ 620,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	7.9	$100,000	$ 790,000

Total Cost

Base Total Cost	$ 1,724,938
Total Landscape Enhancement Cost	$ 1,039,726
Total Cost Including LC Enh.	$ 2,764,664



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR410	Online Basin	128	16	193	0	1200	570	9	$ 1,570	$ 1,832	$ 684	$ 656	$ 4,742	33%	39%	14%	14%	4%
RR41010	Excavated Chl.	729	26	240	0	1.1	122	5	$ 2,630	$ 5,388	$ 400	$ 453	$ 8,871	30%	61%	5%	5%	7%
C41510	Excavated Chl.	2578	12	76	0	0.3	243	7	$ 1,170	$ 1,829	$ 302	$ 353	$ 3,655	32%	50%	8%	10%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	7%
C51010	Excavated Chl.	648	33	604	0	1.3	122	5	$ 3,290	$ 13,187	$ 501	$ 562	$ 17,540	19%	75%	3%	3%	15%
C51020	Excavated Chl.	1298	16	127	0	0.5	158	6	$ 1,590	$ 2,933	$ 310	$ 340	$ 5,174	31%	57%	6%	7%	4%
C51060	Excavated Chl.	1424	15	48	0	0.5	171	6	$ 1,490	$ 1,191	$ 308	$ 394	$ 3,383	44%	35%	9%	12%	3%
D415	Offline Basin	1231	8	84	0	600	580	7	$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	2%
RR41510	Excavated Chl.	1579	33	496	0	1	188	6	$ 3,250	$ 10,941	$ 717	$ 750	$ 15,659	21%	70%	5%	5%	13%
C42010	Excavated Chl.	1986	69	1493	0	2	203	6	$ 6,940	$ 32,245	$ 1,612	$ 1,639	$ 42,435	16%	76%	4%	4%	36%
C42020	Excavated Chl.	1734	15	107	0	0.4	203	6	$ 1,480	$ 2,547	$ 342	$ 474	$ 4,844	31%	53%	7%	10%	4%
S51010	Excavated Chl.	441	7	26	0	0.3	114	4	$ 740	$ 663	$ 105	$ 156	$ 1,664	44%	40%	6%	9%	1%
		TOTAL	274	3959	0				$27,339	$ 77,706	$ 6,670	$ 7,123	$ 118,838	23%	65%	6%	6%	100%
All Channels			226	3217	0	7.4			$22,580	$ 70,923	$ 4,598	$ 5,122	$ 103,224	22%	69%	4%	5%	87%
All Online Basins			40	658	0				$ 3,960	$ 5,903	$ 1,724	$ 1,658	$ 13,244	30%	45%	13%	13%	11%
All Offline Basins			8	84	0				$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	2%
Channel Cost per mile (in $1000)			$13,949		Basins Cost per ac. ft. (in $1000)				$2.79									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	32%	27%	0%				33%	26%	28%	23%	28%
All Online Basins % increase	43%	8%	0%				42%	8%	42%	41%	27%
All Offline Basins % increase	50%	6%	0%				53%	5%	52%	50%	34%
Total % increase	34%	24%	0%				35%	25%	33%	29%	28%

SUN VALLEY ADMP
Step 2 - Alt. B3
Hassayampa Sub-area

Hassayampa Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Excavated Corridors ROW

Step 2 Basins

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SUN VALLEY AREA DRAINAGE MASTER PLAN

Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR410	Online Basin	128	16	193	0	1200	570	9	$ 1,570	$ 1,832	$ 684	$ 656	$ 4,742	33%	39%	14%	14%	4%
RR41010	Excavated Chl.	729	26	240	0	1.1	122	5	$ 2,630	$ 5,388	$ 400	$ 453	$ 8,871	30%	61%	5%	5%	7%
C41510	Excavated Chl.	2578	12	76	0	0.3	243	7	$ 1,170	$ 1,829	$ 302	$ 353	$ 3,655	32%	50%	8%	10%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	7%
C51010	Excavated Chl.	648	33	604	0	1.3	122	5	$ 3,290	$ 13,187	$ 501	$ 562	$ 17,540	19%	75%	3%	3%	15%
C51020	Excavated Chl.	1298	16	127	0	0.5	158	6	$ 1,590	$ 2,933	$ 310	$ 340	$ 5,174	31%	57%	6%	7%	4%
C51060	Excavated Chl.	1424	15	48	0	0.5	171	6	$ 1,490	$ 1,191	$ 308	$ 394	$ 3,383	44%	35%	9%	12%	3%
D415	Offline Basin	1231	8	84	0	600	580	7	$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	2%
RR41510	Excavated Chl.	1579	33	496	0	1	188	6	$ 3,250	$ 10,941	$ 717	$ 750	$ 15,659	21%	70%	5%	5%	13%
C42010	Excavated Chl.	1986	69	1493	0	2	203	6	$ 6,940	$ 32,245	$ 1,612	$ 1,639	$ 42,435	16%	76%	4%	4%	36%
C42020	Excavated Chl.	1734	15	107	0	0.4	203	6	$ 1,480	$ 2,547	$ 342	$ 474	$ 4,844	31%	53%	7%	10%	4%
S51010	Excavated Chl.	441	7	26	0	0.3	114	4	$ 740	$ 663	$ 105	$ 156	$ 1,664	44%	40%	6%	9%	1%
	TOTAL	274	3959	0					$ 27,339	$ 77,706	$ 6,670	$ 7,123	**$ 118,838**	23%	65%	6%	6%	100%
All Channels		226	3217	0	7.4				$ 22,580	$ 70,923	$ 4,598	$ 5,122	$ 103,224	22%	69%	4%	5%	87%
All Online Basins		40	658	0					$ 3,960	$ 5,903	$ 1,724	$ 1,658	$ 13,244	30%	45%	13%	13%	11%
All Offline Basins		8	84	0					$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	2%
Channel Cost per mile (in $1000)		$13,949		Basins Cost per ac. ft. (in $1000)					$2.79									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RR410	Online Basin	128	23	203	0	1470	670	9	$ 2,260	$ 1,923	$ 985	$ 939	$ 6,107	37%	31%	16%	15%	4%
RR41010	Excavated Chl.	729	36	327	0	1.1	283	5	$ 3,610	$ 7,225	$ 551	$ 593	$ 11,979	30%	60%	5%	5%	8%
C41510	Excavated Chl.	2578	15	90	0	0.3	416	7	$ 1,490	$ 2,141	$ 364	$ 411	$ 4,405	34%	49%	8%	9%	3%
RR500	Online Basin	186	34	509	0	1630	900	11	$ 3,370	$ 4,434	$ 1,467	$ 1,404	$ 10,675	32%	42%	14%	13%	7%
C51010	Excavated Chl.	648	45	827	0	1.3	283	5	$ 4,520	$ 17,888	$ 689	$ 739	$ 23,836	19%	75%	3%	3%	16%
C51020	Excavated Chl.	1298	21	164	0	0.5	325	6	$ 2,140	$ 3,719	$ 405	$ 429	$ 6,694	32%	56%	6%	6%	4%
C51060	Excavated Chl.	1424	20	61	0	0.5	341	6	$ 1,990	$ 1,468	$ 399	$ 479	$ 4,336	46%	34%	9%	11%	3%
D415	Offline Basin	1231	12	89	0	780	680	7	$ 1,220	$ 922	$ 530	$ 516	$ 3,188	38%	29%	17%	16%	2%
RR41510	Excavated Chl.	1579	43	623	0	1	358	6	$ 4,280	$ 13,631	$ 904	$ 926	$ 19,742	22%	69%	5%	5%	13%
C42010	Excavated Chl.	1986	90	1838	0	2	373	6	$ 9,020	$ 39,542	$ 1,991	$ 1,994	$ 52,547	17%	75%	4%	4%	35%
C42020	Excavated Chl.	1734	19	131	0	0.4	373	6	$ 1,920	$ 3,064	$ 423	$ 550	$ 5,957	32%	51%	7%	9%	4%
S51010	Excavated Chl.	441	10	35	0	0.3	272	4	$ 1,020	$ 861	$ 144	$ 193	$ 2,217	46%	39%	6%	9%	1%
	TOTAL	368	4897	0					$ 36,840	$ 96,817	$ 8,852	$ 9,174	**$ 151,683**	24%	64%	6%	6%	100%
All Channels		299	4096	0	7.4				$ 29,990	$ 89,539	$ 5,870	$ 6,315	$ 131,714	23%	68%	4%	5%	87%
All Online Basins		57	712	0					$ 5,630	$ 6,356	$ 2,452	$ 2,343	$ 16,782	34%	38%	15%	14%	11%
All Offline Basins		12	89	0					$ 1,220	$ 922	$ 530	$ 516	$ 3,188	38%	29%	17%	16%	2%
Channel Cost per mile (in $1000)		$17,799		Basins Cost per ac. ft. (in $1000)					$3.72									
All Channels % increase		32%	27%	0%					33%	26%	28%	23%	28%					
All Online Basins % increase		43%	8%	0%					42%	8%	42%	41%	27%					
All Offline Basins % increase		50%	6%	0%					53%	5%	52%	50%	34%					
Total % increase		34%	24%	0%					35%	25%	33%	29%	28%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
RR410	STORAGE	128	7.6	105.02	6	2.18	118	65	22	9	0.503	1.106	1.12	1.12	59	129	130	130
410415	ROUTE	128	98.4	6.07	6.5	2.18	118	65	22	9	0.503	1.106	1.12	1.12	59	129	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415R	COMBINE	422			4.1	2.63	141	74	25	11	0.497	1.043	1.055	1.055	70	147	148	148
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
RR500	STORAGE	181	8.9	180.75	6.9	3.64	171	109	38	17	0.436	1.111	1.171	1.171	85	216	227	227
500415	ROUTE	181	98.3	10.82	7.4	3.64	170	108	38	17	0.436	1.109	1.171	1.171	85	215	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C415L	COMBINE	1386			4.2	5.48	303	146	51	22	0.514	0.988	1.032	1.032	150	289	301	301
C415	COMBINE	1581			4.2	8.11	405	196	67	29	0.464	0.899	0.928	0.928	201	389	401	401
D415	DIVERT	1231			4.1	8.11	386	191	66	28	0.442	0.878	0.906	0.906	191	380	392	392
415420	ROUTE	1095	100.2	67.53	4.9	8.11	369	190	66	28	0.423	0.869	0.906	0.906	183	376	392	392
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1501			4.6	9.88	474	218	75	33	0.446	0.82	0.851	0.851	235	432	449	449
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
RR410	STORAGE	128	7.6	105.02	14	2.18	119	66	23	10	0.505	1.124	1.15	1.15	59	131	134	134
410415	ROUTE	128	98.4	6.07	14.5	2.18	118	66	23	10	0.504	1.124	1.15	1.15	59	131	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415R	COMBINE	609			12.1	2.63	148	78	26	11	0.521	1.098	1.121	1.121	73	154	157	157
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
RR500	STORAGE	186	9.4	192.34	15	3.64	177	119	43	19	0.453	1.219	1.323	1.323	88	237	257	257
500415	ROUTE	186	98.3	11.01	15.5	3.64	177	119	43	19	0.452	1.218	1.323	1.323	88	236	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C415L	COMBINE	2073			12.2	5.48	347	170	60	26	0.588	1.151	1.226	1.226	172	336	358	358
C415	COMBINE	2578			12.2	8.11	489	245	86	37	0.561	1.122	1.179	1.179	243	485	510	510
D415	DIVERT	1231			12	8.11	415	226	80	34	0.476	1.037	1.094	1.094	206	449	473	473
415420	ROUTE	1135	100.2	69.86	12.9	8.11	401	225	80	34	0.459	1.031	1.094	1.094	199	446	473	473
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1734			12.5	9.88	564	271	95	41	0.53	1.02	1.076	1.076	279	537	567	567
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Excavated	0.0143	0.0060	1.10	3	4.5	0.045	729	67.4	159.9	2.4	2.4	3.5	1.0	66	4.6	0.52	1.33
C41510	Excavated	0.0137	0.0050	0.30	3	6.5	0.045	2578	176.1	528.9	3.0	3.0	5.0	1.5	175	4.9	0.49	1.57
C51010	Excavated	0.0222	0.0080	1.30	3	4.5	0.045	648	65.0	134.6	2.1	2.1	3.2	1.3	64	4.8	0.58	1.58
C51020	Excavated	0.0153	0.0055	0.50	3	5.5	0.045	1298	101.9	273.6	2.7	2.7	4.3	1.2	101	4.7	0.51	1.46
C51060	Excavated	0.0055	0.0030	0.50	3	6.0	0.045	1424	119.3	369.5	3.1	3.1	5.4	0.6	118	3.9	0.38	1.02
RR41510	Excavated	0.0162	0.0060	1.00	3	6.0	0.045	1579	128.6	329.1	2.6	2.6	4.7	1.3	127	4.8	0.53	1.75
C42010	Excavated	0.0120	0.0050	2.00	3	6.0	0.045	1986	146.5	420.2	2.9	2.9	5.0	1.0	145	4.7	0.49	1.57
C42020	Excavated	0.0139	0.0050	0.40	3	6.0	0.045	1734	144.5	385.2	2.7	2.7	4.8	1.2	143	4.5	0.48	1.50
S51010	Excavated	0.0171	0.0070	0.30	3	4.0	0.045	441	58.7	106.8	1.8	1.9	3.0	1.0	58	4.1	0.54	1.29

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR410	Online Basin	0.0150	1200	570	9.0	110.5	105.0	134.0	1524	128	7.6	1.4
RR500	Online Basin	0.0250	1300	800	11.0	204.4	192.3	257.0	2063	186	9.4	1.6
D415	Offline Basin	0.0150	600	580	7.0	42.1	37.0	37.0	1347	0	1.1	5.9

Online Basin

HEC1 ID	RR410

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.2	sq. mi
Total Sediment Yield Volume	4.1	ac ft

Required Minimum Sediment Volume

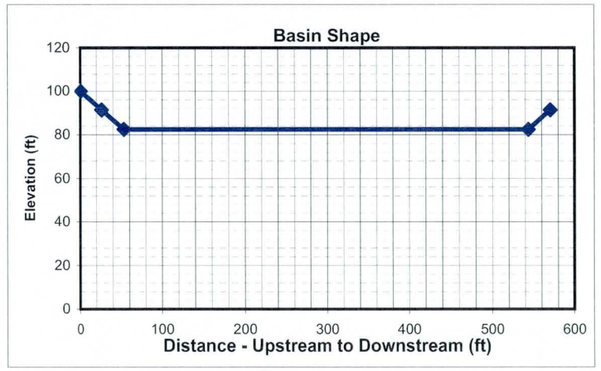
Sediment Volume	4.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1200	1370
Basin Width (ft)	570	570
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	544	519
Top Area (acres)	15.7	17.9
U/S-D/S Height Difference (ft)	8.6	8.6
Excess Area on Upstream (acres)	0.8	1.6

			Base	LC Enhanced
Bottom Length (ft)	1146	Allocated Storage Volume (ac. ft)	110.5	110.6
Bottom Width (ft)	490	Total Available Volume (ac. ft) (incl. Freeboard)	125.3	126.6
		Total Excavation Volume (ac. ft)	192.5	203.3

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	130.0	134	134.0
Peak Inflow (cfs)	1372	1524	1524.0
Peak Outflow (cfs)	128	128	128.0
Stage at Peak Outflow (ft)	7.6	7.6	7.6
Volume at Peak Outflow (ac. ft)	105.0	105.02	105.0

Volume Check

Total Volume needed	109.1	ac. ft
Total Volume Provided	110.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.6	ft
Depth Provided	9	ft
Depth OK?	Yes	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	13.00	39.70	67.31	81.46	95.85	110.48	125.35	140.45	155.80
Outflow	0.0	46.3	80.2	103.6	113.5	122.6	131.0	139.0	146.5	153.6

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	300900	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1200	ft
Base Total ROW Width	570	ft
LC Enh. Total ROW Length	1470	ft
LC Enh. Total ROW Length	670	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	310567	327991
Excavated Area (sq. Yd)	76000	109433

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	56	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	618	sq. Yd
Material Volume	309	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	900	ft
Unit Cost	160	per ft
Cost per outlet	$144,000	
Other Cost	$ -	
Total Cost	$144,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		310,567	cu. Yd	$ 4.00	$ 1,242,268	76,000	sq. Yd	$ 9.00	$ 684,000	76,000	sq. Yd	$ 8.33	$ 633,333
Basin - LC Enhancement		17,424	cu. Yd	$ 4.00	$ 69,696	33,433	sq. Yd	$ 9.00	$ 300,897	33,433	sq. Yd	$ 8.33	$ 278,608
Inlet	Riprap	309	sq. Yd	$ 75.00	$ 23,175	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 33.33	$ 20,600
Inlet - LC Enhancement (20%Inlet)					$ 4,635				$ -				$ 4,120
Outlet	Pipe	1	EA	$ 144,000	$ 144,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 7,200				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 684,000	Base Maintenance Cost			$ 656,150
						LC Enh. Landscape Cost			$ 300,897	LC Enh. Maintenance Cost			$ 282,839
						Total Landscape Cost			$ 984,897	Total Maintenance Cost			$ 938,989

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,409,443	$ 69,696	$ 1,479,139
Contingency Cost (25% of Construction Cost)	$ 352,361	$ 17,424	$ 369,785
Engineering Design Cost (5% of Construction Cost)	$ 70,472	$ 3,485	$ 73,957
Total Construction Cost	$ 1,832,276	$ 90,605	$ 1,922,881

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	6.9	$100,000	$ 690,000
Basin	15.7	$100,000	$ 1,570,000
Other		$100,000	$ -
Total	22.6	$100,000	$ 2,260,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15.7	$100,000	$ 1,570,000
LC Enhancement Cost	acre	6.9	$100,000	$ 690,000
Total Land Cost	acre	22.6	$100,000	$ 2,260,000

Total Cost

Base Total Cost	$ 4,742,426
Total LC Enhancement Cost	$ 1,364,341
Total Cost Including LC Enh.	$ 6,106,767

Open Channel

Structure ID	RR41010

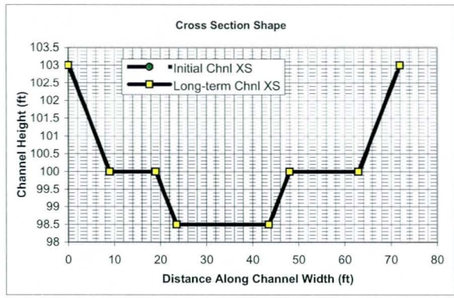
HEC1 ID	410415

Longitudal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

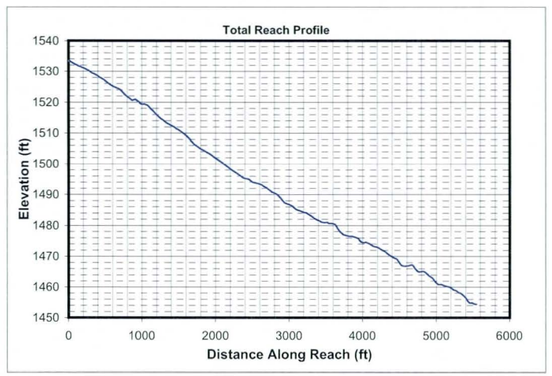
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	20	4.5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	43.5	48	63	72
Y	103	100	100	98.5	98.5	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	20	4.5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	43.5	48	63	72
Y	103	100	100	98.5	98.5	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR410	S415							TOTAL
HEC1 Peak-Flow	128	791							919
Weighting Factor	1.00	0.76							
Flow into Channel	128	601							729

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.343	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	729	cfs	
Long-term Max. Chnl Capacity	1224	cfs	
Q2 Channel	73	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	72	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	27.5	28.1	1.0	98.5	99.7	2.6	1.2	27.1	1.0	0.45	0.45
182	57.7	65.4	1.1	98.5	100.5	2.8	2.0	57.1	1.1	0.75	0.46
547	64.8	132.4	2.0	98.5	101.6	4.1	3.1	63.7	2.1	1.17	0.51
729	67.4	159.9	2.4	98.5	102.0	4.6	3.5	66.3	2.4	1.33	0.52

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	27.5	28.1	1.0	98.5	99.7	2.6	1.2	27.1	1.0	0.45	0.45
182	57.7	65.4	1.1	98.5	100.5	2.8	2.0	57.1	1.1	0.75	0.46
547	64.8	132.4	2.0	98.5	101.6	4.1	3.1	63.7	2.1	1.17	0.51
729	67.4	159.9	2.4	98.5	102.0	4.6	3.5	66.3	2.4	1.33	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
73										0
182										0
547										0
729										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
73	1.74	1.4057	1.3354	Erosive	Erosive	Erosive	0.3	Stable	5.0	Stable	Stable
182	1.74	1.4373	1.3655	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
547	1.74	1.6208	1.5397	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable
729	1.74	1.6669	1.5836	Erosive	Erosive	Erosive	0.4	Stable	10.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	73	182	547	729	73	182	547	729	73	182	547	729
Bray - Equation #1	23	37	66	77	1.1	1.5	2.2	2.4	2.9	3.3	3.8	4.0
Bray - Equation #2	30	48	87	101	1.2	1.7	2.4	2.6	2.0	2.3	2.6	2.7
Hey	6	11	21	24	3.3	4.7	7.1	7.9				
Ackers & Charlton/Lacey	22	32	51	57					1.6	1.9	2.3	2.4
Parker	59	93	161	185	0.8	1.2	1.9	2.1				
Chang	38	66	129	154	0.1	0.1	-0.2	-0.3				
Kellerhals	15	24	42	49	1.5	2.2	3.4	3.8	3.1	3.4	3.8	3.9
AMAFCA/Schumm	27	57	64	66								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	12.8	18.1	27.3	30.4	3	5	7	8	2.6	3.3	4.3	4.6
Average	24	40	66	75	1.5	2.1	3.1	3.4	2.5	2.8	3.4	3.5
Values As Designed	27	57	64	66	1.2	2.0	3.1	3.5	2.6	2.8	4.1	4.6
Difference with Design	-3	-18	2	9	0.3	0.1	0.0	-0.1	-0.1	0.0	-0.8	-1.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	347	211	447	2309	859	122	62	78	2287	174	883	707
182	958	538	1135	6518	1921	344	163	219	5739	470	2413	1856
547	4897	1982	3556	39022	3015	1878	572	1105	17423	2135	10899	7862
729	7463	2745	4627	61904	3404	2998	773	1633	23266	3161	15864	11622

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	1765	1074	2274	11751	4371	622	313	395	11640	888	4495	3599
182	1949	1095	2310	13268	3911	700	332	446	11682	956	4912	3778
547	3323	1345	2413	26479	2046	1274	388	750	11822	1449	7395	5335
729	3798	1397	2355	31504	1733	1526	394	831	11841	1609	8074	5915

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	347	180	298	631	485	74	62	78	594	77	407	294
182	958	462	774	1780	1099	207	163	219	1502	208	1125	773
547	4897	1756	2563	10656	1820	986	572	1105	4685	1023	5431	3227
729	7463	2445	3347	16905	2074	1453	773	1633	6278	1233	8033	4694

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	1765	916	1516	3209	2471	379	313	395	3022	390	2071	1495
182	1949	941	1577	3623	2238	422	332	446	3058	424	2291	1573
547	3323	1192	1739	7231	1235	669	388	750	3179	694	3685	2190
729	3798	1245	1703	8603	1056	739	394	831	3195	628	4088	2389

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
73	0.0008	0.0012	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0083	0.0005	0.0017	0.0059	0.0038
182	0.0007	0.0011	237	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0083	0.0004	0.0009	0.0059	0.0038
547	0.0003	0.0006	318	0.97	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0083	0.0002	0.0004	0.0059	0.0037
729	0.0003	0.0005	342	1.04	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0083	0.0002	0.0003	0.0059	0.0037

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	45.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	348	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	348 ft	Depth	3 ft
Width	72 ft	Side slope	3 ft/ft
Total Volume per Basin		1.47	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
73	1.1	-0.4	0.1	24.6	1.2	1.0	2.6	0.0060	0.1	0.0	1.0	1.5
182	1.1	-0.6	0.1	24.6	2.0	1.1	2.8	0.0060	0.2	0.0	1.0	1.6
547	1.1	-0.8	0.2	24.6	3.1	2.1	4.1	0.0060	0.4	0.0	1.0	1.9
729	1.1	-0.9	0.3	24.6	3.5	2.4	4.6	0.0060	0.4	0.0	1.0	2.0

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	128	cfs
Stage at Peak Flow	98.4	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	3.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.12	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	6
Channel Width (ft)	72	99
Channel XS Area (sq. ft)	225.8	286.55
Channel Perimeter (ft)	74	100

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	386873	527023
Excavated Area (sq. Yd)	44488	61171

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	927	sq. Yd
Volume	1854	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	72	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.3	ft
Structure Height	12.3	ft
Number of Structures	16	
Volume per structure	98	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,350	
Area per structure	24	sq. Yd
Total Area	384	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2372	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,488	
Other Cost	$ -	
Total cost per basin	$ 9,488	
Area per basin	2,781	sq. Yd
Total Area	5,562	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	386,873	cu. Yd	$ 10.00	$ 3,868,730	44,488	sq. Yd	$ 9.00	$ 400,392	44,488	sq. Yd	$ 8.33	$ 370,733
Exc. Chl - LC Enhancement	Excavated	140,150	cu. Yd	$ 10.00	$ 1,401,500	16,683	sq. Yd	$ 9.00	$ 150,147	16,683	sq. Yd	$ 8.33	$ 139,025
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,854	cu. Yd	$ 75.00	$ 139,050	927	sq. Yd	$ -	$ -	927	sq. Yd	$ 25.00	$ 23,175
Drop Structures	Riprap	16	EA	$ 7,350.00	$ 117,600	384	sq. Yd	$ -	$ -	384	sq. Yd	$ 33.33	$ 12,800
Drop Str. - LC Enhancement	Riprap	16	EA	$ 735.00	$ 11,760	38	sq. Yd	$ -	$ -	38	sq. Yd	$ 33.33	$ 1,280
Sedimentation Basins		2	EA	$ 9,488.00	$ 18,976	5,562	sq. Yd	$ -	$ -	5,562	sq. Yd	$ 8.33	$ 46,350
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 400,392	Base Maintenance Cost			$ 453,058
						LC Enhancement Cost			$ 150,147	LC Enhancement Cost			$ 140,305
						Total Landscape Cost			$ 550,539	Total Maintenance Cost			$ 593,363

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,144,356	$ 1,413,260	$ 5,557,616
Contingency Cost (25% of Construction Cost)	$ 1,036,089	$ 353,315	$ 1,389,404
Engineering Design Cost (5% of Construction Cost)	$ 207,218	$ 70,663	$ 277,881
Total Construction Cost	$ 5,387,663	$ 1,837,238	$ 7,224,901

Land Cost

Channel Length	5561 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	17.1	$100,000	$ 1,710,000
LC Enhancement Buffer	50	6.4	$100,000	$ 640,000
Channel	72	9.2	$100,000	$ 920,000
Channel LC Enhancement	27	3.4	$100,000	$ 340,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	283	36.1		$ 3,610,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	26.3	$100,000	$ 2,630,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	36.1	$100,000	$ 3,610,000

Total Cost

Base Total Cost	$ 8,871,113
Total Landscape Enhancement Cost	$ 3,107,690
Total Cost Including LC Enh.	$ 11,978,803

Open Channel

Structure ID	C41510

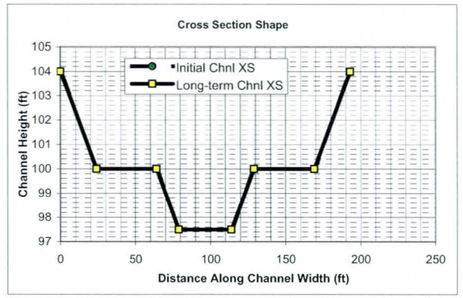
HEC1 ID	410415

Longitudal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

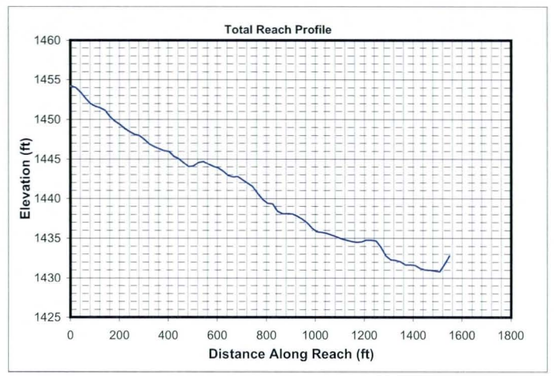
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
6	4	40	6	35	6.5	6	40	4	6

PT. ID	1	2	3	4	5	6	7	8
X	0	24	64	79	114	129	169	193
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
6	4	40	6	35	6.5	6	40	4	6

PT. ID	1	2	3	4	5	6	7	8
X	0	24	64	79	114	129	169	193
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	2578									2578
Weighting Factor	1.00									
Flow into Channel	2578									2578

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR41010	500415_C51060								TOTAL
Flow Volume (ac. ft)	134.00	257.00								391
Sediment Conc. (ppm)	2389	951								
Sediment Volume (ac. ft)	0.12	0.09								0.21
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.12	0.09								0.21

Hydrology

Drainage Area	1.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2578	cfs	
Long-term Max. Chnl Capacity	4825	cfs	
Q2 Channel	258	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	193	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
258	57.4	84.8	1.5	97.5	99.3	3.0	1.8	57.1	1.5	0.57	0.44
645	153.0	217.6	1.4	97.5	100.6	3.0	3.1	152.5	1.4	0.97	0.44
1934	169.7	438.6	2.6	97.5	102.0	4.4	4.5	169.0	2.6	1.40	0.48
2578	176.1	528.9	3.0	97.5	102.5	4.9	5.0	175.3	3.0	1.57	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
258	57.4	84.8	1.5	97.5	99.3	3.0	1.8	57.1	1.5	0.57	0.44
645	153.0	217.6	1.4	97.5	100.6	3.0	3.1	152.5	1.4	0.97	0.44
1934	169.7	438.6	2.6	97.5	102.0	4.4	4.5	169.0	2.6	1.40	0.48
2578	176.1	528.9	3.0	97.5	102.5	4.9	5.0	175.3	3.0	1.57	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR41010	500415_C51060								
258	294	249								542
645	773	592								1365
1934	3227	2496								5723
2578	4694	3649								8343

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
258	1.74	1.5175	1.4417	Erosive	Erosive	Erosive	0.4	Stable	6.1	Stable	Stable
645	1.74	1.5052	1.4299	Erosive	Erosive	Erosive	0.4	Stable	7.9	Stable	Stable
1934	1.74	1.6895	1.6051	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable
2578	1.74	1.7360	1.6492	Erosive	Erosive	Erosive	0.5	Stable	11.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	258	645	1934	2578	258	645	1934	2578	258	645	1934	2578
Bray - Equation #1	44	72	128	149	1.7	2.3	3.3	3.6	3.4	3.9	4.6	4.7
Bray - Equation #2	58	94	169	196	1.9	2.5	3.6	4.0	2.4	2.7	3.1	3.3
Hey	13	23	42	49	5.3	7.5	11.4	12.7				
Ackers & Charlton/Lacey	37	54	86	98					2.0	2.4	2.8	3.0
Parker	110	174	302	349	1.4	2.0	3.2	3.6				
Chang	77	134	262	311	0.1	-0.1	-0.6	-0.9				
Kellerhals	29	46	79	91	2.5	3.6	5.6	6.3	3.6	3.9	4.3	4.5
AMAFCA/Schumm	57	153	169	175								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	21.3	30.0	45.4	50.5	6	8	12	13	3.3	4.2	5.5	5.9
Average	46	80	130	148	2.4	3.4	5.0	5.5	2.9	3.4	4.1	4.3
Values As Designed	57	152	169	175	1.8	3.1	4.5	5.0	3.0	3.0	4.4	4.9
Difference with Design	-11	-73	-39	-27	0.6	0.2	0.5	0.5	-0.1	0.4	-0.3	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1287	709	1420	10821	2189	475	196	309	7711	672	3659	2677
645	3113	1692	3529	25844	5711	1143	483	746	19258	1637	8903	6551
1934	16087	6221	10772	155652	8850	6797	1676	3681	58326	7463	39797	28666
2578	24596	8619	14088	247392	9961	10858	2264	5426	77863	11053	57849	42725

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1852	1021	2044	15573	3150	683	282	445	11096	967	5266	3853
645	1792	974	2031	14877	3287	658	278	429	11086	942	5125	3771
1934	3087	1194	2067	29867	1698	1304	322	706	11192	1432	7636	5500
2578	3540	1240	2027	35602	1434	1563	326	781	11205	1591	8325	6148

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1287	599	898	2378	1161	257	196	309	1627	266	1520	954
645	3113	1427	2240	5680	3015	623	483	746	4051	645	3679	2337
1934	16087	5423	7417	34208	4947	2954	1676	3681	12618	2288	17768	9915
2578	24596	7558	9594	54370	5626	4357	2264	5426	16904	2501	26319	14501

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1852	862	1292	3422	1671	371	282	445	2341	383	2187	1373
645	1792	821	1290	3270	1736	359	278	429	2332	371	2118	1345
1934	3087	1041	1423	6564	949	567	322	706	2421	439	3409	1903
2578	3540	1088	1381	7824	810	627	326	781	2433	360	3788	2087

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
258	0.0006	0.0008	265	0.81	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0055	0.0003	0.0014	0.0050	0.0028
645	0.0006	0.0008	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0055	0.0002	0.0007	0.0050	0.0028
1934	0.0003	0.0005	351	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0055	0.0001	0.0003	0.0050	0.0027
2578	0.0002	0.0004	378	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0055	0.0001	0.0002	0.0050	0.0027

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	13.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.20	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft
Width	193 ft	Side slope	3 ft/ft
Total Volume per Basin		3.86	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
258	1.1	-0.6	0.1	24.6	1.8	1.5	3.0	0.0050	0.2	0.0	1.0	1.6
645	1.1	-1.0	0.1	24.6	3.1	1.4	3.0	0.0050	0.3	0.0	1.0	1.8
1934	1.1	-1.1	0.3	24.6	4.5	2.6	4.4	0.0050	0.5	0.0	1.0	2.1
2578	1.1	-1.2	0.3	24.6	5.0	3.0	4.9	0.0050	0.6	0.0	1.0	2.3

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	128	cfs
Stage at Peak Flow	98.4	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	0.42	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.31	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	6
Channel Width (ft)	193	232
Channel XS Area (sq. ft)	801	927.75
Channel Perimeter (ft)	194	232

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	123098	145935
Excavated Area (sq. Yd)	33603	40394

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	261	sq. Yd
Volume	522	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	193	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.9	ft
Structure Height	13.9	ft
Number of Structures	5	
Volume per structure	299	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,425	
Area per structure	64	sq. Yd
Total Area	322	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6227	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 24,908	
Other Cost	$ -	
Total cost per basin	$ 24,908	
Area per basin	6,721	sq. Yd
Total Area	6,721	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	123,098	cu. Yd	$ 10.00	$ 1,230,980	33,603	sq. Yd	$ 9.00	$ 302,427	33,603	sq. Yd	$ 8.33	$ 280,025
Exc. Chl - LC Enhancement	Excavated	22,837	cu. Yd	$ 10.00	$ 228,370	6,791	sq. Yd	$ 9.00	$ 61,119	6,791	sq. Yd	$ 8.33	$ 56,592
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	522	cu. Yd	$ 75.00	$ 39,150	261	sq. Yd	$ -	$ -	261	sq. Yd	$ 25.00	$ 6,525
Drop Structures	Riprap	5	EA	$ 22,425.00	$ 112,125	322	sq. Yd	$ -	$ -	322	sq. Yd	$ 33.33	$ 10,733
Drop Str. - LC Enhancement	Riprap	5	EA	$ 2,242.50	$ 11,213	32	sq. Yd	$ -	$ -	32	sq. Yd	$ 33.33	$ 1,073
Sedimentation Basins		1	EA	$ 24,908.00	$ 24,908	6,721	sq. Yd	$ -	$ -	6,721	sq. Yd	$ 8.33	$ 56,008
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 302,427	Base Maintenance Cost			$ 353,292
						LC Enhancement Cost			$ 61,119	LC Enhancement Cost			$ 57,665
						Total Landscape Cost			$ 363,546	Total Maintenance Cost			$ 410,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,407,163	$ 239,583	$ 1,646,746
Contingency Cost (25% of Construction Cost)	$ 351,791	$ 59,896	$ 411,686
Engineering Design Cost (5% of Construction Cost)	$ 70,358	$ 11,979	$ 82,337
Total Construction Cost	$ 1,829,312	$ 311,457	$ 2,140,769

Land Cost

Channel Length	1567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	4.8	$100,000	$ 480,000
LC Enhancement Buffer	50	1.8	$100,000	$ 180,000
Channel	193	6.9	$100,000	$ 690,000
Channel LC Enhancement	39	1.4	$100,000	$ 140,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	416	14.9		$ 1,490,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	11.7	$100,000	$ 1,170,000
LC Enhancement Cost	acre	3.2	$100,000	$ 320,000
Total Land Cost	acre	14.9	$100,000	$ 1,490,000

Total Cost

Base Total Cost	$ 3,655,031
Total Landscape Enhancement Cost	$ 750,241
Total Cost Including LC Enh.	$ 4,405,272

Online Basin

HEC1 ID	RR500

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.6	sq. mi
Total Sediment Yield Volume	6.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	6.9	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1300	1530
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	23.9	28.1
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	1.9	4.3

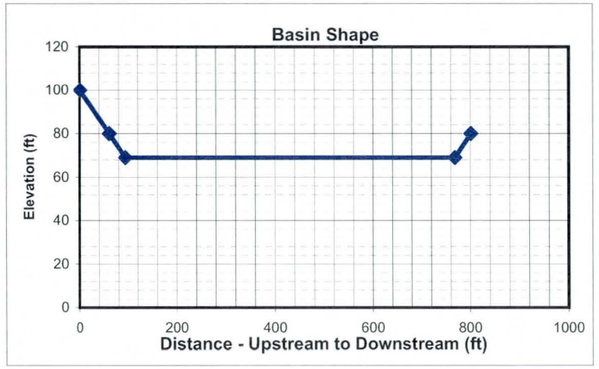
			Base	LC Enhanced
Bottom Length (ft)	1234	Allocated Storage Volume (ac. ft)	204.4	203.8
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	226.3	227.4
		Total Excavation Volume (ac. ft)	465.2	508.5

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	12	13
Volume	0.00	38.71	78.49	119.35	161.30	182.69	204.35	226.30	248.52	271.03
Outflow	0.0	85.6	121.0	148.2	171.1	181.5	191.3	200.7	209.6	218.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	227.0	257	257.0
Peak Inflow (cfs)	1743	2063	2063.0
Peak Outflow (cfs)	181	186	186.0
Stage at Peak Outflow (ft)	8.9	9.4	9.4
Volume at Peak Outflow (ac. ft)	180.8	192.34	192.3

Volume Check

Total Volume needed	199.2	ac. ft
Total Volume Provided	204.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.4	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	427000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1300	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	1630	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	750523	820380
Excavated Area (sq. Yd)	115556	163000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	98	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1089	sq. Yd
Material Volume	545	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		750,523	cu. Yd	$ 4.00	$ 3,002,092	115,556	sq. Yd	$ 9.00	$ 1,040,004	115,556	sq. Yd	$ 8.33	$ 962,967
Basin - LC Enhancement		69,857	cu. Yd	$ 4.00	$ 279,428	47,444	sq. Yd	$ 9.00	$ 426,996	47,444	sq. Yd	$ 8.33	$ 395,367
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,040,004	Base Maintenance Cost			$ 1,001,483
						LC Enh. Landscape Cost			$ 426,996	LC Enh. Maintenance Cost			$ 402,738
						Total Landscape Cost			$ 1,467,000	Total Maintenance Cost			$ 1,404,221

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,130,967	$ 279,428	$ 3,410,395
Contingency Cost (25% of Construction Cost)	$ 782,742	$ 69,857	$ 852,599
Engineering Design Cost (5% of Construction Cost)	$ 156,548	$ 13,971	$ 170,520
Total Construction Cost	$ 4,070,257	$ 363,256	$ 4,433,514

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	9.8	$100,000	$ 980,000
Basin	23.9	$100,000	$ 2,390,000
Other		$100,000	$ -
Total	33.7	$100,000	$ 3,370,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.9	$100,000	$ 2,390,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 8,501,744
Total LC Enhancement Cost	$ 2,172,990
Total Cost Including LC Enh.	$ 10,674,734

Open Channel

Structure ID	C51010

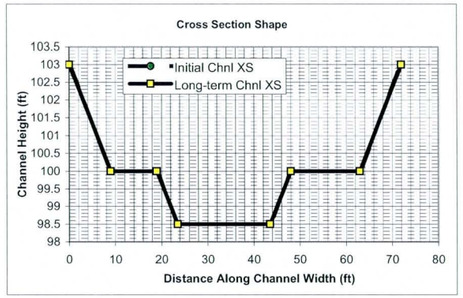
HEC1 ID	500415

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

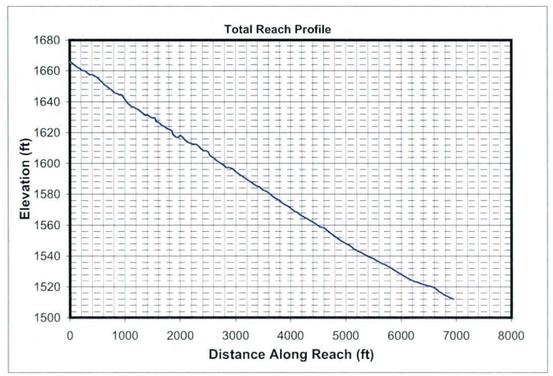
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	20	4.5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	43.5	48	63	72
Y	103	100	100	98.5	98.5	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	20	4.5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	43.5	48	63	72
Y	103	100	100	98.5	98.5	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510								TOTAL
HEC1 Peak-Flow	186	2099								2285
Weighting Factor	1.00	0.22								
Flow into Channel	186	462								648

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.409	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	648	cfs	
Long-term Max. Chnl Capacity	1413	cfs	
Q2 Channel	65	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	72	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	26.5	23.6	0.9	98.5	99.5	2.7	1.0	26.1	0.9	0.51	0.51
162	56.6	55.5	1.0	98.5	100.3	2.9	1.8	56.0	1.0	0.92	0.52
486	62.7	111.7	1.8	98.5	101.3	4.4	2.8	61.8	1.8	1.39	0.57
648	65.0	134.6	2.1	98.5	101.7	4.8	3.2	64.0	2.1	1.58	0.58

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	26.5	23.6	0.9	98.5	99.5	2.7	1.0	26.1	0.9	0.51	0.51
162	56.6	55.5	1.0	98.5	100.3	2.9	1.8	56.0	1.0	0.92	0.52
486	62.7	111.7	1.8	98.5	101.3	4.4	2.8	61.8	1.8	1.39	0.57
648	65.0	134.6	2.1	98.5	101.7	4.8	3.2	64.0	2.1	1.58	0.58

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
65										0
162										0
486										0
648										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
65	1.74	1.3640	1.2958	Erosive	Erosive	Erosive	0.3	Stable	5.3	Stable	Stable
162	1.74	1.3923	1.3226	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
486	1.74	1.5780	1.4991	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
648	1.74	1.6250	1.5437	Erosive	Erosive	Erosive	0.4	Stable	10.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**65**	**162**	**486**	**648**	**65**	**162**	**486**	**648**	**65**	**162**	**486**	**648**
Bray - Equation #1	21	35	62	72	1.1	1.4	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	28	46	81	95	1.2	1.6	2.3	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	23	3.1	4.5	6.8	7.5				
Ackers & Charlton/Lacey	21	30	48	55					1.6	1.9	2.2	2.4
Parker	55	87	151	175	0.8	1.1	1.8	2.0				
Chang	39	68	132	157	0.1	0.0	-0.3	-0.4				
Kellerhals	14	23	40	46	1.4	2.1	3.2	3.6	3.1	3.4	3.8	3.9
AMAFCA/Schumm	26	56	62	64								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	11.6	16.4	24.7	27.6	3	4	7	7	2.8	3.5	4.7	5.0
Average	23	38	63	72	1.5	2.0	2.9	3.2	2.5	2.9	3.4	3.6
Values As Designed	26	56	62	64	1.0	1.8	2.8	3.2	2.7	2.9	4.4	4.8
Difference with Design	-3	-18	1	8	0.4	0.1	0.1	0.1	-0.3	-0.1	-0.9	-1.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	441	265	611	3932	991	199	83	95	3980	239	1214	1095
162	1203	663	1559	10949	2240	548	216	264	9968	636	3259	2864
486	6201	2395	4581	66154	3448	3351	724	1304	30125	2827	14238	12304
648	9471	3304	6014	105249	3875	5334	973	1921	40205	4166	20569	18280

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	2525	1519	3496	22510	5676	1140	475	546	22784	1369	6950	6272
162	2755	1519	3569	25074	5130	1254	494	604	22828	1456	7463	6559
486	4734	1828	3497	50501	2632	2558	553	995	22997	2158	10869	9393
648	5422	1892	3443	60258	2218	3054	557	1100	23018	2385	11776	10466

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	441	223	386	852	521	108	83	95	829	101	511	377
162	1203	561	974	2373	1191	293	216	264	2088	272	1388	984
486	6201	2090	3124	14338	1932	1360	724	1304	6449	1325	6561	4128
648	9471	2900	4052	22812	2192	2002	973	1921	8631	1906	9661	6047

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	2525	1274	2210	4879	2985	617	475	546	4745	579	2923	2160
162	2755	1284	2232	5435	2727	670	494	604	4782	623	3179	2253
486	4734	1595	2385	10945	1475	1038	553	995	4923	1012	5008	3151
648	5422	1660	2320	13060	1255	1146	557	1100	4942	1092	5531	3462

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
65	0.0009	0.0013	262	0.80	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0087	0.0006	0.0019	0.0079	0.0045
162	0.0008	0.0012	274	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0087	0.0004	0.0009	0.0079	0.0044
486	0.0004	0.0007	370	1.13	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0087	0.0002	0.0004	0.0079	0.0043
648	0.0003	0.0006	399	1.22	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0087	0.0002	0.0003	0.0078	0.0042

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	98.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	33	
Distance between structs.	211	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	211 ft	Depth	3 ft
Width	72 ft	Side slope	3 ft/ft
Total Volume per Basin		0.88	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
65	1.1	-0.3	0.1	24.6	1.0	0.9	2.7	0.0080	0.1	0.0	1.0	1.5
162	1.1	-0.6	0.1	24.6	1.8	1.0	2.9	0.0080	0.2	0.0	1.0	1.6
486	1.1	-0.7	0.3	24.6	2.8	1.8	4.4	0.0080	0.3	0.0	1.0	1.9
648	1.1	-0.8	0.3	24.6	3.2	2.1	4.8	0.0080	0.4	0.0	1.0	2.0

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	3.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.34	ac. ft
Deposited(+)/Eroded(-) Volume	0.44	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	6
Channel Width (ft)	72	99
Channel XS Area (sq. ft)	225.8	286.55
Channel Perimeter (ft)	74	100

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	974625	1333938
Excavated Area (sq. Yd)	55712	76604

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	1161	sq. Yd
Volume	1934	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	72	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.8	ft
Structure Height	11.8	ft
Number of Structures	33	
Volume per structure	95	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,125	
Area per structure	24	sq. Yd
Total Area	792	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	1420	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 5,680	
Other Cost	$ -	
Total cost per basin	$ 5,680	
Area per basin	1,688	sq. Yd
Total Area	5,064	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	974,625	cu. Yd	$ 10.00	$ 9,746,250	55,712	sq. Yd	$ 9.00	$ 501,408	55,712	sq. Yd	$ 8.33	$ 464,267
Exc. Chl - LC Enhancement	Excavated	359,313	cu. Yd	$ 10.00	$ 3,593,130	20,892	sq. Yd	$ 9.00	$ 188,028	20,892	sq. Yd	$ 8.33	$ 174,100
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,934	cu. Yd	$ 75.00	$ 145,050	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 25.00	$ 29,025
Drop Structures	Riprap	33	EA	$ 7,125.00	$ 235,125	792	sq. Yd	$ -	$ -	792	sq. Yd	$ 33.33	$ 26,400
Drop Str. - LC Enhancement	Riprap	33	EA	$ 712.50	$ 23,513	79	sq. Yd	$ -	$ -	79	sq. Yd	$ 33.33	$ 2,640
Sedimentation Basins		3	EA	$ 5,680.00	$ 17,040	5,064	sq. Yd	$ -	$ -	5,064	sq. Yd	$ 8.33	$ 42,200
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 501,408	Base Maintenance Cost			$ 561,892
						LC Enhancement Cost			$ 188,028	LC Enhancement Cost			$ 176,740
						Total Landscape Cost			$ 689,436	Total Maintenance Cost			$ 738,632

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 10,143,465	$ 3,616,643	$ 13,760,108
Contingency Cost (25% of Construction Cost)	$ 2,535,866	$ 904,161	$ 3,440,027
Engineering Design Cost (5% of Construction Cost)	$ 507,173	$ 180,832	$ 688,005
Total Construction Cost	$ 13,186,505	$ 4,701,635	$ 17,888,140

Land Cost

Channel Length	6964	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	21.4	$100,000	$ 2,140,000
LC Enhancement Buffer	50	8	$100,000	$ 800,000
Channel	72	11.5	$100,000	$ 1,150,000
Channel LC Enhancement	27	4.3	$100,000	$ 430,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	283	45.2		$ 4,520,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	32.9	$100,000	$ 3,290,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	45.2	$100,000	$ 4,520,000

Total Cost

Base Total Cost	$ 17,539,804
Total Landscape Enhancement Cost	$ 6,296,403
Total Cost Including LC Enh.	$ 23,836,207

Open Channel

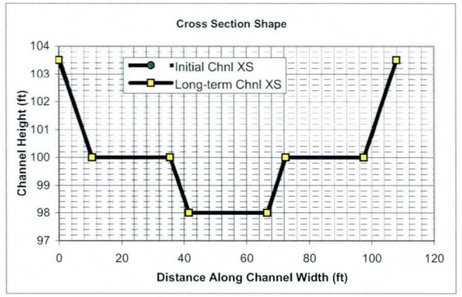
Structure ID	C51020	HEC1 ID	500415

Longitudal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

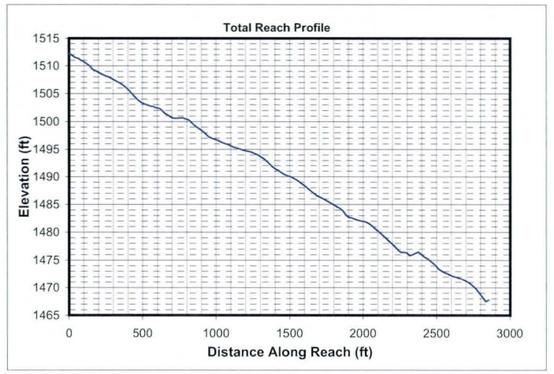
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	25	3	25	5.5	3	25	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	35.5	41.5	66.5	72.5	97.5	108
Y	103.5	100	100	98	98	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	25	3	25	5.5	3	25	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	35.5	41.5	66.5	72.5	97.5	108
Y	103.5	100	100	98	98	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.53							
Flow into Channel	186	1112							1298

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51010	500415_S51010							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	3462	2592							
Sediment Volume (ac. ft)	0.34	0.25							0.59
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.34	0.25							0.59

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1298	cfs	
Long-term Max. Chnl Capacity	2357	cfs	
Q2 Channel	130	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	34.5	44.6	1.3	98.0	99.5	2.9	1.5	34.1	1.3	0.52	0.45
325	91.4	114.0	1.2	98.0	100.6	2.8	2.6	90.5	1.3	0.89	0.45
974	99.0	227.6	2.3	98.0	101.8	4.3	3.8	97.8	2.3	1.30	0.49
1298	101.9	273.6	2.7	98.0	102.3	4.7	4.3	100.5	2.7	1.46	0.51

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	34.5	44.6	1.3	98.0	99.5	2.9	1.5	34.1	1.3	0.52	0.45
325	91.4	114.0	1.2	98.0	100.6	2.8	2.6	90.5	1.3	0.89	0.45
974	99.0	227.6	2.3	98.0	101.8	4.3	3.8	97.8	2.3	1.30	0.49
1298	101.9	273.6	2.7	98.0	102.3	4.7	4.3	100.5	2.7	1.46	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51010	500415_S51010								
130	377	204								582
325	984	516								1499
974	4128	2107								6235
1298	6047	3081								9129

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
130	1.74	1.4785	1.4046	Erosive	Erosive	Erosive	0.3	Stable	5.6	Stable	Stable
325	1.74	1.4666	1.3933	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
974	1.74	1.6560	1.5732	Erosive	Erosive	Erosive	0.4	Stable	9.9	Stable	Stable
1298	1.74	1.7042	1.6190	Erosive	Erosive	Erosive	0.4	Stable	10.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	130	325	974	1298	130	325	974	1298	130	325	974	1298
Bray - Equation #1	31	50	89	104	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	41	66	117	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.6
Parker	78	124	214	248	1.0	1.5	2.4	2.7				
Chang	52	91	178	212	0.1	0.0	-0.3	-0.5				
Kellerhals	21	32	56	65	1.9	2.7	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	34	91	98	101								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	16.2	22.8	34.4	38.4	4	6	9	10	2.9	3.7	4.8	5.2
Average	32	55	89	102	1.9	2.6	3.9	4.3	2.7	3.1	3.7	3.9
Values As Designed	34	91	98	101	1.5	2.6	3.8	4.3	2.9	2.8	4.3	4.7
Difference with Design	-2	-36	-8	2	0.4	0.0	0.1	0.0	-0.3	0.2	-0.6	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	663	381	791	5784	1294	257	107	156	4581	356	1907	1480
325	1617	911	1974	13867	3362	622	265	378	11442	872	4670	3634
974	8439	3369	6065	84997	5125	3778	929	1916	34663	3984	21092	15851
1298	12944	4672	7914	135880	5736	6073	1255	2838	46275	5910	30715	23656

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	1894	1089	2261	16531	3697	733	305	445	13093	1018	5451	4229
325	1849	1041	2257	15854	3843	711	303	432	13081	997	5340	4155
974	3216	1284	2311	32392	1953	1440	354	730	13210	1518	8038	6041
1298	3700	1335	2262	38838	1640	1736	359	811	13227	1689	8779	6761

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	663	320	499	1242	678	138	107	156	943	142	782	515
325	1617	763	1250	2979	1753	337	265	378	2348	345	1907	1267
974	8439	2927	4158	18259	2839	1625	929	1916	7327	1527	9336	5389
1298	12944	4085	5366	29190	3212	2404	1255	2838	9818	1660	13868	7876

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	1894	914	1426	3551	1937	395	305	445	2694	405	2236	1473
325	1849	873	1429	3406	2004	385	303	432	2684	394	2180	1449
974	3216	1116	1585	6958	1082	619	354	730	2792	582	3558	2054
1298	3700	1167	1534	8343	918	687	359	811	2806	474	3964	2251

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
130	0.0006	0.0009	262	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0005	0.0069	0.0004	0.0015	0.0054	0.0033
325	0.0007	0.0010	258	0.78	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0003	0.0008	0.0054	0.0033
974	0.0003	0.0005	350	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0069	0.0002	0.0003	0.0054	0.0032
1298	0.0003	0.0004	378	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0069	0.0001	0.0003	0.0054	0.0032

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	28.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	287	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	287 ft	Depth	3 ft
Width	108 ft	Side slope	3 ft/ft
Total Volume per Basin		1.90	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
130	1.1	-0.5	0.1	24.6	1.5	1.3	2.9	0.0055	0.2	0.0	1.0	1.6
325	1.1	-0.8	0.1	24.6	2.6	1.3	2.8	0.0055	0.3	0.0	1.0	1.7
974	1.1	-1.0	0.3	24.6	3.8	2.3	4.3	0.0055	0.4	0.0	1.0	2.0
1298	1.1	-1.0	0.3	24.6	4.3	2.7	4.7	0.0055	0.5	0.0	1.0	2.1

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	4.3	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.2	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.93	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	0.71	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	6
Channel Width (ft)	108	141
Channel XS Area (sq. ft)	403.2	493.95
Channel Perimeter (ft)	110	142

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	205369	264667
Excavated Area (sq. Yd)	34488	45026

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	479	sq. Yd
Volume	958	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	108	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.1	ft
Structure Height	13.1	ft
Number of Structures	10	
Volume per structure	158	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,850	
Area per structure	36	sq. Yd
Total Area	360	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3065	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,260	
Other Cost	$ -	
Total cost per basin	$ 12,260	
Area per basin	3,449	sq. Yd
Total Area	3,449	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	205,369	cu. Yd	$ 10.00	$ 2,053,690	34,488	sq. Yd	$ 9.00	$ 310,392	34,488	sq. Yd	$ 8.33	$ 287,400
Exc. Chl - LC Enhancement	Excavated	59,298	cu. Yd	$ 10.00	$ 592,980	10,538	sq. Yd	$ 9.00	$ 94,842	10,538	sq. Yd	$ 8.33	$ 87,817
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	958	cu. Yd	$ 75.00	$ 71,850	479	sq. Yd	$ -	$ -	479	sq. Yd	$ 25.00	$ 11,975
Drop Structures	Riprap	10	EA	$ 11,850.00	$ 118,500	360	sq. Yd	$ -	$ -	360	sq. Yd	$ 33.33	$ 12,000
Drop Str. - LC Enhancement	Riprap	10	EA	$ 1,185.00	$ 11,850	36	sq. Yd	$ -	$ -	36	sq. Yd	$ 33.33	$ 1,200
Sedimentation Basins		1	EA	$ 12,260.00	$ 12,260	3,449	sq. Yd	$ -	$ -	3,449	sq. Yd	$ 8.33	$ 28,742
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 310,392	Base Maintenance Cost			$ 340,117
						LC Enhancement Cost			$ 94,842	LC Enhancement Cost			$ 89,017
						Total Landscape Cost			$ 405,234	Total Maintenance Cost			$ 429,133

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,256,300	$ 604,830	$ 2,861,130
Contingency Cost (25% of Construction Cost)	$ 564,075	$ 151,208	$ 715,283
Engineering Design Cost (5% of Construction Cost)	$ 112,815	$ 30,242	$ 143,057
Total Construction Cost	$ 2,933,190	$ 786,279	$ 3,719,469

Land Cost

Channel Length	2874	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	8.8	$100,000	$ 880,000
LC Enhancement Buffer	50	3.3	$100,000	$ 330,000
Channel	108	7.1	$100,000	$ 710,000
Channel LC Enhancement	33	2.2	$100,000	$ 220,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	325	21.4		$ 2,140,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15.9	$100,000	$ 1,590,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	21.4	$100,000	$ 2,140,000

Total Cost

Base Total Cost	$ 5,173,699
Total Landscape Enhancement Cost	$ 1,520,138
Total Cost Including LC Enh.	$ 6,693,836

Open Channel

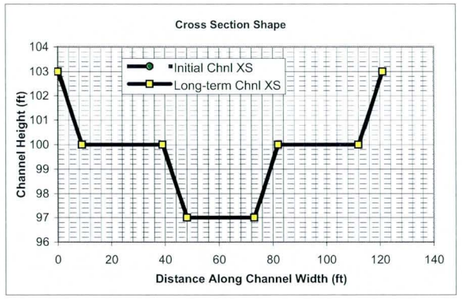
Structure ID	C51060	HEC1 ID	500415

Longitudal Geometry

Length	2541.7	ft
U/S Elev	1468.2	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0055	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

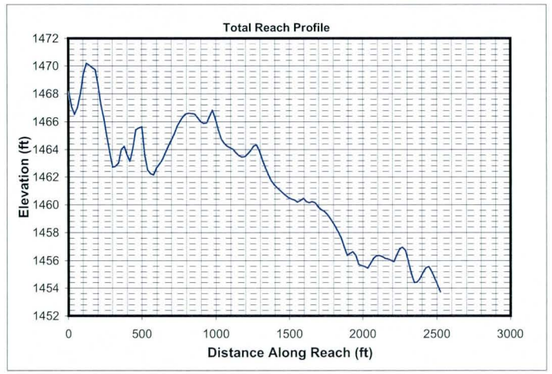
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	73	82	112	121
Y	103	100	100	97	97	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	73	82	112	121
Y	103	100	100	97	97	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.59							
Flow into Channel	186	1238							1424

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51020								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	2251								
Sediment Volume (ac. ft)	0.22								0.22
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.22								0.22

Hydrology

Drainage Area	1.08	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1424	cfs	
Long-term Max. Chnl Capacity	1853	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	121	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	37.0	58.1	1.6	97.0	98.9	2.5	1.9	36.4	1.6	0.35	0.34
356	107.1	154.1	1.4	97.0	100.5	2.3	3.5	106.0	1.5	0.65	0.34
1068	115.9	307.4	2.7	97.0	101.9	3.5	4.9	114.3	2.7	0.92	0.37
1424	119.3	369.5	3.1	97.0	102.4	3.9	5.4	117.6	3.1	1.02	0.38

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	37.0	58.1	1.6	97.0	98.9	2.5	1.9	36.4	1.6	0.35	0.34
356	107.1	154.1	1.4	97.0	100.5	2.3	3.5	106.0	1.5	0.65	0.34
1068	115.9	307.4	2.7	97.0	101.9	3.5	4.9	114.3	2.7	0.92	0.37
1424	119.3	369.5	3.1	97.0	102.4	3.9	5.4	117.6	3.1	1.02	0.38

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
	500415_C51020								
142	515								515
356	1267								1267
1068	5389								5389
1424	7876								7876

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
142	1.74	1.5399	1.4629	Erosive	Erosive	Erosive	0.4	Stable	4.8	Stable	Stable
356	1.74	1.5108	1.4352	Erosive	Erosive	Erosive	0.4	Stable	6.5	Stable	Stable
1068	1.74	1.7004	1.6154	Erosive	Erosive	Erosive	0.4	Stable	8.5	Stable	Stable
1424	1.74	1.7391	1.6521	Erosive	Erosive	Erosive	0.5	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	142	356	1068	1424	142	356	1068	1424	142	356	1068	1424
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	144	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	225	259	1.1	1.6	2.5	2.8				
Chang	44	78	154	184	0.3	0.3	0.1	0.0				
Kellerhals	21	34	59	68	2.0	2.9	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	36	106	114	118								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	18.8	26.5	40.0	44.5	5	7	11	12	2.4	3.0	3.9	4.2
Average	33	57	92	105	2.1	2.8	4.2	4.6	2.6	3.0	3.5	3.7
Values As Designed	36	106	114	118	1.9	3.5	4.9	5.4	2.5	2.3	3.5	3.9
Difference with Design	-3	-49	-22	-13	0.2	-0.7	-0.7	-0.8	0.1	0.7	0.1	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	317	188	310	1263	828	64	44	80	1032	125	680	448
356	737	432	735	2839	2263	141	101	180	2554	292	1566	1076
1068	3849	1778	2701	17418	3620	885	452	1037	7996	1440	8058	4476
1424	5906	2513	3719	27853	4086	1352	631	1567	10719	2178	12070	6599

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	826	489	806	3291	2156	168	114	209	2688	327	1772	1168
356	768	450	766	2959	2359	147	105	187	2662	304	1632	1122
1068	1337	618	938	6051	1258	307	157	360	2778	500	2799	1555
1424	1539	655	969	7257	1065	352	164	408	2793	568	3145	1719

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	317	166	218	511	535	47	44	80	388	53	375	249
356	737	379	519	1148	1447	104	101	180	947	95	858	592
1068	3849	1614	2046	7043	2461	620	452	1037	3140	555	4639	2496
1424	5906	2293	2801	11263	2809	935	631	1567	4239	662	7032	3649

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	826	431	569	1331	1394	123	114	209	1010	139	978	648
356	768	395	541	1197	1508	108	105	187	987	99	894	617
1068	1337	561	711	2447	855	215	157	360	1091	193	1611	867
1424	1539	597	730	2934	732	244	164	408	1104	172	1832	951

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
142	0.0006	0.0008	173	0.53	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0067	0.0004	0.0015	0.0029	0.0026
356	0.0007	0.0008	165	0.50	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0005	0.0067	0.0003	0.0008	0.0030	0.0026
1068	0.0003	0.0005	225	0.68	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0067	0.0002	0.0003	0.0029	0.0025
1424	0.0003	0.0004	243	0.74	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0067	0.0001	0.0003	0.0029	0.0025

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	6.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	847	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.10	sq. mi
Total Sediment Yield Volume	0.19	ac ft

Sedimentation Basins

Length	847 ft	Depth	3 ft
Width	121 ft	Side slope	3 ft/ft
Total Volume per Basin		6.47	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
142	1.1	-0.6	0.1	24.6	1.9	1.6	2.5	0.0030	0.2	0.0	1.0	1.6
356	1.1	-1.2	0.1	24.6	3.5	1.5	2.3	0.0030	0.4	0.0	1.0	1.8
1068	1.1	-1.4	0.2	24.6	4.9	2.7	3.5	0.0030	0.5	0.0	1.0	2.1
1424	1.1	-1.5	0.2	24.6	5.4	3.1	3.9	0.0030	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	5.4	ft
Channel Depth as designed	6.0	ft
Available Freeboard	0.6	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.41	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	0.32	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2542	2542
Side Slope (?H:1V)	3	6
Channel Width (ft)	121	157
Channel XS Area (sq. ft)	438	546
Channel Perimeter (ft)	123	158

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	77236	98114
Excavated Area (sq. Yd)	34176	44344

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2542	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	424	sq. Yd
Volume	847	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2542	2542
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2542	2542
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	121	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	9.8	ft	
Structure Height	12.8	ft	
Number of Structures	3		
Volume per structure	172	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 12,900		
Area per structure	40	sq. Yd	
Total Area	121	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10438	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 41,752	
Other Cost	$ -	
Total cost per basin	$ 41,752	
Area per basin	11,390	sq. Yd
Total Area	11,390	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	77,236	cu. Yd	$ 10.00	$ 772,360	34,176	sq. Yd	$ 9.00	$ 307,584	34,176	sq. Yd	$ 8.33	$ 284,800
Exc. Chl - LC Enhancement	Excavated	20,878	cu. Yd	$ 10.00	$ 208,780	10,168	sq. Yd	$ 9.00	$ 91,512	10,168	sq. Yd	$ 8.33	$ 84,733
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	847	cu. Yd	$ 75.00	$ 63,525	424	sq. Yd	$ -	$ -	424	sq. Yd	$ 25.00	$ 10,600
Drop Structures	Riprap	3	EA	$ 12,900.00	$ 38,700	121	sq. Yd	$ -	$ -	121	sq. Yd	$ 33.33	$ 4,033
Drop Str. - LC Enhancement	Riprap	3	EA	$ 1,290.00	$ 3,870	12	sq. Yd	$ -	$ -	12	sq. Yd	$ 33.33	$ 403
Sedimentation Basins		1	EA	$ 41,752.00	$ 41,752	11,390	sq. Yd	$ -	$ -	11,390	sq. Yd	$ 8.33	$ 94,917
Other					$ -				$ -				$ -
Base Landscape Cost									$ 307,584	Base Maintenance Cost			$ 394,350
LC Enhancement Cost									$ 91,512	LC Enhancement Cost			$ 85,137
Total Landscape Cost									$ 399,096	Total Maintenance Cost			$ 479,487

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 916,337	$ 212,650	$ 1,128,987
Contingency Cost (25% of Construction Cost)	$ 229,084	$ 53,163	$ 282,247
Engineering Design Cost (5% of Construction Cost)	$ 45,817	$ 10,633	$ 56,449
Total Construction Cost	$ 1,191,238	$ 276,445	$ 1,467,683

Land Cost

Channel Length	2542	ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	7.8	$100,000	$ 780,000
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	121	7.1	$100,000	$ 710,000
Channel LC Enhancement	36	2.1	$100,000	$ 210,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	341	19.9		$ 1,990,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	14.9	$100,000	$ 1,490,000
LC Enhancement Cost	acre	5	$100,000	$ 500,000
Total Land Cost	acre	19.9	$100,000	$ 1,990,000

Total Cost

Base Total Cost	$	3,383,172
Total Landscape Enhancement Cost	$	953,094
Total Cost Including LC Enh.	$	4,336,266

Offline Basin

HEC1 ID	D415

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

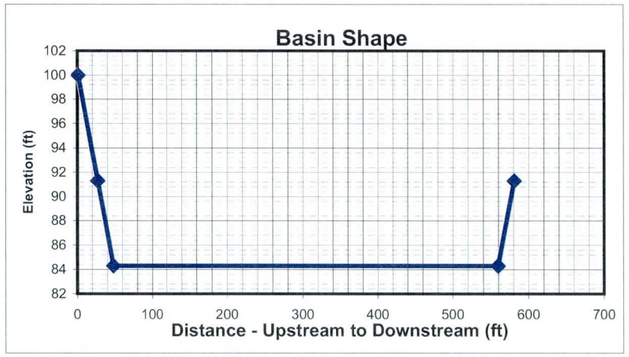
Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	600	680
Basin Width (ft)	580	580
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	7	7
Freeboard (ft)	1	1
Effective Basin Width (ft)	553.9	527.8
Top Area (acres)	8.0	9.1
U/S-D/S Height Difference (ft)	8.7	8.7
Excess Area on Upstream (acres)	0.4	0.8

			Base	LC Enhanced
Bottom Length (ft)	558	Allocated Storage Volume (ac. ft)	42.1	41.8
Bottom Width (ft)	511.9	Total Available Volume (ac. ft) (incl. Freeboard)	49.6	49.9
		Total Excavation Volume (ac. ft)	84.4	89.3



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1581	2578	2578
Peak flow after diversion (cfs)	1231	1231	1231
Diverted Peak Flow (cfs)	350	1347	1347
Total Diverted Flow Volume (ac. ft)	9.0	37	37.0
Peak Stage	1.1	ft	

Volume Check			***Stage Check***	
Total Volume needed	37.0	ac. ft	Depth Needed	2.1
Total Volume Provided	42.1	ac. ft	Depth Provided	7

Volume OK?	Yes	Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)	0										
Inflow (cfs)	0	200	400	600	800	1000	1231	1400	2000	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	169	769	1769	2769

Culvert at Sta. 512+67

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	182400	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	580	ft
LC Enh. Total ROW Length	780	ft
LC Enh. Total ROW Length	680	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	136165	144071
Excavated Area (sq. Yd)	38667	58933

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	50	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	552	sq. Yd
Material Volume	276	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	700	ft
Unit Cost	160	per ft
Cost per outlet	$112,000	
Other Cost	$ -	
Total Cost	$112,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		136,165	cu. Yd	$ 4.00	$ 544,660	38,667	sq. Yd	$ 9.00	$ 348,003	38,667	sq. Yd	$ 8.33	$ 322,225
Basin - LC Enhanced		7,906	cu. Yd	$ 4.00	$ 31,624	20,266	sq. Yd	$ 9.00	$ 182,394	20,266	sq. Yd	$ 8.33	$ 168,883
Inlet	Riprap	276	sq. Yd	$ 75.00	$ 20,700	552	sq. Yd	$ -	$ -	552	sq. Yd	$ 33.33	$ 18,400
Inlet - LC Enhanced (20%Total)					$ 4,140				$ -				$ 3,680
Outlet	Pipe	1	EA	$ 112,000	$ 112,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 5,600				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 348,003	Base Maintenance Cost			$ 342,842
						LC Enh. Landscape Cost			$ 182,394	LC Enh. Maintenance Cost			$ 172,674
						Total Landscape Cost			$ 530,397	Total Maintenance Cost			$ 515,516

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 677,360	$ 31,624	$ 708,984
Contingency Cost (25% of Construction Cost)	$ 169,340	$ 7,906	$ 177,246
Engineering Design Cost (5% of Construction Cost)	$ 33,868	$ 1,581	$ 35,449
Total Construction Cost	$ 880,568	$ 41,111	$ 921,679

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.2	$100,000	$ 418,733
Basin	8.0	$100,000	$ 800,000
Other		$100,000	$ -
Total	12.2	$100,000	$ 1,220,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	8.0	$100,000	$ 798,898
LC Enhancement Cost	acre	4.2	$100,000	$ 421,102
Total Land Cost	acre	12.2	$100,000	$ 1,220,000

Total Cost

Base Total Cost	$ 2,370,311
Total LC Enhancement Cost	$ 817,281
Total Cost Including LC Enh.	$ 3,187,592

Open Channel

Structure ID	RR41510

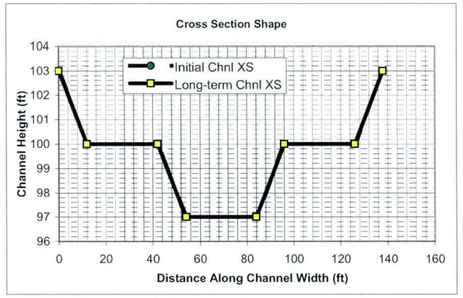
HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

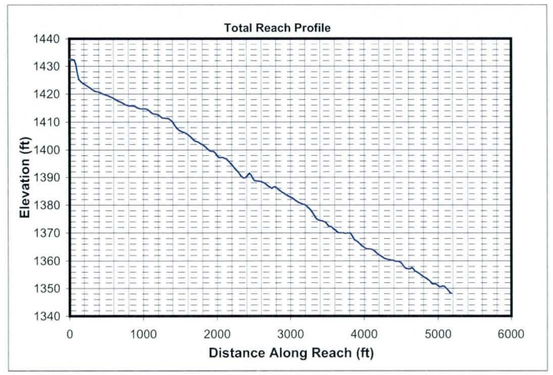
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	30	4	30	6	4	30	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	54	84	96	126	138
Y	103	100	100	97	97	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	30	4	30	6	4	30	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	54	84	96	126	138
Y	103	100	100	97	97	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420								TOTAL
HEC1 Peak-Flow	1231	1740								2971
Weighting Factor	1.00	0.20								
Flow into Channel	1231	348								1579

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.645	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1579	cfs	
Long-term Max. Chnl Capacity	3044	cfs	
Q2 Channel	158	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	138	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	42.2	52.9	1.3	97.0	98.5	3.0	1.5	41.8	1.3	0.55	0.47
395	50.4	98.4	2.0	97.0	99.5	4.0	2.5	49.7	2.0	0.92	0.50
1184	125.0	273.8	2.2	97.0	101.2	4.3	4.2	123.9	2.2	1.59	0.51
1579	128.6	329.1	2.6	97.0	101.7	4.8	4.7	127.5	2.6	1.75	0.53

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
158	42.2	52.9	1.3	97.0	98.5	3.0	1.5	41.8	1.3	0.55	0.47
395	50.4	98.4	2.0	97.0	99.5	4.0	2.5	49.7	2.0	0.92	0.50
1184	125.0	273.8	2.2	97.0	101.2	4.3	4.2	123.9	2.2	1.59	0.51
1579	128.6	329.1	2.6	97.0	101.7	4.8	4.7	127.5	2.6	1.75	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
158										0
395										0
1184										0
1579										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
158	1.74	1.4682	1.3947	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
395	1.74	1.6059	1.5256	Erosive	Erosive	Erosive	0.4	Stable	8.1	Stable	Stable
1184	1.74	1.6398	1.5578	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable
1579	1.74	1.6879	1.6035	Erosive	Erosive	Erosive	0.4	Stable	11.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	158	395	1184	1579	158	395	1184	1579	158	395	1184	1579
Bray - Equation #1	34	56	99	115	1.4	1.9	2.8	3.1	3.2	3.6	4.3	4.4
Bray - Equation #2	45	73	130	152	1.6	2.1	3.1	3.4	2.2	2.5	2.9	3.0
Hey	10	17	32	37	4.4	6.2	9.5	10.6				
Ackers & Charlton/Lacey	30	44	70	79					1.9	2.2	2.6	2.7
Parker	86	136	236	273	1.1	1.7	2.6	2.9				
Chang	61	106	206	245	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	36	62	72	2.1	3.0	4.6	5.2	3.4	3.7	4.1	4.3
AMAFCA/Schumm	42	50	124	128								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.1	24.2	36.5	40.6	5	6	10	11	3.2	4.0	5.2	5.6
Average	37	56	101	116	2.1	2.8	4.1	4.6	2.8	3.2	3.8	4.0
Values As Designed	42	50	124	127	1.5	2.5	4.2	4.7	3.0	4.0	4.3	4.8
Difference with Design	-5	6	-22	-12	0.6	0.3	-0.1	-0.1	-0.2	-0.8	-0.5	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	915	512	1067	7692	1606	361	149	212	6048	475	2514	1959
395	3412	1461	2723	32303	2458	1487	413	775	15228	1608	8442	6392
1184	11409	4421	8047	110450	6503	5143	1264	2535	45733	5227	27213	20722
1579	17518	6135	10522	176600	7277	8259	1707	3753	61052	7757	39615	30927

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	2150	1202	2507	18073	3774	848	349	498	14211	1115	5907	4603
395	3207	1373	2559	30359	2310	1398	388	728	14312	1511	7934	6007
1184	3574	1385	2521	34602	2037	1611	396	794	14327	1638	8525	6492
1579	4116	1442	2472	41494	1710	1940	401	882	14345	1823	9308	7267

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	915	433	679	1736	863	198	149	212	1314	196	1072	706
395	3412	1270	1837	7291	1378	693	413	775	3377	711	3809	2270
1184	11409	3864	5573	24930	3676	2256	1264	2535	10172	2222	12455	7305
1579	17518	5394	7206	39861	4156	3337	1707	3753	13625	2414	18483	10678

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
158	2150	1018	1594	4079	2028	464	349	498	3088	461	2518	1659
395	3207	1193	1727	6853	1295	651	388	728	3174	668	3580	2133
1184	3574	1211	1746	7810	1152	707	396	794	3187	696	3902	2289
1579	4116	1267	1693	9366	977	784	401	882	3201	567	4343	2509

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
158	0.0006	0.0010	265	0.81	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0004	0.0016	0.0059	0.0033
395	0.0004	0.0006	331	1.01	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0064	0.0002	0.0008	0.0059	0.0032
1184	0.0003	0.0005	351	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0064	0.0002	0.0003	0.0059	0.0032
1579	0.0003	0.0005	379	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0064	0.0001	0.0003	0.0059	0.0032

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	52.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	289	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	289 ft	Depth	3 ft
Width	138 ft	Side slope	3 ft/ft
Total Volume per Basin		2.49	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
158	1.1	-0.5	0.1	24.6	1.5	1.3	3.0	0.0060	0.2	0.0	1.0	1.6
395	1.1	-0.7	0.2	24.6	2.5	2.0	4.0	0.0060	0.3	0.0	1.0	1.8
1184	1.1	-1.1	0.3	24.6	4.2	2.2	4.3	0.0060	0.5	0.0	1.0	2.1
1579	1.1	-1.1	0.3	24.6	4.7	2.6	4.8	0.0060	0.5	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1135	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	4.7	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.45	ac. ft
Deposited(+)/Eroded(-) Volume	0.23	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	6
Channel Width (ft)	138	174
Channel XS Area (sq. ft)	504	612
Channel Perimeter (ft)	140	175

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	800287	1004538
Excavated Area (sq. Yd)	79703	100495

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	866	sq. Yd
Volume	1733	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	138	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.9	ft
Structure Height	12.9	ft
Number of Structures	18	
Volume per structure	198	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 14,850	
Area per structure	46	sq. Yd
Total Area	828	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4017	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 16,068	
Other Cost	$ -	
Total cost per basin	$ 16,068	
Area per basin	4,428	sq. Yd
Total Area	4,428	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	800,287	cu. Yd	$ 10.00	$ 8,002,870	79,703	sq. Yd	$ 9.00	$ 717,327	79,703	sq. Yd	$ 8.33	$ 664,192
Exc. Chl - LC Enhancement	Excavated	204,251	cu. Yd	$ 10.00	$ 2,042,510	20,792	sq. Yd	$ 9.00	$ 187,128	20,792	sq. Yd	$ 8.33	$ 173,267
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,733	cu. Yd	$ 75.00	$ 129,975	866	sq. Yd	$ -	$ -	866	sq. Yd	$ 25.00	$ 21,650
Drop Structures	Riprap	18	EA	$ 14,850.00	$ 267,300	828	sq. Yd	$ -	$ -	828	sq. Yd	$ 33.33	$ 27,600
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,485.00	$ 26,730	83	sq. Yd	$ -	$ -	83	sq. Yd	$ 33.33	$ 2,760
Sedimentation Basins		1	EA	$ 16,068.00	$ 16,068	4,428	sq. Yd	$ -	$ -	4,428	sq. Yd	$ 8.33	$ 36,900
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 717,327	Base Maintenance Cost			$ 750,342
						LC Enhancement Cost			$ 187,128	LC Enhancement Cost			$ 176,027
						Total Landscape Cost			$ 904,455	Total Maintenance Cost			$ 926,368

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 8,416,213	$ 2,069,240	$ 10,485,453
Contingency Cost (25% of Construction Cost)	$ 2,104,053	$ 517,310	$ 2,621,363
Engineering Design Cost (5% of Construction Cost)	$ 420,811	$ 103,462	$ 524,273
Total Construction Cost	$ 10,941,077	$ 2,690,012	$ 13,631,089

Land Cost

Channel Length	5198 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	16	$100,000	$ 1,600,000
LC Enhancement Buffer	50	6	$100,000	$ 600,000
Channel	138	16.5	$100,000	$ 1,650,000
Channel LC Enhancement	36	4.3	$100,000	$ 430,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	358	42.8		$ 4,280,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	32.5	$100,000	$ 3,250,000
LC Enhancement Cost	acre	10.3	$100,000	$ 1,030,000
Total Land Cost	acre	42.8	$100,000	$ 4,280,000

Total Cost

Base Total Cost	$ 15,658,746
Total Landscape Enhancement Cost	$ 4,083,167
Total Cost Including LC Enh.	$ 19,741,912

Open Channel

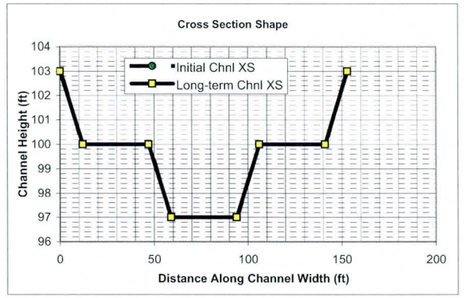
Structure ID	C42010	HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

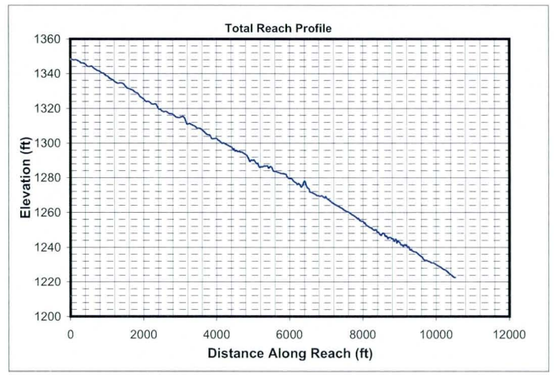
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	35	4	35	6	4	35	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	59	94	106	141	153
Y	103	100	100	97	97	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	35	4	35	6	4	35	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	59	94	106	141	153
Y	103	100	100	97	97	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	1231	1740							2971
Weighting Factor	1.00	0.43							
Flow into Channel	1231	755							1986

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	473.00								473
Sediment Conc. (ppm)	2509								
Sediment Volume (ac. ft)	0.45								0.45
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.45								0.45

Hydrology

Drainage Area	3.057	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1986	cfs	
Long-term Max. Chnl Capacity	3131	cfs	
Q2 Channel	199	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	153	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	48.5	67.8	1.4	97.0	98.6	2.9	1.6	48.1	1.4	0.51	0.43
497	57.6	125.9	2.2	97.0	99.7	3.9	2.7	56.9	2.2	0.85	0.47
1490	142.5	349.7	2.5	97.0	101.5	4.3	4.5	141.3	2.5	1.42	0.48
1986	146.5	420.2	2.9	97.0	102.0	4.7	5.0	145.3	2.9	1.57	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	48.5	67.8	1.4	97.0	98.6	2.9	1.6	48.1	1.4	0.51	0.43
497	57.6	125.9	2.2	97.0	99.7	3.9	2.7	56.9	2.2	0.85	0.47
1490	142.5	349.7	2.5	97.0	101.5	4.3	4.5	141.3	2.5	1.42	0.48
1986	146.5	420.2	2.9	97.0	102.0	4.7	5.0	145.3	2.9	1.57	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
199	706									706
497	2270									2270
1490	7305									7305
1986	10678									10678

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
199	1.74	1.5016	1.4265	Erosive	Erosive	Erosive	0.4	Stable	5.7	Stable	Stable
497	1.74	1.6402	1.5582	Erosive	Erosive	Erosive	0.4	Stable	7.9	Stable	Stable
1490	1.74	1.6747	1.5910	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable
1986	1.74	1.7229	1.6368	Erosive	Erosive	Erosive	0.4	Stable	11.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	199	497	1490	1986	199	497	1490	1986	199	497	1490	1986
Bray - Equation #1	39	63	112	130	1.5	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	147	171	1.7	2.3	3.3	3.6	2.3	2.6	3.0	3.1
Hey	12	20	36	42	4.8	6.8	10.4	11.5				
Ackers & Charlton/Lacey	33	49	77	87					1.9	2.3	2.7	2.8
Parker	97	153	265	306	1.2	1.8	2.9	3.2				
Chang	65	115	223	266	0.1	0.0	-0.5	-0.7				
Kellerhals	25	40	69	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	48	57	142	145								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	19.3	27.2	41.1	45.8	5	7	11	12	3.1	3.9	5.2	5.6
Average	41	62	113	129	2.3	3.1	4.5	5.0	2.8	3.3	3.9	4.1
Values As Designed	48	57	141	145	1.6	2.7	4.5	5.0	2.9	3.9	4.3	4.7
Difference with Design	-7	6	-28	-16	0.6	0.3	0.0	0.0	-0.1	-0.7	-0.3	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	939	524	1012	6367	1649	315	147	225	4808	454	2408	1713
497	3513	1515	2689	26834	2529	1181	415	831	12137	1566	8246	5587
1490	11770	4611	7919	91953	6684	4185	1276	2725	36466	5114	26727	18130
1986	18078	6413	10304	147079	7487	6743	1728	4041	48702	7628	39129	27030

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1755	978	1890	11893	3080	588	274	420	8981	848	4499	3201
497	2625	1132	2009	20051	1890	882	310	621	9069	1170	6162	4175
1490	2932	1148	1972	22903	1665	1042	318	679	9083	1274	6657	4516
1986	3377	1198	1925	27476	1399	1260	323	755	9098	1425	7310	5049

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	939	451	686	1721	943	188	147	225	1247	196	1112	714
497	3513	1335	1839	7254	1507	670	415	831	3218	716	4003	2300
1490	11770	4086	5693	24858	4017	2189	1276	2725	9702	1887	13140	7395
1986	18078	5715	7427	39761	4545	3243	1728	4041	13006	2049	19565	10833

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1755	842	1282	3215	1761	352	274	420	2329	366	2077	1334
497	2625	998	1374	5421	1126	501	310	621	2405	535	2991	1719
1490	2932	1018	1418	6192	1001	545	318	679	2417	470	3273	1842
1986	3377	1068	1387	7428	849	606	323	755	2430	383	3655	2024

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
199	0.0006	0.0009	241	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0003	0.0014	0.0050	0.0029
497	0.0003	0.0005	301	0.92	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0060	0.0002	0.0007	0.0049	0.0029
1490	0.0003	0.0005	319	0.97	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0050	0.0028
1986	0.0002	0.0004	345	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0050	0.0028

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	73.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	25	
Distance between structs.	421	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	421 ft	Depth	3 ft	
Width	153 ft	Side slope	3 ft/ft	
Total Volume per Basin		4.09	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
199	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	0.0	1.0	1.6
497	1.1	-0.7	0.2	24.6	2.7	2.2	3.9	0.0050	0.3	0.0	1.0	1.8
1490	1.1	-1.2	0.2	24.6	4.5	2.5	4.3	0.0050	0.5	0.0	1.0	2.1
1986	1.1	-1.2	0.3	24.6	5.0	2.9	4.7	0.0050	0.6	0.0	1.0	2.3

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1135	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.0	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	1.23	ac. ft
Outflowing Sediment Volume	0.36	ac. ft
Deposited(+)/Eroded(-) Volume	0.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	6
Channel Width (ft)	153	189
Channel XS Area (sq. ft)	564	672
Channel Perimeter (ft)	155	190

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2408439	2965491
Excavated Area (sq. Yd)	179095	221235

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	1756	sq. Yd
Volume	3512	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	153	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.5	ft
Structure Height	13.5	ft
Number of Structures	25	
Volume per structure	229	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 17,175	
Area per structure	51	sq. Yd
Total Area	1,275	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6599	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,396	
Other Cost	$ -	
Total cost per basin	$ 26,396	
Area per basin	7,164	sq. Yd
Total Area	7,164	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,408,439	cu. Yd	$ 10.00	$ 24,084,390	179,095	sq. Yd	$ 9.00	$ 1,611,855	179,095	sq. Yd	$ 8.33	$ 1,492,458
Exc. Chl - LC Enhancement	Excavated	557,052	cu. Yd	$ 10.00	$ 5,570,520	42,140	sq. Yd	$ 9.00	$ 379,260	42,140	sq. Yd	$ 8.33	$ 351,167
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,512	cu. Yd	$ 75.00	$ 263,400	1,756	sq. Yd	$ -	$ -	1,756	sq. Yd	$ 25.00	$ 43,900
Drop Structures	Riprap	25	EA	$ 17,175.00	$ 429,375	1,275	sq. Yd	$ -	$ -	1,275	sq. Yd	$ 33.33	$ 42,500
Drop Str. - LC Enhancement	Riprap	25	EA	$ 1,717.50	$ 42,938	128	sq. Yd	$ -	$ -	128	sq. Yd	$ 33.33	$ 4,250
Sedimentation Basins		1	EA	$ 26,396.00	$ 26,396	7,164	sq. Yd	$ -	$ -	7,164	sq. Yd	$ 8.33	$ 59,700
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,611,855	Base Maintenance Cost			$ 1,638,558
						LC Enhancement Cost			$ 379,260	LC Enhancement Cost			$ 355,417
						Total Landscape Cost			$ 1,991,115	Total Maintenance Cost			$ 1,993,975

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 24,803,561	$ 5,613,458	$ 30,417,019
Contingency Cost (25% of Construction Cost)	$ 6,200,890	$ 1,403,364	$ 7,604,255
Engineering Design Cost (5% of Construction Cost)	$ 1,240,178	$ 280,673	$ 1,520,851
Total Construction Cost	$ 32,244,629	$ 7,297,495	$ 39,542,124

Land Cost

Channel Length	10535	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	32.4	$100,000	$ 3,240,000
LC Enhancement Buffer	50	12.1	$100,000	$ 1,210,000
Channel	153	37	$100,000	$ 3,700,000
Channel LC Enhancement	36	8.7	$100,000	$ 870,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	373	90.2		$ 9,020,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	69.4	$100,000	$ 6,940,000
LC Enhancement Cost	acre	20.8	$100,000	$ 2,080,000
Total Land Cost	acre	90.2	$100,000	$ 9,020,000

Total Cost

Base Total Cost	$ 42,435,043
Total Landscape Enhancement Cost	$ 10,112,171
Total Cost Including LC Enh.	$ 52,547,214

Open Channel

Structure ID	C42020

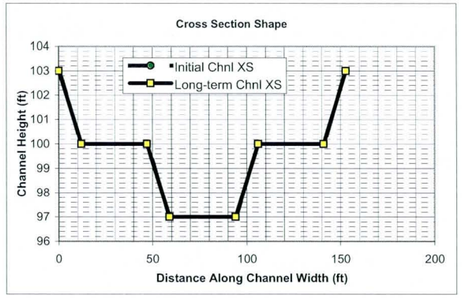
HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

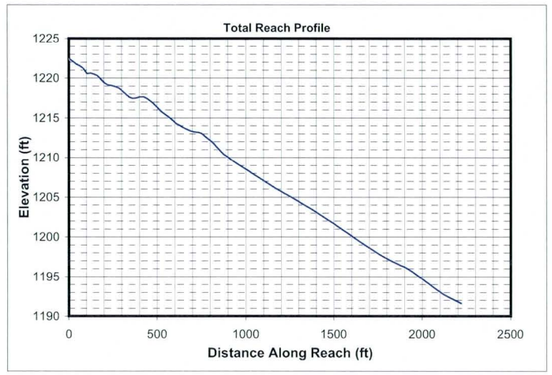
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	35	4	35	6	4	35	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	59	94	106	141	153
Y	103	100	100	97	97	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3	35	4	35	6	4	35	3	4

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	59	94	106	141	153
Y	103	100	100	97	97	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1734									1734
Weighting Factor	1.00									
Flow into Channel	1734									1734

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	473.00									473
Sediment Conc. (ppm)	2024									
Sediment Volume (ac. ft)	0.36									0.36
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.36									0.36

Hydrology

Drainage Area	4.058	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1734	cfs	
Long-term Max. Chnl Capacity	3131	cfs	
Q2 Channel	173	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	153	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
173	47.5	62.0	1.3	97.0	98.5	2.8	1.5	47.1	1.3	0.47	0.43
434	55.9	114.7	2.1	97.0	99.5	3.8	2.5	55.3	2.1	0.79	0.46
1301	140.8	320.8	2.3	97.0	101.3	4.1	4.3	139.7	2.3	1.35	0.47
1734	144.5	385.2	2.7	97.0	101.8	4.5	4.8	143.3	2.7	1.50	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
173	47.5	62.0	1.3	97.0	98.5	2.8	1.5	47.1	1.3	0.47	0.43
434	55.9	114.7	2.1	97.0	99.5	3.8	2.5	55.3	2.1	0.79	0.46
1301	140.8	320.8	2.3	97.0	101.3	4.1	4.3	139.7	2.3	1.35	0.47
1734	144.5	385.2	2.7	97.0	101.8	4.5	4.8	143.3	2.7	1.50	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
173	714									714
434	2300									2300
1301	7395									7395
1734	10833									10833

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
173	1.74	1.4802	1.4062	Erosive	Erosive	Erosive	0.3	Stable	5.4	Stable	Stable
434	1.74	1.6203	1.5393	Erosive	Erosive	Erosive	0.4	Stable	7.5	Stable	Stable
1301	1.74	1.6518	1.5692	Erosive	Erosive	Erosive	0.4	Stable	10.0	Stable	Stable
1734	1.74	1.7003	1.6153	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	173	434	1301	1734	173	434	1301	1734	173	434	1301	1734
Bray - Equation #1	36	58	104	121	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	47	77	137	159	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	34	39	4.6	6.5	9.8	11.0				
Ackers & Charlton/Lacey	31	46	73	83					1.9	2.2	2.6	2.8
Parker	90	143	248	286	1.2	1.7	2.7	3.1				
Chang	60	106	206	245	0.1	0.0	-0.4	-0.6				
Kellerhals	24	37	65	75	2.1	3.1	4.8	5.4	3.4	3.7	4.2	4.3
AMAFCA/Schumm	47	55	140	144								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	18.4	25.9	39.1	43.5	5	7	10	12	3.0	3.8	5.0	5.4
Average	39	59	107	122	2.2	3.0	4.3	4.8	2.8	3.2	3.8	4.0
Values As Designed	47	55	140	143	1.5	2.5	4.3	4.8	2.8	3.8	4.1	4.5
Difference with Design	-8	3	-33	-22	0.6	0.4	0.0	0.0	0.0	-0.6	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
173	770	456	935	6423	1694	282	124	183	5265	417	2254	1709
434	2896	1327	2514	27221	2578	1087	359	690	13281	1428	7749	5557
1301	9606	4020	7410	92186	6887	3958	1103	2254	39893	4618	24941	17898
1734	14770	5601	9624	147633	7701	6408	1499	3360	53272	6870	36526	26660

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
173	1648	976	2001	13741	3624	602	265	391	11264	893	4823	3657
434	2478	1136	2151	23296	2206	930	307	591	11366	1222	6632	4756
1301	2740	1147	2114	26298	1965	1129	315	643	11380	1317	7115	5106
1734	3160	1198	2059	31587	1648	1371	321	719	11398	1470	7815	5704

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
173	770	381	596	1386	879	154	124	183	1080	162	912	602
434	2896	1142	1584	5876	1406	559	359	690	2801	592	3329	1930
1301	9606	3480	4883	19901	3789	1815	1103	2254	8445	1815	10862	6178
1734	14770	4882	6583	31870	4288	2696	1499	3360	11329	1971	16230	9043

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
173	1648	815	1276	2966	1881	330	265	391	2311	346	1951	1289
434	2478	977	1356	5029	1203	478	307	591	2397	507	2849	1652
1301	2740	993	1393	5677	1081	518	315	643	2409	518	3099	1762
1734	3160	1045	1408	6819	917	577	321	719	2424	422	3473	1935

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
173	0.0007	0.0009	251	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0063	0.0004	0.0016	0.0050	0.0030
434	0.0004	0.0006	314	0.96	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0002	0.0008	0.0049	0.0029
1301	0.0003	0.0005	331	1.01	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0001	0.0004	0.0050	0.0029
1734	0.0003	0.0005	358	1.09	0.056	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0063	0.0001	0.0003	0.0050	0.0029

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	19.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	153 ft	Side slope	3 ft/ft
Total Volume per Basin		3.08	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
173	1.1	-0.5	0.1	24.6	1.5	1.3	2.8	0.0050	0.2	0.0	1.0	1.6
434	1.1	-0.7	0.2	24.6	2.5	2.1	3.8	0.0050	0.3	0.0	1.0	1.8
1301	1.1	-1.1	0.2	24.6	4.3	2.3	4.1	0.0050	0.5	0.0	1.0	2.1
1734	1.1	-1.2	0.3	24.6	4.8	2.7	4.5	0.0050	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1135	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	4.8	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	2.26	ac. ft
Outflowing Sediment Volume	0.35	ac. ft
Deposited(+)/Eroded(-) Volume	1.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	6
Channel Width (ft)	153	189
Channel XS Area (sq. ft)	564	672
Channel Perimeter (ft)	155	190

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	172969	211619
Excavated Area (sq. Yd)	38046	46998

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	373	sq. Yd
Volume	746	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	153	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.8	ft
Structure Height	12.8	ft
Number of Structures	7	
Volume per structure	217	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,275	
Area per structure	51	sq. Yd
Total Area	357	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	4969	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 19,876	
Other Cost	$ -	
Total cost per basin	$ 19,876	
Area per basin	5,435	sq. Yd
Total Area	16,305	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	172,969	cu. Yd	$ 10.00	$ 1,729,690	38,046	sq. Yd	$ 9.00	$ 342,414	38,046	sq. Yd	$ 8.33	$ 317,050
Exc. Chl - LC Enhancement	Excavated	38,650	cu. Yd	$ 10.00	$ 386,500	8,952	sq. Yd	$ 9.00	$ 80,568	8,952	sq. Yd	$ 8.33	$ 74,600
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	746	cu. Yd	$ 75.00	$ 55,950	373	sq. Yd	$ -	$ -	373	sq. Yd	$ 25.00	$ 9,325
Drop Structures	Riprap	7	EA	$ 16,275.00	$ 113,925	357	sq. Yd	$ -	$ -	357	sq. Yd	$ 33.33	$ 11,900
Drop Str. - LC Enhancement	Riprap	7	EA	$ 1,627.50	$ 11,393	36	sq. Yd	$ -	$ -	36	sq. Yd	$ 33.33	$ 1,190
Sedimentation Basins		3	EA	$ 19,876.00	$ 59,628	16,305	sq. Yd	$ -	$ -	16,305	sq. Yd	$ 8.33	$ 135,875
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 342,414	Base Maintenance Cost			$ 474,150
						LC Enhancement Cost			$ 80,568	LC Enhancement Cost			$ 75,790
						Total Landscape Cost			$ 422,982	Total Maintenance Cost			$ 549,940

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,959,193	$ 397,893	$ 2,357,086
Contingency Cost (25% of Construction Cost)	$ 489,798	$ 99,473	$ 589,271
Engineering Design Cost (5% of Construction Cost)	$ 97,960	$ 19,895	$ 117,854
Total Construction Cost	$ 2,546,951	$ 517,260	$ 3,064,211

Land Cost

Channel Length	2238 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	6.9	$100,000	$ 690,000
LC Enhancement Buffer	50	2.6	$100,000	$ 260,000
Channel	153	7.9	$100,000	$ 790,000
Channel LC Enhancement	36	1.8	$100,000	$ 180,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	373	19.2		$ 1,920,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	14.8	$100,000	$ 1,480,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	19.2	$100,000	$ 1,920,000

Total Cost

Base Total Cost	$ 4,843,515
Total Landscape Enhancement Cost	$ 1,113,618
Total Cost Including LC Enh.	$ 5,957,133

Open Channel

Structure ID	S51010

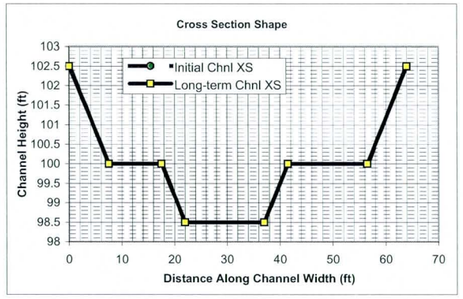
HEC1 ID	S51010

Longitudal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

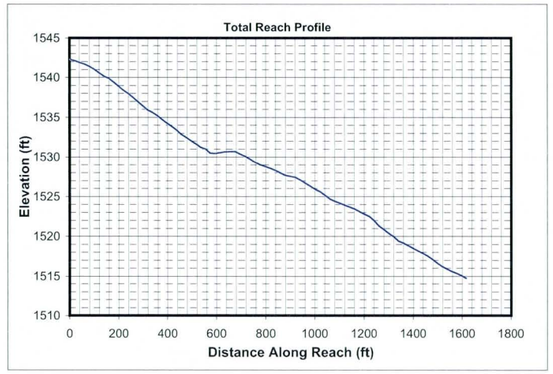
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	10	3	15	4	3	15	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	17.5	22	37	41.5	56.5	64
Y	102.5	100	100	98.5	98.5	100	100	102.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	10	3	15	4	3	15	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	17.5	22	37	41.5	56.5	64
Y	102.5	100	100	98.5	98.5	100	100	102.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510									TOTAL
HEC1 Peak-Flow	2099									2099
Weighting Factor	0.21									
Flow into Channel	441									441

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	896	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	64	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	21.3	17.9	0.8	98.5	99.5	2.5	1.0	21.0	0.9	0.43	0.47
110	51.4	44.1	0.9	98.5	100.3	2.5	1.8	50.8	0.9	0.78	0.47
331	56.7	88.6	1.6	98.5	101.1	3.7	2.6	55.8	1.6	1.15	0.52
441	58.7	106.8	1.8	98.5	101.5	4.1	3.0	57.7	1.9	1.29	0.54

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	21.3	17.9	0.8	98.5	99.5	2.5	1.0	21.0	0.9	0.43	0.47
110	51.4	44.1	0.9	98.5	100.3	2.5	1.8	50.8	0.9	0.78	0.47
331	56.7	88.6	1.6	98.5	101.1	3.7	2.6	55.8	1.6	1.15	0.52
441	58.7	106.8	1.8	98.5	101.5	4.1	3.0	57.7	1.9	1.29	0.54

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
44									0
110									0
331									0
441									0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.3463	1.2790	Erosive	Erosive	Erosive	0.3	Stable	4.8	Stable	Stable
110	1.74	1.3517	1.2841	Erosive	Erosive	Erosive	0.3	Stable	6.5	Stable	Stable
331	1.74	1.5381	1.4611	Erosive	Erosive	Erosive	0.4	Stable	8.7	Stable	Stable
441	1.74	1.5852	1.5059	Erosive	Erosive	Erosive	0.4	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	44	110	331	441	44	110	331	441	44	110	331	441
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	29	51	100	119	0.1	0.1	-0.1	-0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	21	51	56	58								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	10.3	14.5	22.0	24.5	3	4	6	7	2.4	3.1	4.0	4.3
Average	19	32	52	59	1.3	1.8	2.6	2.8	2.3	2.7	3.2	3.3
Values As Designed	21	51	56	58	1.0	1.8	2.6	3.0	2.5	2.5	3.7	4.1
Difference with Design	-2	-19	-4	2	0.3	0.0	-0.1	-0.1	-0.2	0.1	-0.6	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	227	144	326	1582	659	86	43	48	1817	119	584	512
110	581	350	819	4046	1613	221	111	124	4546	302	1492	1291
331	3000	1325	2658	24500	2515	1180	408	672	13829	1362	6931	5307
441	4586	1844	3442	39009	2832	1961	555	1004	18471	2017	10140	7805

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1908	1211	2742	13308	5545	722	365	405	15286	1000	4911	4309
110	1955	1177	2757	13616	5429	744	373	417	15297	1015	5020	4345
331	3365	1486	2982	27482	2821	1324	457	754	15511	1528	7774	5953
441	3858	1551	2896	32817	2382	1650	467	845	15539	1697	8530	6567

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	227	122	210	414	365	52	43	48	451	52	263	204
110	581	296	534	1060	895	133	111	124	1131	133	675	516
331	3000	1164	1807	6420	1483	659	408	672	3557	644	3365	2107
441	4586	1630	2480	10221	1688	977	555	1004	4772	975	5008	3081

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1908	1023	1765	3487	3067	435	365	405	3796	439	2216	1719
110	1955	997	1797	3568	3010	447	373	417	3806	446	2271	1735
331	3365	1305	2027	7201	1663	740	457	754	3990	722	3775	2363
441	3858	1371	2086	8599	1420	822	467	845	4014	820	4213	2592

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0010	0.0014	223	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0099	0.0007	0.0023	0.0069	0.0045
110	0.0010	0.0014	225	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0099	0.0004	0.0012	0.0069	0.0045
331	0.0005	0.0008	304	0.93	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0099	0.0003	0.0005	0.0069	0.0043
441	0.0004	0.0007	328	1.00	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0099	0.0002	0.0004	0.0069	0.0043

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	16.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	272	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	272 ft	Depth	3 ft
Width	64 ft	Side slope	3 ft/ft
Total Volume per Basin		1.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	-0.3	0.1	24.6	1.0	0.9	2.5	0.0070	0.1	0.0	1.0	1.5
110	1.1	-0.6	0.1	24.6	1.8	0.9	2.5	0.0070	0.2	0.0	1.0	1.6
331	1.1	-0.7	0.2	24.6	2.6	1.6	3.7	0.0070	0.3	0.0	1.0	1.8
441	1.1	-0.8	0.2	24.6	3.0	1.9	4.1	0.0070	0.3	0.0	1.0	1.9

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	2063	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	0.50	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	6
Channel Width (ft)	64	88
Channel XS Area (sq. ft)	170.5	218.5
Channel Perimeter (ft)	65	88

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	42263	57147
Excavated Area (sq. Yd)	11620	15977

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	272	sq. Yd
Volume	454	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1634	1634
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	64	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.5	ft
Structure Height	10.5	ft
Number of Structures	6	
Volume per structure	75	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 5,625	
Area per structure	21	sq. Yd
Total Area	128	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	1613	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,452	
Other Cost	$ -	
Total cost per basin	$ 6,452	
Area per basin	1,936	sq. Yd
Total Area	5,808	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	42,263	cu. Yd	$ 10.00	$ 422,630	11,620	sq. Yd	$ 9.00	$ 104,580	11,620	sq. Yd	$ 8.33	$ 96,833
Exc. Chl - LC Enhancement	Excavated	14,884	cu. Yd	$ 10.00	$ 148,840	4,357	sq. Yd	$ 9.00	$ 39,213	4,357	sq. Yd	$ 8.33	$ 36,308
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	454	cu. Yd	$ 75.00	$ 34,050	272	sq. Yd	$ -	$ -	272	sq. Yd	$ 25.00	$ 6,800
Drop Structures	Riprap	6	EA	$ 5,625.00	$ 33,750	128	sq. Yd	$ -	$ -	128	sq. Yd	$ 33.33	$ 4,267
Drop Str. - LC Enhancement	Riprap	6	EA	$ 562.50	$ 3,375	13	sq. Yd	$ -	$ -	13	sq. Yd	$ 33.33	$ 427
Sedimentation Basins		3	EA	$ 6,452.00	$ 19,356	5,808	sq. Yd	$ -	$ -	5,808	sq. Yd	$ 8.33	$ 48,400
Other					$ -				$ -				$ -
Base Landscape Cost									$ 104,580	Base Maintenance Cost			$ 156,300
LC Enhancement Cost									$ 39,213	LC Enhancement Cost			$ 36,735
Total Landscape Cost									$ 143,793	Total Maintenance Cost			$ 193,035

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 509,786	$ 152,215	$ 662,001
Contingency Cost (25% of Construction Cost)	$ 127,447	$ 38,054	$ 165,500
Engineering Design Cost (5% of Construction Cost)	$ 25,489	$ 7,611	$ 33,100
Total Construction Cost	$ 662,722	$ 197,880	$ 860,601

Land Cost

Channel Length	1634 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	5	$100,000	$ 500,000
LC Enhancement Buffer	50	1.9	$100,000	$ 190,000
Channel	64	2.4	$100,000	$ 240,000
Channel LC Enhancement	24	0.9	$100,000	$ 90,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	272	10.2		$ 1,020,000

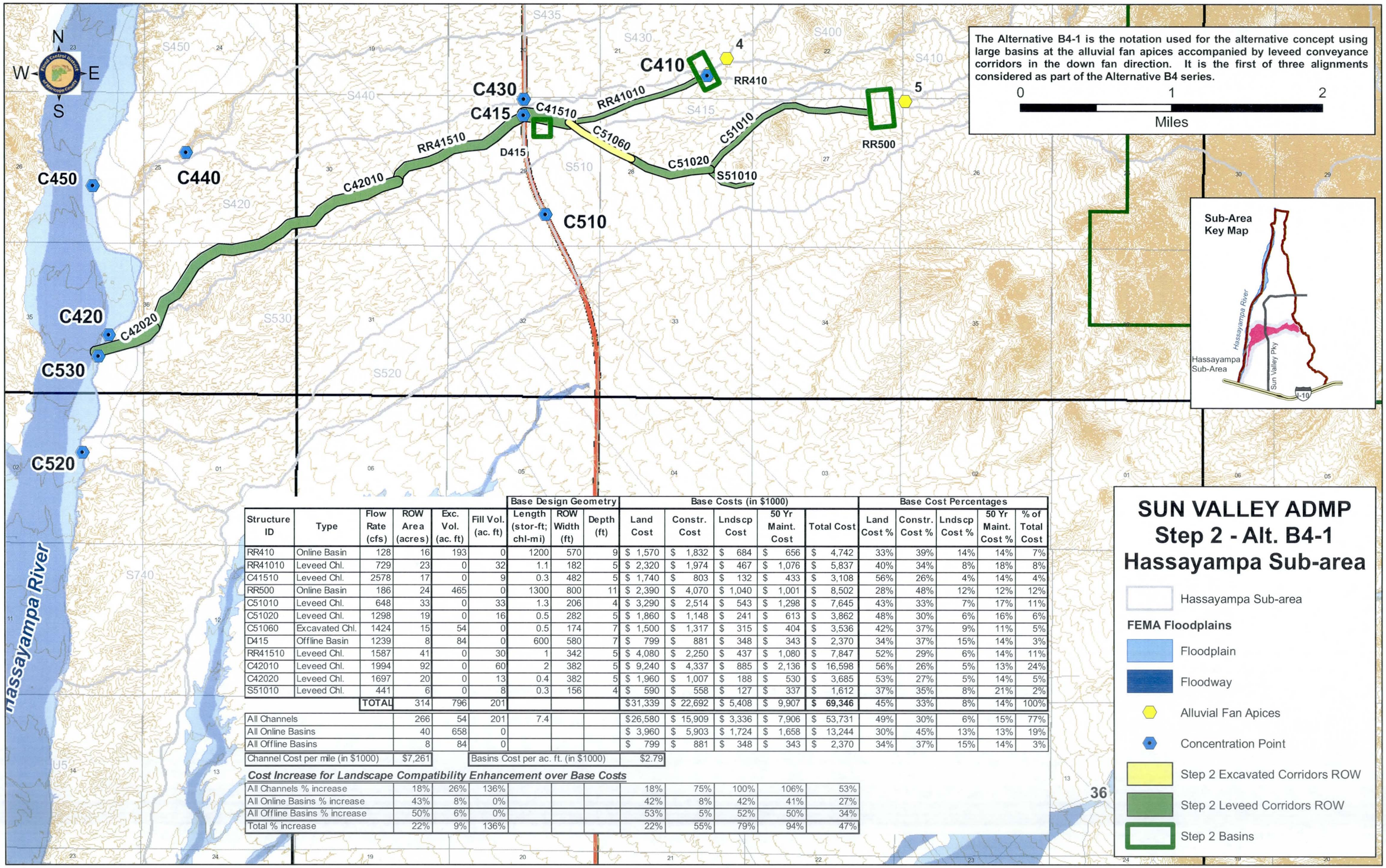
Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.4	$100,000	$ 740,000
LC Enhancement Cost	acre	2.8	$100,000	$ 280,000
Total Land Cost	acre	10.2	$100,000	$ 1,020,000

Total Cost

Base Total Cost	$ 1,663,602
Total Landscape Enhancement Cost	$ 553,828
Total Cost Including LC Enh.	$ 2,217,429



						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	128	16	193	0	1200	570	9	$ 1,570	$ 1,832	$ 684	$ 656	$ 4,742	33%	39%	14%	14%	7%
RR41010	Leveed Chl.	729	23	0	32	1.1	182	5	$ 2,320	$ 1,974	$ 467	$ 1,076	$ 5,837	40%	34%	8%	18%	8%
C41510	Leveed Chl.	2578	17	0	9	0.3	482	5	$ 1,740	$ 803	$ 132	$ 433	$ 3,108	56%	26%	4%	14%	4%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	12%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,514	$ 543	$ 1,298	$ 7,645	43%	33%	7%	17%	11%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,148	$ 241	$ 613	$ 3,862	48%	30%	6%	16%	6%
C51060	Excavated Chl.	1424	15	54	0	0.5	174	7	$ 1,500	$ 1,317	$ 315	$ 404	$ 3,536	42%	37%	9%	11%	5%
D415	Offline Basin	1239	8	84	0	600	580	7	$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	3%
RR41510	Leveed Chl.	1587	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	11%
C42010	Leveed Chl.	1994	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	24%
C42020	Leveed Chl.	1697	20	0	13	0.4	382	5	$ 1,960	$ 1,007	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 558	$ 127	$ 337	$ 1,612	37%	35%	8%	21%	2%
	TOTAL	314	796	201					$31,339	$ 22,692	$ 5,408	$ 9,907	**$ 69,346**	45%	33%	8%	14%	100%
All Channels		266	54	201	7.4				$26,580	$ 15,909	$ 3,336	$ 7,906	$ 53,731	49%	30%	6%	15%	77%
All Online Basins		40	658	0					$ 3,960	$ 5,903	$ 1,724	$ 1,658	$ 13,244	30%	45%	13%	13%	19%
All Offline Basins		8	84	0					$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	3%
Channel Cost per mile (in $1000)		$7,261		Basins Cost per ac. ft. (in $1000)				$2.79										

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	18%	26%	136%				18%	75%	100%	106%	53%	
All Online Basins % increase	43%	8%	0%				42%	8%	42%	41%	27%	
All Offline Basins % increase	50%	6%	0%				53%	5%	52%	50%	34%	
Total % increase	22%	9%	136%				22%	55%	79%	94%	47%	

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR410	Online Basin	128	16	193	0	1200	570	9	$ 1,570	$ 1,832	$ 684	$ 656	$ 4,742	33%	39%	14%	14%	7%
RR41010	Leveed Chl.	729	23	0	32	1.1	182	5	$ 2,320	$ 1,974	$ 467	$ 1,076	$ 5,837	40%	34%	8%	18%	8%
C41510	Leveed Chl.	2578	17	0	9	0.3	482	5	$ 1,740	$ 803	$ 132	$ 433	$ 3,108	56%	26%	4%	14%	4%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	12%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,514	$ 543	$ 1,298	$ 7,645	43%	33%	7%	17%	11%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,148	$ 241	$ 613	$ 3,862	48%	30%	6%	16%	6%
C51060	Excavated Chl.	1424	15	54	0	0.5	174	7	$ 1,500	$ 1,317	$ 315	$ 404	$ 3,536	42%	37%	9%	11%	5%
D415	Offline Basin	1239	8	84	0	600	580	7	$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	3%
RR41510	Leveed Chl.	1587	41	0	30	1	342	5	$ 4,080	$ 2,250	$ 437	$ 1,080	$ 7,847	52%	29%	6%	14%	11%
C42010	Leveed Chl.	1994	92	0	60	2	382	5	$ 9,240	$ 4,337	$ 885	$ 2,136	$ 16,598	56%	26%	5%	13%	24%
C42020	Leveed Chl.	1697	20	0	13	0.4	382	5	$ 1,960	$ 1,007	$ 188	$ 530	$ 3,685	53%	27%	5%	14%	5%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 558	$ 127	$ 337	$ 1,612	37%	35%	8%	21%	2%
	TOTAL	314	796	201					$ 31,339	$ 22,692	$ 5,408	$ 9,907	**$ 69,346**	45%	33%	8%	14%	100%
All Channels		266	54	201	7.4				$ 26,580	$ 15,909	$ 3,336	$ 7,906	$ 53,731	49%	30%	6%	15%	77%
All Online Basins		40	658	0					$ 3,960	$ 5,903	$ 1,724	$ 1,658	$ 13,244	30%	45%	13%	13%	19%
All Offline Basins		8	84	0					$ 799	$ 881	$ 348	$ 343	$ 2,370	34%	37%	15%	14%	3%
Channel Cost per mile (in $1000)		$7,261		Basins Cost per ac. ft. (in $1000)					$2.79									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RR410	Online Basin	128	23	203	0	1470	670	9	$ 2,260	$ 1,923	$ 985	$ 939	$ 6,107	37%	31%	16%	15%	6%
RR41010	Leveed Chl.	729	30	0	75	1.1	233	5	$ 2,970	$ 3,771	$ 968	$ 2,375	$ 10,083	29%	37%	10%	24%	10%
C41510	Leveed Chl.	2578	19	0	21	0.3	533	5	$ 1,920	$ 1,326	$ 273	$ 801	$ 4,319	44%	31%	6%	19%	4%
RR500	Online Basin	186	34	509	0	1630	900	11	$ 3,370	$ 4,434	$ 1,467	$ 1,404	$ 10,675	32%	42%	14%	13%	10%
C51010	Leveed Chl.	648	41	0	80	1.3	254	4	$ 4,060	$ 4,530	$ 1,128	$ 2,730	$ 12,448	33%	36%	9%	22%	12%
C51020	Leveed Chl.	1298	22	0	39	0.5	333	5	$ 2,200	$ 2,087	$ 500	$ 1,285	$ 6,072	36%	34%	8%	21%	6%
C51060	Excavated Chl.	1424	20	68	0	0.5	347	7	$ 2,020	$ 1,629	$ 414	$ 496	$ 4,559	44%	36%	9%	11%	4%
D415	Offline Basin	1239	12	89	0	780	680	7	$ 1,220	$ 922	$ 530	$ 516	$ 3,188	38%	29%	17%	16%	3%
RR41510	Leveed Chl.	1587	47	0	70	1	393	5	$ 4,690	$ 3,962	$ 904	$ 2,298	$ 11,854	40%	33%	8%	19%	12%
C42010	Leveed Chl.	1994	105	0	141	2	433	5	$ 10,470	$ 7,786	$ 1,833	$ 4,601	$ 24,690	42%	32%	7%	19%	24%
C42020	Leveed Chl.	1697	22	0	30	0.4	433	5	$ 2,220	$ 1,744	$ 389	$ 1,054	$ 5,407	41%	32%	7%	19%	5%
S51010	Leveed Chl.	441	8	0	19	0.3	204	4	$ 770	$ 1,026	$ 265	$ 672	$ 2,733	28%	38%	10%	25%	3%
	TOTAL	383	869	475					$ 38,170	$ 35,137	$ 9,657	$ 19,171	**$ 102,135**	37%	34%	9%	19%	100%
All Channels		314	68	475	7.4				$ 31,320	$ 27,859	$ 6,675	$ 16,312	$ 82,166	38%	34%	8%	20%	80%
All Online Basins		57	712	0					$ 5,630	$ 6,356	$ 2,452	$ 2,343	$ 16,782	34%	38%	15%	14%	16%
All Offline Basins		12	89	0					$ 1,220	$ 922	$ 530	$ 516	$ 3,188	38%	29%	17%	16%	3%
Channel Cost per mile (in $1000)		$11,104		Basins Cost per ac. ft. (in $1000)					$3.72									
All Channels % increase		18%	26%	136%					18%	75%	100%	106%	53%					
All Online Basins % increase		43%	8%	0%					42%	8%	42%	41%	27%					
All Offline Basins % increase		50%	6%	0%					53%	5%	52%	50%	34%					
Total % increase		22%	9%	136%					22%	55%	79%	94%	47%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
RR410	STORAGE	128	7.6	105.02	6	2.18	118	65	22	9	0.503	1.106	1.12	1.12	59	129	130	130
410415	ROUTE	127	100.2	13.8	7.5	2.18	117	65	22	9	0.499	1.106	1.12	1.12	58	129	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415R	COMBINE	422			4.1	2.63	127	74	25	11	0.45	1.043	1.055	1.055	63	146	148	148
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
RR500	STORAGE	181	8.9	180.75	6.9	3.64	171	109	38	17	0.436	1.111	1.171	1.171	85	216	227	227
500415	ROUTE	181	98.8	10.82	7.5	3.64	170	108	38	17	0.436	1.108	1.171	1.171	85	215	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C415L	COMBINE	1386			4.2	5.48	303	146	51	22	0.514	0.988	1.032	1.032	150	289	301	301
C415	COMBINE	1581			4.2	8.11	393	196	67	29	0.451	0.899	0.928	0.928	195	389	401	401
D415	DIVERT	1231			4.1	8.11	374	191	66	28	0.429	0.877	0.906	0.906	186	380	392	392
415420	ROUTE	803	100.8	99.56	5.3	8.11	330	189	66	28	0.378	0.864	0.906	0.906	163	374	392	392
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1021			4.3	9.88	410	216	75	33	0.386	0.812	0.851	0.851	203	428	449	449
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
RR410	STORAGE	128	7.6	105.02	14	2.18	119	66	23	10	0.505	1.124	1.15	1.15	59	131	134	134
410415	ROUTE	127	100.2	13.8	15.5	2.18	117	66	23	10	0.5	1.124	1.15	1.15	58	131	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415R	COMBINE	609			12.1	2.63	134	78	26	11	0.473	1.097	1.121	1.121	66	154	157	157
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
RR500	STORAGE	186	9.4	192.34	15	3.64	177	119	43	19	0.453	1.219	1.323	1.323	88	237	257	257
500415	ROUTE	186	98.8	11.03	15.5	3.64	177	119	43	19	0.452	1.218	1.323	1.323	88	236	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C415L	COMBINE	2073			12.2	5.48	347	170	60	26	0.588	1.151	1.226	1.226	172	336	358	358
C415	COMBINE	2578			12.2	8.11	476	245	86	37	0.545	1.122	1.179	1.179	236	485	510	510
D415	DIVERT	1239			12.2	8.11	401	226	79	34	0.459	1.036	1.093	1.093	199	448	473	473
415420	ROUTE	856	100.8	103.48	13.3	8.11	356	222	79	34	0.408	1.017	1.093	1.093	177	440	473	473
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1697			12.3	9.88	493	266	95	41	0.464	1.003	1.076	1.076	244	529	567	567
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Leveed	0.0143	0.0060	1.10	3	4.5	0.045	729	109.1	149.5	1.4	1.4	1.4	3.1	109	4.9	0.73	0.54
C41510	Leveed	0.0137	0.0050	0.30	3	4.5	0.045	2578	408.6	547.0	1.3	1.3	1.4	3.1	408	4.7	0.72	0.42
C51010	Leveed	0.0222	0.0080	1.30	3	4.0	0.045	648	136.3	133.4	1.0	1.0	1.0	3.0	136	4.9	0.86	0.50
C51020	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1298	208.3	267.8	1.3	1.3	1.3	3.2	208	4.8	0.75	0.49
C51060	Excavated	0.0055	0.0030	0.50	3	6.5	0.045	1424	117.6	367.4	3.1	3.2	5.2	1.3	116	3.9	0.38	0.96
RR41510	Leveed	0.0162	0.0060	1.00	3	4.5	0.045	1587	267.9	328.7	1.2	1.2	1.2	3.3	267	4.8	0.77	0.47
C42010	Leveed	0.0120	0.0050	2.00	3	4.5	0.045	1994	309.1	437.1	1.4	1.4	1.4	3.1	309	4.6	0.68	0.45
C42020	Leveed	0.0139	0.0055	0.40	3	4.5	0.045	1697	307.9	378.7	1.2	1.2	1.2	3.3	307	4.5	0.71	0.43
S51010	Leveed	0.0171	0.0072	0.30	3	4.0	0.045	441	87.3	95.7	1.1	1.1	1.1	2.9	87	4.6	0.77	0.52

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR410	Online Basin	0.0150	1200	570	9.0	110.5	105.0	134.0	1524	128	7.6	1.4
RR500	Online Basin	0.0250	1300	800	11.0	204.4	192.3	257.0	2063	186	9.4	1.6
D415	Offline Basin	0.0150	600	580	7.0	42.1	37.0	37.0	1339	0	1.1	5.9

Online Basin

HEC1 ID	RR410

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.2	sq. mi
Total Sediment Yield Volume	4.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	4.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1200	1370
Basin Width (ft)	570	570
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	544	519
Top Area (acres)	15.7	17.9
U/S-D/S Height Difference (ft)	8.6	8.6
Excess Area on Upstream (acres)	0.8	1.6

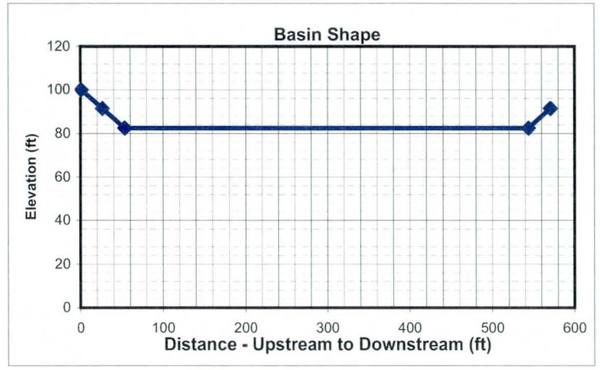
			Base	LC Enhanced
Bottom Length (ft)	1146	Allocated Storage Volume (ac. ft)	110.5	110.6
Bottom Width (ft)	490	Total Available Volume (ac. ft) (incl. Freeboard)	125.3	126.6
		Total Excavation Volume (ac. ft)	192.5	203.3

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	13.00	39.70	67.31	81.46	95.85	110.48	125.35	140.45	155.80
Outflow	0.0	46.3	80.2	103.6	113.5	122.6	131.0	139.0	146.5	153.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	130.0	134	134.0
Peak Inflow (cfs)	1372	1524	1524.0
Peak Outflow (cfs)	128	128	128.0
Stage at Peak Outflow (ft)	7.6	7.6	7.6
Volume at Peak Outflow (ac. ft)	105.0	105.02	105.0

Volume Check

Total Volume needed	109.1	ac. ft
Total Volume Provided	110.5	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	8.6	ft
Depth Provided	9	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	300900	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1200	ft
Base Total ROW Width	570	ft
LC Enh. Total ROW Length	1470	ft
LC Enh. Total ROW Length	670	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	310567	327991
Excavated Area (sq. Yd)	76000	109433

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	56	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	618	sq. Yd
Material Volume	309	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	900	ft
Unit Cost	160	per ft
Cost per outlet	$144,000	
Other Cost	$ -	
Total Cost	$144,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		310,567	cu. Yd	$ 4.00	$ 1,242,268	76,000	sq. Yd	$ 9.00	$ 684,000	76,000	sq. Yd	$ 8.33	$ 633,333
Basin - LC Enhancement		17,424	cu. Yd	$ 4.00	$ 69,696	33,433	sq. Yd	$ 9.00	$ 300,897	33,433	sq. Yd	$ 8.33	$ 278,608
Inlet	Riprap	309	sq. Yd	$ 75.00	$ 23,175	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 33.33	$ 20,600
Inlet - LC Enhancement (20%Inlet)					$ 4,635				$ -				$ 4,120
Outlet	Pipe	1	EA	$ 144,000	$ 144,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 7,200				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 684,000	Base Maintenance Cost			$ 656,150
						LC Enh. Landscape Cost			$ 300,897	LC Enh. Maintenance Cost			$ 282,839
						Total Landscape Cost			$ 984,897	Total Maintenance Cost			$ 938,989

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,409,443	$ 69,696	$ 1,479,139
Contingency Cost (25% of Construction Cost)	$ 352,361	$ 17,424	$ 369,785
Engineering Design Cost (5% of Construction Cost)	$ 70,472	$ 3,485	$ 73,957
Total Construction Cost	$ 1,832,276	$ 90,605	$ 1,922,881

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	6.9	$100,000	$ 690,000
Basin	15.7	$100,000	$ 1,570,000
Other		$100,000	$ -
Total	22.6	$100,000	$ 2,260,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15.7	$100,000	$ 1,570,000
LC Enhancement Cost	acre	6.9	$100,000	$ 690,000
Total Land Cost	acre	22.6	$100,000	$ 2,260,000

Total Cost

Base Total Cost	$ 4,742,426
Total LC Enhancement Cost	$ 1,364,341
Total Cost Including LC Enh.	$ 6,106,767

Open Channel

Structure ID	RR41010

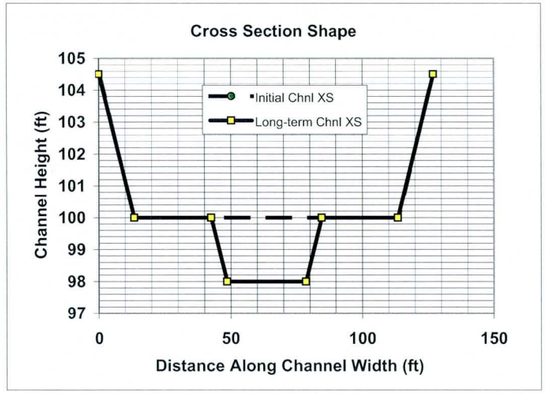
HEC1 ID	410415

Longitundal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

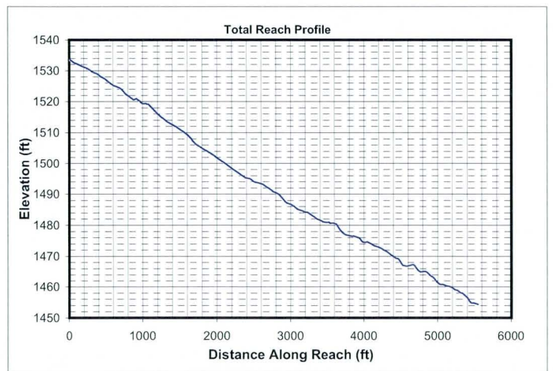
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	100	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	113.5	113.5	113.5	127
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	29	3	30	6.5	3	29	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	42.5	48.5	78.5	84.5	113.5	127
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR410	S415								TOTAL
HEC1 Peak-Flow	128	791								919
Weighting Factor	1.00	0.76								
Flow into Channel	128	601								729

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.343	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	729	cfs	
Long-term Max. Chnl Capacity	4082	cfs	
Q2 Channel	73	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	127	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	102.3	36.6	0.4	100.0	100.4	2.0	0.4	102.2	0.4	0.14	0.59
182	104.0	63.8	0.6	100.0	100.6	2.9	0.6	103.8	0.6	0.23	0.64
547	107.6	125.1	1.2	100.0	101.2	4.4	1.2	107.2	1.2	0.45	0.71
729	109.1	149.5	1.4	100.0	101.4	4.9	1.4	108.6	1.4	0.54	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	36.0	31.2	0.9	98.0	99.0	2.3	1.0	35.7	0.9	0.36	0.44
182	40.3	56.6	1.4	98.0	99.6	3.2	1.6	39.7	1.4	0.61	0.48
547	106.2	161.3	1.5	98.0	100.9	3.4	2.9	105.2	1.5	1.07	0.48
729	108.0	193.0	1.8	98.0	101.2	3.8	3.2	107.0	1.8	1.19	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
73										0
182										0
547										0
729										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
73	1.74	1.0790	1.0250	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
182	1.74	1.2455	1.1832	Erosive	Erosive	Erosive	0.3	Stable	6.2	Stable	Stable
547	1.74	1.4430	1.3708	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
729	1.74	1.4939	1.4192	Erosive	Erosive	Erosive	0.4	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	73	182	547	729	73	182	547	729	73	182	547	729
Bray - Equation #1	23	37	66	77	1.1	1.5	2.2	2.4	2.9	3.3	3.8	4.0
Bray - Equation #2	30	48	87	101	1.2	1.7	2.4	2.6	2.0	2.3	2.6	2.7
Hey	6	11	21	24	3.3	4.7	7.1	7.9				
Ackers & Charlton/Lacey	22	32	51	57					1.6	1.9	2.3	2.4
Parker	59	93	161	185	0.8	1.2	1.9	2.1				
Chang	38	66	129	154	0.1	0.1	-0.2	-0.3				
Kellerhals	15	24	42	49	1.5	2.2	3.4	3.8	3.1	3.4	3.8	3.9
AMAFCA/Schumm	36	40	105	107								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	12.8	18.1	27.3	30.4	3	5	7	8	2.6	3.3	4.3	4.6
Average	25	38	70	79	1.5	2.1	3.1	3.4	2.5	2.8	3.4	3.5
Values As Designed	36	40	105	107	1.0	1.6	2.9	3.2	2.3	3.2	3.4	3.8
Difference with Design	-11	-2	-36	-28	0.6	0.5	0.2	0.3	0.1	-0.4	0.0	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	568	357	731	1042	1580	168	152	92	2143	165	616	692
182	2333	1162	2202	4895	2362	714	501	468	5649	578	2580	2131
547	12496	4214	6764	30945	3648	3351	1642	2376	17339	2778	12252	8891
729	19353	5823	8822	50018	4070	4972	2196	3523	23185	4207	18072	13113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	2893	1818	3718	5302	8041	856	772	469	10906	838	3137	3523
182	4750	2366	4482	9964	4808	1454	1019	953	11499	1177	5253	4339
547	8479	2859	4590	20998	2475	2274	1114	1612	11766	1885	8313	6033
729	9849	2964	4490	25455	2071	2530	1118	1793	11799	2141	9197	6673

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	302	166	269	521	564	63	56	64	580	68	348	273
182	1164	523	790	2293	889	249	177	272	1531	249	1357	863
547	3769	1577	2416	7514	2473	799	547	877	4617	795	4357	2704
729	5822	2237	3331	12107	2796	1202	754	1338	6211	1216	6592	3964

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	1535	844	1371	2651	2870	318	283	323	2950	345	1773	1387
182	2370	1065	1609	4668	1811	508	360	553	3117	506	2762	1757
547	2558	1070	1640	5098	1678	542	371	595	3133	540	2956	1835
729	2963	1138	1695	6161	1423	612	384	681	3161	619	3355	2017

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
73	0.0022	0.0034	133	0.41	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0083	0.0005	0.0026	0.0142	0.0062
182	0.0011	0.0020	174	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0083	0.0004	0.0013	0.0142	0.0060
547	0.0005	0.0010	240	0.73	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0083	0.0002	0.0006	0.0142	0.0058
729	0.0004	0.0009	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0083	0.0002	0.0005	0.0142	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	45.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	348	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	348 ft	Depth	3 ft
Width	127 ft	Side slope	3 ft/ft
Total Volume per Basin		2.75	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
73	1.1	-0.3	0.1	24.6	1.0	0.9	2.3	0.0060	0.1	0.0	2.0	2.8
182	1.1	-0.5	0.1	24.6	1.6	1.4	3.2	0.0060	0.2	0.0	2.0	2.9
547	1.1	-0.8	0.2	24.6	2.9	1.5	3.4	0.0060	0.3	0.0	2.0	3.1
729	1.1	-0.9	0.2	24.6	3.2	1.8	3.8	0.0060	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	127	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	0.54	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	3
Channel Width (ft)	127	127
Channel XS Area (sq. ft)	582.8	582.8
Channel Perimeter (ft)	129	129

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1854	sq. Yd
Volume	4325	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5561	5561
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25951	53756
Left Levee Volume (cu. Yd)	25539	60141
Right Levee Length (ft)	5561	5561
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25951	53756
Right Levee Volume (cu. Yd)	25539	60141
Total Levee Surface Area (sq. Yd)	51902	107512
Total Levee Volume (cu. Yd)	51078	120282

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8650	20390
Left Levee Lining Volume (cu. Yd)	4325	10195
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8650	20390
Right Levee Lining Volume (cu. Yd)	4325	10195
Total Lining Area (sq. Yd)	17301	40781
Total Lining Volume (cu. Yd)	8650	20390

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	127	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	16	
Volume per structure	142	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,650	
Area per structure	42	sq. Yd
Total Area	677	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4437	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,748	
Other Cost	$ -	
Total cost per basin	$ 17,748	
Area per basin	4,905	sq. Yd
Total Area	4,905	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	51,078	cu. Yd	$ 7.00	$ 357,546	51,902	sq. Yd	$ 9.00	$ 467,118	51,902	sq. Yd	$ 11.67	$ 605,523
Levee - LC Enhancement	Fill	69,204	cu. Yd	$ 7.00	$ 484,428	55,610	sq. Yd	$ 9.00	$ 500,490	69,204	sq. Yd	$ 11.67	$ 807,380
Levee Lining	Riprap	8,650	cu. Yd	$ 75.00	$ 648,750	17,301	sq. Yd	$ -	$ -	17,301	sq. Yd	$ 20.83	$ 360,435
Levee Lining -LC Enhancement	Riprap	11,740	cu. Yd	$ 75.00	$ 880,500	23,480	sq. Yd	$ -	$ -	23,480	sq. Yd	$ 20.83	$ 489,162
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,325	cu. Yd	$ 75.00	$ 324,375	1,854	sq. Yd	$ -	$ -	1,854	sq. Yd	$ 25.00	$ 46,350
Drop Structures	Riprap	16	EA	$ 10,650.00	$ 170,400	677	sq. Yd	$ -	$ -	677	sq. Yd	$ 33.33	$ 22,567
Drop Str. - LC Enhancement	Riprap	16	EA	$ 1,065.00	$ 17,040	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,257
Sedimentation Basins		1	EA	$ 17,748.00	$ 17,748	4,905	sq. Yd	$ -	$ -	4,905	sq. Yd	$ 8.33	$ 40,875
Other					$ -				$ -				$ -

Base Landscape Cost	$ 467,118	Base Maintenance Cost	$ 1,075,750
LC Enhancement Cost	$ 500,490	LC Enhancement Cost	$ 1,298,799
Total Landscape Cost	$ 967,608	Total Maintenance Cost	$ 2,374,549

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,518,819	$ 1,381,968	$ 2,900,787
Contingency Cost (25% of Construction Cost)	$ 379,705	$ 345,492	$ 725,197
Engineering Design Cost (5% of Construction Cost)	$ 75,941	$ 69,098	$ 145,039
Total Construction Cost	$ 1,974,465	$ 1,796,558	$ 3,771,023

Land Cost

Channel Length	5561 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	127	16.2	$100,000	$ 1,620,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7	$100,000	$ 700,000
Levee LC Enhancement	51	6.5	$100,000	$ 650,000
Other	0	0	$100,000	$ -
Total	233	29.7		$ 2,970,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	23.2	$100,000	$ 2,320,000
LC Enhancement Cost	acre	6.5	$100,000	$ 650,000
Total Land Cost	acre	29.7	$100,000	$ 2,970,000

Total Cost

Base Total Cost	$ 5,837,333
Total Landscape Enhancement Cost	$ 4,245,847
Total Cost Including LC Enh.	$ 10,083,180

Open Channel

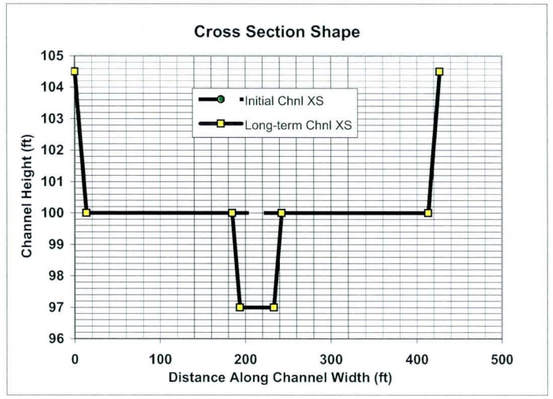
Structure ID	C41510	HEC1 ID	410415

Longitundal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

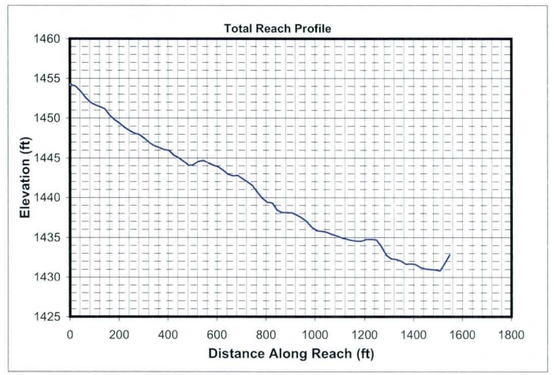
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	171	3	40	7.5	3	171	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	184.5	193.5	233.5	242.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	2578									2578
Weighting Factor	1.00									
Flow into Channel	2578									2578

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR4101 0	500415_C5106 0								TOTAL
Flow Volume (ac. ft)	134.00	257.00								391
Sediment Conc. (ppm)	2017	956								
Sediment Volume (ac. ft)	0.10	0.09								0.19
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.10	0.09								0.19

Hydrology

Drainage Area	1.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2578	cfs	
Long-term Max. Chnl Capacity	13143	cfs	
Q2 Channel	258	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
258	402.2	136.6	0.3	100.0	100.3	1.9	0.3	402.0	0.3	0.11	0.57
645	403.7	236.9	0.6	100.0	100.6	2.7	0.6	403.5	0.6	0.18	0.63
1934	407.2	459.7	1.1	100.0	101.1	4.2	1.1	406.8	1.1	0.36	0.70
2578	408.6	547.0	1.3	100.0	101.4	4.7	1.4	408.1	1.3	0.42	0.72

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
258	51.3	81.1	1.6	97.0	98.8	3.2	1.8	50.7	1.6	0.56	0.44
645	403.7	320.8	0.8	97.0	100.4	2.0	3.4	402.6	0.8	1.07	0.40
1934	408.4	623.1	1.5	97.0	101.2	3.1	4.2	407.1	1.5	1.30	0.44
2578	410.3	741.9	1.8	97.0	101.5	3.5	4.5	408.8	1.8	1.39	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR4101 0	500415_C5106 0								
258	273	249								521
645	863	596								1459
1934	2704	2511								5215
2578	3964	3670								7634

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
258	1.74	1.0626	1.0095	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
645	1.74	1.2312	1.1696	Erosive	Erosive	Erosive	0.3	Stable	7.5	Stable	Stable
1934	1.74	1.4331	1.3614	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
2578	1.74	1.4858	1.4115	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	258	645	1934	2578	258	645	1934	2578	258	645	1934	2578
Bray - Equation #1	44	72	128	149	1.7	2.3	3.3	3.6	3.4	3.9	4.6	4.7
Bray - Equation #2	58	94	169	196	1.9	2.5	3.6	4.0	2.4	2.7	3.1	3.3
Hey	13	23	42	49	5.3	7.5	11.4	12.7				
Ackers & Charlton/Lacey	37	54	86	98					2.0	2.4	2.8	3.0
Parker	110	174	302	349	1.4	2.0	3.2	3.6				
Chang	77	134	262	311	0.1	-0.1	-0.6	-0.9				
Kellerhals	29	46	79	91	2.5	3.6	5.6	6.3	3.6	3.9	4.3	4.5
AMAFCA/Schumm	51	403	408	409								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	21.3	30.0	45.4	50.5	6	8	12	13	3.3	4.2	5.5	5.9
Average	46	105	154	172	2.4	3.4	5.0	5.5	2.9	3.4	4.1	4.3
Values As Designed	51	403	407	409	1.8	3.4	4.2	4.5	3.2	2.0	3.1	3.5
Difference with Design	-5	-298	-254	-237	0.7	-0.1	0.8	1.0	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1803	1155	2336	3214	5792	505	474	273	7052	532	1920	2278
645	7457	3859	7359	15227	8680	2266	1656	1487	18779	1862	8309	6995
1934	40579	14256	23221	97981	13277	10884	5564	7854	57871	9034	40564	29190
2578	63199	19774	30170	159424	14736	16221	7464	11734	77418	13748	60234	43102

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	2594	1662	3362	4626	8335	726	682	393	10148	765	2763	3278
645	4293	2221	4236	8765	4996	1304	953	856	10810	1072	4783	4026
1934	7786	2735	4456	18801	2548	2088	1068	1507	11104	1733	7784	5601
2578	9095	2846	4342	22943	2121	2334	1074	1689	11141	1979	8668	6203

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1358	617	897	2581	1085	271	199	328	1637	282	1601	987
645	1832	965	1544	2879	5102	297	302	348	3649	409	2025	1759
1934	9956	4376	6761	18489	8451	1988	1490	2397	12235	2051	11739	7267
2578	15500	6295	9248	30060	9522	3044	2097	3729	16528	3157	18050	10657

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
258	1954	888	1291	3714	1562	390	286	472	2356	406	2304	1420
645	1055	556	889	1657	2937	171	174	200	2100	236	1165	1013
1934	1910	840	1297	3548	1622	382	286	460	2348	394	2253	1394
2578	2231	906	1331	4326	1370	438	302	537	2379	454	2598	1534

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
258	0.0024	0.0036	127	0.39	0.046	0.0007	30	0.035	0.0005	0.0159	0.0008	0.0018	0.0055	0.0003	0.0025	0.0137	0.0053
645	0.0012	0.0021	167	0.51	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0055	0.0002	0.0013	0.0137	0.0051
1934	0.0005	0.0011	232	0.71	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0055	0.0001	0.0006	0.0137	0.0050
2578	0.0004	0.0009	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0055	0.0001	0.0005	0.0137	0.0049

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	13.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.20	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		8.77	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
258	1.1	-0.5	0.1	24.6	1.8	1.6	3.2	0.0050	0.2	0.0	3.0	4.2
645	1.1	-1.2	0.1	24.6	3.4	0.8	2.0	0.0050	0.3	0.0	3.0	4.4
1934	1.1	-1.3	0.1	24.6	4.2	1.5	3.1	0.0050	0.4	0.0	3.0	4.6
2578	1.1	-1.3	0.2	24.6	4.5	1.8	3.5	0.0050	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	127	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.32	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2007.8	2007.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	522	sq. Yd
Volume	1393	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1567	1567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	7313	15148
Left Levee Volume (cu. Yd)	7197	16947
Right Levee Length (ft)	1567	1567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	7313	15148
Right Levee Volume (cu. Yd)	7197	16947
Total Levee Surface Area (sq. Yd)	14626	30296
Total Levee Volume (cu. Yd)	14394	33894

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2438	5746
Left Levee Lining Volume (cu. Yd)	1219	2873
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2438	5746
Right Levee Lining Volume (cu. Yd)	1219	2873
Total Lining Area (sq. Yd)	4875	11491
Total Lining Volume (cu. Yd)	2438	5746

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	427	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.7	ft	
Structure Height	9.7	ft	
Number of Structures	5		
Volume per structure	462	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 34,650		
Area per structure	142	sq. Yd	
Total Area	712	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14149	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 56,596	
Other Cost	$ -	
Total cost per basin	$ 56,596	
Area per basin	14,870	sq. Yd
Total Area	14,870	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,394	cu. Yd	$ 7.00	$ 100,758	14,626	sq. Yd	$ 9.00	$ 131,634	14,626	sq. Yd	$ 11.67	$ 170,637
Levee - LC Enhancement	Fill	19,500	cu. Yd	$ 7.00	$ 136,500	15,670	sq. Yd	$ 9.00	$ 141,030	19,500	sq. Yd	$ 11.67	$ 227,500
Levee Lining	Riprap	2,438	cu. Yd	$ 75.00	$ 182,850	4,875	sq. Yd	$ -	$ -	4,875	sq. Yd	$ 20.83	$ 101,565
Levee Lining -LC Enhancement	Riprap	3,308	cu. Yd	$ 75.00	$ 248,100	6,616	sq. Yd	$ -	$ -	6,616	sq. Yd	$ 20.83	$ 137,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,393	cu. Yd	$ 75.00	$ 104,475	522	sq. Yd	$ -	$ -	522	sq. Yd	$ 25.00	$ 13,050
Drop Structures	Riprap	5	EA	$ 34,650.00	$ 173,250	712	sq. Yd	$ -	$ -	712	sq. Yd	$ 33.33	$ 23,733
Drop Str. - LC Enhancement	Riprap	5	EA	$ 3,465.00	$ 17,325	71	sq. Yd	$ -	$ -	71	sq. Yd	$ 33.33	$ 2,373
Sedimentation Basins		1	EA	$ 56,596.00	$ 56,596	14,870	sq. Yd	$ -	$ -	14,870	sq. Yd	$ 8.33	$ 123,917
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 131,634	Base Maintenance Cost			$ 432,901
						LC Enhancement Cost			$ 141,030	LC Enhancement Cost			$ 367,711
						Total Landscape Cost			$ 272,664	Total Maintenance Cost			$ 800,613

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 617,929	$ 401,925	$ 1,019,854
Contingency Cost (25% of Construction Cost)	$ 154,482	$ 100,481	$ 254,964
Engineering Design Cost (5% of Construction Cost)	$ 30,896	$ 20,096	$ 50,993
Total Construction Cost	$ 803,308	$ 522,503	$ 1,325,810

Land Cost

Channel Length	1567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	15.4	$100,000	$ 1,540,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2	$100,000	$ 200,000
Levee LC Enhancement	51	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	533	19.2		$ 1,920,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.4	$100,000	$ 1,740,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	19.2	$100,000	$ 1,920,000

Total Cost

Base Total Cost	$ 3,107,843
Total Landscape Enhancement Cost	$ 1,211,244
Total Cost Including LC Enh.	$ 4,319,087

Online Basin

HEC1 ID	RR500

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.6	sq. mi
Total Sediment Yield Volume	6.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	6.9	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1300	1530
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	23.9	28.1
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	1.9	4.3

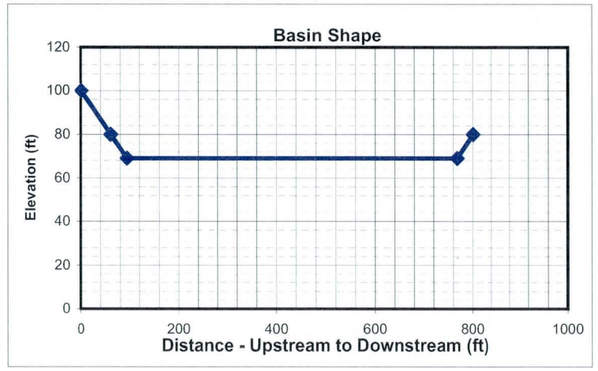
			Base	LC Enhanced
Bottom Length (ft)	1234	Allocated Storage Volume (ac. ft)	204.4	203.8
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	226.3	227.4
		Total Excavation Volume (ac. ft)	465.2	508.5

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	12	13
Volume	0.00	38.71	78.49	119.35	161.30	182.69	204.35	226.30	248.52	271.03
Outflow	0.0	85.6	121.0	148.2	171.1	181.5	191.3	200.7	209.6	218.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	227.0	257	257.0
Peak Inflow (cfs)	1743	2063	2063.0
Peak Outflow (cfs)	181	186	186.0
Stage at Peak Outflow (ft)	8.9	9.4	9.4
Volume at Peak Outflow (ac. ft)	180.8	192.34	192.3

Volume Check

Total Volume needed	199.2	ac. ft
Total Volume Provided	204.4	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.4	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	427000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1300	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	1630	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	750523	820380
Excavated Area (sq. Yd)	115556	163000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	98	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1089	sq. Yd
Material Volume	545	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		750,523	cu. Yd	$ 4.00	$ 3,002,092	115,556	sq. Yd	$ 9.00	$ 1,040,004	115,556	sq. Yd	$ 8.33	$ 962,967	
Basin - LC Enhancement		69,857	cu. Yd	$ 4.00	$ 279,428	47,444	sq. Yd	$ 9.00	$ 426,996	47,444	sq. Yd	$ 8.33	$ 395,367	
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300	
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260	
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 1,040,004	Base Maintenance Cost			$ 1,001,483	
						LC Enh. Landscape Cost			$ 426,996	LC Enh. Maintenance Cost			$ 402,738	
						Total Landscape Cost			$ 1,467,000	Total Maintenance Cost			$ 1,404,221	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,130,967	$ 279,428	$ 3,410,395
Contingency Cost (25% of Construction Cost)	$ 782,742	$ 69,857	$ 852,599
Engineering Design Cost (5% of Construction Cost)	$ 156,548	$ 13,971	$ 170,520
Total Construction Cost	$ 4,070,257	$ 363,256	$ 4,433,514

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	9.8	$100,000	$ 980,000
Basin	23.9	$100,000	$ 2,390,000
Other		$100,000	$ -
Total	33.7	$100,000	$ 3,370,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.9	$100,000	$ 2,390,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 8,501,744
Total LC Enhancement Cost	$ 2,172,990
Total Cost Including LC Enh.	$ 10,674,734

Open Channel

Structure ID	C51010

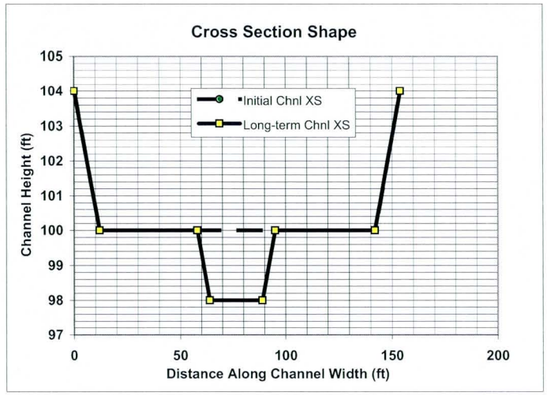
HEC1 ID	500415

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

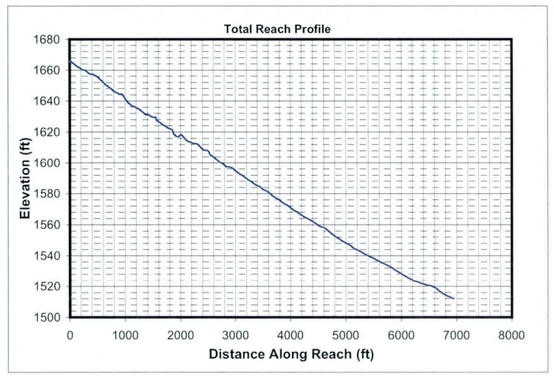
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	130	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	142	142	142	154
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	46	3	25	6	3	47	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	58	64	89	95	142	154
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.22							
Flow into Channel	186	462							648

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.409	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	648	cfs	
Long-term Max. Chnl Capacity	4733	cfs	
Q2 Channel	65	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	131.6	33.0	0.3	100.0	100.3	2.0	0.3	131.5	0.3	0.13	0.69
162	132.8	57.5	0.4	100.0	100.4	2.8	0.4	132.6	0.4	0.22	0.75
486	135.3	111.9	0.8	100.0	100.8	4.3	0.8	135.1	0.8	0.42	0.84
648	136.3	133.4	1.0	100.0	101.0	4.9	1.0	136.0	1.0	0.50	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	30.7	25.1	0.8	98.0	98.9	2.6	0.9	30.4	0.8	0.45	0.50
162	34.7	45.6	1.3	98.0	99.5	3.6	1.5	34.2	1.3	0.77	0.54
486	134.9	151.8	1.1	98.0	100.7	3.2	2.7	134.1	1.1	1.34	0.53
648	136.3	181.1	1.3	98.0	100.9	3.6	2.9	135.4	1.3	1.45	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
65										0
162										0
486										0
648										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
65	1.74	0.9696	0.9211	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
162	1.74	1.1376	1.0807	Erosive	Erosive	Erosive	0.2	Stable	6.9	Stable	Stable
486	1.74	1.3374	1.2705	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
648	1.74	1.3894	1.3199	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	65	162	486	648	65	162	486	648	65	162	486	648
Bray - Equation #1	21	35	62	72	1.1	1.4	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	28	46	81	95	1.2	1.6	2.3	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	23	3.1	4.5	6.8	7.5				
Ackers & Charlton/Lacey	21	30	48	55					1.6	1.9	2.2	2.4
Parker	55	87	151	175	0.8	1.1	1.8	2.0				
Chang	39	68	132	157	0.1	0.0	-0.3	-0.4				
Kellerhals	14	23	40	46	1.4	2.1	3.2	3.6	3.1	3.4	3.8	3.9
AMAFCA/Schumm	30	34	134	136								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	11.6	16.4	24.7	27.6	3	4	7	7	2.8	3.5	4.7	5.0
Average	24	36	70	79	1.5	2.0	2.9	3.2	2.5	2.9	3.4	3.6
Values As Designed	30	34	134	135	0.9	1.5	2.7	2.9	2.6	3.6	3.2	3.6
Difference with Design	-7	2	-64	-56	0.5	0.5	0.2	0.3	-0.1	-0.7	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	761	501	1148	1481	2173	278	241	121	3761	259	808	1048
162	3129	1591	3320	6992	3208	1139	762	604	9809	850	3343	3159
486	16989	5698	9891	44691	4871	5338	2459	3051	29973	3924	15680	12960
648	26392	7853	12961	72516	5408	7930	3278	4518	40055	5903	23048	19078

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	4359	2870	6570	8482	12440	1593	1382	690	21534	1484	4623	6003
162	7167	3643	7603	16013	7346	2608	1744	1382	22465	1946	7657	7234
486	12969	4350	7551	34116	3719	4075	1877	2329	22881	2995	11970	9894
648	15110	4496	7420	41518	3096	4540	1876	2586	22933	3380	13195	10923

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	408	214	385	767	568	99	80	86	821	95	472	363
162	1565	647	1025	3348	886	366	232	344	2126	344	1754	1149
486	4115	1764	3000	8347	3119	986	680	909	6323	910	4694	3168
648	6386	2514	4140	13520	3511	1489	941	1402	8507	1387	7132	4630

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	2336	1227	2202	4390	3254	569	457	494	4702	541	2702	2080
162	3583	1481	2347	7667	2028	839	531	789	4869	787	4017	2631
486	3141	1346	2290	6372	2381	753	519	694	4827	694	3583	2418
648	3656	1439	2371	7741	2010	853	539	803	4870	794	4083	2651

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
65	0.0030	0.0048	139	0.42	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0024	0.0087	0.0006	0.0033	0.0221	0.0084
162	0.0015	0.0028	182	0.56	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0087	0.0004	0.0017	0.0221	0.0081
486	0.0007	0.0015	252	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0087	0.0002	0.0007	0.0221	0.0079
648	0.0005	0.0012	274	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0087	0.0002	0.0006	0.0221	0.0079

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	98.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	33	
Distance between structs.	211	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	211 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		2.02	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
65	1.1	-0.3	0.1	24.6	0.9	0.8	2.6	0.0080	0.1	0.0	2.0	2.8
162	1.1	-0.4	0.2	24.6	1.5	1.3	3.6	0.0080	0.2	0.0	2.0	2.9
486	1.1	-0.8	0.1	24.6	2.7	1.1	3.2	0.0080	0.3	0.0	2.0	3.1
648	1.1	-0.8	0.2	24.6	2.9	1.3	3.6	0.0080	0.3	0.0	2.0	3.1

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.8	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.26	ac. ft
Deposited(+)/Eroded(-) Volume	0.52	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	3
Channel Width (ft)	154	154
Channel XS Area (sq. ft)	630	630
Channel Perimeter (ft)	156	156

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	2321	sq. Yd
Volume	5416	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6964	6964
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	30177	62676
Left Levee Volume (cu. Yd)	26824	64481
Right Levee Length (ft)	6964	6964
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	30177	62676
Right Levee Volume (cu. Yd)	26824	64481
Total Levee Surface Area (sq. Yd)	60354	125352
Total Levee Volume (cu. Yd)	53648	128962

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10059	23213
Left Levee Lining Volume (cu. Yd)	5030	11607
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10059	23213
Right Levee Lining Volume (cu. Yd)	5030	11607
Total Lining Area (sq. Yd)	20118	46427
Total Lining Volume (cu. Yd)	10060	23214

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	154	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	33	
Volume per structure	150	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,250	
Area per basin	51	sq. Yd
Total Area	1,694	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3259	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,036	
Other Cost	$ -	
Total cost per basin	$ 13,036	
Area per basin	3,611	sq. Yd
Total Area	7,222	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	53,648	cu. Yd	$ 7.00	$ 375,536	60,354	sq. Yd	$ 9.00	$ 543,186	60,354	sq. Yd	$ 11.67	$ 704,130
Levee - LC Enhancement	Fill	75,314	cu. Yd	$ 7.00	$ 527,198	64,998	sq. Yd	$ 9.00	$ 584,982	75,314	sq. Yd	$ 11.67	$ 878,663
Levee Lining	Riprap	10,060	cu. Yd	$ 75.00	$ 754,500	20,118	sq. Yd	$ -	$ -	20,118	sq. Yd	$ 20.83	$ 419,130
Levee Lining -LC Enhancement	Riprap	13,154	cu. Yd	$ 75.00	$ 986,550	26,308	sq. Yd	$ -	$ -	26,308	sq. Yd	$ 20.83	$ 548,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,416	cu. Yd	$ 75.00	$ 406,200	2,321	sq. Yd	$ -	$ -	2,321	sq. Yd	$ 25.00	$ 58,025
Drop Structures	Riprap	33	EA	$ 11,250.00	$ 371,250	1,694	sq. Yd	$ -	$ -	1,694	sq. Yd	$ 33.33	$ 56,467
Drop Str. - LC Enhancement	Riprap	33	EA	$ 1,125.00	$ 37,125	169	sq. Yd	$ -	$ -	169	sq. Yd	$ 33.33	$ 5,647
Sedimentation Basins		2	EA	$ 13,036.00	$ 26,072	7,222	sq. Yd	$ -	$ -	7,222	sq. Yd	$ 8.33	$ 60,183
Other					$ -				$ -				$ -

Base Landscape Cost	$ 543,186	Base Maintenance Cost	$ 1,297,935
LC Enhancement Cost	$ 584,982	LC Enhancement Cost	$ 1,432,403
Total Landscape Cost	$ 1,128,168	Total Maintenance Cost	$ 2,730,337

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,933,558	$ 1,550,873	$ 3,484,431
Contingency Cost (25% of Construction Cost)	$ 483,390	$ 387,718	$ 871,108
Engineering Design Cost (5% of Construction Cost)	$ 96,678	$ 77,544	$ 174,222
Total Construction Cost	$ 2,513,625	$ 2,016,135	$ 4,529,760

Land Cost

Channel Length	6964 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	154	24.6	$100,000	$ 2,460,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.3	$100,000	$ 830,000
Levee LC Enhancement	48	7.7	$100,000	$ 770,000
Other	0	0	$100,000	$ -
Total	254	40.6		$ 4,060,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	32.9	$100,000	$ 3,290,000
LC Enhancement Cost	acre	7.7	$100,000	$ 770,000
Total Land Cost	acre	40.6	$100,000	$ 4,060,000

Total Cost

Base Total Cost	$ 7,644,746
Total Landscape Enhancement Cost	$ 4,803,519
Total Cost Including LC Enh.	$ 12,448,266

Open Channel

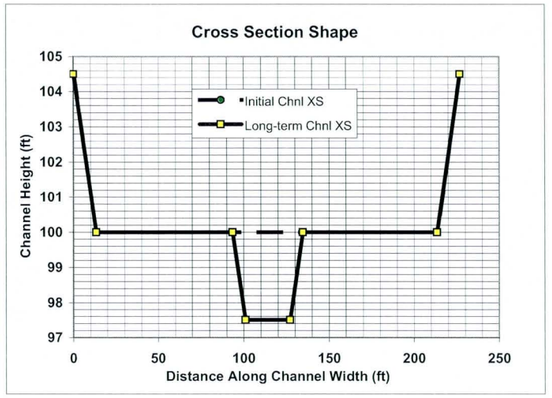
Structure ID	C51020	HEC1 ID	500415

Longitudal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

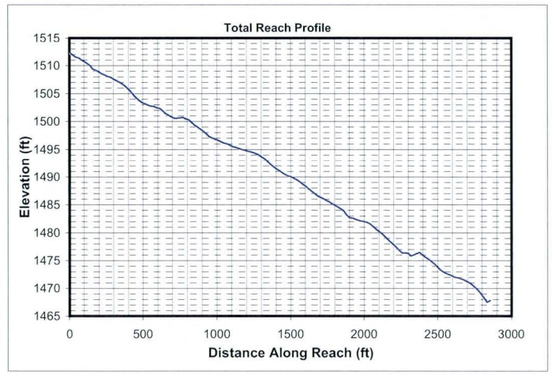
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	26	7	3	79	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	127	134.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.53							
Flow into Channel	186	1112							1298

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51010	500415_S51010							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	2651	2356							
Sediment Volume (ac. ft)	0.26	0.23							0.49
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.26	0.23							0.49

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1298	cfs	
Long-term Max. Chnl Capacity	7362	cfs	
Q2 Channel	130	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	202.1	66.5	0.3	100.0	100.3	2.0	0.3	202.0	0.3	0.12	0.60
325	203.6	115.5	0.6	100.0	100.6	2.8	0.6	203.4	0.6	0.21	0.66
974	207.0	224.7	1.1	100.0	101.1	4.3	1.1	206.6	1.1	0.41	0.73
1298	208.3	267.8	1.3	100.0	101.3	4.8	1.3	207.9	1.3	0.49	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	35.1	43.7	1.2	97.5	98.9	3.0	1.4	34.7	1.3	0.54	0.47
325	41.4	80.9	2.0	97.5	99.9	4.0	2.4	40.6	2.0	0.91	0.50
974	207.5	298.1	1.4	97.5	101.1	3.3	3.6	206.3	1.4	1.33	0.48
1298	209.2	355.5	1.7	97.5	101.3	3.7	3.8	208.0	1.7	1.43	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51010	500415_S51010								
130	363	200								563
325	1149	617								1766
974	3168	1919								5087
1298	4630	2800								7430

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
130	1.74	1.0528	1.0002	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
325	1.74	1.2208	1.1598	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
974	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1298	1.74	1.4735	1.3998	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	130	325	974	1298	130	325	974	1298	130	325	974	1298
Bray - Equation #1	31	50	89	104	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	41	66	117	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.6
Parker	78	124	214	248	1.0	1.5	2.4	2.7				
Chang	54	94	183	218	0.1	0.0	-0.4	-0.6				
Kellerhals	21	32	56	65	1.9	2.7	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	35	41	207	208								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	15.9	22.4	33.9	37.7	4	6	9	10	3.0	3.8	5.0	5.4
Average	32	50	101	114	1.9	2.6	3.8	4.2	2.7	3.1	3.7	3.9
Values As Designed	35	41	206	208	1.4	2.4	3.6	3.8	3.0	4.0	3.3	3.7
Difference with Design	-2	9	-106	-94	0.5	0.2	0.3	0.4	-0.3	-0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	1058	676	1406	1945	3095	322	292	167	4254	317	1138	1334
325	4369	2209	4266	9191	4609	1380	971	867	11222	1102	4811	4091
974	23661	8042	13120	58830	7041	6530	3194	4463	34451	5293	23043	17061
1298	36787	11124	17110	95529	7822	9713	4272	6637	46066	8029	34065	25196

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	3025	1931	4019	5559	8846	920	834	477	12159	906	3252	3812
325	4995	2526	4877	10508	5269	1577	1110	992	12830	1260	5501	4677
974	9017	3065	5000	22420	2683	2488	1217	1701	13129	2017	8782	6502
1298	10515	3180	4891	27304	2236	2776	1221	1897	13167	2295	9737	7202

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	742	354	555	1417	714	160	121	172	1080	160	871	577
325	2780	1037	1500	6018	1129	565	336	632	2776	585	3110	1861
974	6404	2715	4270	12512	4662	1367	963	1491	8189	1352	7434	4669
1298	9945	3877	5886	20289	5248	2071	1338	2297	11029	2074	11331	6853

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	2121	1011	1586	4051	2041	458	345	491	3087	458	2489	1649
325	3178	1186	1715	6880	1291	646	384	723	3174	668	3556	2127
974	2440	1035	1627	4768	1777	521	367	568	3121	515	2833	1779
1298	2843	1108	1682	5799	1500	592	382	656	3152	593	3239	1959

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
130	0.0024	0.0037	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0069	0.0004	0.0027	0.0153	0.0061
325	0.0012	0.0021	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0010	0.0069	0.0003	0.0013	0.0153	0.0059
974	0.0005	0.0011	240	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0153	0.0057
1298	0.0004	0.0009	261	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0153	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	319	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	319 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
130	1.1	-0.4	0.1	24.6	1.4	1.3	3.0	0.0060	0.2	0.0	2.5	3.5
325	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	0.0	2.5	3.7
974	1.1	-1.0	0.1	24.6	3.6	1.4	3.3	0.0060	0.4	0.0	2.5	3.8
1298	1.1	-1.1	0.2	24.6	3.8	1.7	3.7	0.0060	0.4	0.0	2.5	3.9

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.8	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.83	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	0.62	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1044.5	1044.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	958	sq. Yd
Volume	2235	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2874	2874
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13412	27782
Left Levee Volume (cu. Yd)	13199	31082
Right Levee Length (ft)	2874	2874
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13412	27782
Right Levee Volume (cu. Yd)	13199	31082
Total Levee Surface Area (sq. Yd)	26824	55564
Total Levee Volume (cu. Yd)	26398	62164

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4471	10538
Left Levee Lining Volume (cu. Yd)	2235	5269
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4471	10538
Right Levee Lining Volume (cu. Yd)	2235	5269
Total Lining Area (sq. Yd)	8941	21076
Total Lining Volume (cu. Yd)	4470	10538

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	9	
Volume per structure	245	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,375	
Area per structure	76	sq. Yd
Total Area	681	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	7518	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 30,072	
Other Cost	$ -	
Total cost per basin	$ 30,072	
Area per basin	8,054	sq. Yd
Total Area	8,054	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	26,398	cu. Yd	$ 7.00	$ 184,786	26,824	sq. Yd	$ 9.00	$ 241,416	26,824	sq. Yd	$ 11.67	$ 312,947
Levee - LC Enhancement	Fill	35,766	cu. Yd	$ 7.00	$ 250,362	28,740	sq. Yd	$ 9.00	$ 258,660	35,766	sq. Yd	$ 11.67	$ 417,270
Levee Lining	Riprap	4,470	cu. Yd	$ 75.00	$ 335,250	8,941	sq. Yd	$ -	$ -	8,941	sq. Yd	$ 20.83	$ 186,278
Levee Lining -LC Enhancement	Riprap	6,068	cu. Yd	$ 75.00	$ 455,100	12,135	sq. Yd	$ -	$ -	12,135	sq. Yd	$ 20.83	$ 252,806
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,235	cu. Yd	$ 75.00	$ 167,625	958	sq. Yd	$ -	$ -	958	sq. Yd	$ 25.00	$ 23,950
Drop Structures	Riprap	9	EA	$ 18,375.00	$ 165,375	681	sq. Yd	$ -	$ -	681	sq. Yd	$ 33.33	$ 22,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,837.50	$ 16,538	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,270
Sedimentation Basins		1	EA	$ 30,072.00	$ 30,072	8,054	sq. Yd	$ -	$ -	8,054	sq. Yd	$ 8.33	$ 67,117
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 241,416	Base Maintenance Cost			$ 612,991
						LC Enhancement Cost			$ 258,660	LC Enhancement Cost			$ 672,346
						Total Landscape Cost			$ 500,076	Total Maintenance Cost			$ 1,285,337

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 883,108	$ 722,000	$ 1,605,108
Contingency Cost (25% of Construction Cost)	$ 220,777	$ 180,500	$ 401,277
Engineering Design Cost (5% of Construction Cost)	$ 44,155	$ 36,100	$ 80,255
Total Construction Cost	$ 1,148,040	$ 938,599	$ 2,086,640

Land Cost

Channel Length	2874 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	15	$100,000	$ 1,500,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	333	22		$ 2,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	18.6	$100,000	$ 1,860,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	22	$100,000	$ 2,200,000

Total Cost

Base Total Cost	$ 3,862,448
Total Landscape Enhancement Cost	$ 2,209,605
Total Cost Including LC Enh.	$ 6,072,052

Open Channel

Structure ID	C51060

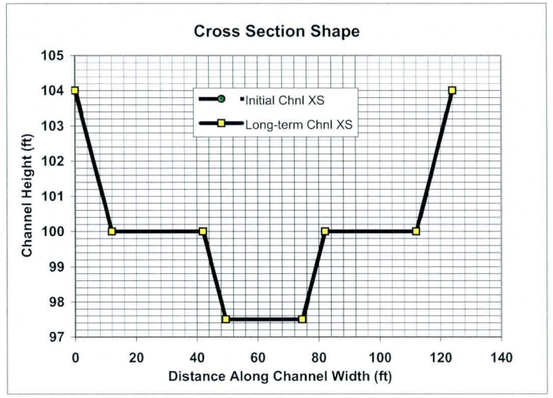
HEC1 ID	500415

Longitudal Geometry

Length	2541.7	ft
U/S Elev	1468.2	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0055	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

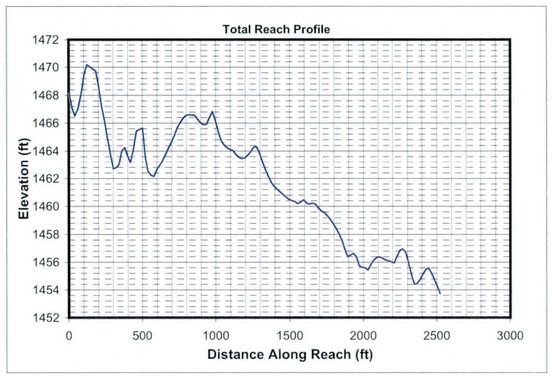
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	25	6.5	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	49.5	74.5	82	112	124
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	25	6.5	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	49.5	74.5	82	112	124
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.59							
Flow into Channel	186	1238							1424

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51020								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	2127								
Sediment Volume (ac. ft)	0.21								0.21
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.21								0.21

Hydrology

Drainage Area	1.08	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1424	cfs	
Long-term Max. Chnl Capacity	2497	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	124	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	37.0	58.1	1.6	97.5	99.4	2.5	1.9	36.4	1.6	0.35	0.34
356	105.3	153.0	1.5	97.5	100.7	2.3	3.2	104.2	1.5	0.60	0.34
1068	114.2	305.5	2.7	97.5	102.1	3.5	4.6	112.7	2.7	0.86	0.37
1424	117.6	367.4	3.1	97.5	102.7	3.9	5.2	115.9	3.2	0.96	0.38

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	37.0	58.1	1.6	97.5	99.4	2.5	1.9	36.4	1.6	0.35	0.34
356	105.3	153.0	1.5	97.5	100.7	2.3	3.2	104.2	1.5	0.60	0.34
1068	114.2	305.5	2.7	97.5	102.1	3.5	4.6	112.7	2.7	0.86	0.37
1424	117.6	367.4	3.1	97.5	102.7	3.9	5.2	115.9	3.2	0.96	0.38

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51020									
142	577									577
356	1861									1861
1068	4669									4669
1424	6853									6853

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
142	1.74	1.5399	1.4629	Erosive	Erosive	Erosive	0.4	Stable	4.8	Stable	Stable
356	1.74	1.5138	1.4381	Erosive	Erosive	Erosive	0.4	Stable	6.2	Stable	Stable
1068	1.74	1.7031	1.6179	Erosive	Erosive	Erosive	0.4	Stable	8.2	Stable	Stable
1424	1.74	1.7423	1.6552	Erosive	Erosive	Erosive	0.5	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	142	356	1068	1424	142	356	1068	1424	142	356	1068	1424
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	144	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	225	259	1.1	1.6	2.5	2.8				
Chang	44	78	154	184	0.3	0.3	0.1	0.0				
Kellerhals	21	34	59	68	2.0	2.9	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	36	104	113	116								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	18.8	26.5	40.0	44.5	5	7	11	12	2.4	3.0	3.9	4.2
Average	33	57	92	105	2.1	2.8	4.2	4.6	2.6	3.0	3.5	3.7
Values As Designed	36	104	113	116	1.9	3.2	4.6	5.2	2.5	2.3	3.5	3.9
Difference with Design	-3	-48	-21	-11	0.2	-0.4	-0.4	-0.5	0.1	0.6	0.0	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	317	188	310	1263	828	64	44	80	1032	125	680	448
356	745	437	740	2874	2240	143	102	182	2557	294	1584	1082
1068	3885	1791	2708	17602	3585	893	454	1045	7999	1451	8121	4503
1424	5959	2529	3728	28134	4048	1363	633	1579	10721	2194	12155	6640

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	826	489	806	3291	2156	168	114	209	2688	327	1772	1168
356	776	455	771	2995	2335	149	106	190	2665	307	1651	1127
1068	1350	622	941	6115	1245	310	158	363	2779	504	2821	1564
1424	1552	659	971	7330	1055	355	165	411	2793	572	3167	1730

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	317	166	218	511	535	47	44	80	388	53	375	249
356	745	383	523	1162	1434	106	102	182	949	99	869	596
1068	3885	1626	2049	7118	2439	625	454	1045	3143	558	4678	2511
1424	5959	2308	2807	11376	2785	942	633	1579	4241	654	7086	3670

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	826	431	569	1331	1394	123	114	209	1010	139	978	648
356	776	399	545	1211	1494	110	106	190	989	103	905	621
1068	1350	565	712	2473	847	217	158	363	1092	194	1625	872
1424	1552	601	731	2964	725	245	165	411	1105	170	1846	956

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
142	0.0006	0.0008	173	0.53	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0067	0.0004	0.0016	0.0029	0.0026
356	0.0007	0.0008	166	0.51	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0005	0.0067	0.0003	0.0008	0.0030	0.0026
1068	0.0003	0.0004	226	0.69	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0067	0.0002	0.0003	0.0030	0.0025
1424	0.0003	0.0004	244	0.74	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0067	0.0001	0.0003	0.0029	0.0025

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	6.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	847	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.10	sq. mi
Total Sediment Yield Volume	0.19	ac ft

Sedimentation Basins

Length	847 ft	Depth	3 ft
Width	124 ft	Side slope	3 ft/ft
Total Volume per Basin		6.64	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
142	1.1	-0.6	0.1	24.6	1.9	1.6	2.5	0.0030	0.2	0.0	1.0	1.6
356	1.1	-1.1	0.1	24.6	3.2	1.5	2.3	0.0030	0.3	0.0	1.0	1.8
1068	1.1	-1.3	0.2	24.6	4.6	2.7	3.5	0.0030	0.5	0.0	1.0	2.1
1424	1.1	-1.4	0.2	24.6	5.2	3.2	3.9	0.0030	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	98.8	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	5.2	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	0.30	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2542	2542
Side Slope (?H:1V)	3	6
Channel Width (ft)	124	163
Channel XS Area (sq. ft)	529.2	655.95
Channel Perimeter (ft)	126	164

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	86714	110251
Excavated Area (sq. Yd)	35023	46038

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2542	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	424	sq. Yd
Volume	847	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2542	2542
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2542	2542
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	124	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.9	ft
Structure Height	12.9	ft
Number of Structures	3	
Volume per structure	177	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,275	
Area per structure	41	sq. Yd
Total Area	124	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10713	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 42,852	
Other Cost	$ -	
Total cost per basin	$ 42,852	
Area per basin	11,673	sq. Yd
Total Area	11,673	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	86,714	cu. Yd	$ 10.00	$ 867,140	35,023	sq. Yd	$ 9.00	$ 315,207	35,023	sq. Yd	$ 8.33	$ 291,858
Exc. Chl - LC Enhancement	Excavated	23,537	cu. Yd	$ 10.00	$ 235,370	11,015	sq. Yd	$ 9.00	$ 99,135	11,015	sq. Yd	$ 8.33	$ 91,792
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	847	cu. Yd	$ 75.00	$ 63,525	424	sq. Yd	$ -	$ -	424	sq. Yd	$ 25.00	$ 10,600
Drop Structures	Riprap	3	EA	$ 13,275.00	$ 39,825	124	sq. Yd	$ -	$ -	124	sq. Yd	$ 33.33	$ 4,133
Drop Str. - LC Enhancement	Riprap	3	EA	$ 1,327.50	$ 3,983	12	sq. Yd	$ -	$ -	12	sq. Yd	$ 33.33	$ 413
Sedimentation Basins		1	EA	$ 42,852.00	$ 42,852	11,673	sq. Yd	$ -	$ -	11,673	sq. Yd	$ 8.33	$ 97,275
Other					$ -				$ -				$ -
Base Landscape Cost									$ 315,207	Base Maintenance Cost			$ 403,867
LC Enhancement Cost									$ 99,135	LC Enhancement Cost			$ 92,205
Total Landscape Cost									$ 414,342	Total Maintenance Cost			$ 496,072

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,013,342	$ 239,353	$ 1,252,695
Contingency Cost (25% of Construction Cost)	$ 253,336	$ 59,838	$ 313,174
Engineering Design Cost (5% of Construction Cost)	$ 50,667	$ 11,968	$ 62,635
Total Construction Cost	$ 1,317,345	$ 311,158	$ 1,628,503

Land Cost

Channel Length	2542 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	7.8	$100,000	$ 780,000
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	124	7.2	$100,000	$ 720,000
Channel LC Enhancement	39	2.3	$100,000	$ 230,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	347	20.2		$ 2,020,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15	$100,000	$ 1,500,000
LC Enhancement Cost	acre	5.2	$100,000	$ 520,000
Total Land Cost	acre	20.2	$100,000	$ 2,020,000

Total Cost

Base Total Cost	$ 3,536,418
Total Landscape Enhancement Cost	$ 1,022,498
Total Cost Including LC Enh.	$ 4,558,917

Offline Basin

HEC1 ID	D415

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

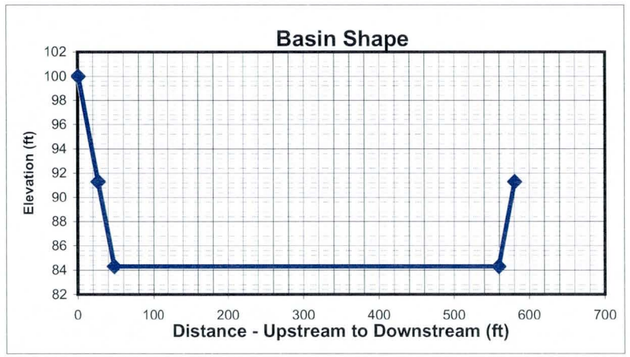
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	600	680
Basin Width (ft)	580	580
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	7	7
Freeboard (ft)	1	1
Effective Basin Width (ft)	553.9	527.8
Top Area (acres)	8.0	9.1
U/S-D/S Height Difference (ft)	8.7	8.7
Excess Area on Upstream (acres)	0.4	0.8

			Base	LC Enhanced
Bottom Length (ft)	558	Allocated Storage Volume (ac. ft)	42.1	41.8
Bottom Width (ft)	511.9	Total Available Volume (ac. ft) (incl. Freeboard)	49.6	49.9
		Total Excavation Volume (ac. ft)	84.4	89.3

Stage-Storage-Discharge

Stage (ft)	0										
Inflow (cfs)	0	200	400	600	800	1000	1231	1400	2000	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	169	769	1769	2769



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1581	2578	2578
Peak flow after diversion (cfs)	1231	1239	1239
Diverted Peak Flow (cfs)	350	1339	1339
Total Diverted Flow Volume (ac. ft)	9.0	37	37.0
Peak Stage	1.1	ft	

Volume Check			***Stage Check***	
Total Volume needed	37.0	ac. ft	Depth Needed	2.1
Total Volume Provided	42.1	ac. ft	Depth Provided	7

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 512+67

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	182400	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	580	ft
LC Enh. Total ROW Length	780	ft
LC Enh. Total ROW Length	680	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	136165	144071
Excavated Area (sq. Yd)	38667	58933

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	50	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	552	sq. Yd
Material Volume	276	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	700	ft
Unit Cost	160	per ft
Cost per outlet	$112,000	
Other Cost	$ -	
Total Cost	$112,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		136,165	cu. Yd	$ 4.00	$ 544,660	38,667	sq. Yd	$ 9.00	$ 348,003	38,667	sq. Yd	$ 8.33	$ 322,225	
Basin - LC Enhanced		7,906	cu. Yd	$ 4.00	$ 31,624	20,266	sq. Yd	$ 9.00	$ 182,394	20,266	sq. Yd	$ 8.33	$ 168,883	
Inlet	Riprap	276	sq. Yd	$ 75.00	$ 20,700	552	sq. Yd	$ -	$ -	552	sq. Yd	$ 33.33	$ 18,400	
Inlet - LC Enhanced (20%Total)					$ 4,140				$ -				$ 3,680	
Outlet	Pipe	1	EA	$ 112,000	$ 112,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhanced (5%Total)					$ 5,600				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 348,003	Base Maintenance Cost			$ 342,842	
						LC Enh. Landscape Cost			$ 182,394	LC Enh. Maintenance Cost			$ 172,674	
						Total Landscape Cost			$ 530,397	Total Maintenance Cost			$ 515,516	

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 677,360	$ 31,624	$ 708,984
Contingency Cost (25% of Construction Cost)	$ 169,340	$ 7,906	$ 177,246
Engineering Design Cost (5% of Construction Cost)	$ 33,868	$ 1,581	$ 35,449
Total Construction Cost	$ 880,568	$ 41,111	$ 921,679

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.2	$100,000	$ 418,733
Basin	8.0	$100,000	$ 800,000
Other		$100,000	$ -
Total	12.2	$100,000	$ 1,220,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	8.0	$100,000	$ 798,898
LC Enhancement Cost	acre	4.2	$100,000	$ 421,102
Total Land Cost	acre	12.2	$100,000	$ 1,220,000

Total Cost

Base Total Cost	$ 2,370,311
Total LC Enhancement Cost	$ 817,281
Total Cost Including LC Enh.	$ 3,187,592

Open Channel

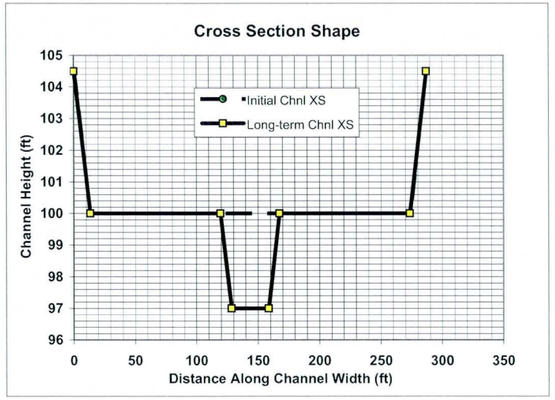
Structure ID	RR41510	HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

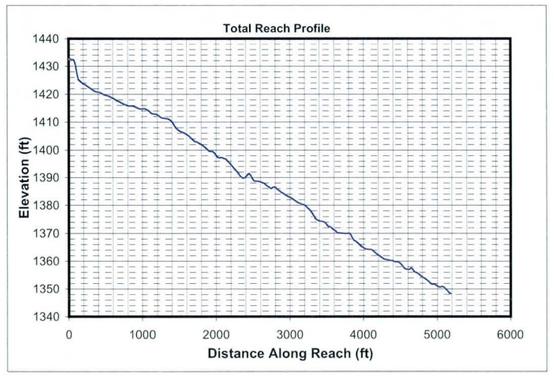
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	260	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	273.5	273.5	273.5	287
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	106	3	30	7.5	3	106	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	119.5	128.5	158.5	167.5	273.5	287
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	1239	1740							2979
Weighting Factor	1.00	0.20							
Flow into Channel	1239	348							1587

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	2.645	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1587	cfs	
Long-term Max. Chnl Capacity	9639	cfs	
Q2 Channel	159	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	287	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
159	262.0	81.9	0.3	100.0	100.3	1.9	0.3	261.9	0.3	0.12	0.61
397	263.4	142.1	0.5	100.0	100.5	2.8	0.5	263.3	0.5	0.20	0.67
1190	266.6	276.1	1.0	100.0	101.0	4.3	1.0	266.3	1.0	0.39	0.75
1587	267.9	328.7	1.2	100.0	101.2	4.8	1.2	267.5	1.2	0.47	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
159	39.5	51.7	1.3	97.0	98.5	3.1	1.5	39.0	1.3	0.56	0.47
397	46.0	95.2	2.1	97.0	99.5	4.2	2.5	45.2	2.1	0.95	0.51
1190	267.1	372.1	1.4	97.0	101.0	3.2	4.0	265.8	1.4	1.49	0.48
1587	268.8	443.3	1.6	97.0	101.2	3.6	4.2	267.4	1.7	1.59	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
159										0
397										0
1190										0
1587										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
159	1.74	1.0369	0.9851	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
397	1.74	1.2053	1.1450	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1190	1.74	1.4066	1.3362	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
1587	1.74	1.4590	1.3861	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	159	397	1190	1587	159	397	1190	1587	159	397	1190	1587
Bray - Equation #1	34	56	99	116	1.4	2.0	2.8	3.1	3.2	3.7	4.3	4.4
Bray - Equation #2	45	73	131	152	1.6	2.1	3.1	3.4	2.2	2.5	2.9	3.0
Hey	10	17	32	37	4.4	6.3	9.5	10.6				
Ackers & Charlton/Lacey	30	44	70	80					1.9	2.2	2.6	2.7
Parker	87	137	237	274	1.1	1.7	2.6	2.9				
Chang	61	106	207	246	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	36	62	72	2.1	3.0	4.6	5.2	3.4	3.7	4.1	4.3
AMAFCA/Schumm	39	45	266	268								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.2	24.2	36.5	40.7	5	6	10	11	3.2	4.0	5.2	5.6
Average	36	56	116	130	2.1	2.8	4.1	4.6	2.8	3.2	3.8	4.0
Values As Designed	39	45	266	267	1.5	2.5	4.0	4.2	3.1	4.2	3.2	3.6
Difference with Design	-3	10	-150	-137	0.6	0.3	0.1	0.3	-0.3	-1.0	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
159	1351	870	1834	2495	4021	420	381	211	5647	414	1446	1735
397	5584	2842	5559	11807	5978	1803	1266	1101	14886	1426	6126	5307
1190	30323	10342	17068	75798	9107	8544	4164	5684	45687	6819	29365	22082
1587	47184	14304	22263	123217	10105	12716	5568	8458	61088	10340	43417	32605

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
159	3158	2033	4287	5833	9399	983	890	493	13201	967	3381	4057
397	5222	2657	5198	11041	5590	1686	1184	1030	13920	1333	5729	4963
1190	9452	3224	5320	23626	2839	2663	1298	1772	14241	2126	9153	6883
1587	11031	3344	5204	28805	2362	2973	1302	1977	14281	2417	10150	7622

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
159	951	443	682	1837	831	205	151	221	1326	204	1113	724
397	3585	1294	1862	7856	1302	720	414	807	3402	750	3968	2360
1190	7619	3258	5195	14750	5880	1631	1168	1773	9989	1611	8864	5612
1587	11847	4664	7158	23952	6616	2479	1628	2742	13463	2473	13548	8234

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
159	2224	1035	1595	4294	1943	479	352	517	3100	477	2603	1693
397	3352	1210	1741	7346	1218	673	388	755	3181	701	3711	2207
1190	2375	1015	1619	4598	1833	508	364	553	3114	502	2763	1749
1587	2770	1090	1673	5599	1547	579	381	641	3147	578	3167	1925

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
159	0.0025	0.0039	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0064	0.0004	0.0027	0.0161	0.0062
397	0.0013	0.0022	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0064	0.0002	0.0014	0.0162	0.0060
1190	0.0006	0.0012	241	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0001	0.0006	0.0162	0.0058
1587	0.0005	0.0010	262	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0001	0.0005	0.0162	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	52.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	289	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	289 ft	Depth	3 ft
Width	287 ft	Side slope	3 ft/ft
Total Volume per Basin		5.36	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
159	1.1	-0.5	0.1	24.6	1.5	1.3	3.1	0.0060	0.2	0.0	3.0	4.2
397	1.1	-0.7	0.2	24.6	2.5	2.1	4.2	0.0060	0.3	0.0	3.0	4.4
1190	1.1	-1.2	0.1	24.6	4.0	1.4	3.2	0.0060	0.4	0.0	3.0	4.5
1587	1.1	-1.2	0.2	24.6	4.2	1.7	3.6	0.0060	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	856	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.39	ac. ft
Deposited(+)/Eroded(-) Volume	0.28	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	3
Channel Width (ft)	287	287
Channel XS Area (sq. ft)	1347.8	1347.8
Channel Perimeter (ft)	289	289

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1733	sq. Yd
Volume	4620	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5198	5198
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24257	50247
Left Levee Volume (cu. Yd)	23872	56215
Right Levee Length (ft)	5198	5198
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24257	50247
Right Levee Volume (cu. Yd)	23872	56215
Total Levee Surface Area (sq. Yd)	48514	100494
Total Levee Volume (cu. Yd)	47744	112430

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8086	19059
Left Levee Lining Volume (cu. Yd)	4043	9530
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8086	19059
Right Levee Lining Volume (cu. Yd)	4043	9530
Total Lining Area (sq. Yd)	16172	38119
Total Lining Volume (cu. Yd)	8086	19060

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	287	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	18	
Volume per structure	303	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,725	
Area per structure	96	sq. Yd
Total Area	1,722	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8647	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 34,588	
Other Cost	$ -	
Total cost per basin	$ 34,588	
Area per basin	9,209	sq. Yd
Total Area	9,209	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,744	cu. Yd	$ 7.00	$ 334,208	48,514	sq. Yd	$ 9.00	$ 436,626	48,514	sq. Yd	$ 11.67	$ 565,997
Levee - LC Enhancement	Fill	64,686	cu. Yd	$ 7.00	$ 452,802	51,980	sq. Yd	$ 9.00	$ 467,820	64,686	sq. Yd	$ 11.67	$ 754,670
Levee Lining	Riprap	8,086	cu. Yd	$ 75.00	$ 606,450	16,172	sq. Yd	$ -	$ -	16,172	sq. Yd	$ 20.83	$ 336,907
Levee Lining -LC Enhancement	Riprap	10,974	cu. Yd	$ 75.00	$ 823,050	21,947	sq. Yd	$ -	$ -	21,947	sq. Yd	$ 20.83	$ 457,231
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,620	cu. Yd	$ 75.00	$ 346,500	1,733	sq. Yd	$ -	$ -	1,733	sq. Yd	$ 25.00	$ 43,325
Drop Structures	Riprap	18	EA	$ 22,725.00	$ 409,050	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 33.33	$ 57,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 2,272.50	$ 40,905	172	sq. Yd	$ -	$ -	172	sq. Yd	$ 33.33	$ 5,740
Sedimentation Basins		1	EA	$ 34,588.00	$ 34,588	9,209	sq. Yd	$ -	$ -	9,209	sq. Yd	$ 8.33	$ 76,742
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 436,626	Base Maintenance Cost			$ 1,080,371
						LC Enhancement Cost			$ 467,820	LC Enhancement Cost			$ 1,217,641
						Total Landscape Cost			$ 904,446	Total Maintenance Cost			$ 2,298,012

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,730,796	$ 1,316,757	$ 3,047,553
Contingency Cost (25% of Construction Cost)	$ 432,699	$ 329,189	$ 761,888
Engineering Design Cost (5% of Construction Cost)	$ 86,540	$ 65,838	$ 152,378
Total Construction Cost	$ 2,250,035	$ 1,711,784	$ 3,961,819

Land Cost

Channel Length	5198 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	287	34.2	$100,000	$ 3,420,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.6	$100,000	$ 660,000
Levee LC Enhancement	51	6.1	$100,000	$ 610,000
Other	0	0	$100,000	$ -
Total	393	46.9		$ 4,690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	40.8	$100,000	$ 4,080,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	46.9	$100,000	$ 4,690,000

Total Cost

Base Total Cost	$ 7,847,032
Total Landscape Enhancement Cost	$ 4,007,246
Total Cost Including LC Enh.	$ 11,854,277

Open Channel

Structure ID	C42010

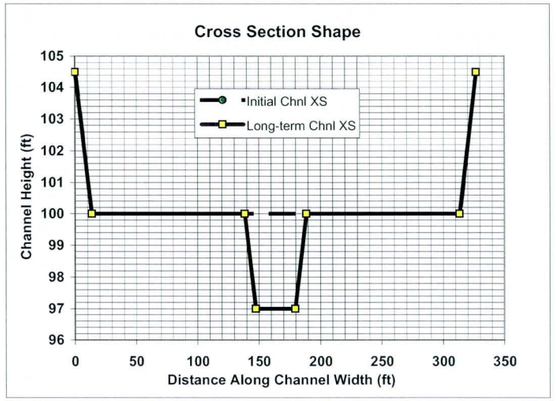
HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

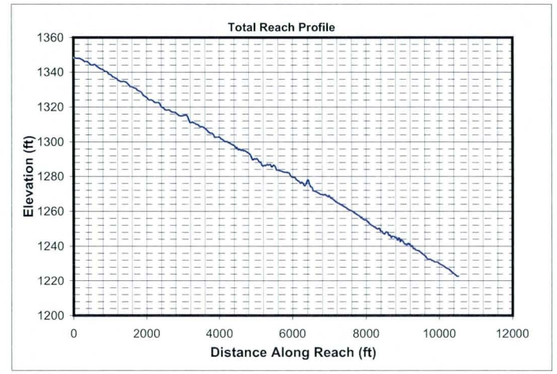
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	1239	1740							2979
Weighting Factor	1.00	0.43							
Flow into Channel	1239	755							1994

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	473.00								473
Sediment Conc. (ppm)	2207								
Sediment Volume (ac. ft)	0.39								0.39
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.39								0.39

Hydrology

Drainage Area	3.057	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1994	cfs	
Long-term Max. Chnl Capacity	10012	cfs	
Q2 Channel	199	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	302.3	108.9	0.4	100.0	100.4	1.8	0.4	302.2	0.4	0.11	0.54
499	304.0	188.9	0.6	100.0	100.6	2.6	0.6	303.8	0.6	0.20	0.59
1496	307.6	367.1	1.2	100.0	101.2	4.1	1.2	307.3	1.2	0.38	0.66
1994	309.1	437.1	1.4	100.0	101.4	4.6	1.4	308.6	1.4	0.45	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
199	43.0	64.8	1.5	97.0	98.7	3.1	1.7	42.4	1.5	0.54	0.44
499	50.6	119.8	2.4	97.0	99.9	4.2	2.9	49.6	2.4	0.92	0.47
1496	308.4	477.3	1.5	97.0	101.2	3.1	4.2	307.0	1.6	1.30	0.44
1994	310.2	568.7	1.8	97.0	101.5	3.5	4.5	308.8	1.8	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
199	724									724
499	2360									2360
1496	5612									5612
1994	8234									8234

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
199	1.74	1.0807	1.0267	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
499	1.74	1.2490	1.1866	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
1496	1.74	1.4503	1.3778	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1994	1.74	1.5028	1.4276	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	199	499	1496	1994	199	499	1496	1994	199	499	1496	1994
Bray - Equation #1	39	63	112	130	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	147	171	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	42	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	153	266	307	1.2	1.8	2.9	3.2				
Chang	66	115	224	266	0.1	0.0	-0.5	-0.7				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	42	50	307	309								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	19.4	27.3	41.2	45.9	5	7	11	12	3.1	3.9	5.2	5.6
Average	40	62	130	146	2.3	3.1	4.5	5.0	2.8	3.3	3.9	4.1
Values As Designed	42	50	307	309	1.7	2.9	4.2	4.5	3.1	4.2	3.1	3.5
Difference with Design	-2	12	-177	-163	0.5	0.2	0.4	0.6	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1170	746	1463	2020	4084	294	287	171	4353	336	1233	1469
499	4833	2548	4813	9558	6183	1393	1059	971	11726	1187	5447	4520
1496	26239	9546	15533	61359	9543	6780	3639	5238	36305	5803	27008	18818
1994	40839	13275	20106	99747	10613	10112	4899	7853	48595	8845	40238	27738

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	2176	1387	2722	3758	7599	547	533	318	8100	625	2294	2733
499	3597	1897	3582	7114	4601	1037	788	722	8727	884	4054	3364
1496	6509	2368	3853	15222	2367	1682	903	1299	9006	1440	6700	4668
1994	7598	2470	3741	18559	1975	1881	912	1461	9041	1646	7487	5161

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1002	466	690	1888	880	201	150	242	1261	209	1186	743
499	3760	1367	1868	8029	1389	707	418	879	3243	662	4238	2414
1496	7794	3406	5231	14553	6442	1556	1157	1878	9476	1606	9185	5662
1994	12117	4892	7163	23635	7263	2376	1624	2914	12796	2471	14099	8304

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
199	1865	867	1283	3514	1637	373	280	450	2346	390	2206	1383
499	2798	1017	1390	5975	1034	526	311	654	2414	493	3154	1797
1496	1934	845	1298	3610	1598	386	287	466	2351	398	2279	1405
1994	2254	910	1333	4397	1351	442	302	542	2381	460	2623	1545

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
199	0.0024	0.0034	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0060	0.0003	0.0025	0.0119	0.0050
499	0.0012	0.0020	161	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0060	0.0002	0.0013	0.0120	0.0048
1496	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0060	0.0001	0.0006	0.0119	0.0046
1994	0.0004	0.0009	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0004	0.0119	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	73.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	25	
Distance between structs.	421	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	421 ft	Depth	3 ft	
Width	327 ft	Side slope	3	ft/ft
Total Volume per Basin		9.03	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
199	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	0.0	3.0	4.2
499	1.1	-0.8	0.2	24.6	2.9	2.4	4.2	0.0050	0.3	0.0	3.0	4.5
1496	1.1	-1.2	0.1	24.6	4.2	1.6	3.1	0.0050	0.4	0.0	3.0	4.6
1994	1.1	-1.3	0.2	24.6	4.5	1.8	3.5	0.0050	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	856	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.18	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	0.86	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	3512	sq. Yd
Volume	9364	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10535	10535
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	49163	101838
Left Levee Volume (cu. Yd)	48383	113934
Right Levee Length (ft)	10535	10535
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	49163	101838
Right Levee Volume (cu. Yd)	48383	113934
Total Levee Surface Area (sq. Yd)	98326	203676
Total Levee Volume (cu. Yd)	96766	227868

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16388	38628
Left Levee Lining Volume (cu. Yd)	8194	19314
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16388	38628
Right Levee Lining Volume (cu. Yd)	8194	19314
Total Lining Area (sq. Yd)	32776	77257
Total Lining Volume (cu. Yd)	16388	38628

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.8	ft
Structure Height	9.8	ft
Number of Structures	25	
Volume per structure	357	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 26,775	
Area per structure	109	sq. Yd
Total Area	2,725	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14568	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 58,272	
Other Cost	$ -	
Total cost per basin	$ 58,272	
Area per basin	15,311	sq. Yd
Total Area	15,311	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	96,766	cu. Yd	$ 7.00	$ 677,362	98,326	sq. Yd	$ 9.00	$ 884,934	98,326	sq. Yd	$ 11.67	$ 1,147,137
Levee - LC Enhancement	Fill	131,102	cu. Yd	$ 7.00	$ 917,714	105,350	sq. Yd	$ 9.00	$ 948,150	131,102	sq. Yd	$ 11.67	$ 1,529,523
Levee Lining	Riprap	16,388	cu. Yd	$ 75.00	$ 1,229,100	32,776	sq. Yd	$ -	$ -	32,776	sq. Yd	$ 20.83	$ 682,824
Levee Lining -LC Enhancement	Riprap	22,240	cu. Yd	$ 75.00	$ 1,668,000	44,481	sq. Yd	$ -	$ -	44,481	sq. Yd	$ 20.83	$ 926,690
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	9,364	cu. Yd	$ 75.00	$ 702,300	3,512	sq. Yd	$ -	$ -	3,512	sq. Yd	$ 25.00	$ 87,800
Drop Structures	Riprap	25	EA	$ 26,775.00	$ 669,375	2,725	sq. Yd	$ -	$ -	2,725	sq. Yd	$ 33.33	$ 90,833
Drop Str. - LC Enhancement	Riprap	25	EA	$ 2,677.50	$ 66,938	273	sq. Yd	$ -	$ -	273	sq. Yd	$ 33.33	$ 9,083
Sedimentation Basins		1	EA	$ 58,272.00	$ 58,272	15,311	sq. Yd	$ -	$ -	15,311	sq. Yd	$ 8.33	$ 127,592
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 884,934	Base Maintenance Cost			$ 2,136,186
						LC Enhancement Cost			$ 948,150	LC Enhancement Cost			$ 2,465,296
						Total Landscape Cost			$ 1,833,084	Total Maintenance Cost			$ 4,601,482

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,336,409	$ 2,652,652	$ 5,989,061
Contingency Cost (25% of Construction Cost)	$ 834,102	$ 663,163	$ 1,497,265
Engineering Design Cost (5% of Construction Cost)	$ 166,820	$ 132,633	$ 299,453
Total Construction Cost	$ 4,337,332	$ 3,448,447	$ 7,785,779

Land Cost

Channel Length	10535	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	79.1	$100,000	$ 7,910,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.3	$100,000	$ 1,330,000
Levee LC Enhancement	51	12.3	$100,000	$ 1,230,000
Other	0	0	$100,000	$ -
Total	433	104.7		$ 10,470,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	92.4	$100,000	$ 9,240,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	104.7	$100,000	$ 10,470,000

Total Cost

Base Total Cost	$ 16,598,451
Total Landscape Enhancement Cost	$ 8,091,893
Total Cost Including LC Enh.	$ 24,690,345

Open Channel

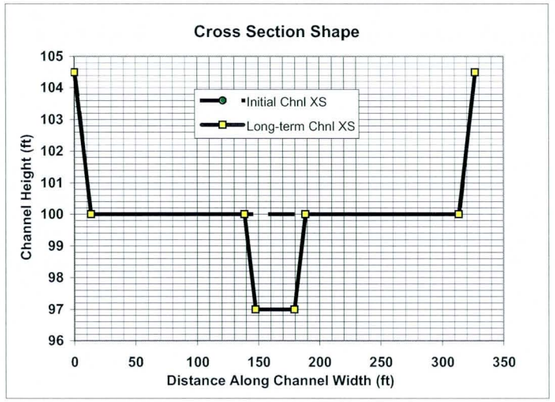
Structure ID	C42020	HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

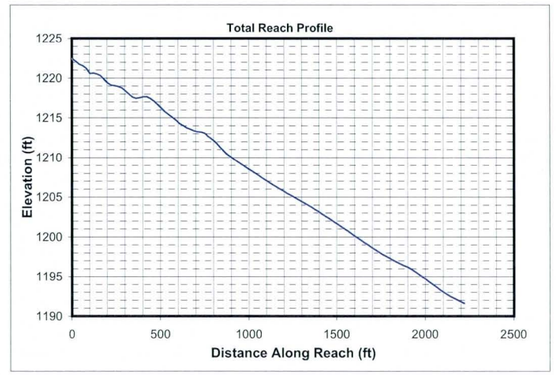
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	32	7.5	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	147.5	179.5	188.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1697									1697
Weighting Factor	1.00									
Flow into Channel	1697									1697

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	473.00									473
Sediment Conc. (ppm)	1797									
Sediment Volume (ac. ft)	0.32									0.32
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.32									0.32

Hydrology

Drainage Area	4.058	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1697	cfs	
Long-term Max. Chnl Capacity	10501	cfs	
Q2 Channel	170	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	302.0	94.4	0.3	100.0	100.3	1.8	0.3	301.9	0.3	0.11	0.57
424	303.4	163.8	0.5	100.0	100.5	2.6	0.5	303.3	0.5	0.19	0.62
1273	306.6	318.1	1.0	100.0	101.0	4.0	1.0	306.3	1.0	0.36	0.69
1697	307.9	378.7	1.2	100.0	101.2	4.5	1.2	307.5	1.2	0.43	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	41.8	56.5	1.4	97.0	98.5	3.0	1.5	41.3	1.4	0.53	0.45
424	48.5	103.9	2.1	97.0	99.6	4.1	2.6	47.7	2.2	0.90	0.49
1273	307.2	420.4	1.4	97.0	101.0	3.0	4.0	305.9	1.4	1.37	0.46
1697	308.8	500.7	1.6	97.0	101.2	3.4	4.2	307.5	1.6	1.46	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
170	743									743
424	2414									2414
1273	5662									5662
1697	8304									8304

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
170	1.74	1.0372	0.9853	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
424	1.74	1.2056	1.1453	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1273	1.74	1.4072	1.3368	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1697	1.74	1.4597	1.3867	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	170	424	1273	1697	170	424	1273	1697	170	424	1273	1697
Bray - Equation #1	36	58	103	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	135	157	1.6	2.2	3.1	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.5	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	72	82					1.9	2.2	2.6	2.8
Parker	89	142	245	283	1.2	1.7	2.7	3.0				
Chang	61	108	209	249	0.1	0.0	-0.5	-0.6				
Kellerhals	23	37	64	74	2.1	3.1	4.7	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	41	48	306	308								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.9	25.2	38.1	42.4	5	7	10	11	3.1	3.9	5.2	5.5
Average	38	58	123	138	2.1	2.9	4.3	4.7	2.8	3.2	3.8	4.0
Values As Designed	41	48	306	307	1.5	2.6	4.0	4.2	3.0	4.1	3.0	3.4
Difference with Design	-3	10	-183	-170	0.6	0.3	0.3	0.5	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1122	732	1490	1968	4110	302	294	158	4663	343	1169	1486
424	4640	2491	4880	9317	6212	1424	1077	910	12521	1182	5181	4530
1273	25222	9307	15704	59876	9571	6923	3694	4947	38717	5685	25659	18664
1697	39263	12934	20330	97373	10639	10324	4970	7422	51816	8640	38197	27446

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2453	1600	3258	4302	8985	661	642	345	10194	749	2556	3249
424	4058	2178	4267	8148	5432	1245	942	796	10949	1034	4531	3962
1273	7352	2713	4578	17453	2790	2018	1077	1442	11286	1657	7479	5440
1697	8584	2828	4445	21288	2326	2257	1087	1623	11328	1889	8351	6000

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	907	429	656	1714	847	189	143	214	1238	193	1069	691
424	3428	1264	1777	7349	1329	671	398	790	3185	711	3846	2250
1273	6945	3091	4963	12980	6296	1445	1089	1637	9288	1458	8160	5214
1697	10805	4451	6777	21091	7101	2213	1534	2555	12549	2239	12550	7624

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1983	938	1434	3748	1852	413	312	468	2706	421	2337	1510
424	2997	1105	1554	6427	1162	587	348	690	2785	622	3363	1967
1273	2024	901	1447	3784	1835	421	317	477	2708	425	2379	1520
1697	2362	973	1482	4611	1552	484	335	559	2743	490	2744	1667

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
170	0.0027	0.0039	123	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0029	0.0139	0.0056
424	0.0014	0.0022	161	0.49	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0063	0.0002	0.0014	0.0139	0.0054
1273	0.0006	0.0012	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0006	0.0139	0.0052
1697	0.0005	0.0010	243	0.74	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0139	0.0052

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	18.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		6.81	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
170	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0055	0.2	0.0	3.0	4.2
424	1.1	-0.7	0.2	24.6	2.6	2.2	4.1	0.0055	0.3	0.0	3.0	4.4
1273	1.1	-1.2	0.1	24.6	4.0	1.4	3.0	0.0055	0.4	0.0	3.0	4.5
1697	1.1	-1.2	0.2	24.6	4.2	1.6	3.4	0.0055	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	856	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	473.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.22	ac. ft
Outflowing Sediment Volume	0.35	ac. ft
Deposited(+)/Eroded(-) Volume	1.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1533.8	1533.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	746	sq. Yd
Volume	1989	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2238	2238
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	10444	21634
Left Levee Volume (cu. Yd)	10278	24204
Right Levee Length (ft)	2238	2238
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	10444	21634
Right Levee Volume (cu. Yd)	10278	24204
Total Levee Surface Area (sq. Yd)	20888	43268
Total Levee Volume (cu. Yd)	20556	48408

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3481	8206
Left Levee Lining Volume (cu. Yd)	1741	4103
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3481	8206
Right Levee Lining Volume (cu. Yd)	1741	4103
Total Lining Area (sq. Yd)	6963	16412
Total Lining Volume (cu. Yd)	3482	8206

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.2	ft
Structure Height	9.2	ft
Number of Structures	7	
Volume per structure	336	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,200	
Area per structure	109	sq. Yd
Total Area	763	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10987	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,948	
Other Cost	$ -	
Total cost per basin	$ 43,948	
Area per basin	11,615	sq. Yd
Total Area	11,615	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	20,556	cu. Yd	$ 7.00	$ 143,892	20,888	sq. Yd	$ 9.00	$ 187,992	20,888	sq. Yd	$ 11.67	$ 243,693
Levee - LC Enhancement	Fill	27,852	cu. Yd	$ 7.00	$ 194,964	22,380	sq. Yd	$ 9.00	$ 201,420	27,852	sq. Yd	$ 11.67	$ 324,940
Levee Lining	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	6,963	sq. Yd	$ -	$ -	6,963	sq. Yd	$ 20.83	$ 145,056
Levee Lining -LC Enhancement	Riprap	4,724	cu. Yd	$ 75.00	$ 354,300	9,449	sq. Yd	$ -	$ -	9,449	sq. Yd	$ 20.83	$ 196,861
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,989	cu. Yd	$ 75.00	$ 149,175	746	sq. Yd	$ -	$ -	746	sq. Yd	$ 25.00	$ 18,650
Drop Structures	Riprap	7	EA	$ 25,200.00	$ 176,400	763	sq. Yd	$ -	$ -	763	sq. Yd	$ 33.33	$ 25,433
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,520.00	$ 17,640	76	sq. Yd	$ -	$ -	76	sq. Yd	$ 33.33	$ 2,543
Sedimentation Basins		1	EA	$ 43,948.00	$ 43,948	11,615	sq. Yd	$ -	$ -	11,615	sq. Yd	$ 8.33	$ 96,792
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 187,992	Base Maintenance Cost			$ 529,624
						LC Enhancement Cost			$ 201,420	LC Enhancement Cost			$ 524,344
						Total Landscape Cost			$ 389,412	Total Maintenance Cost			$ 1,053,968

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 774,565	$ 566,904	$ 1,341,469
Contingency Cost (25% of Construction Cost)	$ 193,641	$ 141,726	$ 335,367
Engineering Design Cost (5% of Construction Cost)	$ 38,728	$ 28,345	$ 67,073
Total Construction Cost	$ 1,006,935	$ 736,975	$ 1,743,910

Land Cost

Channel Length	2238 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	16.8	$100,000	$ 1,680,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2.8	$100,000	$ 280,000
Levee LC Enhancement	51	2.6	$100,000	$ 260,000
Other	0	0	$100,000	$ -
Total	433	22.2		$ 2,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.6	$100,000	$ 1,960,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	22.2	$100,000	$ 2,220,000

Total Cost

Base Total Cost	$ 3,684,550
Total Landscape Enhancement Cost	$ 1,722,740
Total Cost Including LC Enh.	$ 5,407,290

Open Channel

Structure ID	S51010

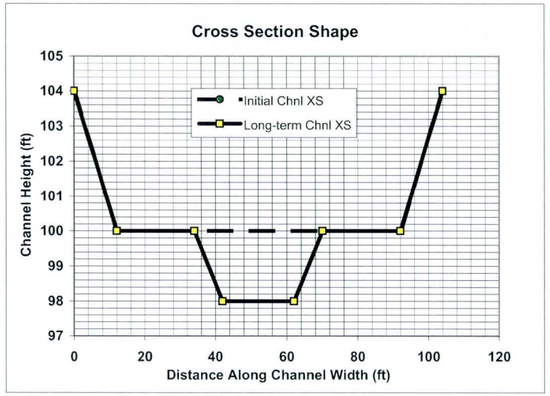
HEC1 ID	S51010

Longitudal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0072	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

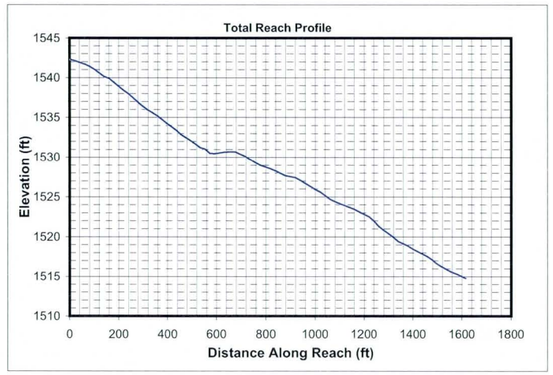
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	4	80	4	4	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	92	92	92	104
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	22	4	20	6	4	22	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	34	42	62	70	92	104
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510									TOTAL
HEC1 Peak-Flow	2099									2099
Weighting Factor	0.21									
Flow into Channel	441									441

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	3006	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	104	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	81.8	23.5	0.3	100.0	100.3	1.9	0.3	81.7	0.3	0.13	0.62
110	83.2	40.9	0.5	100.0	100.5	2.7	0.5	83.0	0.5	0.23	0.68
331	86.1	80.1	0.9	100.0	101.0	4.1	1.0	85.8	0.9	0.43	0.75
441	87.3	95.7	1.1	100.0	101.1	4.6	1.1	86.9	1.1	0.52	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	26.9	19.5	0.7	98.0	98.8	2.3	0.8	26.7	0.7	0.37	0.47
110	31.6	36.0	1.1	98.0	99.4	3.1	1.4	31.2	1.2	0.63	0.50
331	84.1	102.9	1.2	98.0	100.6	3.2	2.6	83.4	1.2	1.16	0.51
441	85.6	123.2	1.4	98.0	100.8	3.6	2.8	84.9	1.5	1.26	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
44										0
110										0
331										0
441										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.0105	0.9600	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
110	1.74	1.1770	1.1181	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
331	1.74	1.3744	1.3057	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
441	1.74	1.4254	1.3541	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	44	110	331	441	44	110	331	441	44	110	331	441
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	29	52	101	120	0.1	0.1	-0.1	-0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	27	31	84	85								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	10.3	14.5	21.8	24.3	3	4	6	6	2.5	3.1	4.1	4.4
Average	20	30	55	62	1.3	1.8	2.6	2.8	2.3	2.7	3.2	3.3
Values As Designed	27	31	83	85	0.8	1.4	2.6	2.8	2.3	3.1	3.2	3.6
Difference with Design	-7	-2	-29	-23	0.4	0.3	0.0	0.0	0.0	-0.4	0.0	-0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	379	249	531	699	1225	119	110	57	1697	121	401	508
110	1558	815	1632	3286	1839	517	370	304	4482	408	1710	1538
331	8346	2967	5083	20775	2849	2441	1226	1577	13769	1912	8176	6284
441	12923	4102	6614	33578	3180	3622	1642	2346	18413	2883	12069	9216

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	3192	2092	4471	5884	10306	1004	922	478	14272	1017	3375	4274
110	5244	2743	5492	11058	6188	1740	1245	1021	15082	1374	5753	5176
331	9362	3328	5702	23303	3196	2738	1375	1768	15445	2145	9171	7048
441	10872	3451	5564	28248	2676	3047	1381	1973	15491	2425	10153	7753

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	210	117	202	367	421	47	42	42	462	49	240	200
110	789	366	589	1561	685	183	132	177	1217	174	913	617
331	2534	1094	1797	5081	1916	583	406	571	3667	552	2913	1919
441	3914	1555	2474	8186	2168	878	562	876	4935	841	4413	2800

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1764	987	1699	3091	3545	395	352	352	3890	413	2016	1682
110	2655	1230	1983	5252	2305	616	443	597	4094	585	3071	2076
331	2843	1227	2015	5699	2149	654	455	640	4114	620	3268	2153
441	3292	1308	2081	6887	1824	739	472	737	4151	707	3713	2356

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0028	0.0042	130	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0021	0.0099	0.0007	0.0033	0.0170	0.0074
110	0.0014	0.0025	171	0.52	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0099	0.0004	0.0017	0.0171	0.0071
331	0.0006	0.0013	235	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0099	0.0003	0.0007	0.0170	0.0069
441	0.0005	0.0011	255	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0099	0.0002	0.0006	0.0170	0.0069

Drop Structures

Design Slope	0.0072	ft/ft
Total Drop Needed	16.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	272	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	272 ft	Depth	3 ft
Width	104 ft	Side slope	3 ft/ft
Total Volume per Basin		1.72	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	-0.3	0.1	24.6	0.8	0.7	2.3	0.0072	0.1	0.0	2.0	2.8
110	1.1	-0.4	0.1	24.6	1.4	1.2	3.1	0.0072	0.2	0.0	2.0	2.9
331	1.1	-0.8	0.1	24.6	2.6	1.2	3.2	0.0072	0.3	0.0	2.0	3.1
441	1.1	-0.8	0.2	24.6	2.8	1.5	3.6	0.0072	0.3	0.0	2.0	3.1

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	2063	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.23	ac. ft
Deposited(+)/Eroded(-) Volume	0.52	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	3
Channel Width (ft)	104	104
Channel XS Area (sq. ft)	424	424
Channel Perimeter (ft)	106	106

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	545	sq. Yd
Volume	1271	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1634	1634
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	7081	14706
Left Levee Volume (cu. Yd)	6294	15130
Right Levee Length (ft)	1634	1634
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	7081	14706
Right Levee Volume (cu. Yd)	6294	15130
Total Levee Surface Area (sq. Yd)	14162	29412
Total Levee Volume (cu. Yd)	12588	30260

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2360	5447
Left Levee Lining Volume (cu. Yd)	1180	2723
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2360	5447
Right Levee Lining Volume (cu. Yd)	1180	2723
Total Lining Area (sq. Yd)	4720	10893
Total Lining Volume (cu. Yd)	2360	5446

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	104	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	6	
Volume per structure	104	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,800	
Area per structure	35	sq. Yd
Total Area	208	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2775	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,100	
Other Cost	$ -	
Total cost per basin	$ 11,100	
Area per basin	3,146	sq. Yd
Total Area	6,292	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	12,588	cu. Yd	$ 7.00	$ 88,116	14,162	sq. Yd	$ 9.00	$ 127,458	14,162	sq. Yd	$ 11.67	$ 165,223	
Levee - LC Enhancement	Fill	17,672	cu. Yd	$ 7.00	$ 123,704	15,250	sq. Yd	$ 9.00	$ 137,250	17,672	sq. Yd	$ 11.67	$ 206,173	
Levee Lining	Riprap	2,360	cu. Yd	$ 75.00	$ 177,000	4,720	sq. Yd	$ -	$ -	4,720	sq. Yd	$ 20.83	$ 98,343	
Levee Lining -LC Enhancement	Riprap	3,086	cu. Yd	$ 75.00	$ 231,450	6,173	sq. Yd	$ -	$ -	6,173	sq. Yd	$ 20.83	$ 128,602	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	1,271	cu. Yd	$ 75.00	$ 95,325	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 25.00	$ 13,625	
Drop Structures	Riprap	6	EA	$ 7,800.00	$ 46,800	208	sq. Yd	$ -	$ -	208	sq. Yd	$ 33.33	$ 6,933	
Drop Str. - LC Enhancement	Riprap	6	EA	$ 780.00	$ 4,680	21	sq. Yd	$ -	$ -	21	sq. Yd	$ 33.33	$ 693	
Sedimentation Basins		2	EA	$ 11,100.00	$ 22,200	6,292	sq. Yd	$ -	$ -	6,292	sq. Yd	$ 8.33	$ 52,433	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 127,458	Base Maintenance Cost	$ 336,558
LC Enhancement Cost	$ 137,250	LC Enhancement Cost	$ 335,469
Total Landscape Cost	$ 264,708	Total Maintenance Cost	$ 672,026

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 429,441	$ 359,834	$ 789,275
Contingency Cost (25% of Construction Cost)	$ 107,360	$ 89,959	$ 197,319
Engineering Design Cost (5% of Construction Cost)	$ 21,472	$ 17,992	$ 39,464
Total Construction Cost	$ 558,273	$ 467,784	$ 1,026,058

Land Cost

Channel Length	1634 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	104	3.9	$100,000	$ 390,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2	$100,000	$ 200,000
Levee LC Enhancement	48	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	204	7.7		$ 770,000

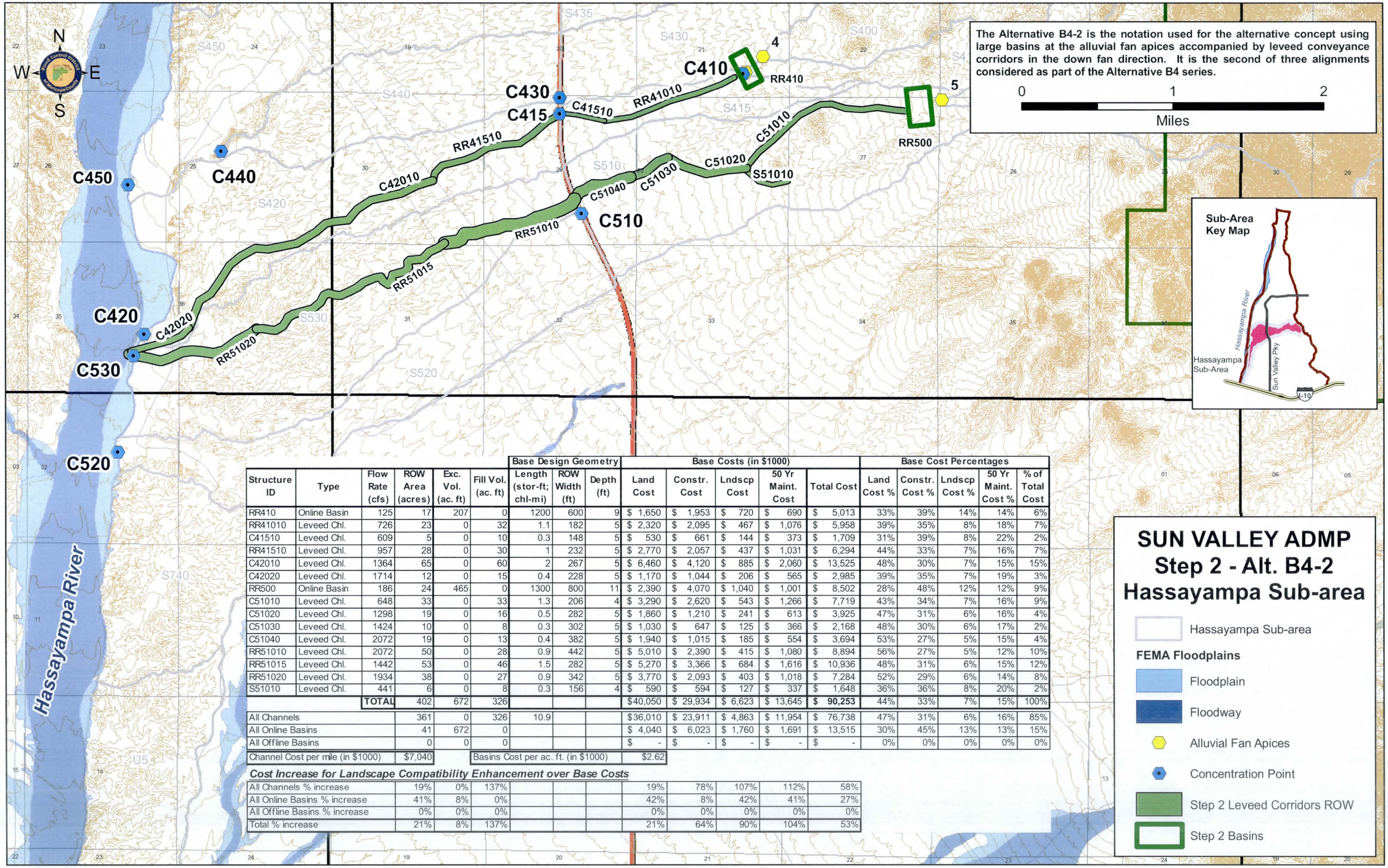
Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	5.9	$100,000	$ 590,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	7.7	$100,000	$ 770,000

Total Cost

Base Total Cost	$ 1,612,289
Total Landscape Enhancement Cost	$ 1,120,503
Total Cost Including LC Enh.	$ 2,732,792



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	17	207	0	1200	600	9	$ 1,650	$ 1,953	$ 720	$ 690	$ 5,013	33%	39%	14%	14%	6%
RR41010	Leveed Chl.	726	23	0	32	1.1	182	5	$ 2,320	$ 2,095	$ 467	$ 1,076	$ 5,958	39%	35%	8%	18%	7%
C41510	Leveed Chl.	609	5	0	10	0.3	148	5	$ 530	$ 661	$ 144	$ 373	$ 1,709	31%	39%	8%	22%	2%
RR41510	Leveed Chl.	957	28	0	30	1	232	5	$ 2,770	$ 2,057	$ 437	$ 1,031	$ 6,294	44%	33%	7%	16%	7%
C42010	Leveed Chl.	1364	65	0	60	2	267	5	$ 6,460	$ 4,120	$ 885	$ 2,060	$ 13,525	48%	30%	7%	15%	15%
C42020	Leveed Chl.	1714	12	0	15	0.4	228	5	$ 1,170	$ 1,044	$ 206	$ 565	$ 2,985	39%	35%	7%	19%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	9%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,620	$ 543	$ 1,266	$ 7,719	43%	34%	7%	16%	9%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,210	$ 241	$ 613	$ 3,925	47%	31%	6%	16%	4%
C51030	Leveed Chl.	1424	10	0	8	0.3	302	5	$ 1,030	$ 647	$ 125	$ 366	$ 2,168	48%	30%	6%	17%	2%
C51040	Leveed Chl.	2072	19	0	13	0.4	382	5	$ 1,940	$ 1,015	$ 185	$ 554	$ 3,694	53%	27%	5%	15%	4%
RR51010	Leveed Chl.	2072	50	0	28	0.9	442	5	$ 5,010	$ 2,390	$ 415	$ 1,080	$ 8,894	56%	27%	5%	12%	10%
RR51015	Leveed Chl.	1442	53	0	46	1.5	282	5	$ 5,270	$ 3,366	$ 684	$ 1,616	$ 10,936	48%	31%	6%	15%	12%
RR51020	Leveed Chl.	1934	38	0	27	0.9	342	5	$ 3,770	$ 2,093	$ 403	$ 1,018	$ 7,284	52%	29%	6%	14%	8%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 594	$ 127	$ 337	$ 1,648	36%	36%	8%	20%	2%
	TOTAL	402	672	326					$40,050	$ 29,934	$ 6,623	$ 13,645	**$ 90,253**	44%	33%	7%	15%	100%
All Channels		361	0	326	10.9				$36,010	$ 23,911	$ 4,863	$ 11,954	$ 76,738	47%	31%	6%	16%	85%
All Online Basins		41	672	0					$ 4,040	$ 6,023	$ 1,760	$ 1,691	$ 13,515	30%	45%	13%	13%	15%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$7,040		Basins Cost per ac. ft. (in $1000)					$2.62									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	19%	0%	137%				19%	78%	107%	112%	58%
All Online Basins % increase	41%	8%	0%				42%	8%	42%	41%	27%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	21%	8%	137%				21%	64%	90%	104%	53%

SUN VALLEY ADMP
Step 2 - Alt. B4-2
Hassayampa Sub-area

Hassayampa Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Leveed Corridors ROW

Step 2 Basins

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	17	207	0	1200	600	9	$ 1,650	$ 1,953	$ 720	$ 690	$ 5,013	33%	39%	14%	14%	6%
RR41010	Leveed Chl.	726	23	0	32	1.1	182	5	$ 2,320	$ 2,095	$ 467	$ 1,076	$ 5,958	39%	35%	8%	18%	7%
C41510	Leveed Chl.	609	5	0	10	0.3	148	5	$ 530	$ 661	$ 144	$ 373	$ 1,709	31%	39%	8%	22%	2%
RR41510	Leveed Chl.	957	28	0	30	1	232	5	$ 2,770	$ 2,057	$ 437	$ 1,031	$ 6,294	44%	33%	7%	16%	7%
C42010	Leveed Chl.	1364	65	0	60	2	267	5	$ 6,460	$ 4,120	$ 885	$ 2,060	$ 13,525	48%	30%	7%	15%	15%
C42020	Leveed Chl.	1714	12	0	15	0.4	228	5	$ 1,170	$ 1,044	$ 206	$ 565	$ 2,985	39%	35%	7%	19%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	9%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,620	$ 543	$ 1,266	$ 7,719	43%	34%	7%	16%	9%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,210	$ 241	$ 613	$ 3,925	47%	31%	6%	16%	4%
C51030	Leveed Chl.	1424	10	0	8	0.3	302	5	$ 1,030	$ 647	$ 125	$ 366	$ 2,168	48%	30%	6%	17%	2%
C51040	Leveed Chl.	2072	19	0	13	0.4	382	5	$ 1,940	$ 1,015	$ 185	$ 554	$ 3,694	53%	27%	5%	15%	4%
RR51010	Leveed Chl.	2072	50	0	28	0.9	442	5	$ 5,010	$ 2,390	$ 415	$ 1,080	$ 8,894	56%	27%	5%	12%	10%
RR51015	Leveed Chl.	1442	53	0	46	1.5	282	5	$ 5,270	$ 3,366	$ 684	$ 1,616	$ 10,936	48%	31%	6%	15%	12%
RR51020	Leveed Chl.	1934	38	0	27	0.9	342	5	$ 3,770	$ 2,093	$ 403	$ 1,018	$ 7,284	52%	29%	6%	14%	8%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 594	$ 127	$ 337	$ 1,648	36%	36%	8%	20%	2%
	TOTAL	402	672	326					$ 40,050	$ 29,934	$ 6,623	$ 13,645	**$ 90,253**	44%	33%	7%	15%	100%
All Channels		361	0	326	10.9				$ 36,010	$ 23,911	$ 4,863	$ 11,954	$ 76,738	47%	31%	6%	16%	85%
All Online Basins		41	672	0					$ 4,040	$ 6,023	$ 1,760	$ 1,691	$ 13,515	30%	45%	13%	13%	15%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$7,040		Basins Cost per ac. ft. (in $1000)					$2.62									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	LCE Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	24	219	0	1470	700	9	$ 2,360	$ 2,054	$ 1,029	$ 980	$ 6,424	37%	32%	16%	15%	5%
RR41010	Leveed Chl.	726	30	0	75	1.1	233	5	$ 2,970	$ 3,892	$ 968	$ 2,375	$ 10,204	29%	38%	9%	23%	7%
C41510	Leveed Chl.	609	7	0	24	0.3	202	5	$ 720	$ 1,208	$ 291	$ 777	$ 2,997	24%	40%	10%	26%	2%
RR41510	Leveed Chl.	957	34	0	70	1	283	5	$ 3,380	$ 3,745	$ 904	$ 2,246	$ 10,275	33%	36%	9%	22%	7%
C42010	Leveed Chl.	1364	77	0	141	2	318	5	$ 7,690	$ 7,538	$ 1,833	$ 4,522	$ 21,583	36%	35%	8%	21%	16%
C42020	Leveed Chl.	1714	15	0	35	0.4	282	5	$ 1,450	$ 1,833	$ 416	$ 1,143	$ 4,842	30%	38%	9%	24%	4%
RR500	Online Basin	186	34	509	0	1630	900	11	$ 3,370	$ 4,434	$ 1,467	$ 1,404	$ 10,675	32%	42%	14%	13%	8%
C51010	Leveed Chl.	648	41	0	80	1.3	254	4	$ 4,060	$ 4,633	$ 1,128	$ 2,698	$ 12,519	32%	37%	9%	22%	9%
C51020	Leveed Chl.	1298	22	0	39	0.5	333	5	$ 2,200	$ 2,149	$ 500	$ 1,285	$ 6,134	36%	35%	8%	21%	4%
C51030	Leveed Chl.	1424	12	0	20	0.3	353	5	$ 1,200	$ 1,131	$ 258	$ 713	$ 3,302	36%	34%	8%	22%	2%
C51040	Leveed Chl.	2072	22	0	30	0.4	433	5	$ 2,200	$ 1,737	$ 384	$ 1,070	$ 5,390	41%	32%	7%	20%	4%
RR51010	Leveed Chl.	2072	56	0	66	0.9	493	5	$ 5,590	$ 4,030	$ 860	$ 2,239	$ 12,719	44%	32%	7%	18%	9%
RR51015	Leveed Chl.	1442	62	0	109	1.5	333	5	$ 6,220	$ 6,016	$ 1,416	$ 3,519	$ 17,171	36%	35%	8%	20%	12%
RR51020	Leveed Chl.	1934	43	0	64	0.9	393	5	$ 4,330	$ 3,662	$ 834	$ 2,140	$ 10,966	39%	33%	8%	20%	8%
S51010	Leveed Chl.	441	8	0	19	0.3	204	4	$ 770	$ 1,061	$ 265	$ 672	$ 2,768	28%	38%	10%	24%	2%
	TOTAL	487	728	728	772				$ 48,510	$ 49,121	$ 12,555	$ 27,784	**$ 137,971**	35%	36%	9%	20%	100%
All Channels		429	0	772	10.9				$ 42,780	$ 42,633	$ 10,059	$ 25,400	$ 120,872	35%	35%	8%	21%	88%
All Online Basins		58	728	0					$ 5,730	$ 6,488	$ 2,496	$ 2,385	$ 17,099	34%	38%	15%	14%	12%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$11,089		Basins Cost per ac. ft. (in $1000)					$3.43									
All Channels % increase		19%	0%	137%					19%	78%	107%	112%	58%					
All Online Basins % increase		41%	8%	0%					42%	8%	42%	41%	27%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		21%	8%	137%					21%	64%	90%	104%	53%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
RR410	STORAGE	125	7.2	105.15	6	2.18	116	65	22	9	0.492	1.103	1.12	1.12	57	128	130	130
410415	ROUTE	125	100.7	6.76	6.5	2.18	115	65	22	9	0.492	1.102	1.12	1.12	57	128	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415	COMBINE	422			4.1	2.63	137	74	25	11	0.484	1.04	1.055	1.055	68	146	148	148
415420	ROUTE	165	100.5	28.25	5.7	2.63	121	73	25	11	0.427	1.03	1.055	1.055	60	145	148	148
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1227			4.3	4.4	252	108	37	16	0.532	0.911	0.928	0.928	125	214	218	218
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
RR500	STORAGE	181	8.9	180.75	6.9	3.64	171	109	38	17	0.436	1.111	1.171	1.171	85	216	227	227
500510	ROUTE	180	100.3	27.15	8	3.64	168	108	38	17	0.43	1.106	1.171	1.171	83	215	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C510	COMBINE	1384			4.2	5.48	271	145	51	22	0.46	0.981	1.032	1.032	134	287	301	301
510530	ROUTE	745	100.8	90.43	5.3	5.48	231	140	51	22	0.393	0.954	1.032	1.032	115	279	301	301
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128
C530	COMBINE	1198			4.5	7.7	390	182	65	28	0.47	0.877	0.937	0.937	193	360	385	385
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
RR410	STORAGE	125	7.2	105.15	14	2.18	116	66	23	10	0.494	1.121	1.15	1.15	58	131	134	134
410415	ROUTE	125	100.7	6.76	14.5	2.18	116	66	23	10	0.494	1.121	1.15	1.15	57	130	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415	COMBINE	609			12.1	2.63	144	78	26	11	0.507	1.094	1.121	1.121	71	154	157	157
415420	ROUTE	191	100.5	31.21	13.5	2.63	126	77	26	11	0.443	1.084	1.121	1.121	62	152	157	157
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1714			12.3	4.4	293	124	42	18	0.62	1.048	1.076	1.076	146	246	253	253
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
RR500	STORAGE	186	9.4	192.34	15	3.64	177	119	43	19	0.453	1.219	1.323	1.323	88	237	257	257
500510	ROUTE	186	100.3	27.66	16	3.64	175	119	43	19	0.448	1.214	1.323	1.323	87	235	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C510	COMBINE	2072			12.2	5.48	315	168	60	26	0.534	1.14	1.226	1.226	156	333	358	358
510530	ROUTE	1052	101	111.67	13.1	5.48	274	163	60	26	0.465	1.104	1.226	1.226	136	323	358	358
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127
C530	COMBINE	1669			12.5	7.7	496	222	81	35	0.598	1.071	1.17	1.17	246	440	481	481
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Leveed	0.0143	0.0060	1.10	3	4.5	0.045	726	109.0	149.1	1.4	1.4	1.4	3.1	109	4.9	0.73	0.54
C41510	Leveed	0.0137	0.0060	0.30	3	5.0	0.045	609	71.1	114.3	1.6	1.6	1.8	3.2	71	5.3	0.74	0.66
RR41510	Leveed	0.0162	0.0070	1.00	3	4.5	0.045	957	158.1	196.5	1.2	1.2	1.3	3.2	158	4.9	0.77	0.56
C42010	Leveed	0.0120	0.0054	2.00	3	4.5	0.045	1364	194.7	289.3	1.5	1.5	1.5	3.0	194	4.7	0.68	0.51
C42020	Leveed	0.0139	0.0057	0.40	3	5.0	0.045	1714	152.5	287.6	1.9	1.9	2.0	3.0	152	6.0	0.76	0.70
C51010	Leveed	0.0222	0.0090	1.30	3	4.0	0.045	648	136.3	133.4	1.0	1.0	1.0	3.0	136	4.9	0.86	0.56
C51020	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1298	208.3	267.8	1.3	1.3	1.3	3.2	208	4.8	0.75	0.49
C51030	Leveed	0.0123	0.0050	0.30	3	4.5	0.045	1424	228.9	314.4	1.4	1.4	1.4	3.1	228	4.5	0.68	0.44
C51040	Leveed	0.0116	0.0050	0.40	3	4.5	0.045	2072	309.4	451.9	1.5	1.5	1.5	3.0	309	4.6	0.67	0.46
RR51010	Leveed	0.0150	0.0055	0.90	3	4.5	0.045	2072	367.8	448.3	1.2	1.2	1.2	3.3	367	4.6	0.74	0.42
RR51015	Leveed	0.0126	0.0050	1.50	3	4.5	0.045	1442	209.4	302.8	1.4	1.4	1.5	3.0	209	4.8	0.70	0.46
RR51020	Leveed	0.0115	0.0045	0.90	3	4.5	0.045	1934	269.8	410.8	1.5	1.5	1.6	2.9	269	4.7	0.67	0.44
S51010	Leveed	0.0171	0.0072	0.30	3	4.0	0.045	441	87.3	95.7	1.1	1.1	1.1	2.9	87	4.6	0.77	0.52

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR410	Online Basin	0.0150	1200	600	9.0	116.7	105.2	134.0	1524	125	7.2	1.8
RR500	Online Basin	0.0250	1300	800	11.0	204.4	192.3	257.0	2063	186	9.4	1.6

Online Basin

HEC1 ID	RR410

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.2	sq. mi
Total Sediment Yield Volume	4.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	4.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1200	1370
Basin Width (ft)	600	600
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	573	546
Top Area (acres)	16.5	18.9
U/S-D/S Height Difference (ft)	9.0	9.0
Excess Area on Upstream (acres)	0.8	1.7

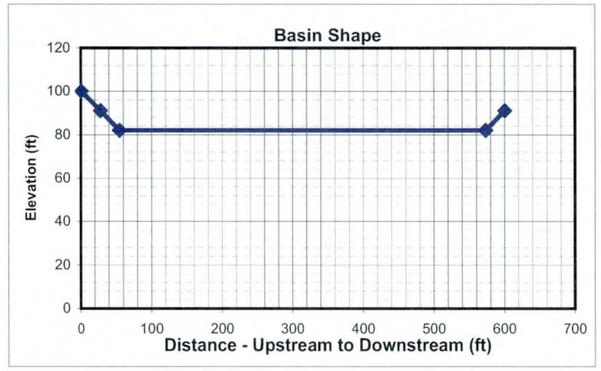
			Base	LC Enhanced
Bottom Length (ft)	1146	Allocated Storage Volume (ac. ft)	116.7	117.1
Bottom Width (ft)	519	Total Available Volume (ac. ft) (incl. Freeboard)	132.4	134
		Total Excavation Volume (ac. ft)	206.8	218.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	13.77	42.00	71.17	86.11	101.29	116.71	132.38	148.28	164.44
Outflow	0.0	46.3	80.2	103.6	113.5	122.6	131.0	139.0	146.5	153.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	130.0	134	134.0
Peak Inflow (cfs)	1372	1524	1524.0
Peak Outflow (cfs)	125	125	125.0
Stage at Peak Outflow (ft)	7.2	7.2	7.2
Volume at Peak Outflow (ac. ft)	105.2	105.15	105.2

Volume Check

Total Volume needed	109.3	ac. ft
Total Volume Provided	116.7	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	8.2	ft
Depth Provided	9	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	309000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1200	ft
Base Total ROW Width	600	ft
LC Enh. Total ROW Length	1470	ft
LC Enh. Total ROW Length	700	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	333637	353159
Excavated Area (sq. Yd)	80000	114333

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	57	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	632	sq. Yd
Material Volume	316	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	900	ft
Unit Cost	160	per ft
Cost per outlet	$144,000	
Other Cost	$ -	
Total Cost	$144,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		333,637	cu. Yd	$ 4.00	$ 1,334,548	80,000	sq. Yd	$ 9.00	$ 720,000	80,000	sq. Yd	$ 8.33	$ 666,667
Basin - LC Enhancement		19,522	cu. Yd	$ 4.00	$ 78,088	34,333	sq. Yd	$ 9.00	$ 308,997	34,333	sq. Yd	$ 8.33	$ 286,108
Inlet	Riprap	316	sq. Yd	$ 75.00	$ 23,700	632	sq. Yd	$ -	$ -	632	sq. Yd	$ 33.33	$ 21,067
Inlet - LC Enhancement (20%Inlet)					$ 4,740				$ -				$ 4,213
Outlet	Pipe	1	EA	$ 144,000	$ 144,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 7,200				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 720,000	Base Maintenance Cost			$ 689,950
						LC Enh. Landscape Cost			$ 308,997	LC Enh. Maintenance Cost			$ 290,433
						Total Landscape Cost			$ 1,028,997	Total Maintenance Cost			$ 980,383

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,502,248	$ 78,088	$ 1,580,336
Contingency Cost (25% of Construction Cost)	$ 375,562	$ 19,522	$ 395,084
Engineering Design Cost (5% of Construction Cost)	$ 75,112	$ 3,904	$ 79,017
Total Construction Cost	$ 1,952,922	$ 101,514	$ 2,054,437

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.1	$100,000	$ 710,000
Basin	16.5	$100,000	$ 1,650,000
Other		$100,000	$ -
Total	23.6	$100,000	$ 2,360,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	16.5	$100,000	$ 1,650,000
LC Enhancement Cost	acre	7.1	$100,000	$ 710,000
Total Land Cost	acre	23.6	$100,000	$ 2,360,000

Total Cost

Base Total Cost	$ 5,012,872
Total LC Enhancement Cost	$ 1,410,944
Total Cost Including LC Enh.	$ 6,423,816

Open Channel

Structure ID	RR41010

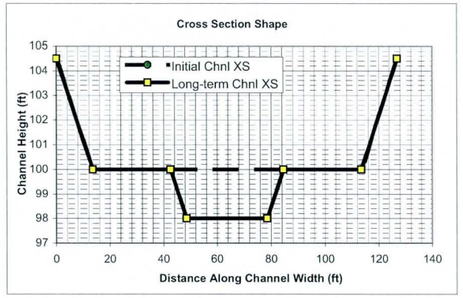
HEC1 ID	410415

Longitudal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

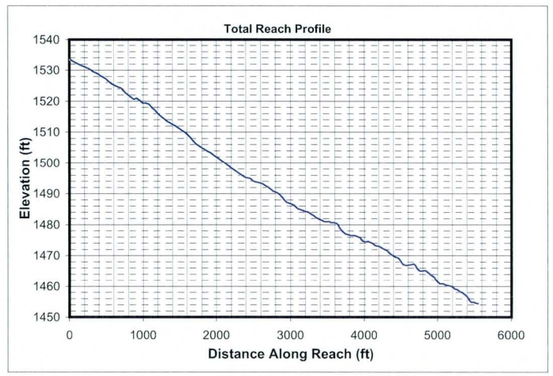
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	100	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	113.5	113.5	113.5	127
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	29	3	30	6.5	3	29	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	42.5	48.5	78.5	84.5	113.5	127
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR410	S415							TOTAL
HEC1 Peak-Flow	125	791							916
Weighting Factor	1.00	0.76							
Flow into Channel	125	601							726

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.343	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	726	cfs	
Long-term Max. Chnl Capacity	4082	cfs	
Q2 Channel	73	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	127	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	102.3	36.5	0.4	100.0	100.4	2.0	0.4	102.2	0.4	0.14	0.59
182	104.0	63.6	0.6	100.0	100.6	2.9	0.6	103.7	0.6	0.23	0.64
545	107.6	124.8	1.2	100.0	101.2	4.4	1.2	107.2	1.2	0.45	0.71
726	109.0	149.1	1.4	100.0	101.4	4.9	1.4	108.6	1.4	0.54	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	36.0	31.2	0.9	98.0	98.9	2.3	0.9	35.7	0.9	0.36	0.44
182	40.2	56.5	1.4	98.0	99.6	3.2	1.6	39.7	1.4	0.61	0.48
545	106.1	160.9	1.5	98.0	100.9	3.4	2.9	105.2	1.5	1.07	0.48
726	108.0	192.5	1.8	98.0	101.2	3.8	3.2	107.0	1.8	1.18	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
73										0
182										0
545										0
726										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
73	1.74	1.0782	1.0243	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
182	1.74	1.2448	1.1825	Erosive	Erosive	Erosive	0.3	Stable	6.2	Stable	Stable
545	1.74	1.4422	1.3701	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
726	1.74	1.4932	1.4185	Erosive	Erosive	Erosive	0.4	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	73	182	545	726	73	182	545	726	73	182	545	726
Bray - Equation #1	23	37	66	77	1.1	1.5	2.2	2.4	2.9	3.3	3.8	4.0
Bray - Equation #2	30	48	86	101	1.2	1.7	2.4	2.6	2.0	2.2	2.6	2.7
Hey	6	11	21	24	3.3	4.7	7.1	7.9				
Ackers & Charlton/Lacey	22	32	51	57					1.6	1.9	2.3	2.4
Parker	59	93	160	185	0.8	1.2	1.9	2.1				
Chang	38	66	129	153	0.1	0.1	-0.2	-0.3				
Kellerhals	15	24	42	48	1.5	2.2	3.4	3.8	3.1	3.4	3.8	3.9
AMAFCA/Schumm	36	40	105	107								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	12.8	18.1	27.3	30.4	3	5	7	8	2.6	3.3	4.3	4.6
Average	25	38	70	79	1.5	2.1	3.1	3.4	2.5	2.8	3.4	3.5
Values As Designed	36	40	105	107	0.9	1.6	2.9	3.2	2.3	3.2	3.4	3.8
Difference with Design	-11	-2	-36	-28	0.6	0.5	0.2	0.3	0.1	-0.4	0.0	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	565	355	727	1035	1577	167	151	91	2133	164	612	689
182	2319	1157	2192	4861	2358	710	498	465	5625	575	2565	2120
545	12418	4194	6738	30732	3642	3332	1635	2362	17267	2761	12183	8842
726	19229	5796	8787	49674	4064	4943	2187	3503	23089	4182	17972	13039

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	2887	1815	3713	5287	8059	854	771	467	10902	837	3129	3520
182	4740	2364	4480	9936	4820	1451	1019	951	11498	1175	5242	4334
545	8461	2858	4591	20940	2482	2270	1114	1609	11765	1882	8301	6025
726	9826	2962	4490	25384	2077	2526	1117	1790	11799	2137	9184	6663

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	300	165	268	518	563	62	55	63	577	67	346	271
182	1157	521	787	2278	888	248	176	270	1525	247	1349	859
545	3746	1569	2405	7462	2469	795	544	872	4597	791	4330	2689
726	5785	2226	3315	12025	2791	1195	751	1330	6185	1208	6553	3942

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	1531	843	1369	2645	2876	317	283	322	2948	344	1769	1386
182	2366	1064	1608	4656	1815	507	360	552	3116	505	2757	1755
545	2552	1069	1639	5084	1682	541	371	594	3132	539	2951	1832
726	2956	1137	1694	6145	1426	611	384	680	3160	617	3349	2015

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
73	0.0022	0.0034	133	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0084	0.0005	0.0027	0.0142	0.0062
182	0.0011	0.0020	174	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0084	0.0004	0.0013	0.0142	0.0060
545	0.0005	0.0010	239	0.73	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0084	0.0002	0.0006	0.0142	0.0058
726	0.0004	0.0009	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0084	0.0002	0.0005	0.0142	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	45.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	348	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	348 ft	Depth	3 ft
Width	127 ft	Side slope	3 ft/ft
Total Volume per Basin		2.75	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
73	1.1	-0.3	0.1	24.6	0.9	0.9	2.3	0.0060	0.1	1.5	2.0	4.7
182	1.1	-0.5	0.1	24.6	1.6	1.4	3.2	0.0060	0.2	1.5	2.0	4.9
545	1.1	-0.8	0.2	24.6	2.9	1.5	3.4	0.0060	0.3	1.5	2.0	5.1
726	1.1	-0.9	0.2	24.6	3.2	1.8	3.8	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	125	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	0.54	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	3
Channel Width (ft)	127	127
Channel XS Area (sq. ft)	582.8	582.8
Channel Perimeter (ft)	129	129

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1854	sq. Yd
Volume	5561	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5561	5561
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25951	53756
Left Levee Volume (cu. Yd)	25539	60141
Right Levee Length (ft)	5561	5561
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25951	53756
Right Levee Volume (cu. Yd)	25539	60141
Total Levee Surface Area (sq. Yd)	51902	107512
Total Levee Volume (cu. Yd)	51078	120282

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8650	20390
Left Levee Lining Volume (cu. Yd)	4325	10195
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8650	20390
Right Levee Lining Volume (cu. Yd)	4325	10195
Total Lining Area (sq. Yd)	17301	40781
Total Lining Volume (cu. Yd)	8650	20390

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	127	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	16	
Volume per structure	142	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,650	
Area per structure	42	sq. Yd
Total Area	677	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4437	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,748	
Other Cost	$ -	
Total cost per basin	$ 17,748	
Area per basin	4,905	sq. Yd
Total Area	4,905	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	51,078	cu. Yd	$ 7.00	$ 357,546	51,902	sq. Yd	$ 9.00	$ 467,118	51,902	sq. Yd	$ 11.67	$ 605,523	
Levee - LC Enhancement	Fill	69,204	cu. Yd	$ 7.00	$ 484,428	55,610	sq. Yd	$ 9.00	$ 500,490	69,204	sq. Yd	$ 11.67	$ 807,380	
Levee Lining	Riprap	8,650	cu. Yd	$ 75.00	$ 648,750	17,301	sq. Yd	$ -	$ -	17,301	sq. Yd	$ 20.83	$ 360,435	
Levee Lining -LC Enhancement	Riprap	11,740	cu. Yd	$ 75.00	$ 880,500	23,480	sq. Yd	$ -	$ -	23,480	sq. Yd	$ 20.83	$ 489,162	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	5,561	cu. Yd	$ 75.00	$ 417,075	1,854	sq. Yd	$ -	$ -	1,854	sq. Yd	$ 25.00	$ 46,350	
Drop Structures	Riprap	16	EA	$ 10,650.00	$ 170,400	677	sq. Yd	$ -	$ -	677	sq. Yd	$ 33.33	$ 22,567	
Drop Str. - LC Enhancement	Riprap	16	EA	$ 1,065.00	$ 17,040	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,257	
Sedimentation Basins		1	EA	$ 17,748.00	$ 17,748	4,905	sq. Yd	$ -	$ -	4,905	sq. Yd	$ 8.33	$ 40,875	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 467,118	Base Maintenance Cost			$ 1,075,750	
						LC Enhancement Cost			$ 500,490	LC Enhancement Cost			$ 1,298,799	
						Total Landscape Cost			$ 967,608	Total Maintenance Cost			$ 2,374,549	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,611,519	$ 1,381,968	$ 2,993,487
Contingency Cost (25% of Construction Cost)	$ 402,880	$ 345,492	$ 748,372
Engineering Design Cost (5% of Construction Cost)	$ 80,576	$ 69,098	$ 149,674
Total Construction Cost	$ 2,094,975	$ 1,796,558	$ 3,891,533

Land Cost

Channel Length	5561	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	127	16.2	$100,000	$ 1,620,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7	$100,000	$ 700,000
Levee LC Enhancement	51	6.5	$100,000	$ 650,000
Other	0	0	$100,000	$ -
Total	233	29.7		$ 2,970,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.2	$100,000	$ 2,320,000
LC Enhancement Cost	acre	6.5	$100,000	$ 650,000
Total Land Cost	acre	29.7	$100,000	$ 2,970,000

Total Cost

Base Total Cost	$ 5,957,843
Total Landscape Enhancement Cost	$ 4,245,847
Total Cost Including LC Enh.	$ 10,203,690

Open Channel

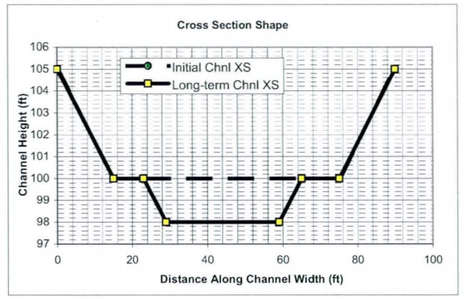
Structure ID	C41510	HEC1 ID	410415

Longitudinal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

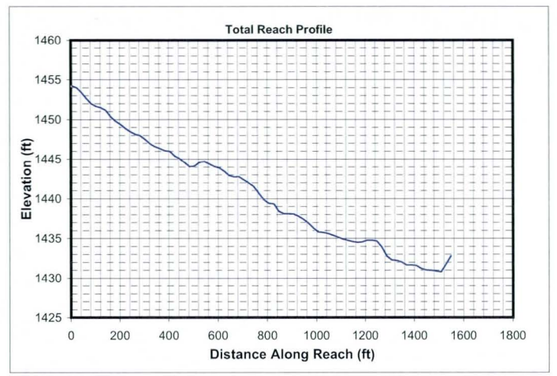
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	60	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	75	75	75	90
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	8	3	30	7	3	10	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	23	29	59	65	75	90
Y	105	100	100	98	98	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	609									609
Weighting Factor	1.00									
Flow into Channel	609									609

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR41010									TOTAL
Flow Volume (ac. ft)	134.00									134
Sediment Conc. (ppm)	2015									
Sediment Volume (ac. ft)	0.10									0.10
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.10									0.10

Hydrology

Drainage Area	0.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	609	cfs	
Long-term Max. Chnl Capacity	3282	cfs	
Q2 Channel	61	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	90	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
61	62.8	27.3	0.4	100.0	100.4	2.2	0.4	62.7	0.4	0.17	0.59
152	64.9	48.0	0.7	100.0	100.8	3.2	0.8	64.6	0.7	0.29	0.65
457	69.4	95.3	1.4	100.0	101.5	4.8	1.5	68.9	1.4	0.55	0.72
609	71.1	114.3	1.6	100.0	101.8	5.3	1.8	70.5	1.6	0.66	0.74

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
61	35.4	27.9	0.8	98.0	98.9	2.2	0.9	35.1	0.8	0.32	0.43
152	39.3	50.3	1.3	98.0	99.5	3.0	1.5	38.8	1.3	0.55	0.47
457	65.5	119.3	1.8	98.0	100.8	3.8	2.8	64.6	1.8	1.03	0.50
609	67.8	143.8	2.1	98.0	101.1	4.2	3.1	66.8	2.2	1.17	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR41010									
61	271									271
152	859									859
457	2689									2689
609	3942									3942

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
61	1.74	1.1397	1.0827	Erosive	Erosive	Erosive	0.2	Stable	4.1	Stable	Stable
152	1.74	1.3036	1.2384	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
457	1.74	1.4955	1.4207	Erosive	Erosive	Erosive	0.4	Stable	8.4	Stable	Stable
609	1.74	1.5445	1.4673	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	61	152	457	609	61	152	457	609	61	152	457	609
Bray - Equation #1	21	34	60	70	1.0	1.4	2.0	2.2	2.8	3.2	3.7	3.9
Bray - Equation #2	27	44	79	92	1.2	1.6	2.2	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	22	3.1	4.4	6.6	7.4				
Ackers & Charlton/Lacey	20	30	47	53					1.6	1.9	2.2	2.3
Parker	54	85	147	170	0.8	1.1	1.8	2.0				
Chang	34	59	116	138	0.1	0.1	-0.1	-0.2				
Kellerhals	14	22	38	44	1.4	2.0	3.1	3.5	3.1	3.4	3.8	3.9
AMAFCA/Schumm	35	39	65	67								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	12.0	16.9	25.5	28.4	3	5	7	8	2.5	3.1	4.1	4.4
Average	23	35	60	69	1.5	2.0	2.9	3.2	2.4	2.8	3.3	3.4
Values As Designed	35	39	65	67	0.9	1.5	2.8	3.1	2.2	3.0	3.8	4.2
Difference with Design	-12	-4	-4	2	0.6	0.5	0.2	0.1	0.2	-0.3	-0.5	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	533	315	648	1015	1093	161	136	96	1728	145	593	587
152	2165	987	1811	4719	1624	638	414	440	4495	518	2361	1834
457	11377	3486	5298	29191	2533	2907	1311	2100	13723	2483	10777	7744
609	17497	4792	6962	46816	2842	4289	1745	3079	18338	3746	15758	11442

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	3247	1919	3946	6185	6657	983	825	587	10524	881	3613	3579
152	5276	2405	4412	11499	3958	1555	1008	1073	10953	1262	5752	4468
457	9241	2832	4304	23711	2057	2362	1065	1706	11147	2017	8754	6290
609	10659	2920	4241	28520	1731	2613	1063	1876	11171	2282	9600	6971

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	231	130	211	388	514	46	43	46	475	53	262	218
152	895	421	653	1718	814	193	143	208	1270	192	1049	687
457	3695	1418	2088	7783	1713	761	471	848	3895	775	4176	2511
609	5647	1984	2867	12389	1950	1127	641	1265	5226	1176	6217	3681

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	1405	794	1288	2365	3131	280	261	281	2896	320	1599	1329
152	2180	1026	1591	4187	1985	471	350	506	3094	469	2555	1674
457	3002	1152	1696	6322	1391	618	383	689	3164	629	3392	2040
609	3440	1208	1746	7547	1188	687	390	771	3184	716	3788	2242

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
61	0.0018	0.0028	144	0.44	0.048	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0089	0.0006	0.0023	0.0137	0.0061
152	0.0009	0.0016	188	0.57	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0089	0.0004	0.0012	0.0137	0.0059
457	0.0004	0.0009	256	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0089	0.0002	0.0005	0.0136	0.0058
609	0.0003	0.0007	277	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0089	0.0002	0.0004	0.0136	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	12.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.86	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft
Width	90 ft	Side slope	3 ft/ft
Total Volume per Basin		1.70	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
61	1.1	-0.3	0.1	24.6	0.9	0.8	2.2	0.0060	0.1	1.5	2.0	4.7
152	1.1	-0.4	0.1	24.6	1.5	1.3	3.0	0.0060	0.2	1.5	2.0	4.8
457	1.1	-0.8	0.2	24.6	2.8	1.8	3.8	0.0060	0.3	1.5	2.0	5.1
609	1.1	-0.8	0.2	24.6	3.1	2.2	4.2	0.0060	0.4	1.5	2.0	5.2

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	125	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.96	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.84	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	3
Channel Width (ft)	90	90
Channel XS Area (sq. ft)	447	447
Channel Perimeter (ft)	92	92

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	522	sq. Yd
Volume	1567	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1567	1567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	8009	16192
Left Levee Volume (cu. Yd)	8415	19500
Right Levee Length (ft)	1567	1567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	8009	16192
Right Levee Volume (cu. Yd)	8415	19500
Total Levee Surface Area (sq. Yd)	16018	32384
Total Levee Volume (cu. Yd)	16830	39000

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2786	6268
Left Levee Lining Volume (cu. Yd)	1393	3134
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2786	6268
Right Levee Lining Volume (cu. Yd)	1393	3134
Total Lining Area (sq. Yd)	5572	12536
Total Lining Volume (cu. Yd)	2786	6268

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	90	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.3	ft
Structure Height	11.3	ft
Number of Structures	5	
Volume per structure	113	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,475	
Area per structure	30	sq. Yd
Total Area	150	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2743	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 10,972	
Other Cost	$ -	
Total cost per basin	$ 10,972	
Area per basin	3,134	sq. Yd
Total Area	6,268	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	16,830	cu. Yd	$ 7.00	$ 117,810	16,018	sq. Yd	$ 9.00	$ 144,162	16,018	sq. Yd	$ 11.67	$ 186,877
Levee - LC Enhancement	Fill	22,170	cu. Yd	$ 7.00	$ 155,190	16,366	sq. Yd	$ 9.00	$ 147,294	22,170	sq. Yd	$ 11.67	$ 258,650
Levee Lining	Riprap	2,786	cu. Yd	$ 75.00	$ 208,950	5,572	sq. Yd	$ -	$ -	5,572	sq. Yd	$ 20.83	$ 116,074
Levee Lining -LC Enhancement	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	6,964	sq. Yd	$ -	$ -	6,964	sq. Yd	$ 20.83	$ 145,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,567	cu. Yd	$ 75.00	$ 117,525	522	sq. Yd	$ -	$ -	522	sq. Yd	$ 25.00	$ 13,050
Drop Structures	Riprap	5	EA	$ 8,475.00	$ 42,375	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,000
Drop Str. - LC Enhancement	Riprap	5	EA	$ 847.50	$ 4,238	15	sq. Yd	$ -	$ -	15	sq. Yd	$ 33.33	$ 500
Sedimentation Basins		2	EA	$ 10,972.00	$ 21,944	6,268	sq. Yd	$ -	$ -	6,268	sq. Yd	$ 8.33	$ 52,233
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 144,162	Base Maintenance Cost			$ 373,234
						LC Enhancement Cost			$ 147,294	LC Enhancement Cost			$ 404,243
						Total Landscape Cost			$ 291,456	Total Maintenance Cost			$ 777,477

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 508,604	$ 420,578	$ 929,182
Contingency Cost (25% of Construction Cost)	$ 127,151	$ 105,144	$ 232,295
Engineering Design Cost (5% of Construction Cost)	$ 25,430	$ 21,029	$ 46,459
Total Construction Cost	$ 661,185	$ 546,751	$ 1,207,936

Land Cost

Channel Length	1567	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	90	3.2	$100,000	$ 320,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	2.1	$100,000	$ 210,000
Levee LC Enhancement	54	1.9	$100,000	$ 190,000
Other	0	0	$100,000	$ -
Total	202	7.2		$ 720,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.3	$100,000	$ 530,000
LC Enhancement Cost	acre	1.9	$100,000	$ 190,000
Total Land Cost	acre	7.2	$100,000	$ 720,000

Total Cost

Base Total Cost	$ 1,708,581
Total Landscape Enhancement Cost	$ 1,288,287
Total Cost Including LC Enh.	$ 2,996,869

Open Channel

Structure ID	RR41510

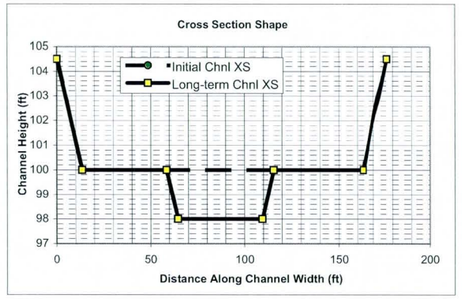
HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

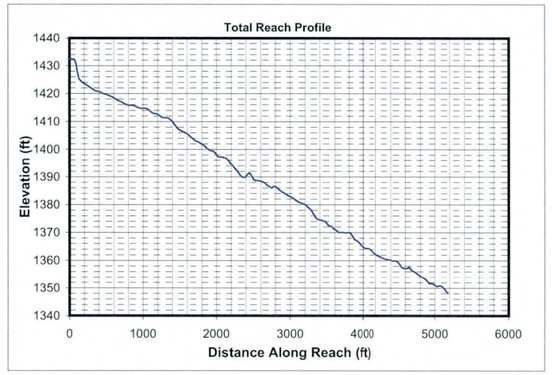
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	150	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	163.5	163.5	163.5	177
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	45	3	45	6.5	3	48	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	58.5	64.5	109.5	115.5	163.5	177
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415	S420								TOTAL
HEC1 Peak-Flow	609	1740								2349
Weighting Factor	1.00	0.20								
Flow into Channel	609	348								957

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.985	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	957	cfs	
Long-term Max. Chnl Capacity	6491	cfs	
Q2 Channel	96	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	177	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
96	152.0	48.6	0.3	100.0	100.3	2.0	0.3	151.9	0.3	0.14	0.61
239	153.5	84.5	0.6	100.0	100.6	2.8	0.6	153.3	0.6	0.24	0.67
718	156.8	164.8	1.1	100.0	101.1	4.4	1.1	156.5	1.1	0.47	0.75
957	158.1	196.5	1.2	100.0	101.3	4.9	1.3	157.7	1.2	0.56	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
96	50.3	40.2	0.8	98.0	98.8	2.4	0.8	50.1	0.8	0.37	0.47
239	54.2	71.7	1.3	98.0	99.5	3.3	1.5	53.7	1.3	0.63	0.51
718	155.2	211.1	1.4	98.0	100.7	3.4	2.7	154.3	1.4	1.19	0.51
957	156.8	251.9	1.6	98.0	101.0	3.8	3.0	155.9	1.6	1.30	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
96										0
239										0
718										0
957										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
96	1.74	1.0441	0.9919	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
239	1.74	1.2117	1.1511	Erosive	Erosive	Erosive	0.3	Stable	6.3	Stable	Stable
718	1.74	1.4115	1.3409	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
957	1.74	1.4634	1.3902	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	96	239	718	957	96	239	718	957	96	239	718	957
Bray - Equation #1	26	43	76	89	1.2	1.6	2.4	2.6	3.0	3.4	4.0	4.1
Bray - Equation #2	35	56	100	116	1.3	1.8	2.6	2.9	2.1	2.3	2.7	2.8
Hey	8	13	24	28	3.6	5.2	7.8	8.7				
Ackers & Charlton/Lacey	24	36	57	64					1.7	2.0	2.4	2.5
Parker	67	106	184	213	0.9	1.3	2.1	2.4				
Chang	47	82	160	190	0.1	0.0	-0.4	-0.5				
Kellerhals	18	28	48	56	1.7	2.4	3.8	4.2	3.2	3.5	3.9	4.1
AMAFCA/Schumm	50	54	154	156								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	13.8	19.5	29.4	32.7	4	5	8	9	3.0	3.7	4.9	5.3
Average	31	46	85	96	1.7	2.3	3.4	3.8	2.6	3.0	3.6	3.8
Values As Designed	50	54	154	156	0.8	1.5	2.7	3.0	2.4	3.3	3.4	3.8
Difference with Design	-19	-8	-69	-60	0.9	0.9	0.7	0.8	0.2	-0.3	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	832	531	1122	1546	2375	261	234	132	3417	252	895	1054
239	3429	1725	3364	7294	3531	1104	767	678	8987	872	3755	3228
718	18517	6247	10259	46541	5401	5199	2509	3459	27558	4158	17859	13428
957	28752	8631	13394	75480	6005	7725	3352	5135	36845	6296	26354	19815

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	3224	2060	4350	5992	9207	1012	907	513	13247	978	3468	4087
239	5318	2675	5216	11311	5476	1712	1190	1051	13937	1352	5823	5006
718	9571	3229	5303	24057	2792	2687	1297	1788	14245	2149	9231	6941
957	11146	3346	5192	29261	2328	2995	1299	1991	14284	2441	10217	7682

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	476	261	445	843	832	107	93	99	972	109	548	435
239	1877	821	1269	3807	1275	424	287	425	2551	406	2150	1390
718	5799	2401	3840	11779	3724	1303	873	1310	7663	1245	6616	4232
957	8994	3408	5306	19070	4188	1961	1202	2004	10302	1905	10021	6215

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	1844	1013	1723	3267	3225	416	359	383	3766	423	2126	1686
239	2911	1273	1968	5903	1978	657	446	659	3955	629	3334	2156
718	2998	1241	1985	6088	1925	673	451	677	3961	643	3420	2188
957	3487	1321	2057	7393	1624	760	466	777	3994	738	3885	2409

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
96	0.0025	0.0038	134	0.41	0.047	0.0008	30	0.036	0.0006	0.0159	0.0008	0.0019	0.0076	0.0005	0.0028	0.0161	0.0065
239	0.0012	0.0022	176	0.54	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0076	0.0003	0.0014	0.0162	0.0063
718	0.0006	0.0012	243	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0076	0.0002	0.0006	0.0162	0.0061
957	0.0004	0.0010	264	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0076	0.0002	0.0005	0.0161	0.0061

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	47.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	325	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	325 ft	Depth	3 ft
Width	177 ft	Side slope	3 ft/ft
Total Volume per Basin		3.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
96	1.1	-0.3	0.1	24.6	0.8	0.8	2.4	0.0070	0.1	1.5	2.0	4.7
239	1.1	-0.4	0.2	24.6	1.5	1.3	3.3	0.0070	0.2	1.5	2.0	4.9
718	1.1	-0.8	0.2	24.6	2.7	1.4	3.4	0.0070	0.3	1.5	2.0	5.0
957	1.1	-0.8	0.2	24.6	3.0	1.6	3.8	0.0070	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.14	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	3
Channel Width (ft)	177	177
Channel XS Area (sq. ft)	837.8	837.8
Channel Perimeter (ft)	179	179

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1733	sq. Yd
Volume	5198	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5198	5198
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24257	50247
Left Levee Volume (cu. Yd)	23872	56215
Right Levee Length (ft)	5198	5198
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24257	50247
Right Levee Volume (cu. Yd)	23872	56215
Total Levee Surface Area (sq. Yd)	48514	100494
Total Levee Volume (cu. Yd)	47744	112430

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8086	19059
Left Levee Lining Volume (cu. Yd)	4043	9530
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8086	19059
Right Levee Lining Volume (cu. Yd)	4043	9530
Total Lining Area (sq. Yd)	16172	38119
Total Lining Volume (cu. Yd)	8086	19060

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	177	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	16	
Volume per structure	190	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 14,250	
Area per structure	59	sq. Yd
Total Area	944	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	5905	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 23,620	
Other Cost	$ -	
Total cost per basin	$ 23,620	
Area per basin	6,389	sq. Yd
Total Area	6,389	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,744	cu. Yd	$ 7.00	$ 334,208	48,514	sq. Yd	$ 9.00	$ 436,626	48,514	sq. Yd	$ 11.67	$ 565,997
Levee - LC Enhancement	Fill	64,686	cu. Yd	$ 7.00	$ 452,802	51,980	sq. Yd	$ 9.00	$ 467,820	64,686	sq. Yd	$ 11.67	$ 754,670
Levee Lining	Riprap	8,086	cu. Yd	$ 75.00	$ 606,450	16,172	sq. Yd	$ -	$ -	16,172	sq. Yd	$ 20.83	$ 336,907
Levee Lining -LC Enhancement	Riprap	10,974	cu. Yd	$ 75.00	$ 823,050	21,947	sq. Yd	$ -	$ -	21,947	sq. Yd	$ 20.83	$ 457,231
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,198	cu. Yd	$ 75.00	$ 389,850	1,733	sq. Yd	$ -	$ -	1,733	sq. Yd	$ 25.00	$ 43,325
Drop Structures	Riprap	16	EA	$ 14,250.00	$ 228,000	944	sq. Yd	$ -	$ -	944	sq. Yd	$ 33.33	$ 31,467
Drop Str. - LC Enhancement	Riprap	16	EA	$ 1,425.00	$ 22,800	94	sq. Yd	$ -	$ -	94	sq. Yd	$ 33.33	$ 3,147
Sedimentation Basins		1	EA	$ 23,620.00	$ 23,620	6,389	sq. Yd	$ -	$ -	6,389	sq. Yd	$ 8.33	$ 53,242
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 436,626	Base Maintenance Cost			$ 1,030,937
						LC Enhancement Cost			$ 467,820	LC Enhancement Cost			$ 1,215,048
						Total Landscape Cost			$ 904,446	Total Maintenance Cost			$ 2,245,986

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,582,128	$ 1,298,652	$ 2,880,780
Contingency Cost (25% of Construction Cost)	$ 395,532	$ 324,663	$ 720,195
Engineering Design Cost (5% of Construction Cost)	$ 79,106	$ 64,933	$ 144,039
Total Construction Cost	$ 2,056,766	$ 1,688,248	$ 3,745,014

Land Cost

Channel Length	5198	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	177	21.1	$100,000	$ 2,110,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.6	$100,000	$ 660,000
Levee LC Enhancement	51	6.1	$100,000	$ 610,000
Other	0	0	$100,000	$ -
Total	283	33.8		$ 3,380,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	27.7	$100,000	$ 2,770,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	33.8	$100,000	$ 3,380,000

Total Cost

Base Total Cost	$ 6,294,330
Total Landscape Enhancement Cost	$ 3,981,116
Total Cost Including LC Enh.	$ 10,275,446

Open Channel

Structure ID	C42010

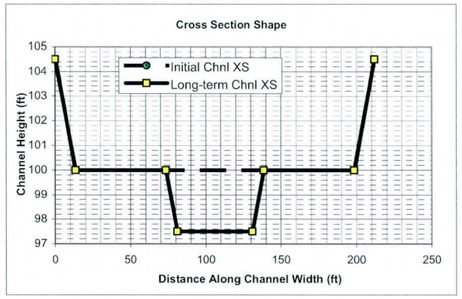
HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0054	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

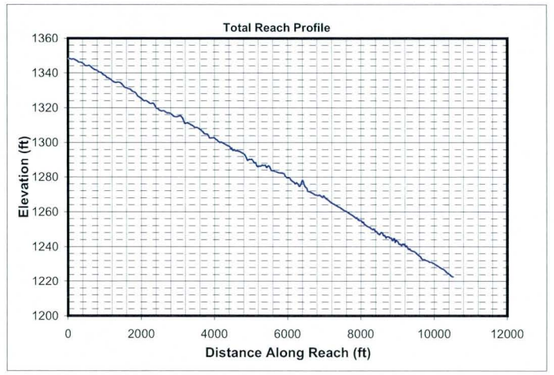
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	185	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	198.5	198.5	198.5	212
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	60	3	50	7	3	60	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	73.5	81	131	138.5	198.5	212
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415	S420							TOTAL
HEC1 Peak-Flow	609	1740							2349
Weighting Factor	1.00	0.43							
Flow into Channel	609	755							1364

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	157.00								157
Sediment Conc. (ppm)	2409								
Sediment Volume (ac. ft)	0.14								0.14
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.14								0.14

Hydrology

Drainage Area	3.057	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1364	cfs	
Long-term Max. Chnl Capacity	7219	cfs	
Q2 Channel	136	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	212	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
136	187.4	71.6	0.4	100.0	100.4	1.9	0.4	187.3	0.4	0.13	0.54
341	189.2	124.5	0.7	100.0	100.7	2.7	0.7	189.0	0.7	0.22	0.59
1023	193.1	242.6	1.3	100.0	101.3	4.2	1.3	192.7	1.3	0.43	0.66
1364	194.7	289.3	1.5	100.0	101.5	4.7	1.5	194.2	1.5	0.51	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
136	56.7	56.3	1.0	97.5	98.6	2.4	1.1	56.4	1.0	0.36	0.43
341	61.5	100.8	1.6	97.5	99.3	3.4	1.8	60.9	1.7	0.61	0.46
1023	191.3	306.8	1.6	97.5	100.9	3.3	3.4	190.2	1.6	1.14	0.46
1364	193.3	366.1	1.9	97.5	101.2	3.7	3.7	192.1	1.9	1.24	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
136	435									435
341	1390									1390
1023	4232									4232
1364	6215									6215

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
136	1.74	1.0989	1.0440	Erosive	Erosive	Erosive	0.2	Stable	4.5	Stable	Stable
341	1.74	1.2667	1.2033	Erosive	Erosive	Erosive	0.3	Stable	6.4	Stable	Stable
1023	1.74	1.4665	1.3932	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1364	1.74	1.5184	1.4425	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	136	341	1023	1364	136	341	1023	1364	136	341	1023	1364
Bray - Equation #1	32	51	92	107	1.4	1.9	2.7	2.9	3.1	3.6	4.2	4.3
Bray - Equation #2	42	67	121	140	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	29	34	4.2	5.9	9.0	10.0				
Ackers & Charlton/Lacey	28	42	66	75					1.8	2.1	2.5	2.7
Parker	80	127	220	254	1.1	1.6	2.5	2.8				
Chang	53	94	182	217	0.1	0.0	-0.3	-0.5				
Kellerhals	21	33	58	66	1.9	2.8	4.3	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	56	61	190	192								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.5	23.3	35.2	39.2	4	6	9	10	2.9	3.7	4.9	5.2
Average	36	53	101	114	2.0	2.7	4.0	4.4	2.7	3.1	3.7	3.9
Values As Designed	56	61	190	192	1.1	1.8	3.4	3.7	2.4	3.4	3.3	3.7
Difference with Design	-21	-8	-89	-78	0.9	0.9	0.6	0.7	0.3	-0.3	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	844	531	1039	1480	2655	220	209	131	3014	238	905	1024
341	3477	1784	3306	6986	4002	999	738	706	8056	845	3913	3165
1023	18792	6608	10513	44593	6178	4796	2496	3714	24867	4133	19106	13254
1364	29192	9169	13643	72336	6879	7138	3351	5543	33273	6293	28369	19562

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	2296	1445	2826	4026	7223	600	569	356	8198	646	2463	2786
341	3783	1941	3597	7600	4354	1087	803	768	8765	919	4257	3443
1023	6815	2396	3813	16172	2240	1739	905	1347	9018	1499	6929	4807
1364	7940	2494	3711	19675	1871	1941	912	1508	9050	1712	7716	5321

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	537	290	456	923	909	108	95	118	929	117	626	464
341	2113	916	1324	4149	1405	430	299	502	2452	440	2462	1499
1023	6246	2636	3972	12110	4312	1275	896	1484	7344	1295	7283	4441
1364	9690	3758	5475	19614	4859	1929	1244	2278	9893	1990	11090	6529

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	1462	788	1239	2511	2472	293	257	322	2526	318	1704	1263
341	2299	997	1441	4514	1528	468	325	547	2668	479	2678	1631
1023	2265	956	1441	4392	1564	462	325	538	2663	470	2641	1611
1364	2636	1022	1489	5335	1322	525	338	619	2691	541	3017	1776

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
136	0.0022	0.0032	126	0.38	0.046	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0068	0.0004	0.0024	0.0119	0.0052
341	0.0011	0.0018	165	0.50	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0068	0.0003	0.0012	0.0120	0.0050
1023	0.0005	0.0010	228	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0068	0.0002	0.0005	0.0119	0.0048
1364	0.0004	0.0008	248	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0068	0.0001	0.0004	0.0119	0.0048

Drop Structures

Design Slope	0.0054	ft/ft
Total Drop Needed	69.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	24	
Distance between structs.	439	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	439 ft	Depth	3 ft
Width	212 ft	Side slope	3 ft/ft
Total Volume per Basin		6.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
136	1.1	-0.4	0.1	24.6	1.1	1.0	2.4	0.0054	0.1	1.5	2.5	5.4
341	1.1	-0.5	0.2	24.6	1.8	1.7	3.4	0.0054	0.2	1.5	2.5	5.6
1023	1.1	-1.0	0.2	24.6	3.4	1.6	3.3	0.0054	0.4	1.5	2.5	5.8
1364	1.1	-1.0	0.2	24.6	3.7	1.9	3.7	0.0054	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.93	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.82	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	3
Channel Width (ft)	212	212
Channel XS Area (sq. ft)	1037	1037
Channel Perimeter (ft)	214	214

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	3512	sq. Yd
Volume	10535	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10535	10535
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	49163	101838
Left Levee Volume (cu. Yd)	48383	113934
Right Levee Length (ft)	10535	10535
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	49163	101838
Right Levee Volume (cu. Yd)	48383	113934
Total Levee Surface Area (sq. Yd)	98326	203676
Total Levee Volume (cu. Yd)	96766	227868

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16388	38628
Left Levee Lining Volume (cu. Yd)	8194	19314
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16388	38628
Right Levee Lining Volume (cu. Yd)	8194	19314
Total Lining Area (sq. Yd)	32776	77257
Total Lining Volume (cu. Yd)	16388	38628

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	212	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	24	
Volume per structure	241	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,075	
Area per structure	71	sq. Yd
Total Area	1,696	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9696	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 38,784	
Other Cost	$ -	
Total cost per basin	$ 38,784	
Area per basin	10,340	sq. Yd
Total Area	10,340	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	96,766	cu. Yd	$ 7.00	$ 677,362	98,326	sq. Yd	$ 9.00	$ 884,934	98,326	sq. Yd	$ 11.67	$ 1,147,137
Levee - LC Enhancement	Fill	131,102	cu. Yd	$ 7.00	$ 917,714	105,350	sq. Yd	$ 9.00	$ 948,150	131,102	sq. Yd	$ 11.67	$ 1,529,523
Levee Lining	Riprap	16,388	cu. Yd	$ 75.00	$ 1,229,100	32,776	sq. Yd	$ -	$ -	32,776	sq. Yd	$ 20.83	$ 682,824
Levee Lining -LC Enhancement	Riprap	22,240	cu. Yd	$ 75.00	$ 1,668,000	44,481	sq. Yd	$ -	$ -	44,481	sq. Yd	$ 20.83	$ 926,690
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	10,535	cu. Yd	$ 75.00	$ 790,125	3,512	sq. Yd	$ -	$ -	3,512	sq. Yd	$ 25.00	$ 87,800
Drop Structures	Riprap	24	EA	$ 18,075.00	$ 433,800	1,696	sq. Yd	$ -	$ -	1,696	sq. Yd	$ 33.33	$ 56,533
Drop Str. - LC Enhancement	Riprap	24	EA	$ 1,807.50	$ 43,380	170	sq. Yd	$ -	$ -	170	sq. Yd	$ 33.33	$ 5,653
Sedimentation Basins		1	EA	$ 38,784.00	$ 38,784	10,340	sq. Yd	$ -	$ -	10,340	sq. Yd	$ 8.33	$ 86,167
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 884,934	Base Maintenance Cost			$ 2,060,461
						LC Enhancement Cost			$ 948,150	LC Enhancement Cost			$ 2,461,866
						Total Landscape Cost			$ 1,833,084	Total Maintenance Cost			$ 4,522,327

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,169,171	$ 2,629,094	$ 5,798,265
Contingency Cost (25% of Construction Cost)	$ 792,293	$ 657,274	$ 1,449,566
Engineering Design Cost (5% of Construction Cost)	$ 158,459	$ 131,455	$ 289,913
Total Construction Cost	$ 4,119,922	$ 3,417,822	$ 7,537,745

Land Cost

Channel Length	10535 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	212	51.3	$100,000	$ 5,130,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.3	$100,000	$ 1,330,000
Levee LC Enhancement	51	12.3	$100,000	$ 1,230,000
Other	0	0	$100,000	$ -
Total	318	76.9		$ 7,690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	64.6	$100,000	$ 6,460,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	76.9	$100,000	$ 7,690,000

Total Cost

Base Total Cost	$ 13,525,317
Total Landscape Enhancement Cost	$ 8,057,839
Total Cost Including LC Enh.	$ 21,583,156

Open Channel

Structure ID	C42020

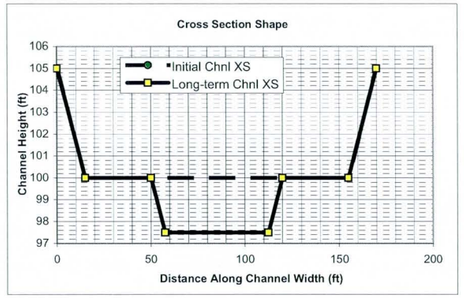
HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0057	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

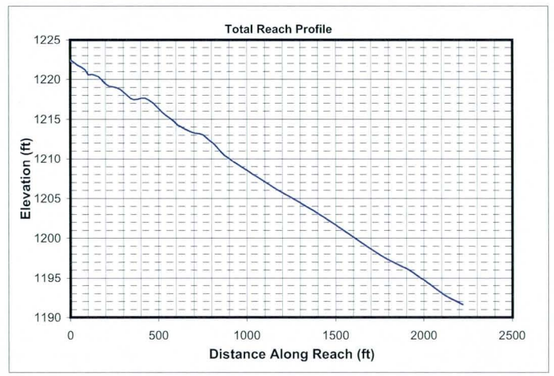
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	140	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	155	155	155	170
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	35	3	55	7.5	3	35	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	50	57.5	112.5	120	155	170
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1714									1714
Weighting Factor	1.00									
Flow into Channel	1714									1714

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	157.00									157
Sediment Conc. (ppm)	1776									
Sediment Volume (ac. ft)	0.11									0.11
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.11									0.11

Hydrology

Drainage Area	4.058	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1714	cfs	
Long-term Max. Chnl Capacity	7166	cfs	
Q2 Channel	171	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	170	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	143.2	70.5	0.5	100.0	100.5	2.4	0.5	143.0	0.5	0.18	0.61
429	145.4	122.9	0.8	100.0	100.9	3.5	0.9	145.2	0.8	0.31	0.67
1286	150.5	240.8	1.6	100.0	101.7	5.3	1.7	150.0	1.6	0.59	0.74
1714	152.5	287.6	1.9	100.0	102.0	6.0	2.0	151.8	1.9	0.70	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	62.1	65.9	1.1	97.5	98.6	2.6	1.1	61.8	1.1	0.40	0.44
429	67.3	117.9	1.8	97.5	99.4	3.6	1.9	66.6	1.8	0.69	0.48
1286	147.7	312.2	2.1	97.5	101.1	4.1	3.6	146.5	2.1	1.28	0.50
1714	150.3	373.6	2.5	97.5	101.5	4.6	4.0	149.0	2.5	1.42	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
171	464									464
429	1499									1499
1286	4441									4441
1714	6529									6529

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
171	1.74	1.1773	1.1185	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
429	1.74	1.3440	1.2768	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
1286	1.74	1.5415	1.4644	Erosive	Erosive	Erosive	0.4	Stable	9.6	Stable	Stable
1714	1.74	1.5925	1.5128	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	171	429	1286	1714	171	429	1286	1714	171	429	1286	1714
Bray - Equation #1	36	58	104	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	136	158	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.6	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	73	82					1.9	2.2	2.6	2.8
Parker	90	142	246	284	1.2	1.7	2.7	3.0				
Chang	63	110	213	253	0.1	-0.1	-0.5	-0.7				
Kellerhals	24	37	65	75	2.1	3.1	4.8	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	62	67	147	149								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.8	25.2	38.0	42.3	5	7	10	11	3.2	4.0	5.2	5.6
Average	40	60	108	122	2.1	2.9	4.3	4.7	2.8	3.2	3.9	4.1
Values As Designed	62	67	147	149	1.1	1.9	3.6	4.0	2.6	3.6	4.1	4.6
Difference with Design	-22	-7	-39	-27	1.0	1.0	0.7	0.7	0.2	-0.4	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1714	961	1952	3377	2746	527	416	327	5019	449	1920	1764
429	7031	2952	5347	15865	3997	2024	1214	1418	12954	1639	7478	5629
1286	37698	10317	14959	100343	6052	9254	3760	6607	39410	8032	33806	24567
1714	58385	14164	19883	162210	6727	13716	4984	9665	52638	11395	49386	36650

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	3711	2080	4224	7309	5945	1141	901	708	10864	971	4156	3819
429	6087	2556	4629	13736	3461	1752	1051	1228	11216	1419	6475	4874
1286	10880	2978	4317	28959	1747	2671	1085	1907	11374	2318	9757	7090
1714	12638	3066	4304	35111	1456	2969	1079	2092	11394	2467	10690	7933

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	785	408	660	1396	1089	165	137	177	1289	170	920	654
429	3089	1263	1817	6281	1663	632	412	722	3367	643	3541	2130
1286	11017	3939	5697	23425	4117	2173	1280	2508	10190	2263	12260	7170
1714	17016	5521	7482	37746	4629	3235	1736	3745	13663	2544	18334	10514

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1699	883	1428	3021	2358	356	297	383	2790	368	1992	1416
429	2675	1094	1573	5438	1440	547	357	625	2915	557	3066	1844
1286	3180	1137	1644	6760	1188	627	369	724	2941	653	3538	2069
1714	3683	1195	1619	8170	1002	700	376	811	2957	551	3969	2276

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
171	0.0015	0.0025	154	0.47	0.048	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0063	0.0004	0.0017	0.0139	0.0054
429	0.0008	0.0014	202	0.61	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0063	0.0002	0.0009	0.0139	0.0053
1286	0.0003	0.0008	278	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0063	0.0001	0.0004	0.0138	0.0052
1714	0.0003	0.0006	301	0.92	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0001	0.0003	0.0138	0.0051

Drop Structures

Design Slope	0.0057	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	170 ft	Side slope	3 ft/ft
Total Volume per Basin		3.45	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
171	1.1	-0.4	0.1	24.6	1.1	1.1	2.6	0.0057	0.1	1.5	2.5	5.4
429	1.1	-0.5	0.2	24.6	1.9	1.8	3.6	0.0057	0.2	1.5	2.5	5.6
1286	1.1	-0.9	0.2	24.6	3.6	2.1	4.1	0.0057	0.4	1.5	2.5	5.9
1714	1.1	-1.0	0.3	24.6	4.0	2.5	4.6	0.0057	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	2.0	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.01	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	1.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	3
Channel Width (ft)	170	170
Channel XS Area (sq. ft)	931.2	931.2
Channel Perimeter (ft)	172	172

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	746	sq. Yd
Volume	2238	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2238	2238
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	11439	23126
Left Levee Volume (cu. Yd)	12019	27851
Right Levee Length (ft)	2238	2238
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	11439	23126
Right Levee Volume (cu. Yd)	12019	27851
Total Levee Surface Area (sq. Yd)	22878	46252
Total Levee Volume (cu. Yd)	24038	55702

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3979	8952
Left Levee Lining Volume (cu. Yd)	1989	4476
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3979	8952
Right Levee Lining Volume (cu. Yd)	1989	4476
Total Lining Area (sq. Yd)	7957	17904
Total Lining Volume (cu. Yd)	3978	8952

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	170	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.5	ft
Structure Height	12.5	ft
Number of Structures	7	
Volume per structure	236	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 17,700	
Area per structure	57	sq. Yd
Total Area	397	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	5566	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 22,264	
Other Cost	$ -	
Total cost per basin	$ 22,264	
Area per basin	6,038	sq. Yd
Total Area	12,076	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	24,038	cu. Yd	$ 7.00	$ 168,266	22,878	sq. Yd	$ 9.00	$ 205,902	22,878	sq. Yd	$ 11.67	$ 266,910
Levee - LC Enhancement	Fill	31,664	cu. Yd	$ 7.00	$ 221,648	23,374	sq. Yd	$ 9.00	$ 210,366	31,664	sq. Yd	$ 11.67	$ 369,413
Levee Lining	Riprap	3,978	cu. Yd	$ 75.00	$ 298,350	7,957	sq. Yd	$ -	$ -	7,957	sq. Yd	$ 20.83	$ 165,778
Levee Lining -LC Enhancement	Riprap	4,974	cu. Yd	$ 75.00	$ 373,050	9,947	sq. Yd	$ -	$ -	9,947	sq. Yd	$ 20.83	$ 207,222
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,238	cu. Yd	$ 75.00	$ 167,850	746	sq. Yd	$ -	$ -	746	sq. Yd	$ 25.00	$ 18,650
Drop Structures	Riprap	7	EA	$ 17,700.00	$ 123,900	397	sq. Yd	$ -	$ -	397	sq. Yd	$ 33.33	$ 13,233
Drop Str. - LC Enhancement	Riprap	7	EA	$ 1,770.00	$ 12,390	40	sq. Yd	$ -	$ -	40	sq. Yd	$ 33.33	$ 1,323
Sedimentation Basins		2	EA	$ 22,264.00	$ 44,528	12,076	sq. Yd	$ -	$ -	12,076	sq. Yd	$ 8.33	$ 100,633
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 205,902	Base Maintenance Cost			$ 565,204
						LC Enhancement Cost			$ 210,366	LC Enhancement Cost			$ 577,959
						Total Landscape Cost			$ 416,268	Total Maintenance Cost			$ 1,143,163

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 802,894	$ 607,088	$ 1,409,982
Contingency Cost (25% of Construction Cost)	$ 200,724	$ 151,772	$ 352,496
Engineering Design Cost (5% of Construction Cost)	$ 40,145	$ 30,354	$ 70,499
Total Construction Cost	$ 1,043,762	$ 789,214	$ 1,832,977

Land Cost

Channel Length	2238	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	170	8.7	$100,000	$ 870,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	3	$100,000	$ 300,000
Levee LC Enhancement	54	2.8	$100,000	$ 280,000
Other	0	0	$100,000	$ -
Total	282	14.5		$ 1,450,000

Total Cost

Base Total Cost	$	2,984,869
Total Landscape Enhancement Cost	$	1,857,539
Total Cost Including LC Enh.	$	4,842,408

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	11.7	$100,000	$ 1,170,000
LC Enhancement Cost	acre	2.8	$100,000	$ 280,000
Total Land Cost	acre	14.5	$100,000	$ 1,450,000

Online Basin

HEC1 ID	RR500

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.6	sq. mi
Total Sediment Yield Volume	6.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	6.9	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1300	1530
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	23.9	28.1
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	1.9	4.3

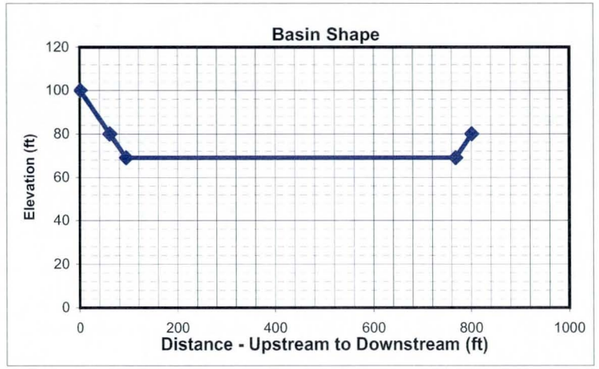
			Base	LC Enhanced
Bottom Length (ft)	1234	Allocated Storage Volume (ac. ft)	204.4	203.8
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	226.3	227.4
		Total Excavation Volume (ac. ft)	465.2	508.5

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	12	13
Volume	0.00	38.71	78.49	119.35	161.30	182.69	204.35	226.30	248.52	271.03
Outflow	0.0	85.6	121.0	148.2	171.1	181.5	191.3	200.7	209.6	218.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	227.0	257	257.0
Peak Inflow (cfs)	1743	2063	2063.0
Peak Outflow (cfs)	181	186	186.0
Stage at Peak Outflow (ft)	8.9	9.4	9.4
Volume at Peak Outflow (ac. ft)	180.8	192.34	192.3

Volume Check

Total Volume needed	199.2	ac. ft
Total Volume Provided	204.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.4	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	427000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1300	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	1630	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	750523	820380
Excavated Area (sq. Yd)	115556	163000

Inlet			***Outlet***		
Inlet Type	Riprap		Outlet Type	Pipe	
(Riprap, Concrete)			(None, Riprap Weir, Concrete Weir, Pipe)		
			Pipe Length	550	ft
Inlet Length	98	ft	Unit Cost	160	per ft
Inlet Width	100	ft	Cost per outlet	$88,000	
Material Thickness	1.5	ft	Other Cost	$ -	
Inlet Area	1089	sq. Yd	Total Cost	$88,000	
Material Volume	545	cu. Yd	Outlet Area	133	sq. Yd

Structure Type		Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		750,523	cu. Yd	$ 4.00	$ 3,002,092	115,556	sq. Yd	$ 9.00	$ 1,040,004	115,556	sq. Yd	$ 8.33	$ 962,967
Basin - LC Enhancement		69,857	cu. Yd	$ 4.00	$ 279,428	47,444	sq. Yd	$ 9.00	$ 426,996	47,444	sq. Yd	$ 8.33	$ 395,367
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,040,004	Base Maintenance Cost			$ 1,001,483
						LC Enh. Landscape Cost			$ 426,996	LC Enh. Maintenance Cost			$ 402,738
						Total Landscape Cost			$ 1,467,000	Total Maintenance Cost			$ 1,404,221

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,130,967	$ 279,428	$ 3,410,395
Contingency Cost (25% of Construction Cost)	$ 782,742	$ 69,857	$ 852,599
Engineering Design Cost (5% of Construction Cost)	$ 156,548	$ 13,971	$ 170,520
Total Construction Cost	$ 4,070,257	$ 363,256	$ 4,433,514

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	9.8	$100,000	$ 980,000
Basin	23.9	$100,000	$ 2,390,000
Other		$100,000	$ -
Total	33.7	$100,000	$ 3,370,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.9	$100,000	$ 2,390,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 8,501,744
Total LC Enhancement Cost	$ 2,172,990
Total Cost Including LC Enh.	$ 10,674,734

Open Channel

Structure ID	C51010

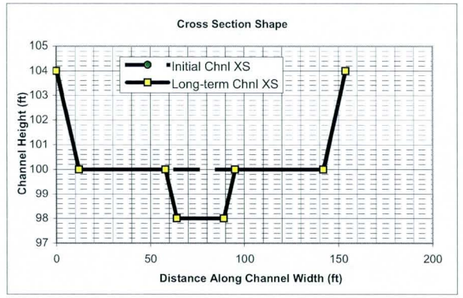
HEC1 ID	500510

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

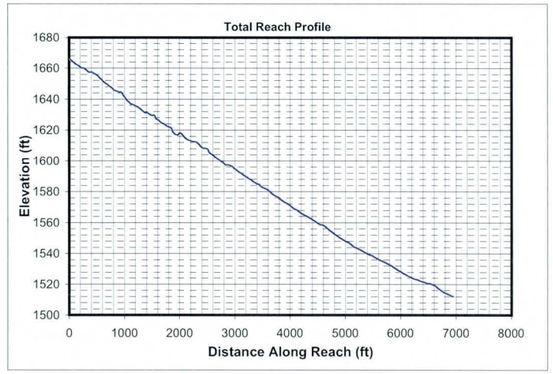
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	130	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	142	142	142	154
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	46	3	25	6	3	47	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	58	64	89	95	142	154
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.22							
Flow into Channel	186	462							648

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.409	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	648	cfs	
Long-term Max. Chnl Capacity	5020	cfs	
Q2 Channel	65	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	131.6	33.0	0.3	100.0	100.3	2.0	0.3	131.5	0.3	0.14	0.69
162	132.8	57.5	0.4	100.0	100.4	2.8	0.4	132.6	0.4	0.25	0.75
486	135.3	111.9	0.8	100.0	100.8	4.3	0.8	135.1	0.8	0.47	0.84
648	136.3	133.4	1.0	100.0	101.0	4.9	1.0	136.0	1.0	0.56	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	30.5	24.1	0.8	98.0	98.9	2.7	0.9	30.2	0.8	0.49	0.53
162	34.4	43.9	1.3	98.0	99.5	3.7	1.5	33.9	1.3	0.84	0.57
486	134.7	146.4	1.1	98.0	100.6	3.3	2.6	133.8	1.1	1.48	0.56
648	136.0	174.6	1.3	98.0	100.8	3.7	2.8	135.1	1.3	1.60	0.58

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
65										0
162										0
486										0
648										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
65	1.74	0.9696	0.9211	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
162	1.74	1.1376	1.0807	Erosive	Erosive	Erosive	0.2	Stable	7.2	Stable	Stable
486	1.74	1.3374	1.2705	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
648	1.74	1.3894	1.3199	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	65	162	486	648	65	162	486	648	65	162	486	648
Bray - Equation #1	21	35	62	72	1.1	1.4	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	28	46	81	95	1.2	1.6	2.3	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	23	3.1	4.5	6.8	7.5				
Ackers & Charlton/Lacey	21	30	48	55					1.6	1.9	2.2	2.4
Parker	55	87	151	175	0.8	1.1	1.8	2.0				
Chang	40	70	137	163	0.0	-0.1	-0.4	-0.5				
Kellerhals	14	23	40	46	1.4	2.1	3.2	3.6	3.1	3.4	3.8	3.9
AMAFCA/Schumm	30	34	134	135								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	11.4	16.0	24.2	27.0	3	4	6	7	2.9	3.7	4.9	5.2
Average	24	36	71	80	1.4	2.0	2.9	3.2	2.5	2.9	3.5	3.6
Values As Designed	30	34	134	135	0.9	1.5	2.6	2.8	2.7	3.7	3.3	3.7
Difference with Design	-7	2	-63	-55	0.6	0.5	0.3	0.3	-0.2	-0.8	0.1	-0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	761	501	1148	1481	2173	278	241	121	3761	259	808	1048
162	3129	1591	3320	6992	3208	1139	762	604	9809	850	3343	3159
486	16989	5698	9891	44691	4871	5338	2459	3051	29973	3924	15680	12960
648	26392	7853	12961	72516	5408	7930	3278	4518	40055	5903	23048	19078

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	4359	2870	6570	8482	12440	1593	1382	690	21534	1484	4623	6003
162	7167	3643	7603	16013	7346	2608	1744	1382	22465	1946	7657	7234
486	12969	4350	7551	34116	3719	4075	1877	2329	22881	2995	11970	9894
648	15110	4496	7420	41518	3096	4540	1876	2586	22933	3380	13195	10923

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	482	248	444	935	600	124	96	102	989	113	554	426
162	1853	738	1200	4092	928	448	270	397	2548	410	2035	1356
486	4850	2012	3499	10151	3289	1206	796	1050	7586	1083	5447	3725
648	7528	2858	4841	16445	3695	1814	1095	1610	10192	1651	8241	5452

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	2762	1420	2543	5354	3438	708	547	582	5665	647	3174	2440
162	4243	1691	2747	9371	2125	1026	619	910	5835	939	4660	3106
486	3702	1536	2671	7749	2511	921	608	801	5791	827	4158	2843
648	4310	1636	2771	9415	2115	1039	627	922	5835	945	4718	3121

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
65	0.0030	0.0048	139	0.42	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0024	0.0087	0.0006	0.0033	0.0221	0.0084
162	0.0015	0.0028	182	0.56	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0087	0.0004	0.0017	0.0221	0.0081
486	0.0007	0.0015	252	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0087	0.0002	0.0007	0.0221	0.0079
648	0.0005	0.0012	274	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0087	0.0002	0.0006	0.0221	0.0079

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	91.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	31	
Distance between structs.	225	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	225 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		2.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
65	1.1	-0.3	0.1	24.6	0.9	0.8	2.7	0.0090	0.1	1.5	2.0	4.7
162	1.1	-0.4	0.2	24.6	1.5	1.3	3.7	0.0090	0.2	1.5	2.0	4.9
486	1.1	-0.8	0.2	24.6	2.6	1.1	3.3	0.0090	0.3	1.5	2.0	5.0
648	1.1	-0.8	0.2	24.6	2.8	1.3	3.7	0.0090	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.30	ac. ft
Deposited(+)/Eroded(-) Volume	0.47	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	3
Channel Width (ft)	154	154
Channel XS Area (sq. ft)	630	630
Channel Perimeter (ft)	156	156

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2321	sq. Yd
Volume	6964	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6964	6964
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	30177	62676
Left Levee Volume (cu. Yd)	26824	64481
Right Levee Length (ft)	6964	6964
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	30177	62676
Right Levee Volume (cu. Yd)	26824	64481
Total Levee Surface Area (sq. Yd)	60354	125352
Total Levee Volume (cu. Yd)	53648	128962

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10059	23213
Left Levee Lining Volume (cu. Yd)	5030	11607
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10059	23213
Right Levee Lining Volume (cu. Yd)	5030	11607
Total Lining Area (sq. Yd)	20118	46427
Total Lining Volume (cu. Yd)	10060	23214

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	154	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	31	
Volume per structure	150	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,250	
Area per structure	51	sq. Yd
Total Area	1,591	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3485	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,940	
Other Cost	$ -	
Total cost per basin	$ 13,940	
Area per basin	3,844	sq. Yd
Total Area	3,844	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	53,648	cu. Yd	$ 7.00	$ 375,536	60,354	sq. Yd	$ 9.00	$ 543,186	60,354	sq. Yd	$ 11.67	$ 704,130	
Levee - LC Enhancement	Fill	75,314	cu. Yd	$ 7.00	$ 527,198	64,998	sq. Yd	$ 9.00	$ 584,982	75,314	sq. Yd	$ 11.67	$ 878,663	
Levee Lining	Riprap	10,060	cu. Yd	$ 75.00	$ 754,500	20,118	sq. Yd	$ -	$ -	20,118	sq. Yd	$ 20.83	$ 419,130	
Levee Lining -LC Enhancement	Riprap	13,154	cu. Yd	$ 75.00	$ 986,550	26,308	sq. Yd	$ -	$ -	26,308	sq. Yd	$ 20.83	$ 548,093	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	6,964	cu. Yd	$ 75.00	$ 522,300	2,321	sq. Yd	$ -	$ -	2,321	sq. Yd	$ 25.00	$ 58,025	
Drop Structures	Riprap	31	EA	$ 11,250.00	$ 348,750	1,591	sq. Yd	$ -	$ -	1,591	sq. Yd	$ 33.33	$ 53,033	
Drop Str. - LC Enhancement	Riprap	31	EA	$ 1,125.00	$ 34,875	159	sq. Yd	$ -	$ -	159	sq. Yd	$ 33.33	$ 5,303	
Sedimentation Basins		1	EA	$ 13,940.00	$ 13,940	3,844	sq. Yd	$ -	$ -	3,844	sq. Yd	$ 8.33	$ 32,033	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 543,186	Base Maintenance Cost			$ 1,266,351	
						LC Enhancement Cost			$ 584,982	LC Enhancement Cost			$ 1,432,059	
						Total Landscape Cost			$ 1,128,168	Total Maintenance Cost			$ 2,698,411	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,015,026	$ 1,548,623	$ 3,563,649
Contingency Cost (25% of Construction Cost)	$ 503,757	$ 387,156	$ 890,912
Engineering Design Cost (5% of Construction Cost)	$ 100,751	$ 77,431	$ 178,182
Total Construction Cost	$ 2,619,534	$ 2,013,210	$ 4,632,744

Land Cost

Channel Length	6964 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	154	24.6	$100,000	$ 2,460,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.3	$100,000	$ 830,000
Levee LC Enhancement	48	7.7	$100,000	$ 770,000
Other	0	0	$100,000	$ -
Total	254	40.6		$ 4,060,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	32.9	$100,000	$ 3,290,000
LC Enhancement Cost	acre	7.7	$100,000	$ 770,000
Total Land Cost	acre	40.6	$100,000	$ 4,060,000

Total Cost

Base Total Cost	$ 7,719,071
Total Landscape Enhancement Cost	$ 4,800,251
Total Cost Including LC Enh.	$ 12,519,322

Open Channel

Structure ID	C51020

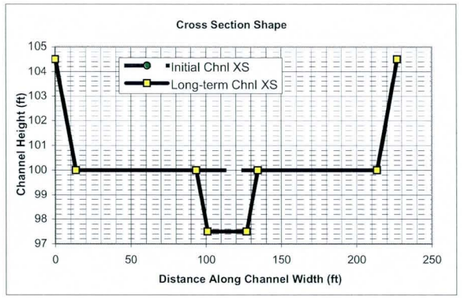
HEC1 ID	500510

Longitudal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

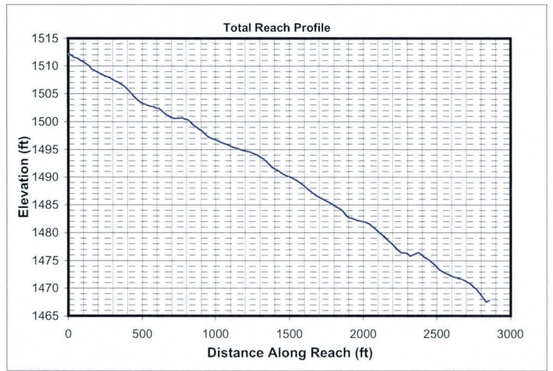
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	26	7	3	79	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	127	134.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.53							
Flow into Channel	186	1112							1298

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51010	500510_S51010							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	3121	2356							
Sediment Volume (ac. ft)	0.30	0.23							0.53
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.30	0.00							0.30

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1298	cfs	
Long-term Max. Chnl Capacity	7362	cfs	
Q2 Channel	130	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	202.1	66.5	0.3	100.0	100.3	2.0	0.3	202.0	0.3	0.12	0.60
325	203.6	115.5	0.6	100.0	100.6	2.8	0.6	203.4	0.6	0.21	0.66
974	207.0	224.7	1.1	100.0	101.1	4.3	1.1	206.6	1.1	0.41	0.73
1298	208.3	267.8	1.3	100.0	101.3	4.8	1.3	207.9	1.3	0.49	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	35.1	43.7	1.2	97.5	98.9	3.0	1.4	34.7	1.3	0.54	0.47
325	41.4	80.9	2.0	97.5	99.9	4.0	2.4	40.6	2.0	0.91	0.50
974	207.5	298.1	1.4	97.5	101.1	3.3	3.6	206.3	1.4	1.33	0.48
1298	209.2	355.5	1.7	97.5	101.3	3.7	3.8	208.0	1.7	1.43	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51010	500510_S51010								
130	426	200								626
325	1356	617								1973
974	3725	1919								5644
1298	5452	2800								8252

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
130	1.74	1.0528	1.0002	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
325	1.74	1.2208	1.1598	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
974	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1298	1.74	1.4735	1.3998	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	130	325	974	1298	130	325	974	1298	130	325	974	1298
Bray - Equation #1	31	50	89	104	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	41	66	117	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.6
Parker	78	124	214	248	1.0	1.5	2.4	2.7				
Chang	54	94	183	218	0.1	0.0	-0.4	-0.6				
Kellerhals	21	32	56	65	1.9	2.7	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	35	41	207	208								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	15.9	22.4	33.9	37.7	4	6	9	10	3.0	3.8	5.0	5.4
Average	32	50	101	114	1.9	2.6	3.8	4.2	2.7	3.1	3.7	3.9
Values As Designed	35	41	206	208	1.4	2.4	3.6	3.8	3.0	4.0	3.3	3.7
Difference with Design	-2	9	-106	-94	0.5	0.2	0.3	0.4	-0.3	-0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	1058	676	1406	1945	3095	322	292	167	4254	317	1138	1334
325	4369	2209	4266	9191	4609	1380	971	867	11222	1102	4811	4091
974	23661	8042	13120	58830	7041	6530	3194	4463	34451	5293	23043	17061
1298	36787	11124	17110	95529	7822	9713	4272	6637	46066	8029	34065	25196

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	3025	1931	4019	5559	8846	920	834	477	12159	906	3252	3812
325	4995	2526	4877	10508	5269	1577	1110	992	12830	1260	5501	4677
974	9017	3065	5000	22420	2683	2488	1217	1701	13129	2017	8782	6502
1298	10515	3180	4891	27304	2236	2776	1221	1897	13167	2295	9737	7202

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	742	354	555	1417	714	160	121	172	1080	160	871	577
325	2780	1037	1500	6018	1129	565	336	632	2776	585	3110	1861
974	6404	2715	4270	12512	4662	1367	963	1491	8189	1352	7434	4669
1298	9945	3877	5886	20289	5248	2071	1338	2297	11029	2074	11331	6853

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	2121	1011	1586	4051	2041	458	345	491	3087	458	2489	1649
325	3178	1186	1715	6880	1291	646	384	723	3174	668	3556	2127
974	2440	1035	1627	4768	1777	521	367	568	3121	515	2833	1779
1298	2843	1108	1682	5799	1500	592	382	656	3152	593	3239	1959

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
130	0.0024	0.0037	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0069	0.0004	0.0027	0.0153	0.0061
325	0.0012	0.0021	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0010	0.0069	0.0003	0.0013	0.0153	0.0059
974	0.0005	0.0011	240	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0153	0.0057
1298	0.0004	0.0009	261	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0153	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	319	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	319 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
130	1.1	-0.4	0.1	24.6	1.4	1.3	3.0	0.0060	0.2	1.5	2.5	5.5
325	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	2.5	5.7
974	1.1	-1.0	0.1	24.6	3.6	1.4	3.3	0.0060	0.4	1.5	2.5	5.8
1298	1.1	-1.1	0.2	24.6	3.8	1.7	3.7	0.0060	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.64	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	0.44	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1044.5	1044.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	958	sq. Yd
Volume	2874	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2874	2874
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13412	27782
Left Levee Volume (cu. Yd)	13199	31082
Right Levee Length (ft)	2874	2874
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13412	27782
Right Levee Volume (cu. Yd)	13199	31082
Total Levee Surface Area (sq. Yd)	26824	55564
Total Levee Volume (cu. Yd)	26398	62164

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4471	10538
Left Levee Lining Volume (cu. Yd)	2235	5269
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4471	10538
Right Levee Lining Volume (cu. Yd)	2235	5269
Total Lining Area (sq. Yd)	8941	21076
Total Lining Volume (cu. Yd)	4470	10538

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	9	
Volume per structure	245	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,375	
Area per structure	76	sq. Yd
Total Area	681	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	7518	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 30,072	
Other Cost	$ -	
Total cost per basin	$ 30,072	
Area per basin	8,054	sq. Yd
Total Area	8,054	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	26,398	cu. Yd	$ 7.00	$ 184,786	26,824	sq. Yd	$ 9.00	$ 241,416	26,824	sq. Yd	$ 11.67	$ 312,947
Levee - LC Enhancement	Fill	35,766	cu. Yd	$ 7.00	$ 250,362	28,740	sq. Yd	$ 9.00	$ 258,660	35,766	sq. Yd	$ 11.67	$ 417,270
Levee Lining	Riprap	4,470	cu. Yd	$ 75.00	$ 335,250	8,941	sq. Yd	$ -	$ -	8,941	sq. Yd	$ 20.83	$ 186,278
Levee Lining -LC Enhancement	Riprap	6,068	cu. Yd	$ 75.00	$ 455,100	12,135	sq. Yd	$ -	$ -	12,135	sq. Yd	$ 20.83	$ 252,806
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,874	cu. Yd	$ 75.00	$ 215,550	958	sq. Yd	$ -	$ -	958	sq. Yd	$ 25.00	$ 23,950
Drop Structures	Riprap	9	EA	$ 18,375.00	$ 165,375	681	sq. Yd	$ -	$ -	681	sq. Yd	$ 33.33	$ 22,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,837.50	$ 16,538	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,270
Sedimentation Basins		1	EA	$ 30,072.00	$ 30,072	8,054	sq. Yd	$ -	$ -	8,054	sq. Yd	$ 8.33	$ 67,117
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 241,416	Base Maintenance Cost			$ 612,991
						LC Enhancement Cost			$ 258,660	LC Enhancement Cost			$ 672,346
						Total Landscape Cost			$ 500,076	Total Maintenance Cost			$ 1,285,337

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 931,033	$ 722,000	$ 1,653,033
Contingency Cost (25% of Construction Cost)	$ 232,758	$ 180,500	$ 413,258
Engineering Design Cost (5% of Construction Cost)	$ 46,552	$ 36,100	$ 82,652
Total Construction Cost	$ 1,210,343	$ 938,599	$ 2,148,942

Land Cost

Channel Length	2874 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	15	$100,000	$ 1,500,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	333	22		$ 2,200,000

Total Cost

Base Total Cost	$ 3,924,750
Total Landscape Enhancement Cost	$ 2,209,605
Total Cost Including LC Enh.	$ 6,134,355

Right of Way

Preservation Corridor Width	0 ft
Maintenance Access	0 ft
Landscape Enhancement Buffer	0 ft
Other	0 ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	18.6	$100,000	$ 1,860,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	22	$100,000	$ 2,200,000

Open Channel

Structure ID	C51030

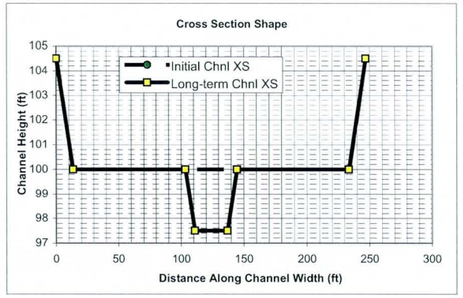
HEC1 ID	500510

Longitudal Geometry

Length	1483.7	ft
U/S Elev	1468.2	ft
D/S Elev	1450.0	ft
Initial Channel Slope	0.0123	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

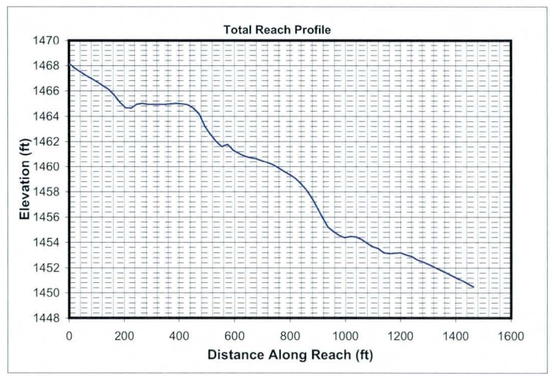
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	220	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	233.5	233.5	233.5	247
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	90	3	26	7	3	89	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	103.5	111	137	144.5	233.5	247
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.59							
Flow into Channel	186	1238							1424

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51020								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	2127								
Sediment Volume (ac. ft)	0.21								0.21
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.21								0.21

Hydrology

Drainage Area	1.84	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1424	cfs	
Long-term Max. Chnl Capacity	7295	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	247	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	222.2	78.1	0.4	100.0	100.4	1.8	0.4	222.1	0.4	0.11	0.54
356	223.9	135.6	0.6	100.0	100.6	2.6	0.6	223.7	0.6	0.19	0.59
1068	227.5	263.9	1.2	100.0	101.2	4.0	1.2	227.1	1.2	0.37	0.66
1424	228.9	314.4	1.4	100.0	101.4	4.5	1.4	228.4	1.4	0.44	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	36.1	49.4	1.4	97.5	99.1	2.9	1.6	35.6	1.4	0.50	0.43
356	223.5	177.3	0.8	97.5	100.4	2.0	2.9	222.5	0.8	0.91	0.40
1068	228.2	345.8	1.5	97.5	101.2	3.1	3.7	227.0	1.5	1.15	0.44
1424	230.1	412.3	1.8	97.5	101.5	3.5	4.0	228.8	1.8	1.24	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51020									
142	577									577
356	1861									1861
1068	4669									4669
1424	6853									6853

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
142	1.74	1.0731	1.0194	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
356	1.74	1.2411	1.1791	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
1068	1.74	1.4418	1.3697	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1424	1.74	1.4940	1.4193	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	142	356	1068	1424	142	356	1068	1424	142	356	1068	1424
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	144	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	225	259	1.1	1.6	2.5	2.8				
Chang	53	94	183	217	0.2	0.0	-0.3	-0.4				
Kellerhals	21	34	59	68	2.0	2.9	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	36	223	227	229								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	17.1	24.0	36.3	40.4	5	6	10	11	2.9	3.6	4.8	5.1
Average	34	70	106	119	2.0	2.7	4.0	4.5	2.7	3.1	3.7	3.9
Values As Designed	36	223	227	229	1.6	2.9	3.7	4.0	2.9	2.0	3.1	3.5
Difference with Design	-2	-153	-121	-109	0.4	-0.2	0.3	0.5	-0.2	1.1	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	850	544	1074	1472	3002	216	210	123	3226	247	894	1078
356	3509	1858	3535	6956	4549	1022	777	701	8687	868	3950	3310
1068	19011	6955	11416	44536	7038	4968	2672	3788	26894	4222	19558	13732
1424	29559	9668	14774	72325	7836	7404	3597	5677	35998	6427	29120	20217

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	2215	1417	2799	3834	7821	562	548	321	8406	643	2330	2809
356	3657	1936	3684	7249	4741	1065	810	731	9053	904	4116	3449
1068	6604	2416	3966	15471	2445	1726	928	1316	9342	1467	6794	4770
1424	7701	2519	3849	18843	2041	1929	937	1479	9379	1675	7587	5267

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	654	317	488	1204	690	131	103	156	892	138	775	504
356	1009	535	850	1589	2820	164	166	192	2015	226	1115	971
1068	5451	2419	3725	10140	4697	1089	818	1313	6754	1127	6433	3997
1424	8467	3476	5089	16446	5304	1666	1151	2040	9125	1731	9876	5852

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	1703	827	1272	3138	1798	341	268	407	2324	359	2020	1314
356	1052	558	886	1656	2939	170	173	200	2100	235	1162	1012
1068	1894	840	1294	3522	1632	378	284	456	2346	391	2235	1388
1424	2206	906	1326	4285	1382	434	300	531	2377	451	2573	1525

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
142	0.0024	0.0035	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0067	0.0004	0.0026	0.0122	0.0053
356	0.0012	0.0020	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0067	0.0003	0.0013	0.0123	0.0050
1068	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0002	0.0006	0.0122	0.0049
1424	0.0004	0.0009	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0067	0.0001	0.0005	0.0122	0.0049

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	10.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	371	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.76	sq. mi
Total Sediment Yield Volume	1.44	ac ft

Sedimentation Basins

Length	371 ft	Depth	3 ft
Width	247 ft	Side slope	3 ft/ft
Total Volume per Basin		5.93	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
142	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	2.5	5.5
356	1.1	-1.0	0.1	24.6	2.9	0.8	2.0	0.0050	0.3	1.5	2.5	5.6
1068	1.1	-1.1	0.1	24.6	3.7	1.5	3.1	0.0050	0.4	1.5	2.5	5.8
1424	1.1	-1.1	0.2	24.6	4.0	1.8	3.5	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.64	ac. ft
Outflowing Sediment Volume	0.15	ac. ft
Deposited(+)/Eroded(-) Volume	1.50	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1484	1484
Side Slope (?H:1V)	3	3
Channel Width (ft)	247	247
Channel XS Area (sq. ft)	1134.5	1134.5
Channel Perimeter (ft)	249	249

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1484	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	495	sq. Yd
Volume	1484	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1484	1484
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	6925	14345
Left Levee Volume (cu. Yd)	6815	16049
Right Levee Length (ft)	1484	1484
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	6925	14345
Right Levee Volume (cu. Yd)	6815	16049
Total Levee Surface Area (sq. Yd)	13850	28690
Total Levee Volume (cu. Yd)	13630	32098

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1484	1484
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2308	5441
Left Levee Lining Volume (cu. Yd)	1154	2721
Right Levee Length (ft)	1484	1484
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2308	5441
Right Levee Lining Volume (cu. Yd)	1154	2721
Total Lining Area (sq. Yd)	4617	10883
Total Lining Volume (cu. Yd)	2308	5442

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	247	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	4	
Volume per structure	266	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 19,950	
Area per structure	82	sq. Yd
Total Area	329	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9567	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 38,268	
Other Cost	$ -	
Total cost per basin	$ 38,268	
Area per basin	10,180	sq. Yd
Total Area	10,180	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	13,630	cu. Yd	$ 7.00	$ 95,410	13,850	sq. Yd	$ 9.00	$ 124,650	13,850	sq. Yd	$ 11.67	$ 161,583
Levee - LC Enhancement	Fill	18,468	cu. Yd	$ 7.00	$ 129,276	14,840	sq. Yd	$ 9.00	$ 133,560	18,468	sq. Yd	$ 11.67	$ 215,460
Levee Lining	Riprap	2,308	cu. Yd	$ 75.00	$ 173,100	4,617	sq. Yd	$ -	$ -	4,617	sq. Yd	$ 20.83	$ 96,185
Levee Lining -LC Enhancement	Riprap	3,134	cu. Yd	$ 75.00	$ 235,050	6,266	sq. Yd	$ -	$ -	6,266	sq. Yd	$ 20.83	$ 130,537
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,484	cu. Yd	$ 75.00	$ 111,300	495	sq. Yd	$ -	$ -	495	sq. Yd	$ 25.00	$ 12,375
Drop Structures	Riprap	4	EA	$ 19,950.00	$ 79,800	329	sq. Yd	$ -	$ -	329	sq. Yd	$ 33.33	$ 10,967
Drop Str. - LC Enhancement	Riprap	4	EA	$ 1,995.00	$ 7,980	33	sq. Yd	$ -	$ -	33	sq. Yd	$ 33.33	$ 1,097
Sedimentation Basins		1	EA	$ 38,268.00	$ 38,268	10,180	sq. Yd	$ -	$ -	10,180	sq. Yd	$ 8.33	$ 84,833
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 124,650	Base Maintenance Cost			$ 365,944
						LC Enhancement Cost			$ 133,560	LC Enhancement Cost			$ 347,094
						Total Landscape Cost			$ 258,210	Total Maintenance Cost			$ 713,037

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 497,878	$ 372,306	$ 870,184
Contingency Cost (25% of Construction Cost)	$ 124,470	$ 93,077	$ 217,546
Engineering Design Cost (5% of Construction Cost)	$ 24,894	$ 18,615	$ 43,509
Total Construction Cost	$ 647,241	$ 483,998	$ 1,131,239

Land Cost

Channel Length	1484 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	247	8.4	$100,000	$ 840,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	1.9	$100,000	$ 190,000
Levee LC Enhancement	51	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	353	12		$ 1,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	10.3	$100,000	$ 1,030,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	12	$100,000	$ 1,200,000

Total Cost

Base Total Cost	$ 2,167,835
Total Landscape Enhancement Cost	$ 1,134,652
Total Cost Including LC Enh.	$ 3,302,486

Open Channel

Structure ID	C51040

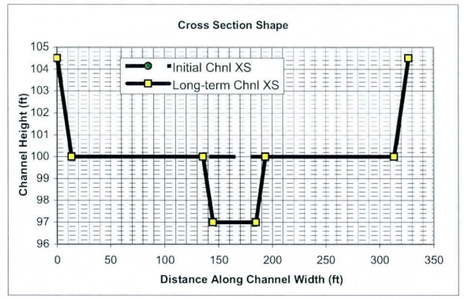
HEC1 ID	500510

Longitudal Geometry

Length	2206.6	ft
U/S Elev	1450.0	ft
D/S Elev	1424.5	ft
Initial Channel Slope	0.0116	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

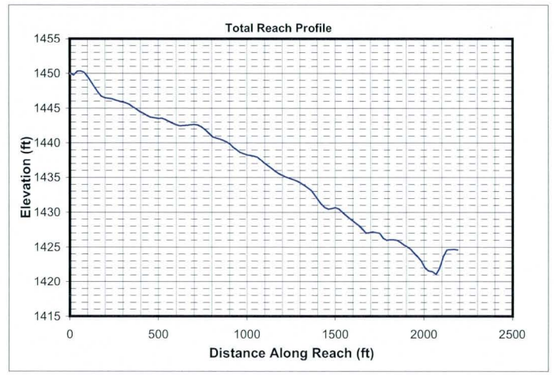
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	122	3	40	7.5	3	120	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	135.5	144.5	184.5	193.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C510								TOTAL
HEC1 Peak-Flow	2072								2072
Weighting Factor	1.00								
Flow into Channel	2072								2072

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51030								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	1525								
Sediment Volume (ac. ft)	0.15								0.15
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.15								0.15

Hydrology

Drainage Area	1.84	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2072	cfs	
Long-term Max. Chnl Capacity	10275	cfs	
Q2 Channel	207	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	302.4	112.5	0.4	100.0	100.4	1.8	0.4	302.2	0.4	0.12	0.53
518	304.1	195.3	0.6	100.0	100.6	2.7	0.6	303.9	0.6	0.20	0.58
1554	307.9	379.6	1.2	100.0	101.2	4.1	1.2	307.5	1.2	0.39	0.65
2072	309.4	451.9	1.5	100.0	101.5	4.6	1.5	308.9	1.5	0.46	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	50.0	70.4	1.4	97.0	98.6	2.9	1.6	49.4	1.4	0.49	0.43
518	56.9	128.6	2.3	97.0	99.7	4.0	2.7	56.1	2.3	0.83	0.47
1554	308.1	488.3	1.6	97.0	101.1	3.2	4.1	306.7	1.6	1.29	0.44
2072	310.0	581.7	1.9	97.0	101.4	3.6	4.4	308.6	1.9	1.38	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51030									
207	504									504
518	971									971
1554	3997									3997
2072	5852									5852

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
207	1.74	1.0908	1.0363	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
518	1.74	1.2592	1.1962	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable
1554	1.74	1.4604	1.3874	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
2072	1.74	1.5128	1.4371	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	207	518	1554	2072	207	518	1554	2072	207	518	1554	2072
Bray - Equation #1	40	64	114	133	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	175	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	99	156	271	313	1.3	1.9	2.9	3.3				
Chang	67	118	229	273	0.1	0.0	-0.5	-0.7				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	50	56	307	309								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	19.6	27.7	41.8	46.5	5	7	11	12	3.2	4.0	5.2	5.6
Average	41	63	132	148	2.3	3.1	4.6	5.1	2.8	3.3	3.9	4.1
Values As Designed	49	56	307	309	1.6	2.7	4.1	4.4	2.9	4.0	3.2	3.6
Difference with Design	-8	7	-175	-161	0.7	0.4	0.5	0.7	-0.1	-0.7	0.7	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1185	752	1462	2040	4084	293	286	175	4300	336	1253	1470
518	4894	2569	4810	9653	6183	1391	1057	989	11587	1193	5528	4532
1554	26573	9629	15530	61955	9546	6772	3637	5325	35881	5851	27413	18919
2072	41357	13391	20102	100706	10618	10100	4896	7981	48029	8925	40845	27905

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	2122	1346	2618	3653	7312	525	513	314	7699	602	2244	2632
518	3505	1840	3445	6914	4428	996	757	708	8299	854	3959	3246
1554	6344	2299	3708	14791	2279	1617	868	1271	8566	1397	6545	4517
2072	7405	2398	3599	18032	1901	1808	877	1429	8600	1598	7314	4996

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	984	472	715	1813	976	197	153	236	1302	206	1165	747
518	3755	1407	1926	7873	1519	712	433	884	3363	732	4263	2443
1554	8273	3581	5447	15543	6542	1648	1212	1995	9866	1702	9739	5959
2072	12865	5137	7478	25240	7371	2514	1698	3089	13316	2619	14931	8751

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1761	845	1280	3245	1748	353	274	422	2331	369	2086	1338
518	2690	1007	1379	5639	1088	510	310	633	2409	525	3054	1749
1554	1975	855	1300	3711	1562	394	289	476	2355	406	2325	1423
2072	2303	920	1339	4519	1320	450	304	553	2384	469	2673	1567

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
207	0.0023	0.0033	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0059	0.0003	0.0025	0.0115	0.0049
518	0.0012	0.0019	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0059	0.0002	0.0012	0.0116	0.0047
1554	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0005	0.0116	0.0045
2072	0.0004	0.0008	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0059	0.0001	0.0004	0.0116	0.0045

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	14.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	441	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.86	sq. mi
Total Sediment Yield Volume	1.63	ac ft

Sedimentation Basins

Length	441 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		9.47	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
207	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	3.0	6.1
518	1.1	-0.7	0.2	24.6	2.7	2.3	4.0	0.0050	0.3	1.5	3.0	6.4
1554	1.1	-1.2	0.1	24.6	4.1	1.6	3.2	0.0050	0.4	1.5	3.0	6.5
2072	1.1	-1.2	0.2	24.6	4.4	1.9	3.6	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.78	ac. ft
Outflowing Sediment Volume	0.17	ac. ft
Deposited(+)/Eroded(-) Volume	1.61	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2207	2207
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1557.8	1557.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2207	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	736	sq. Yd
Volume	2452	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2207	2207
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	10299	21334
Left Levee Volume (cu. Yd)	10136	23868
Right Levee Length (ft)	2207	2207
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	10299	21334
Right Levee Volume (cu. Yd)	10136	23868
Total Levee Surface Area (sq. Yd)	20598	42668
Total Levee Volume (cu. Yd)	20272	47736

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2207	2207
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3433	8092
Left Levee Lining Volume (cu. Yd)	1717	4046
Right Levee Length (ft)	2207	2207
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3433	8092
Right Levee Lining Volume (cu. Yd)	1717	4046
Total Lining Area (sq. Yd)	6866	16185
Total Lining Volume (cu. Yd)	3434	8092

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	5	
Volume per structure	363	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,225	
Area per structure	109	sq. Yd
Total Area	545	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15278	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 61,112	
Other Cost	$ -	
Total cost per basin	$ 61,112	
Area per basin	16,035	sq. Yd
Total Area	16,035	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	20,272	cu. Yd	$ 7.00	$ 141,904	20,598	sq. Yd	$ 9.00	$ 185,382	20,598	sq. Yd	$ 11.67	$ 240,310
Levee - LC Enhancement	Fill	27,464	cu. Yd	$ 7.00	$ 192,248	22,070	sq. Yd	$ 9.00	$ 198,630	27,464	sq. Yd	$ 11.67	$ 320,413
Levee Lining	Riprap	3,434	cu. Yd	$ 75.00	$ 257,550	6,866	sq. Yd	$ -	$ -	6,866	sq. Yd	$ 20.83	$ 143,046
Levee Lining -LC Enhancement	Riprap	4,658	cu. Yd	$ 75.00	$ 349,350	9,318	sq. Yd	$ -	$ -	9,318	sq. Yd	$ 20.83	$ 194,134
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,452	cu. Yd	$ 75.00	$ 183,900	736	sq. Yd	$ -	$ -	736	sq. Yd	$ 25.00	$ 18,400
Drop Structures	Riprap	5	EA	$ 27,225.00	$ 136,125	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 33.33	$ 18,167
Drop Str. - LC Enhancement	Riprap	5	EA	$ 2,722.50	$ 13,613	55	sq. Yd	$ -	$ -	55	sq. Yd	$ 33.33	$ 1,817
Sedimentation Basins		1	EA	$ 61,112.00	$ 61,112	16,035	sq. Yd	$ -	$ -	16,035	sq. Yd	$ 8.33	$ 133,625
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 185,382	Base Maintenance Cost			$ 553,548
						LC Enhancement Cost			$ 198,630	LC Enhancement Cost			$ 516,364
						Total Landscape Cost			$ 384,012	Total Maintenance Cost			$ 1,069,912

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 780,591	$ 555,211	$ 1,335,802
Contingency Cost (25% of Construction Cost)	$ 195,148	$ 138,803	$ 333,950
Engineering Design Cost (5% of Construction Cost)	$ 39,030	$ 27,761	$ 66,790
Total Construction Cost	$ 1,014,768	$ 721,774	$ 1,736,542

Land Cost

Channel Length	2207	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	16.6	$100,000	$ 1,660,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2.8	$100,000	$ 280,000
Levee LC Enhancement	51	2.6	$100,000	$ 260,000
Other	0	0	$100,000	$ -
Total	433	22		$ 2,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.4	$100,000	$ 1,940,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	22	$100,000	$ 2,200,000

Total Cost

Base Total Cost	$ 3,693,698
Total Landscape Enhancement Cost	$ 1,696,768
Total Cost Including LC Enh.	$ 5,390,466

Open Channel

Structure ID	RR51010

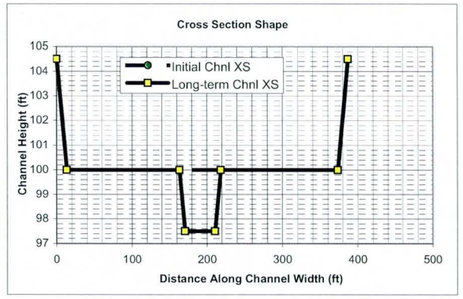
HEC1 ID	510530

Longitudal Geometry

Length	4944.3	ft
U/S Elev	1424.5	ft
D/S Elev	1350.5	ft
Initial Channel Slope	0.0150	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

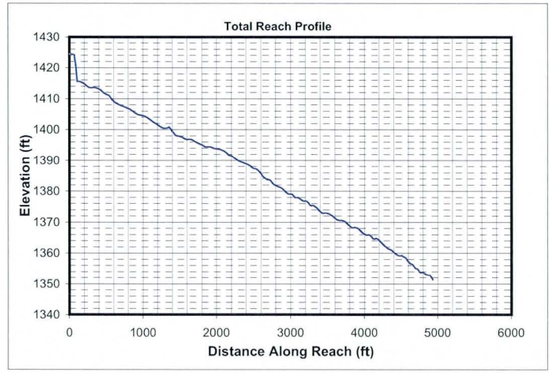
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	150	3	40	7	3	155	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	163.5	171	211	218.5	373.5	387
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C510	S530							TOTAL
HEC1 Peak-Flow	2072	1697							3769
Weighting Factor	1.00	0.00							
Flow into Channel	2072	0							2072

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.23	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2072	cfs	
Long-term Max. Chnl Capacity	12262	cfs	
Q2 Channel	207	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	362.0	112.0	0.3	100.0	100.3	1.9	0.3	361.9	0.3	0.11	0.59
518	363.4	194.1	0.5	100.0	100.5	2.7	0.5	363.2	0.5	0.18	0.64
1554	366.6	376.7	1.0	100.0	101.0	4.1	1.0	366.2	1.0	0.36	0.72
2072	367.8	448.3	1.2	100.0	101.2	4.6	1.2	367.4	1.2	0.42	0.74

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	49.7	68.3	1.4	97.5	99.0	3.0	1.5	49.2	1.4	0.53	0.45
518	363.3	262.1	0.7	97.5	100.4	2.0	2.9	362.4	0.7	0.99	0.41
1554	367.6	509.3	1.4	97.5	101.1	3.1	3.6	366.5	1.4	1.23	0.46
2072	369.3	606.3	1.6	97.5	101.3	3.4	3.8	368.0	1.6	1.32	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
207										0
518										0
1554										0
2072										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
207	1.74	1.0337	0.9820	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
518	1.74	1.2023	1.1422	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable
1554	1.74	1.4042	1.3339	Erosive	Erosive	Erosive	0.3	Stable	8.8	Stable	Stable
2072	1.74	1.4568	1.3840	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	207	518	1554	2072	207	518	1554	2072	207	518	1554	2072
Bray - Equation #1	40	64	114	133	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	175	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	99	156	271	313	1.3	1.9	2.9	3.3				
Chang	69	121	236	281	0.1	-0.1	-0.6	-0.8				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	49	363	367	368								
Moody & Odem	7	7	7	7	0.8	0.8	0.8	0.8				
BUREC	19.3	27.2	41.0	45.7	5	7	11	12	3.3	4.1	5.4	5.8
Average	41	93	137	154	2.2	3.1	4.5	5.0	2.9	3.3	4.0	4.2
Values As Designed	49	362	366	368	1.5	2.9	3.6	3.8	3.0	2.0	3.1	3.4
Difference with Design	-8	-269	-229	-214	0.7	0.2	0.9	1.2	-0.2	1.3	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1534	999	2064	2751	5181	443	418	225	6449	471	1617	2014
518	6346	3340	6531	13030	7772	2000	1468	1247	17173	1623	7037	6142
1554	34535	12343	20648	83841	11896	9623	4942	6642	52921	7787	34405	25417
2072	53781	17120	26813	136412	13206	14341	6631	9933	70796	11826	51083	37449

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	2747	1788	3696	4925	9278	794	749	403	11548	844	2896	3606
518	4545	2392	4678	9332	5566	1433	1051	893	12300	1162	5040	4399
1554	8245	2947	4930	20016	2840	2297	1180	1586	12634	1859	8214	6068
2072	9630	3065	4801	24425	2365	2568	1187	1779	12676	2117	9147	6705

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1126	529	804	2129	1019	234	176	266	1513	238	1325	851
518	1581	841	1385	2502	4586	267	271	288	3391	362	1734	1564
1554	8585	3820	6073	16065	7601	1785	1338	2025	11353	1798	10079	6411
2072	13363	5497	8304	26118	8565	2732	1883	3158	15334	2763	15497	9383

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	2016	948	1439	3812	1825	420	315	476	2709	427	2373	1524
518	1132	602	992	1792	3285	191	194	207	2429	259	1242	1120
1554	2049	912	1450	3835	1815	426	319	483	2710	429	2406	1531
2072	2393	984	1487	4676	1534	489	337	565	2746	495	2775	1680

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
207	0.0026	0.0039	127	0.39	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0059	0.0003	0.0028	0.0149	0.0058
518	0.0013	0.0023	166	0.51	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0011	0.0059	0.0002	0.0014	0.0150	0.0055
1554	0.0006	0.0012	231	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0006	0.0150	0.0054
2072	0.0005	0.0010	251	0.77	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0005	0.0150	0.0054

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	46.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	309	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.23	sq. mi
Total Sediment Yield Volume	0.44	ac ft

Sedimentation Basins

Length	309 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		7.81	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
207	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0055	0.2	1.5	3.0	6.1
518	1.1	-1.0	0.1	24.6	2.9	0.7	2.0	0.0055	0.3	1.5	3.0	6.3
1554	1.1	-1.1	0.1	24.6	3.6	1.4	3.1	0.0055	0.4	1.5	3.0	6.4
2072	1.1	-1.1	0.2	24.6	3.8	1.6	3.4	0.0055	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1052	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	358.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.44	ac. ft
Outflowing Sediment Volume	0.23	ac. ft
Deposited(+)/Eroded(-) Volume	0.21	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4944	4944
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1799.5	1799.5
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4944	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1648	sq. Yd
Volume	5493	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4944	4944
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	23072	47792
Left Levee Volume (cu. Yd)	22706	53468
Right Levee Length (ft)	4944	4944
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	23072	47792
Right Levee Volume (cu. Yd)	22706	53468
Total Levee Surface Area (sq. Yd)	46144	95584
Total Levee Volume (cu. Yd)	45412	106936

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4944	4944
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7691	18128
Left Levee Lining Volume (cu. Yd)	3845	9064
Right Levee Length (ft)	4944	4944
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7691	18128
Right Levee Lining Volume (cu. Yd)	3845	9064
Total Lining Area (sq. Yd)	15381	36256
Total Lining Volume (cu. Yd)	7690	18128

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	16	
Volume per structure	401	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 30,075	
Area per structure	129	sq. Yd
Total Area	2,064	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12600	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 50,400	
Other Cost	$ -	
Total cost per basin	$ 50,400	
Area per basin	13,288	sq. Yd
Total Area	13,288	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	45,412	cu. Yd	$ 7.00	$ 317,884	46,144	sq. Yd	$ 9.00	$ 415,296	46,144	sq. Yd	$ 11.67	$ 538,347
Levee - LC Enhancement	Fill	61,524	cu. Yd	$ 7.00	$ 430,668	49,440	sq. Yd	$ 9.00	$ 444,960	61,524	sq. Yd	$ 11.67	$ 717,780
Levee Lining	Riprap	7,690	cu. Yd	$ 75.00	$ 576,750	15,381	sq. Yd	$ -	$ -	15,381	sq. Yd	$ 20.83	$ 320,444
Levee Lining -LC Enhancement	Riprap	10,438	cu. Yd	$ 75.00	$ 782,850	20,875	sq. Yd	$ -	$ -	20,875	sq. Yd	$ 20.83	$ 434,889
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,493	cu. Yd	$ 75.00	$ 411,975	1,648	sq. Yd	$ -	$ -	1,648	sq. Yd	$ 25.00	$ 41,200
Drop Structures	Riprap	16	EA	$ 30,075.00	$ 481,200	2,064	sq. Yd	$ -	$ -	2,064	sq. Yd	$ 33.33	$ 68,800
Drop Str. - LC Enhancement	Riprap	16	EA	$ 3,007.50	$ 48,120	206	sq. Yd	$ -	$ -	206	sq. Yd	$ 33.33	$ 6,880
Sedimentation Basins		1	EA	$ 50,400.00	$ 50,400	13,288	sq. Yd	$ -	$ -	13,288	sq. Yd	$ 8.33	$ 110,733
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 415,296	Base Maintenance Cost			$ 1,079,524
						LC Enhancement Cost			$ 444,960	LC Enhancement Cost			$ 1,159,549
						Total Landscape Cost			$ 860,256	Total Maintenance Cost			$ 2,239,073

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,838,209	$ 1,261,638	$ 3,099,847
Contingency Cost (25% of Construction Cost)	$ 459,552	$ 315,410	$ 774,962
Engineering Design Cost (5% of Construction Cost)	$ 91,910	$ 63,082	$ 154,992
Total Construction Cost	$ 2,389,672	$ 1,640,129	$ 4,029,801

Land Cost

Channel Length	4944	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	43.9	$100,000	$ 4,390,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.2	$100,000	$ 620,000
Levee LC Enhancement	51	5.8	$100,000	$ 580,000
Other	0	0	$100,000	$ -
Total	493	55.9		$ 5,590,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	50.1	$100,000	$ 5,010,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	55.9	$100,000	$ 5,590,000

Total Cost

Base Total Cost	$ 8,894,492
Total Landscape Enhancement Cost	$ 3,824,638
Total Cost Including LC Enh.	$ 12,719,130

Open Channel

Structure ID	RR51015

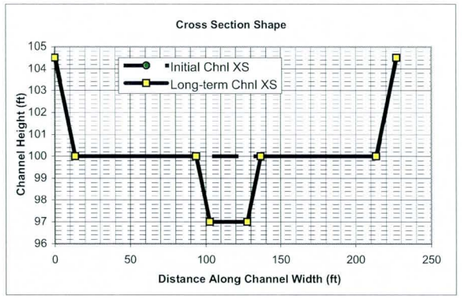
HEC1 ID	510530

Longitudal Geometry

Length	8139.4	ft
U/S Elev	1350.5	ft
D/S Elev	1247.5	ft
Initial Channel Slope	0.0126	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

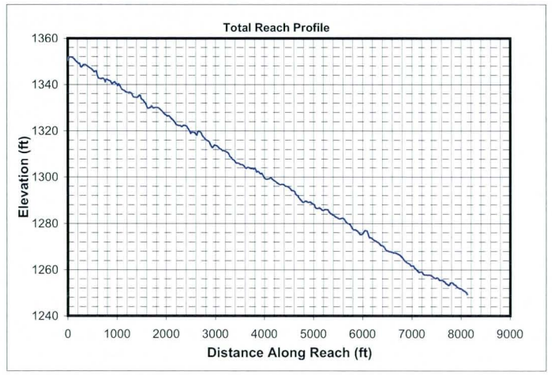
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	25	7.5	3	77	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	102.5	127.5	136.5	213.5	227
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	510530	S530								TOTAL
HEC1 Peak-Flow	1052	1697								2749
Weighting Factor	1.00	0.23								
Flow into Channel	1052	390								1442

Reach Sediment Inflow Characteristics

U/S Contributing ID	510530_RR51010									TOTAL
Flow Volume (ac. ft)	358.00									358
Sediment Conc. (ppm)	1680									
Sediment Volume (ac. ft)	0.23									0.23
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.23									0.23

Hydrology

Drainage Area	0.52	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1442	cfs	
Long-term Max. Chnl Capacity	6914	cfs	
Q2 Channel	144	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
144	202.4	75.1	0.4	100.0	100.4	1.9	0.4	202.2	0.4	0.12	0.56
361	204.1	130.4	0.6	100.0	100.6	2.8	0.6	203.9	0.6	0.20	0.61
1082	207.9	254.1	1.2	100.0	101.2	4.3	1.2	207.5	1.2	0.39	0.68
1442	209.4	302.8	1.4	100.0	101.5	4.8	1.5	208.9	1.4	0.46	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
144	35.4	49.4	1.4	97.0	98.6	2.9	1.6	34.9	1.4	0.51	0.43
361	42.5	92.0	2.2	97.0	99.8	3.9	2.8	41.6	2.2	0.86	0.46
1082	208.2	335.9	1.6	97.0	101.1	3.2	4.1	206.9	1.6	1.29	0.45
1442	210.2	400.7	1.9	97.0	101.5	3.6	4.5	208.8	1.9	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	510530_RR51010									
144	851									851
361	1564									1564
1082	6411									6411
1442	9383									9383

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
144	1.74	1.0899	1.0354	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
361	1.74	1.2577	1.1948	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
1082	1.74	1.4579	1.3850	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1442	1.74	1.5099	1.4344	Erosive	Erosive	Erosive	0.4	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	144	361	1082	1442	144	361	1082	1442	144	361	1082	1442
Bray - Equation #1	33	53	95	110	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	70	124	145	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	36	4.3	6.0	9.2	10.2				
Ackers & Charlton/Lacey	29	43	68	76					1.8	2.1	2.6	2.7
Parker	82	130	226	261	1.1	1.6	2.5	2.8				
Chang	54	94	184	219	0.2	0.0	-0.3	-0.5				
Kellerhals	22	34	59	68	2.0	2.9	4.4	5.0	3.4	3.7	4.1	4.2
AMAFCA/Schumm	35	42	207	209								
Moody & Odem	10	10	10	10	0.9	0.9	0.9	0.9				
BUREC	17.1	24.2	36.5	40.6	5	6	10	11	2.9	3.6	4.8	5.1
Average	33	52	104	117	2.0	2.7	4.0	4.5	2.7	3.1	3.7	3.9
Values As Designed	35	42	207	209	1.6	2.8	4.1	4.5	2.9	3.9	3.2	3.6
Difference with Design	-2	10	-103	-91	0.3	0.0	-0.1	0.0	-0.2	-0.8	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
144	953	602	1192	1691	2928	259	242	149	3487	272	1025	1164
361	3931	2006	3739	7987	4397	1154	842	795	9285	962	4402	3591
1082	21265	7396	11802	51052	6765	5517	2822	4153	28615	4692	21390	15043
1442	33048	10254	15337	82857	7526	8210	3786	6192	38281	7140	31728	22215

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
144	2452	1548	3067	4351	7534	666	624	383	8970	699	2636	2994
361	4046	2064	3848	8220	4525	1187	866	818	9555	990	4530	3695
1082	7295	2537	4049	17513	2321	1892	968	1425	9816	1610	7338	5160
1442	8503	2638	3946	21318	1936	2112	974	1593	9849	1837	8163	5715

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
144	673	324	495	1248	686	135	105	161	905	142	799	516
361	2498	956	1320	5235	1101	478	297	593	2336	516	2858	1653
1082	5835	2508	3789	11052	4472	1161	846	1408	6877	1202	6866	4183
1442	9056	3590	5210	17909	5045	1767	1182	2173	9277	1848	10498	6141

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
144	1732	833	1273	3211	1764	347	270	415	2329	365	2055	1327
361	2570	984	1358	5387	1133	492	305	610	2404	531	2941	1702
1082	2002	860	1300	3791	1534	398	290	483	2359	412	2355	1435
1442	2330	924	1340	4608	1298	455	304	559	2387	475	2701	1580

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
144	0.0022	0.0033	128	0.39	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0066	0.0004	0.0025	0.0126	0.0053
361	0.0011	0.0019	167	0.51	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0066	0.0003	0.0012	0.0126	0.0051
1082	0.0005	0.0010	231	0.71	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0066	0.0002	0.0005	0.0126	0.0050
1442	0.0004	0.0008	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0066	0.0001	0.0004	0.0126	0.0049

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	62.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	21	
Distance between structs.	388	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.52	sq. mi
Total Sediment Yield Volume	0.99	ac ft

Sedimentation Basins

Length	388 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		5.69	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
144	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	3.0	6.2
361	1.1	-0.7	0.2	24.6	2.8	2.2	3.9	0.0050	0.3	1.5	3.0	6.4
1082	1.1	-1.2	0.1	24.6	4.1	1.6	3.2	0.0050	0.4	1.5	3.0	6.5
1442	1.1	-1.2	0.2	24.6	4.5	1.9	3.6	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1052	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	358.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.21	ac. ft
Outflowing Sediment Volume	0.23	ac. ft
Deposited(+)/Eroded(-) Volume	0.99	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8139	8139
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1062.8	1062.8
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8139	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2713	sq. Yd
Volume	9043	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8139	8139
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	37982	78677
Left Levee Volume (cu. Yd)	37379	88022
Right Levee Length (ft)	8139	8139
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	37982	78677
Right Levee Volume (cu. Yd)	37379	88022
Total Levee Surface Area (sq. Yd)	75964	157354
Total Levee Volume (cu. Yd)	74758	176044

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8139	8139
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	12661	29843
Left Levee Lining Volume (cu. Yd)	6330	14922
Right Levee Length (ft)	8139	8139
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	12661	29843
Right Levee Lining Volume (cu. Yd)	6330	14922
Total Lining Area (sq. Yd)	25321	59686
Total Lining Volume (cu. Yd)	12660	29844

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.1	ft
Structure Height	10.1	ft
Number of Structures	21	
Volume per structure	255	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 19,125	
Area per structure	76	sq. Yd
Total Area	1,589	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9180	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 36,720	
Other Cost	$ -	
Total cost per basin	$ 36,720	
Area per basin	9,776	sq. Yd
Total Area	9,776	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	74,758	cu. Yd	$ 7.00	$ 523,306	75,964	sq. Yd	$ 9.00	$ 683,676	75,964	sq. Yd	$ 11.67	$ 886,247
Levee - LC Enhancement	Fill	101,286	cu. Yd	$ 7.00	$ 709,002	81,390	sq. Yd	$ 9.00	$ 732,510	101,286	sq. Yd	$ 11.67	$ 1,181,670
Levee Lining	Riprap	12,660	cu. Yd	$ 75.00	$ 949,500	25,321	sq. Yd	$ -	$ -	25,321	sq. Yd	$ 20.83	$ 527,528
Levee Lining -LC Enhancement	Riprap	17,184	cu. Yd	$ 75.00	$ 1,288,800	34,365	sq. Yd	$ -	$ -	34,365	sq. Yd	$ 20.83	$ 715,931
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	9,043	cu. Yd	$ 75.00	$ 678,225	2,713	sq. Yd	$ -	$ -	2,713	sq. Yd	$ 25.00	$ 67,825
Drop Structures	Riprap	21	EA	$ 19,125.00	$ 401,625	1,589	sq. Yd	$ -	$ -	1,589	sq. Yd	$ 33.33	$ 52,967
Drop Str. - LC Enhancement	Riprap	21	EA	$ 1,912.50	$ 40,163	159	sq. Yd	$ -	$ -	159	sq. Yd	$ 33.33	$ 5,297
Sedimentation Basins		1	EA	$ 36,720.00	$ 36,720	9,776	sq. Yd	$ -	$ -	9,776	sq. Yd	$ 8.33	$ 81,467
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 683,676	Base Maintenance Cost			$ 1,616,033
						LC Enhancement Cost			$ 732,510	LC Enhancement Cost			$ 1,902,897
						Total Landscape Cost			$ 1,416,186	Total Maintenance Cost			$ 3,518,930

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,589,376	$ 2,037,965	$ 4,627,341
Contingency Cost (25% of Construction Cost)	$ 647,344	$ 509,491	$ 1,156,835
Engineering Design Cost (5% of Construction Cost)	$ 129,469	$ 101,898	$ 231,367
Total Construction Cost	$ 3,366,189	$ 2,649,354	$ 6,015,543

Land Cost

Channel Length	8139 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	42.4	$100,000	$ 4,240,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	10.3	$100,000	$ 1,030,000
Levee LC Enhancement	51	9.5	$100,000	$ 950,000
Other	0	0	$100,000	$ -
Total	333	62.2		$ 6,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	52.7	$100,000	$ 5,270,000
LC Enhancement Cost	acre	9.5	$100,000	$ 950,000
Total Land Cost	acre	62.2	$100,000	$ 6,220,000

Total Cost

Base Total Cost	$ 10,935,898
Total Landscape Enhancement Cost	$ 6,234,761
Total Cost Including LC Enh.	$ 17,170,659

Open Channel

Structure ID	RR51020

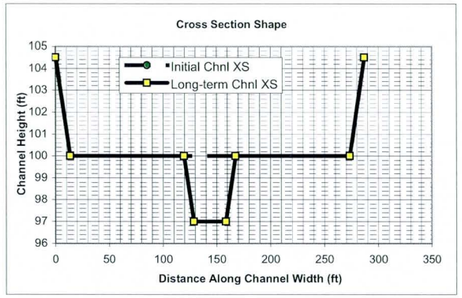
HEC1 ID	510530

Longitudal Geometry

Length	4796.1	ft
U/S Elev	1247.5	ft
D/S Elev	1192.1	ft
Initial Channel Slope	0.0115	ft/ft
Long-term Channel Slope	0.0045	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

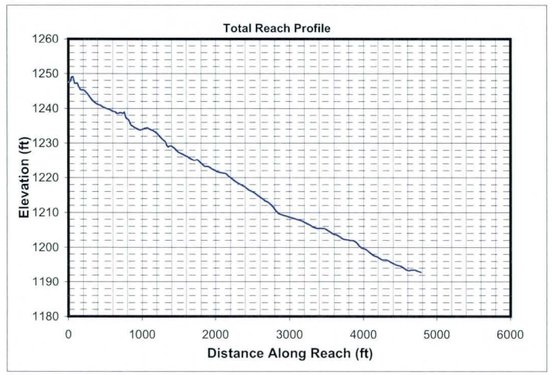
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	260	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	273.5	273.5	273.5	287
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	106	3	30	7.5	3	106	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	119.5	128.5	158.5	167.5	273.5	287
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	510530	S530							TOTAL
HEC1 Peak-Flow	1052	1697							2749
Weighting Factor	1.00	0.52							
Flow into Channel	1052	882							1934

Reach Sediment Inflow Characteristics

U/S Contributing ID	510530_RR51015								TOTAL
Flow Volume (ac. ft)	358.00								358
Sediment Conc. (ppm)	1702								
Sediment Volume (ac. ft)	0.23								0.23
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.23								0.23

Hydrology

Drainage Area	1.16	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1934	cfs	
Long-term Max. Chnl Capacity	8348	cfs	
Q2 Channel	193	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	287	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
193	262.5	102.1	0.4	100.0	100.4	1.9	0.4	262.3	0.4	0.11	0.54
484	264.3	177.3	0.7	100.0	100.7	2.7	0.7	264.1	0.7	0.19	0.59
1451	268.3	344.8	1.3	100.0	101.3	4.2	1.3	267.8	1.3	0.37	0.65
1934	269.8	410.8	1.5	100.0	101.6	4.7	1.6	269.3	1.5	0.44	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
193	41.5	64.8	1.6	97.0	98.8	3.0	1.8	41.0	1.6	0.51	0.42
484	263.8	235.1	0.9	97.0	100.5	2.1	3.5	262.7	0.9	0.97	0.38
1451	269.1	458.1	1.7	97.0	101.3	3.2	4.3	267.8	1.7	1.21	0.43
1934	271.2	546.1	2.0	97.0	101.6	3.5	4.6	269.7	2.0	1.30	0.44

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	510530_RR51015									
193	516									516
484	1653									1653
1451	4183									4183
1934	6141									6141

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
193	1.74	1.1044	1.0492	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
484	1.74	1.2726	1.2089	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
1451	1.74	1.4734	1.3997	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
1934	1.74	1.5256	1.4493	Erosive	Erosive	Erosive	0.4	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	193	484	1451	1934	193	484	1451	1934	193	484	1451	1934
Bray - Equation #1	38	62	110	128	1.5	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	50	81	145	169	1.7	2.3	3.3	3.6	2.3	2.6	3.0	3.1
Hey	11	19	36	42	4.8	6.7	10.2	11.4				
Ackers & Charlton/Lacey	33	48	77	86					1.9	2.2	2.7	2.8
Parker	96	151	262	302	1.2	1.8	2.8	3.2				
Chang	62	109	213	253	0.2	0.0	-0.4	-0.5				
Kellerhals	25	40	69	79	2.2	3.2	5.0	5.6	3.5	3.8	4.2	4.3
AMAFCA/Schumm	41	263	268	270								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	19.5	27.5	41.5	46.3	5	7	11	12	3.0	3.8	4.9	5.3
Average	39	81	123	139	2.2	3.1	4.5	5.0	2.8	3.2	3.9	4.0
Values As Designed	41	263	268	270	1.8	3.5	4.3	4.6	3.0	2.1	3.2	3.5
Difference with Design	-2	-181	-144	-131	0.4	-0.4	0.2	0.4	-0.2	1.2	0.7	0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
193	1148	722	1399	1998	3668	292	280	177	4038	321	1230	1388
484	4738	2437	4496	9445	5530	1343	1000	965	10821	1145	5344	4297
1451	25686	9064	14352	60513	8520	6478	3397	5108	33435	5628	26246	18039
1934	39950	12588	18613	98299	9477	9650	4564	7633	44743	8583	39028	26648

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
193	2202	1385	2684	3832	7036	561	536	340	7746	615	2359	2663
484	3635	1870	3450	7247	4243	1030	768	741	8303	879	4101	3297
1451	6570	2318	3671	15478	2179	1657	869	1306	8552	1440	6713	4614
1934	7664	2415	3571	18857	1818	1851	876	1464	8583	1647	7487	5112

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
193	841	399	588	1545	808	161	125	207	1036	174	1002	626
484	1278	671	1037	2001	3358	200	202	255	2337	279	1427	1186
1451	6912	3015	4480	12776	5581	1321	987	1704	7833	1402	8191	4928
1934	10743	4331	6128	20728	6299	2019	1387	2638	10582	2159	12572	7235

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
193	1613	765	1127	2963	1550	309	240	396	1988	333	1921	1201
484	981	515	795	1535	2577	154	155	196	1793	214	1095	910
1451	1768	771	1146	3268	1428	338	252	436	2003	359	2095	1260
1934	2061	831	1175	3976	1208	387	266	506	2030	414	2412	1388

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
193	0.0022	0.0031	125	0.38	0.046	0.0006	29	0.035	0.0005	0.0159	0.0007	0.0016	0.0060	0.0003	0.0023	0.0115	0.0049
484	0.0011	0.0018	164	0.50	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0060	0.0002	0.0012	0.0115	0.0047
1451	0.0005	0.0009	227	0.69	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0005	0.0115	0.0045
1934	0.0004	0.0008	247	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0060	0.0001	0.0004	0.0115	0.0045

Drop Structures

Design Slope	0.0045	ft/ft
Total Drop Needed	33.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	400	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.16	sq. mi
Total Sediment Yield Volume	2.20	ac ft

Sedimentation Basins

Length	400 ft	Depth	3 ft
Width	287 ft	Side slope	3 ft/ft
Total Volume per Basin		7.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
193	1.1	-0.6	0.1	24.6	1.8	1.6	3.0	0.0045	0.2	1.5	3.0	6.2
484	1.1	-1.2	0.1	24.6	3.5	0.9	2.1	0.0045	0.3	1.5	3.0	6.3
1451	1.1	-1.3	0.1	24.6	4.3	1.7	3.2	0.0045	0.5	1.5	3.0	6.5
1934	1.1	-1.3	0.2	24.6	4.6	2.0	3.5	0.0045	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1052	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	358.0	ac. ft

Freeboard

Max. Flow Depth	1.6	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.43	ac. ft
Outflowing Sediment Volume	0.19	ac. ft
Deposited(+)/Eroded(-) Volume	2.25	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4796	4796
Side Slope (?H:1V)	3	3
Channel Width (ft)	287	287
Channel XS Area (sq. ft)	1347.8	1347.8
Channel Perimeter (ft)	289	289

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4796	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1599	sq. Yd
Volume	5329	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4796	4796
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	22381	46361
Left Levee Volume (cu. Yd)	22026	51868
Right Levee Length (ft)	4796	4796
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	22381	46361
Right Levee Volume (cu. Yd)	22026	51868
Total Levee Surface Area (sq. Yd)	44762	92722
Total Levee Volume (cu. Yd)	44052	103736

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4796	4796
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7460	17585
Left Levee Lining Volume (cu. Yd)	3730	8793
Right Levee Length (ft)	4796	4796
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7460	17585
Right Levee Lining Volume (cu. Yd)	3730	8793
Total Lining Area (sq. Yd)	14921	35171
Total Lining Volume (cu. Yd)	7460	17586

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	287	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.3	ft
Structure Height	10.3	ft
Number of Structures	12	
Volume per structure	327	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 24,525	
Area per structure	96	sq. Yd
Total Area	1,148	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12068	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 48,272	
Other Cost	$ -	
Total cost per basin	$ 48,272	
Area per basin	12,745	sq. Yd
Total Area	12,745	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	44,052	cu. Yd	$ 7.00	$ 308,364	44,762	sq. Yd	$ 9.00	$ 402,858	44,762	sq. Yd	$ 11.67	$ 522,223
Levee - LC Enhancement	Fill	59,684	cu. Yd	$ 7.00	$ 417,788	47,960	sq. Yd	$ 9.00	$ 431,640	59,684	sq. Yd	$ 11.67	$ 696,313
Levee Lining	Riprap	7,460	cu. Yd	$ 75.00	$ 559,500	14,921	sq. Yd	$ -	$ -	14,921	sq. Yd	$ 20.83	$ 310,852
Levee Lining -LC Enhancement	Riprap	10,126	cu. Yd	$ 75.00	$ 759,450	20,250	sq. Yd	$ -	$ -	20,250	sq. Yd	$ 20.83	$ 421,870
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,329	cu. Yd	$ 75.00	$ 399,675	1,599	sq. Yd	$ -	$ -	1,599	sq. Yd	$ 25.00	$ 39,975
Drop Structures	Riprap	12	EA	$ 24,525.00	$ 294,300	1,148	sq. Yd	$ -	$ -	1,148	sq. Yd	$ 33.33	$ 38,267
Drop Str. - LC Enhancement	Riprap	12	EA	$ 2,452.50	$ 29,430	115	sq. Yd	$ -	$ -	115	sq. Yd	$ 33.33	$ 3,827
Sedimentation Basins		1	EA	$ 48,272.00	$ 48,272	12,745	sq. Yd	$ -	$ -	12,745	sq. Yd	$ 8.33	$ 106,208
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 402,858	Base Maintenance Cost			$ 1,017,525
						LC Enhancement Cost			$ 431,640	LC Enhancement Cost			$ 1,122,010
						Total Landscape Cost			$ 834,498	Total Maintenance Cost			$ 2,139,536

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,610,111	$ 1,206,668	$ 2,816,779
Contingency Cost (25% of Construction Cost)	$ 402,528	$ 301,667	$ 704,195
Engineering Design Cost (5% of Construction Cost)	$ 80,506	$ 60,333	$ 140,839
Total Construction Cost	$ 2,093,144	$ 1,568,668	$ 3,661,813

Land Cost

Channel Length	4796 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	287	31.6	$100,000	$ 3,160,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.1	$100,000	$ 610,000
Levee LC Enhancement	51	5.6	$100,000	$ 560,000
Other	0	0	$100,000	$ -
Total	393	43.3		$ 4,330,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.7	$100,000	$ 3,770,000
LC Enhancement Cost	acre	5.6	$100,000	$ 560,000
Total Land Cost	acre	43.3	$100,000	$ 4,330,000

Total Cost

Base Total Cost	$ 7,283,527
Total Landscape Enhancement Cost	$ 3,682,319
Total Cost Including LC Enh.	$ 10,965,846

Open Channel

Structure ID	S51010

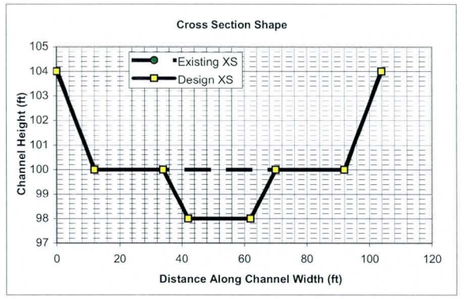
HEC1 ID	S51010

Longitudal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0072	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

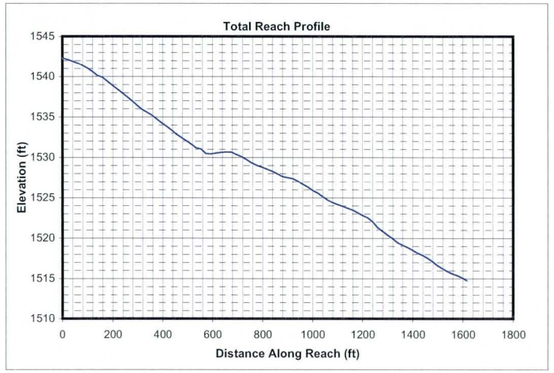
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	4	80	4	4	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	92	92	92	104
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	22	4	20	6	4	22	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	34	42	62	70	92	104
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510								TOTAL
HEC1 Peak-Flow	2099								2099
Weighting Factor	0.21								
Flow into Channel	441								441

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	3006	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	104	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	81.8	23.5	0.3	100.0	100.3	1.9	0.3	81.7	0.3	0.13	0.62
110	83.2	40.9	0.5	100.0	100.5	2.7	0.5	83.0	0.5	0.23	0.68
331	86.1	80.1	0.9	100.0	101.0	4.1	1.0	85.8	0.9	0.43	0.75
441	87.3	95.7	1.1	100.0	101.1	4.6	1.1	86.9	1.1	0.52	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	26.9	19.5	0.7	98.0	98.8	2.3	0.8	26.7	0.7	0.37	0.47
110	31.6	36.0	1.1	98.0	99.4	3.1	1.4	31.2	1.2	0.63	0.50
331	84.1	102.9	1.2	98.0	100.6	3.2	2.6	83.4	1.2	1.16	0.51
441	85.6	123.2	1.4	98.0	100.8	3.6	2.8	84.9	1.5	1.26	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
44										0
110										0
331										0
441										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble) Non-cohesive		Neill (gravel/cobble) Cohesive		USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.0105	0.9600	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
110	1.74	1.1770	1.1181	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
331	1.74	1.3744	1.3057	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
441	1.74	1.4254	1.3541	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	44	110	331	441	44	110	331	441	44	110	331	441
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	29	52	101	120	0.1	0.1	-0.1	-0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	27	31	84	85								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	10.3	14.5	21.8	24.3	3	4	6	6	2.5	3.1	4.1	4.4
Average	20	30	55	62	1.3	1.8	2.6	2.8	2.3	2.7	3.2	3.3
Values As Designed	27	31	83	85	0.8	1.4	2.6	2.8	2.3	3.1	3.2	3.6
Difference with Design	-7	-2	-29	-23	0.4	0.3	0.0	0.0	0.0	-0.4	0.0	-0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	379	249	531	699	1225	119	110	57	1697	121	401	508
110	1558	815	1632	3286	1839	517	370	304	4482	408	1710	1538
331	8346	2967	5083	20775	2849	2441	1226	1577	13769	1912	8176	6284
441	12923	4102	6614	33578	3180	3622	1642	2346	18413	2883	12069	9216

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	3192	2092	4471	5884	10306	1004	922	478	14272	1017	3375	4274
110	5244	2743	5492	11058	6188	1740	1245	1021	15082	1374	5753	5176
331	9362	3328	5702	23303	3196	2738	1375	1768	15445	2145	9171	7048
441	10872	3451	5564	28248	2676	3047	1381	1973	15491	2425	10153	7753

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	210	117	202	367	421	47	42	42	462	49	240	200
110	789	366	589	1561	685	183	132	177	1217	174	913	617
331	2534	1094	1797	5081	1916	583	406	571	3667	552	2913	1919
441	3914	1555	2474	8186	2168	878	562	876	4935	841	4413	2800

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1764	987	1699	3091	3545	395	352	352	3890	413	2016	1682
110	2655	1230	1983	5252	2305	616	443	597	4094	585	3071	2076
331	2843	1227	2015	5699	2149	654	455	640	4114	620	3268	2153
441	3292	1308	2081	6887	1824	739	472	737	4151	707	3713	2356

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0028	0.0042	130	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0021	0.0099	0.0007	0.0033	0.0170	0.0074
110	0.0014	0.0025	171	0.52	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0099	0.0004	0.0017	0.0171	0.0071
331	0.0006	0.0013	235	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0099	0.0003	0.0007	0.0170	0.0069
441	0.0005	0.0011	255	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0099	0.0002	0.0006	0.0170	0.0069

Drop Structures

Design Slope	0.0072	ft/ft
Total Drop Needed	16.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	272	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	272 ft	Depth	3 ft
Width	104 ft	Side slope	3 ft/ft
Total Volume per Basin		1.72	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	-0.3	0.1	24.6	0.8	0.7	2.3	0.0072	0.1	1.5	2.0	4.7
110	1.1	-0.4	0.1	24.6	1.4	1.2	3.1	0.0072	0.2	1.5	2.0	4.8
331	1.1	-0.8	0.1	24.6	2.6	1.2	3.2	0.0072	0.3	1.5	2.0	5.0
441	1.1	-0.8	0.2	24.6	2.8	1.5	3.6	0.0072	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	443	cfs
Stage at Peak Flow	102.3	ft
Flow Volume	28.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	0.72	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	3
Channel Width (ft)	104	104
Channel XS Area (sq. ft)	424	424
Channel Perimeter (ft)	106	106

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	545	sq. Yd
Volume	1634	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1634	1634
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	7081	14706
Left Levee Volume (cu. Yd)	6294	15130
Right Levee Length (ft)	1634	1634
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	7081	14706
Right Levee Volume (cu. Yd)	6294	15130
Total Levee Surface Area (sq. Yd)	14162	29412
Total Levee Volume (cu. Yd)	12588	30260

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1634	1634
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2360	5447
Left Levee Lining Volume (cu. Yd)	1180	2723
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2360	5447
Right Levee Lining Volume (cu. Yd)	1180	2723
Total Lining Area (sq. Yd)	4720	10893
Total Lining Volume (cu. Yd)	2360	5446

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	104	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	6	
Volume per structure	104	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,800	
Area per structure	35	sq. Yd
Total Area	208	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2775	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,100	
Other Cost	$ -	
Total cost per basin	$ 11,100	
Area per basin	3,146	sq. Yd
Total Area	6,292	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	12,588	cu. Yd	$ 7.00	$ 88,116	14,162	sq. Yd	$ 9.00	$ 127,458	14,162	sq. Yd	$ 11.67	$ 165,223
Levee - LC Enhancement	Fill	17,672	cu. Yd	$ 7.00	$ 123,704	15,250	sq. Yd	$ 9.00	$ 137,250	17,672	sq. Yd	$ 11.67	$ 206,173
Levee Lining	Riprap	2,360	cu. Yd	$ 75.00	$ 177,000	4,720	sq. Yd	$ -	$ -	4,720	sq. Yd	$ 20.83	$ 98,343
Levee Lining -LC Enhancement	Riprap	3,086	cu. Yd	$ 75.00	$ 231,450	6,173	sq. Yd	$ -	$ -	6,173	sq. Yd	$ 20.83	$ 128,602
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,634	cu. Yd	$ 75.00	$ 122,550	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 25.00	$ 13,625
Drop Structures	Riprap	6	EA	$ 7,800.00	$ 46,800	208	sq. Yd	$ -	$ -	208	sq. Yd	$ 33.33	$ 6,933
Drop Str. - LC Enhancement	Riprap	6	EA	$ 780.00	$ 4,680	21	sq. Yd	$ -	$ -	21	sq. Yd	$ 33.33	$ 693
Sedimentation Basins		2	EA	$ 11,100.00	$ 22,200	6,292	sq. Yd	$ -	$ -	6,292	sq. Yd	$ 8.33	$ 52,433
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 127,458	Base Maintenance Cost			$ 336,558
						LC Enhancement Cost			$ 137,250	LC Enhancement Cost			$ 335,469
						Total Landscape Cost			$ 264,708	Total Maintenance Cost			$ 672,026

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 456,666	$ 359,834	$ 816,500
Contingency Cost (25% of Construction Cost)	$ 114,167	$ 89,959	$ 204,125
Engineering Design Cost (5% of Construction Cost)	$ 22,833	$ 17,992	$ 40,825
Total Construction Cost	$ 593,666	$ 467,784	$ 1,061,450

Land Cost

Channel Length	1634 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	104	3.9	$100,000	$ 390,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2	$100,000	$ 200,000
Levee LC Enhancement	48	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	204	7.7		$ 770,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

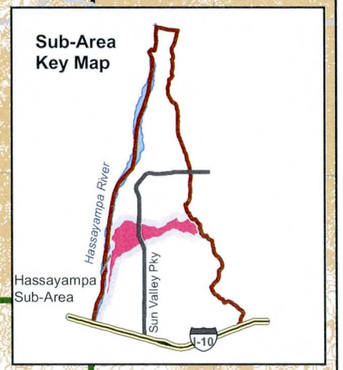
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.9	$100,000	$ 590,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	7.7	$100,000	$ 770,000

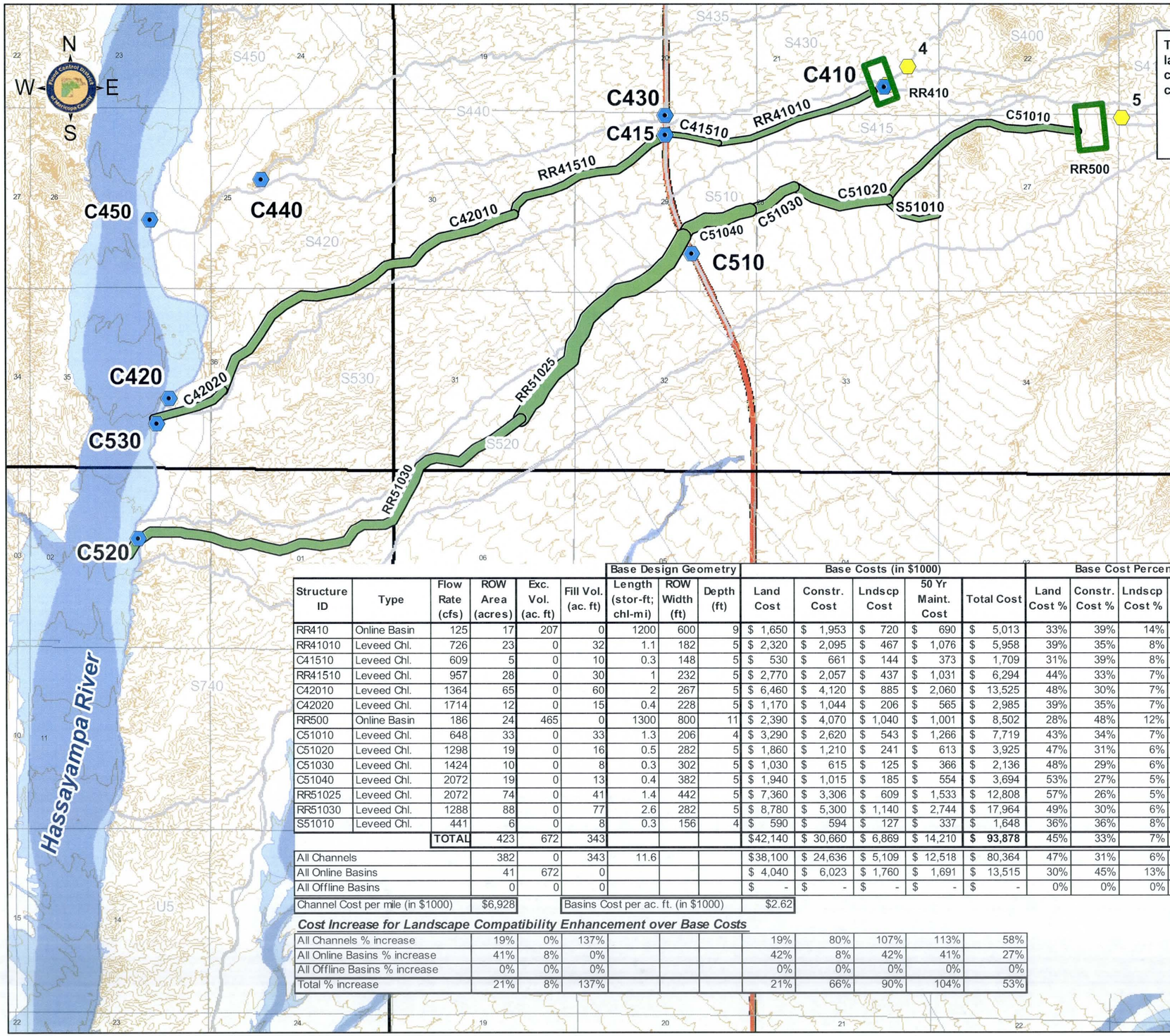
Total Cost

Base Total Cost	$ 1,647,681
Total Landscape Enhancement Cost	$ 1,120,503
Total Cost Including LC Enh.	$ 2,768,184

The Alternative B4-3 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the third of three alignments considered as part of the Alternative B4 series.

0 1 2
Miles





		Base Design Geometry				Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	17	207	0	1200	600	9	$ 1,650	$ 1,953	$ 720	$ 690	$ 5,013	33%	39%	14%	14%	5%
RR41010	Leveed Chl.	726	23	0	32	1.1	182	5	$ 2,320	$ 2,095	$ 467	$ 1,076	$ 5,958	39%	35%	8%	18%	6%
C41510	Leveed Chl.	609	5	0	10	0.3	148	5	$ 530	$ 661	$ 144	$ 373	$ 1,709	31%	39%	8%	22%	2%
RR41510	Leveed Chl.	957	28	0	30	1	232	5	$ 2,770	$ 2,057	$ 437	$ 1,031	$ 6,294	44%	33%	7%	16%	7%
C42010	Leveed Chl.	1364	65	0	60	2	267	5	$ 6,460	$ 4,120	$ 885	$ 2,060	$ 13,525	48%	30%	7%	15%	14%
C42020	Leveed Chl.	1714	12	0	15	0.4	228	5	$ 1,170	$ 1,044	$ 206	$ 565	$ 2,985	39%	35%	7%	19%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	9%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,620	$ 543	$ 1,266	$ 7,719	43%	34%	7%	16%	8%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,210	$ 241	$ 613	$ 3,925	47%	31%	6%	16%	4%
C51030	Leveed Chl.	1424	10	0	8	0.3	302	5	$ 1,030	$ 615	$ 125	$ 366	$ 2,136	48%	29%	6%	17%	2%
C51040	Leveed Chl.	2072	19	0	13	0.4	382	5	$ 1,940	$ 1,015	$ 185	$ 554	$ 3,694	53%	27%	5%	15%	4%
RR51025	Leveed Chl.	2072	74	0	41	1.4	442	5	$ 7,360	$ 3,306	$ 609	$ 1,533	$ 12,808	57%	26%	5%	12%	14%
RR51030	Leveed Chl.	1288	88	0	77	2.6	282	5	$ 8,780	$ 5,300	$ 1,140	$ 2,744	$ 17,964	49%	30%	6%	15%	19%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 594	$ 127	$ 337	$ 1,648	36%	36%	8%	20%	2%
	TOTAL	423	672	343					$42,140	$ 30,660	$ 6,869	$ 14,210	**$ 93,878**	45%	33%	7%	15%	100%
All Channels		382	0	343		11.6			$38,100	$ 24,636	$ 5,109	$ 12,518	$ 80,364	47%	31%	6%	16%	86%
All Online Basins		41	672	0					$ 4,040	$ 6,023	$ 1,760	$ 1,691	$ 13,515	30%	45%	13%	13%	14%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$6,928		Basins Cost per ac. ft. (in $1000)					$2.62									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	19%	0%	137%				19%	80%	107%	113%	58%	
All Online Basins % increase	41%	8%	0%				42%	8%	42%	41%	27%	
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%	
Total % increase	21%	8%	137%				21%	66%	90%	104%	53%	

SUN VALLEY ADMP
Step 2 - Alt. B4-3
Hassayampa Sub-area

Hassayampa Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Leveed Corridors ROW

Step 2 Basins

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SUN VALLEY AREA DRAINAGE MASTER PLAN

Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	17	207	0	1200	600	9	$ 1,650	$ 1,953	$ 720	$ 690	$ 5,013	33%	39%	14%	14%	5%
RR41010	Leveed Chl.	726	23	0	32	1.1	182	5	$ 2,320	$ 2,095	$ 467	$ 1,076	$ 5,958	39%	35%	8%	18%	6%
C41510	Leveed Chl.	609	5	0	10	0.3	148	5	$ 530	$ 661	$ 144	$ 373	$ 1,709	31%	39%	8%	22%	2%
RR41510	Leveed Chl.	957	28	0	30	1	232	5	$ 2,770	$ 2,057	$ 437	$ 1,031	$ 6,294	44%	33%	7%	16%	7%
C42010	Leveed Chl.	1364	65	0	60	2	267	5	$ 6,460	$ 4,120	$ 885	$ 2,060	$ 13,525	48%	30%	7%	15%	14%
C42020	Leveed Chl.	1714	12	0	15	0.4	228	5	$ 1,170	$ 1,044	$ 206	$ 565	$ 2,985	39%	35%	7%	19%	3%
RR500	Online Basin	186	24	465	0	1300	800	11	$ 2,390	$ 4,070	$ 1,040	$ 1,001	$ 8,502	28%	48%	12%	12%	9%
C51010	Leveed Chl.	648	33	0	33	1.3	206	4	$ 3,290	$ 2,620	$ 543	$ 1,266	$ 7,719	43%	34%	7%	16%	8%
C51020	Leveed Chl.	1298	19	0	16	0.5	282	5	$ 1,860	$ 1,210	$ 241	$ 613	$ 3,925	47%	31%	6%	16%	4%
C51030	Leveed Chl.	1424	10	0	8	0.3	302	5	$ 1,030	$ 615	$ 125	$ 366	$ 2,135	48%	29%	6%	17%	2%
C51040	Leveed Chl.	2072	19	0	13	0.4	382	5	$ 1,940	$ 1,015	$ 185	$ 554	$ 3,694	53%	27%	5%	15%	4%
RR51025	Leveed Chl.	2072	74	0	41	1.4	442	5	$ 7,360	$ 3,306	$ 609	$ 1,533	$ 12,808	57%	26%	5%	12%	14%
RR51030	Leveed Chl.	1288	88	0	77	2.6	282	5	$ 8,780	$ 5,300	$ 1,140	$ 2,744	$ 17,964	49%	30%	6%	15%	19%
S51010	Leveed Chl.	441	6	0	8	0.3	156	4	$ 590	$ 594	$ 127	$ 337	$ 1,648	36%	36%	8%	20%	2%
	TOTAL	423	672	343					$ 42,140	$ 30,660	$ 6,869	$ 14,210	**$ 93,878**	45%	33%	7%	15%	100%
All Channels		382	0	343	11.6				$ 38,100	$ 24,636	$ 5,109	$ 12,518	$ 80,364	47%	31%	6%	16%	86%
All Online Basins		41	672	0					$ 4,040	$ 6,023	$ 1,760	$ 1,691	$ 13,515	30%	45%	13%	13%	14%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$6,928		Basins Cost per ac. ft. (in $1000)					$2.62									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	LCE Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	LCE Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR410	Online Basin	125	24	219	0	1470	700	9	$ 2,360	$ 2,054	$ 1,029	$ 980	$ 6,424	37%	32%	16%	15%	4%
RR41010	Leveed Chl.	726	30	0	75	1.1	233	5	$ 2,970	$ 3,892	$ 968	$ 2,375	$ 10,204	29%	38%	9%	23%	7%
C41510	Leveed Chl.	609	7	0	24	0.3	202	5	$ 720	$ 1,208	$ 291	$ 777	$ 2,997	24%	40%	10%	26%	2%
RR41510	Leveed Chl.	957	34	0	70	1	283	5	$ 3,380	$ 3,745	$ 904	$ 2,246	$ 10,275	33%	36%	9%	22%	7%
C42010	Leveed Chl.	1364	77	0	141	2	318	5	$ 7,690	$ 7,538	$ 1,833	$ 4,522	$ 21,583	36%	35%	8%	21%	15%
C42020	Leveed Chl.	1714	15	0	35	0.4	282	5	$ 1,450	$ 1,833	$ 416	$ 1,143	$ 4,842	30%	38%	9%	24%	3%
RR500	Online Basin	186	34	509	0	1630	900	11	$ 3,370	$ 4,434	$ 1,467	$ 1,404	$ 10,675	32%	42%	14%	13%	7%
C51010	Leveed Chl.	648	41	0	80	1.3	254	4	$ 4,060	$ 4,633	$ 1,128	$ 2,698	$ 12,519	32%	37%	9%	22%	9%
C51020	Leveed Chl.	1298	22	0	39	0.5	333	5	$ 2,200	$ 2,149	$ 500	$ 1,285	$ 6,134	36%	35%	8%	21%	4%
C51030	Leveed Chl.	1424	12	0	20	0.3	353	5	$ 1,200	$ 1,099	$ 258	$ 713	$ 3,270	37%	34%	8%	22%	2%
C51040	Leveed Chl.	2072	22	0	30	0.4	433	5	$ 2,200	$ 1,737	$ 384	$ 1,070	$ 5,390	41%	32%	7%	20%	4%
RR51025	Leveed Chl.	2072	82	0	97	1.4	493	5	$ 8,210	$ 5,700	$ 1,261	$ 3,232	$ 18,403	45%	31%	7%	18%	13%
RR51030	Leveed Chl.	1288	104	0	182	2.6	333	5	$ 10,370	$ 9,696	$ 2,361	$ 5,914	$ 28,341	37%	34%	8%	21%	20%
S51010	Leveed Chl.	441	8	0	19	0.3	204	4	$ 770	$ 1,061	$ 265	$ 672	$ 2,768	28%	38%	10%	24%	2%
	TOTAL	512	728	812					$ 50,950	$ 50,778	$ 13,066	$ 29,033	**$ 143,827**	35%	35%	9%	20%	100%
All Channels		454	0	812	11.6				$ 45,220	$ 44,290	$ 10,570	$ 26,648	$ 126,728	36%	35%	8%	21%	88%
All Online Basins		58	728	0					$ 5,730	$ 6,488	$ 2,496	$ 2,385	$ 17,099	34%	38%	15%	14%	12%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$10,925		Basins Cost per ac. ft. (in $1000)					$3.43									
All Channels % increase		19%	0%	137%					19%	80%	107%	113%	58%					
All Online Basins % increase		41%	8%	0%					42%	8%	42%	41%	27%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		21%	8%	137%					21%	66%	90%	104%	53%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
RR410	STORAGE	125	7.2	105.15	6	2.18	116	65	22	9	0.492	1.103	1.12	1.12	57	128	130	130
410415	ROUTE	125	100.7	6.76	6.5	2.18	115	65	22	9	0.492	1.102	1.12	1.12	57	128	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415	COMBINE	422			4.1	2.63	137	74	25	11	0.484	1.04	1.055	1.055	68	146	148	148
415420	ROUTE	165	100.5	28.25	5.7	2.63	121	73	25	11	0.427	1.03	1.055	1.055	60	145	148	148
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	1227			4.3	4.4	252	108	37	16	0.532	0.911	0.928	0.928	125	214	218	218
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
RR500	STORAGE	181	8.9	180.75	6.9	3.64	171	109	38	17	0.436	1.111	1.171	1.171	85	216	227	227
500510	ROUTE	180	100.3	27.15	8	3.64	168	108	38	17	0.43	1.106	1.171	1.171	83	215	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C510		1384			4.2	5.48	271	145	51	22	0.46	0.981	1.032	1.032	134	287	301	301
510520	ROUTE	689	101	93.63	5.4	5.48	227	139	51	22	0.385	0.944	1.032	1.032	113	276	301	301
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
C520	COMBINE	890			4.4	6.96	324	166	60	26	0.433	0.889	0.965	0.965	161	330	358	358
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
RR410	STORAGE	125	7.2	105.15	14	2.18	116	66	23	10	0.494	1.121	1.15	1.15	58	131	134	134
410415	ROUTE	125	100.7	6.76	14.5	2.18	116	66	23	10	0.494	1.121	1.15	1.15	57	130	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415	COMBINE	609			12.1	2.63	144	78	26	11	0.507	1.094	1.121	1.121	71	154	157	157
415420	ROUTE	191	100.5	31.21	13.5	2.63	126	77	26	11	0.443	1.084	1.121	1.121	62	152	157	157
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	1714			12.3	4.4	293	124	42	18	0.62	1.048	1.076	1.076	146	246	253	253
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
RR500	STORAGE	186	9.4	192.34	15	3.64	177	119	43	19	0.453	1.219	1.323	1.323	88	237	257	257
500510	ROUTE	186	100.3	27.66	16	3.64	175	119	43	19	0.448	1.214	1.323	1.323	87	235	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C510		2072			12.2	5.48	315	168	60	26	0.534	1.14	1.226	1.226	156	333	358	358
510520	ROUTE	965	101.2	114.99	13.2	5.48	269	161	60	26	0.457	1.095	1.226	1.226	134	320	358	358
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
C520	COMBINE	1260			12.4	6.96	407	200	74	32	0.544	1.071	1.187	1.187	202	397	441	441
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Leveed	0.0143	0.0060	1.10	3	4.5	0.045	726	109.0	149.1	1.4	1.4	1.4	3.1	109	4.9	0.73	0.54
C41510	Leveed	0.0137	0.0060	0.30	3	5.0	0.045	609	71.1	114.3	1.6	1.6	1.8	3.2	71	5.3	0.74	0.66
RR41510	Leveed	0.0162	0.0070	1.00	3	4.5	0.045	957	158.1	196.5	1.2	1.2	1.3	3.2	158	4.9	0.77	0.56
C42010	Leveed	0.0120	0.0054	2.00	3	4.5	0.045	1364	194.7	289.3	1.5	1.5	1.5	3.0	194	4.7	0.68	0.51
C42020	Leveed	0.0139	0.0057	0.40	3	5.0	0.045	1714	152.5	287.6	1.9	1.9	2.0	3.0	152	6.0	0.76	0.70
C51010	Leveed	0.0222	0.0090	1.30	3	4.0	0.045	648	136.3	133.4	1.0	1.0	1.0	3.0	136	4.9	0.86	0.56
C51020	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1298	208.3	267.8	1.3	1.3	1.3	3.2	208	4.8	0.75	0.49
C51030	Leveed	0.0123	0.0055	0.30	3	4.5	0.045	1424	228.9	314.4	1.4	1.4	1.4	3.1	228	4.5	0.68	0.48
C51040	Leveed	0.0116	0.0050	0.40	3	4.5	0.045	2072	309.4	451.9	1.5	1.5	1.5	3.0	309	4.6	0.67	0.46
RR51025	Leveed	0.0135	0.0050	1.40	3	4.5	0.045	2072	368.0	462.0	1.3	1.3	1.3	3.2	368	4.5	0.70	0.40
RR51030	Leveed	0.0110	0.0050	2.60	3	4.5	0.045	1288	209.1	294.9	1.4	1.4	1.4	3.1	209	4.4	0.65	0.45
S51010	Leveed	0.0171	0.0072	0.30	3	4.0	0.045	441	87.3	95.7	1.1	1.1	1.1	2.9	87	4.6	0.77	0.52

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR410	Online Basin	0.0150	1200	600	9.0	116.7	105.2	134.0	1524	125	7.2	1.8
RR500	Online Basin	0.0250	1300	800	11.0	204.4	192.3	257.0	2063	186	9.4	1.6

Online Basin

HEC1 ID	RR410

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.2	sq. mi
Total Sediment Yield Volume	4.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	4.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1200	1370
Basin Width (ft)	600	600
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	573	546
Top Area (acres)	16.5	18.9
U/S-D/S Height Difference (ft)	9.0	9.0
Excess Area on Upstream (acres)	0.8	1.7

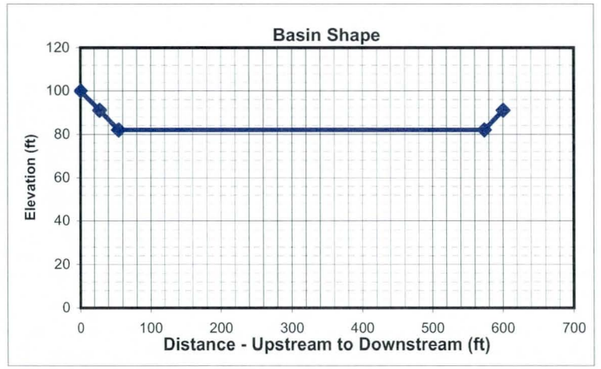
			Base	LC Enhanced
Bottom Length (ft)	1146	Allocated Storage Volume (ac. ft)	116.7	117.1
Bottom Width (ft)	519	Total Available Volume (ac. ft) (incl. Freeboard)	132.4	134
		Total Excavation Volume (ac. ft)	206.8	218.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	13.77	42.00	71.17	86.11	101.29	116.71	132.38	148.28	164.44
Outflow	0.0	46.3	80.2	103.6	113.5	122.6	131.0	139.0	146.5	153.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	130.0	134	134.0
Peak Inflow (cfs)	1372	1524	1524.0
Peak Outflow (cfs)	125	125	125.0
Stage at Peak Outflow (ft)	7.2	7.2	7.2
Volume at Peak Outflow (ac. ft)	105.2	105.15	105.2

Volume Check

Total Volume needed	109.3	ac. ft
Total Volume Provided	116.7	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.2	ft
Depth Provided	9	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	309000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1200	ft
Base Total ROW Width	600	ft
LC Enh. Total ROW Length	1470	ft
LC Enh. Total ROW Length	700	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	333637	353159
Excavated Area (sq. Yd)	80000	114333

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	57	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	632	sq. Yd
Material Volume	316	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	900	ft
Unit Cost	160	per ft
Cost per outlet	$144,000	
Other Cost	$ -	
Total Cost	$144,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		333,637	cu. Yd	$ 4.00	$ 1,334,548	80,000	sq. Yd	$ 9.00	$ 720,000	80,000	sq. Yd	$ 8.33	$ 666,667
Basin - LC Enhancement		19,522	cu. Yd	$ 4.00	$ 78,088	34,333	sq. Yd	$ 9.00	$ 308,997	34,333	sq. Yd	$ 8.33	$ 286,108
Inlet	Riprap	316	sq. Yd	$ 75.00	$ 23,700	632	sq. Yd	$ -	$ -	632	sq. Yd	$ 33.33	$ 21,067
Inlet - LC Enhancement (20%Inlet)					$ 4,740				$ -				$ 4,213
Outlet	Pipe	1	EA	$ 144,000	$ 144,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 7,200				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 720,000	Base Maintenance Cost			$ 689,950
						LC Enh. Landscape Cost			$ 308,997	LC Enh. Maintenance Cost			$ 290,433
						Total Landscape Cost			$ 1,028,997	Total Maintenance Cost			$ 980,383

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,502,248	$ 78,088	$ 1,580,336
Contingency Cost (25% of Construction Cost)	$ 375,562	$ 19,522	$ 395,084
Engineering Design Cost (5% of Construction Cost)	$ 75,112	$ 3,904	$ 79,017
Total Construction Cost	$ 1,952,922	$ 101,514	$ 2,054,437

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.1	$100,000	$ 710,000
Basin	16.5	$100,000	$ 1,650,000
Other		$100,000	$ -
Total	23.6	$100,000	$ 2,360,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	16.5	$100,000	$ 1,650,000
LC Enhancement Cost	acre	7.1	$100,000	$ 710,000
Total Land Cost	acre	23.6	$100,000	$ 2,360,000

Total Cost

Base Total Cost	$ 5,012,872
Total LC Enhancement Cost	$ 1,410,944
Total Cost Including LC Enh.	$ 6,423,816

Open Channel

Structure ID	RR41010

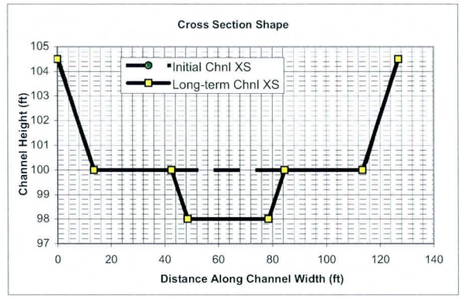
HEC1 ID	410415

Longitudal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

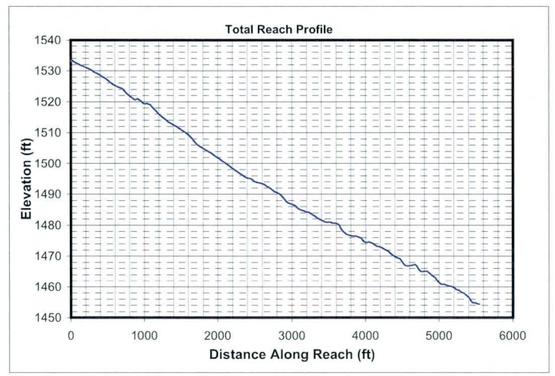
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	100	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	113.5	113.5	113.5	127
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	29	3	30	6.5	3	29	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	42.5	48.5	78.5	84.5	113.5	127
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR410	S415							TOTAL
HEC1 Peak-Flow	125	791							916
Weighting Factor	1.00	0.76							
Flow into Channel	125	601							726

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.343	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	726	cfs	
Long-term Max. Chnl Capacity	4082	cfs	
Q2 Channel	73	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	127	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	102.3	36.5	0.4	100.0	100.4	2.0	0.4	102.2	0.4	0.14	0.59
182	104.0	63.6	0.6	100.0	100.6	2.9	0.6	103.7	0.6	0.23	0.64
545	107.6	124.8	1.2	100.0	101.2	4.4	1.2	107.2	1.2	0.45	0.71
726	109.0	149.1	1.4	100.0	101.4	4.9	1.4	108.6	1.4	0.54	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	36.0	31.2	0.9	98.0	98.9	2.3	0.9	35.7	0.9	0.36	0.44
182	40.2	56.5	1.4	98.0	99.6	3.2	1.6	39.7	1.4	0.61	0.48
545	106.1	160.9	1.5	98.0	100.9	3.4	2.9	105.2	1.5	1.07	0.48
726	108.0	192.5	1.8	98.0	101.2	3.8	3.2	107.0	1.8	1.18	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
73										0
182										0
545										0
726										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
73	1.74	1.0782	1.0243	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
182	1.74	1.2448	1.1825	Erosive	Erosive	Erosive	0.3	Stable	6.2	Stable	Stable
545	1.74	1.4422	1.3701	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
726	1.74	1.4932	1.4185	Erosive	Erosive	Erosive	0.4	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	73	182	545	726	73	182	545	726	73	182	545	726
Bray - Equation #1	23	37	66	77	1.1	1.5	2.2	2.4	2.9	3.3	3.8	4.0
Bray - Equation #2	30	48	86	101	1.2	1.7	2.4	2.6	2.0	2.2	2.6	2.7
Hey	6	11	21	24	3.3	4.7	7.1	7.9				
Ackers & Charlton/Lacey	22	32	51	57					1.6	1.9	2.3	2.4
Parker	59	93	160	185	0.8	1.2	1.9	2.1				
Chang	38	66	129	153	0.1	0.1	-0.2	-0.3				
Kellerhals	15	24	42	48	1.5	2.2	3.4	3.8	3.1	3.4	3.8	3.9
AMAFCA/Schumm	36	40	105	107								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	12.8	18.1	27.3	30.4	3	5	7	8	2.6	3.3	4.3	4.6
Average	25	38	70	79	1.5	2.1	3.1	3.4	2.5	2.8	3.4	3.5
Values As Designed	36	40	105	107	0.9	1.6	2.9	3.2	2.3	3.2	3.4	3.8
Difference with Design	-11	-2	-36	-28	0.6	0.5	0.2	0.3	0.1	-0.4	0.0	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	565	355	727	1035	1577	167	151	91	2133	164	612	689
182	2319	1157	2192	4861	2358	710	498	465	5625	575	2565	2120
545	12418	4194	6738	30732	3642	3332	1635	2362	17267	2761	12183	8842
726	19229	5796	8787	49674	4064	4943	2187	3503	23089	4182	17972	13039

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	2887	1815	3713	5287	8059	854	771	467	10902	837	3129	3520
182	4740	2364	4480	9936	4820	1451	1019	951	11498	1175	5242	4334
545	8461	2858	4591	20940	2482	2270	1114	1609	11765	1882	8301	6025
726	9826	2962	4490	25384	2077	2526	1117	1790	11799	2137	9184	6663

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	300	165	268	518	563	62	55	63	577	67	346	271
182	1157	521	787	2278	888	248	176	270	1525	247	1349	859
545	3746	1569	2405	7462	2469	795	544	872	4597	791	4330	2689
726	5785	2226	3315	12025	2791	1195	751	1330	6185	1208	6553	3942

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	1531	843	1369	2645	2876	317	283	322	2948	344	1769	1386
182	2366	1064	1608	4656	1815	507	360	552	3116	505	2757	1755
545	2552	1069	1639	5084	1682	541	371	594	3132	539	2951	1832
726	2956	1137	1694	6145	1426	611	384	680	3160	617	3349	2015

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
73	0.0022	0.0034	133	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0084	0.0005	0.0027	0.0142	0.0062
182	0.0011	0.0020	174	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0084	0.0004	0.0013	0.0142	0.0060
545	0.0005	0.0010	239	0.73	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0084	0.0002	0.0006	0.0142	0.0058
726	0.0004	0.0009	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0084	0.0002	0.0005	0.0142	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	45.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	348	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	348 ft	Depth	3 ft
Width	127 ft	Side slope	3 ft/ft
Total Volume per Basin		2.75	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
73	1.1	-0.3	0.1	24.6	0.9	0.9	2.3	0.0060	0.1	1.5	2.0	4.7
182	1.1	-0.5	0.1	24.6	1.6	1.4	3.2	0.0060	0.2	1.5	2.0	4.9
545	1.1	-0.8	0.2	24.6	2.9	1.5	3.4	0.0060	0.3	1.5	2.0	5.1
726	1.1	-0.9	0.2	24.6	3.2	1.8	3.8	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	125	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	0.54	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	3
Channel Width (ft)	127	127
Channel XS Area (sq. ft)	582.8	582.8
Channel Perimeter (ft)	129	129

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1854	sq. Yd
Volume	5561	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5561	5561
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25951	53756
Left Levee Volume (cu. Yd)	25539	60141
Right Levee Length (ft)	5561	5561
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25951	53756
Right Levee Volume (cu. Yd)	25539	60141
Total Levee Surface Area (sq. Yd)	51902	107512
Total Levee Volume (cu. Yd)	51078	120282

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8650	20390
Left Levee Lining Volume (cu. Yd)	4325	10195
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8650	20390
Right Levee Lining Volume (cu. Yd)	4325	10195
Total Lining Area (sq. Yd)	17301	40781
Total Lining Volume (cu. Yd)	8650	20390

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	127	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	16	
Volume per structure	142	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,650	
Area per structure	42	sq. Yd
Total Area	677	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4437	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,748	
Other Cost	$ -	
Total cost per basin	$ 17,748	
Area per basin	4,905	sq. Yd
Total Area	4,905	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	51,078	cu. Yd	$ 7.00	$ 357,546	51,902	sq. Yd	$ 9.00	$ 467,118	51,902	sq. Yd	$ 11.67	$ 605,523	
Levee - LC Enhancement	Fill	69,204	cu. Yd	$ 7.00	$ 484,428	55,610	sq. Yd	$ 9.00	$ 500,490	69,204	sq. Yd	$ 11.67	$ 807,380	
Levee Lining	Riprap	8,650	cu. Yd	$ 75.00	$ 648,750	17,301	sq. Yd	$ -	$ -	17,301	sq. Yd	$ 20.83	$ 360,435	
Levee Lining -LC Enhancement	Riprap	11,740	cu. Yd	$ 75.00	$ 880,500	23,480	sq. Yd	$ -	$ -	23,480	sq. Yd	$ 20.83	$ 489,162	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	5,561	cu. Yd	$ 75.00	$ 417,075	1,854	sq. Yd	$ -	$ -	1,854	sq. Yd	$ 25.00	$ 46,350	
Drop Structures	Riprap	16	EA	$ 10,650.00	$ 170,400	677	sq. Yd	$ -	$ -	677	sq. Yd	$ 33.33	$ 22,567	
Drop Str. - LC Enhancement	Riprap	16	EA	$ 1,065.00	$ 17,040	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,257	
Sedimentation Basins		1	EA	$ 17,748.00	$ 17,748	4,905	sq. Yd	$ -	$ -	4,905	sq. Yd	$ 8.33	$ 40,875	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 467,118	Base Maintenance Cost			$ 1,075,750	
						LC Enhancement Cost			$ 500,490	LC Enhancement Cost			$ 1,298,799	
						Total Landscape Cost			$ 967,608	Total Maintenance Cost			$ 2,374,549	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,611,519	$ 1,381,968	$ 2,993,487
Contingency Cost (25% of Construction Cost)	$ 402,880	$ 345,492	$ 748,372
Engineering Design Cost (5% of Construction Cost)	$ 80,576	$ 69,098	$ 149,674
Total Construction Cost	$ 2,094,975	$ 1,796,558	$ 3,891,533

Land Cost

Channel Length	5561 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	127	16.2	$100,000	$ 1,620,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7	$100,000	$ 700,000
Levee LC Enhancement	51	6.5	$100,000	$ 650,000
Other	0	0	$100,000	$ -
Total	233	29.7		$ 2,970,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.2	$100,000	$ 2,320,000
LC Enhancement Cost	acre	6.5	$100,000	$ 650,000
Total Land Cost	acre	29.7	$100,000	$ 2,970,000

Total Cost

Base Total Cost	$ 5,957,843
Total Landscape Enhancement Cost	$ 4,245,847
Total Cost Including LC Enh.	$ 10,203,690

Open Channel

Structure ID	C41510

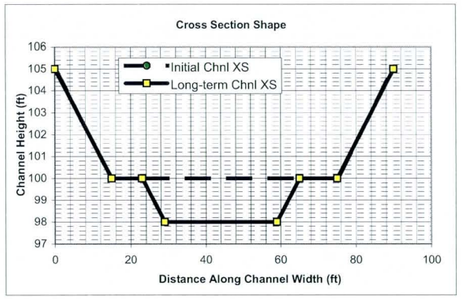
HEC1 ID	410415

Longitundal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

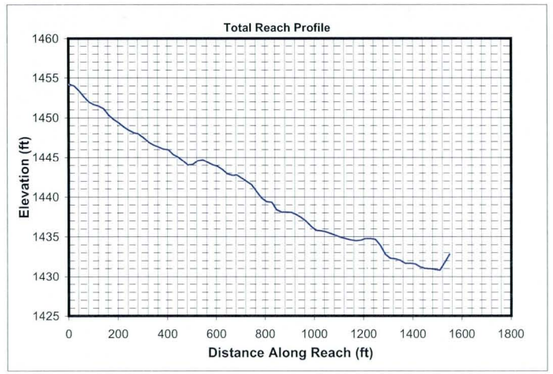
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	60	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	75	75	75	90
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	8	3	30	7	3	10	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	23	29	59	65	75	90
Y	105	100	100	98	98	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415								TOTAL
HEC1 Peak-Flow	609								609
Weighting Factor	1.00								
Flow into Channel	609								609

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR41010								TOTAL
Flow Volume (ac. ft)	134.00								134
Sediment Conc. (ppm)	2015								
Sediment Volume (ac. ft)	0.10								0.10
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.10								0.10

Hydrology

Drainage Area	0.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	609	cfs	
Long-term Max. Chnl Capacity	3282	cfs	
Q2 Channel	61	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	90	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
61	62.8	27.3	0.4	100.0	100.4	2.2	0.4	62.7	0.4	0.17	0.59
152	64.9	48.0	0.7	100.0	100.8	3.2	0.8	64.6	0.7	0.29	0.65
457	69.4	95.3	1.4	100.0	101.5	4.8	1.5	68.9	1.4	0.55	0.72
609	71.1	114.3	1.6	100.0	101.8	5.3	1.8	70.5	1.6	0.66	0.74

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
61	35.4	27.9	0.8	98.0	98.9	2.2	0.9	35.1	0.8	0.32	0.43
152	39.3	50.3	1.3	98.0	99.5	3.0	1.5	38.8	1.3	0.55	0.47
457	65.5	119.3	1.8	98.0	100.8	3.8	2.8	64.6	1.8	1.03	0.50
609	67.8	143.8	2.1	98.0	101.1	4.2	3.1	66.8	2.2	1.17	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR41010									
61	271									271
152	859									859
457	2689									2689
609	3942									3942

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
61	1.74	1.1397	1.0827	Erosive	Erosive	Erosive	0.2	Stable	4.1	Stable	Stable
152	1.74	1.3036	1.2384	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
457	1.74	1.4955	1.4207	Erosive	Erosive	Erosive	0.4	Stable	8.4	Stable	Stable
609	1.74	1.5445	1.4673	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	61	152	457	609	61	152	457	609	61	152	457	609
Bray - Equation #1	21	34	60	70	1.0	1.4	2.0	2.2	2.8	3.2	3.7	3.9
Bray - Equation #2	27	44	79	92	1.2	1.6	2.2	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	22	3.1	4.4	6.6	7.4				
Ackers & Charlton/Lacey	20	30	47	53					1.6	1.9	2.2	2.3
Parker	54	85	147	170	0.8	1.1	1.8	2.0				
Chang	34	59	116	138	0.1	0.1	-0.1	-0.2				
Kellerhals	14	22	38	44	1.4	2.0	3.1	3.5	3.1	3.4	3.8	3.9
AMAFCA/Schumm	35	39	65	67								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	12.0	16.9	25.5	28.4	3	5	7	8	2.5	3.1	4.1	4.4
Average	23	35	60	69	1.5	2.0	2.9	3.2	2.4	2.8	3.3	3.4
Values As Designed	35	39	65	67	0.9	1.5	2.8	3.1	2.2	3.0	3.8	4.2
Difference with Design	-12	-4	-4	2	0.6	0.5	0.2	0.1	0.2	-0.3	-0.5	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	533	315	648	1015	1093	161	136	96	1728	145	593	587
152	2165	987	1811	4719	1624	638	414	440	4495	518	2361	1834
457	11377	3486	5298	29191	2533	2907	1311	2100	13723	2483	10777	7744
609	17497	4792	6962	46816	2842	4289	1745	3079	18338	3746	15758	11442

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	3247	1919	3946	6185	6657	983	825	587	10524	881	3613	3579
152	5276	2405	4412	11499	3958	1555	1008	1073	10953	1262	5752	4468
457	9241	2832	4304	23711	2057	2362	1065	1706	11147	2017	8754	6290
609	10659	2920	4241	28520	1731	2613	1063	1876	11171	2282	9600	6971

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	231	130	211	388	514	46	43	46	475	53	262	218
152	895	421	653	1718	814	193	143	208	1270	192	1049	687
457	3695	1418	2088	7783	1713	761	471	848	3895	775	4176	2511
609	5647	1984	2867	12389	1950	1127	641	1265	5226	1176	6217	3681

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
61	1405	794	1288	2365	3131	280	261	281	2896	320	1599	1329
152	2180	1026	1591	4187	1985	471	350	506	3094	469	2555	1674
457	3002	1152	1696	6322	1391	618	383	689	3164	629	3392	2040
609	3440	1208	1746	7547	1188	687	390	771	3184	716	3788	2242

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
61	0.0018	0.0028	144	0.44	0.048	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0089	0.0006	0.0023	0.0137	0.0061
152	0.0009	0.0016	188	0.57	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0089	0.0004	0.0012	0.0137	0.0059
457	0.0004	0.0009	256	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0089	0.0002	0.0005	0.0136	0.0058
609	0.0003	0.0007	277	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0089	0.0002	0.0004	0.0136	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	12.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	313	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.86	ac ft

Sedimentation Basins

Length	313 ft	Depth	3 ft
Width	90 ft	Side slope	3 ft/ft
Total Volume per Basin		1.70	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
61	1.1	-0.3	0.1	24.6	0.9	0.8	2.2	0.0060	0.1	1.5	2.0	4.7
152	1.1	-0.4	0.1	24.6	1.5	1.3	3.0	0.0060	0.2	1.5	2.0	4.8
457	1.1	-0.8	0.2	24.6	2.8	1.8	3.8	0.0060	0.3	1.5	2.0	5.1
609	1.1	-0.8	0.2	24.6	3.1	2.2	4.2	0.0060	0.4	1.5	2.0	5.2

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	125	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.96	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.84	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	3
Channel Width (ft)	90	90
Channel XS Area (sq. ft)	447	447
Channel Perimeter (ft)	92	92

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	522	sq. Yd
Volume	1567	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1567	1567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	8009	16192
Left Levee Volume (cu. Yd)	8415	19500
Right Levee Length (ft)	1567	1567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	8009	16192
Right Levee Volume (cu. Yd)	8415	19500
Total Levee Surface Area (sq. Yd)	16018	32384
Total Levee Volume (cu. Yd)	16830	39000

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2786	6268
Left Levee Lining Volume (cu. Yd)	1393	3134
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2786	6268
Right Levee Lining Volume (cu. Yd)	1393	3134
Total Lining Area (sq. Yd)	5572	12536
Total Lining Volume (cu. Yd)	2786	6268

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	90	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.3	ft
Structure Height	11.3	ft
Number of Structures	5	
Volume per structure	113	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,475	
Area per structure	30	sq. Yd
Total Area	150	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2743	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 10,972	
Other Cost	$ -	
Total cost per basin	$ 10,972	
Area per basin	3,134	sq. Yd
Total Area	6,268	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	16,830	cu. Yd	$ 7.00	$ 117,810	16,018	sq. Yd	$ 9.00	$ 144,162	16,018	sq. Yd	$ 11.67	$ 186,877
Levee - LC Enhancement	Fill	22,170	cu. Yd	$ 7.00	$ 155,190	16,366	sq. Yd	$ 9.00	$ 147,294	22,170	sq. Yd	$ 11.67	$ 258,650
Levee Lining	Riprap	2,786	cu. Yd	$ 75.00	$ 208,950	5,572	sq. Yd	$ -	$ -	5,572	sq. Yd	$ 20.83	$ 116,074
Levee Lining -LC Enhancement	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	6,964	sq. Yd	$ -	$ -	6,964	sq. Yd	$ 20.83	$ 145,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,567	cu. Yd	$ 75.00	$ 117,525	522	sq. Yd	$ -	$ -	522	sq. Yd	$ 25.00	$ 13,050
Drop Structures	Riprap	5	EA	$ 8,475.00	$ 42,375	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,000
Drop Str. - LC Enhancement	Riprap	5	EA	$ 847.50	$ 4,238	15	sq. Yd	$ -	$ -	15	sq. Yd	$ 33.33	$ 500
Sedimentation Basins		2	EA	$ 10,972.00	$ 21,944	6,268	sq. Yd	$ -	$ -	6,268	sq. Yd	$ 8.33	$ 52,233
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 144,162	Base Maintenance Cost			$ 373,234
						LC Enhancement Cost			$ 147,294	LC Enhancement Cost			$ 404,243
						Total Landscape Cost			$ 291,456	Total Maintenance Cost			$ 777,477

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 508,604	$ 420,578	$ 929,182
Contingency Cost (25% of Construction Cost)	$ 127,151	$ 105,144	$ 232,295
Engineering Design Cost (5% of Construction Cost)	$ 25,430	$ 21,029	$ 46,459
Total Construction Cost	$ 661,185	$ 546,751	$ 1,207,936

Land Cost

Channel Length	1567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	90	3.2	$100,000	$ 320,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	2.1	$100,000	$ 210,000
Levee LC Enhancement	54	1.9	$100,000	$ 190,000
Other	0	0	$100,000	$ -
Total	202	7.2		$ 720,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.3	$100,000	$ 530,000
LC Enhancement Cost	acre	1.9	$100,000	$ 190,000
Total Land Cost	acre	7.2	$100,000	$ 720,000

Total Cost

Base Total Cost	$ 1,708,581
Total Landscape Enhancement Cost	$ 1,288,287
Total Cost Including LC Enh.	$ 2,996,869

Open Channel

Structure ID	RR41510

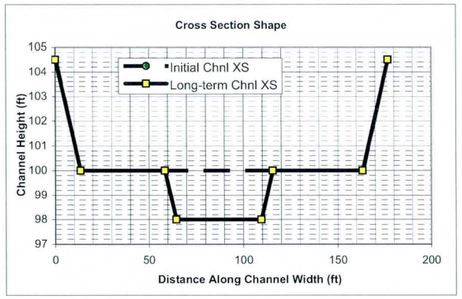
HEC1 ID	415420

Longitudinal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

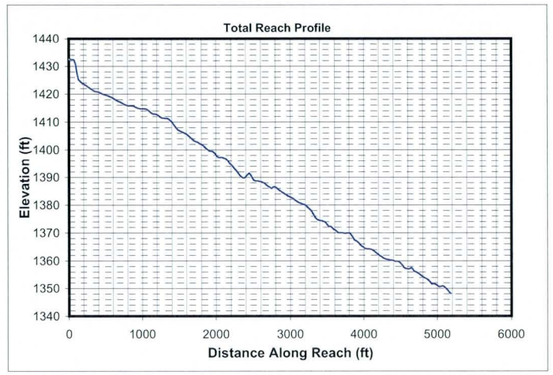
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	150	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	163.5	163.5	163.5	177
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	45	3	45	6.5	3	48	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	58.5	64.5	109.5	115.5	163.5	177
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415	S420								TOTAL
HEC1 Peak-Flow	609	1740								2349
Weighting Factor	1.00	0.20								
Flow into Channel	609	348								957

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.985	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	957	cfs	
Long-term Max. Chnl Capacity	6491	cfs	
Q2 Channel	96	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	177	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
96	152.0	48.6	0.3	100.0	100.3	2.0	0.3	151.9	0.3	0.14	0.61
239	153.5	84.5	0.6	100.0	100.6	2.8	0.6	153.3	0.6	0.24	0.67
718	156.8	164.8	1.1	100.0	101.1	4.4	1.1	156.5	1.1	0.47	0.75
957	158.1	196.5	1.2	100.0	101.3	4.9	1.3	157.7	1.2	0.56	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
96	50.3	40.2	0.8	98.0	98.8	2.4	0.8	50.1	0.8	0.37	0.47
239	54.2	71.7	1.3	98.0	99.5	3.3	1.5	53.7	1.3	0.63	0.51
718	155.2	211.1	1.4	98.0	100.7	3.4	2.7	154.3	1.4	1.19	0.51
957	156.8	251.9	1.6	98.0	101.0	3.8	3.0	155.9	1.6	1.30	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
96										0
239										0
718										0
957										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
96	1.74	1.0441	0.9919	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
239	1.74	1.2117	1.1511	Erosive	Erosive	Erosive	0.3	Stable	6.3	Stable	Stable
718	1.74	1.4115	1.3409	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
957	1.74	1.4634	1.3902	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	96	239	718	957	96	239	718	957	96	239	718	957
Bray - Equation #1	26	43	76	89	1.2	1.6	2.4	2.6	3.0	3.4	4.0	4.1
Bray - Equation #2	35	56	100	116	1.3	1.8	2.6	2.9	2.1	2.3	2.7	2.8
Hey	8	13	24	28	3.6	5.2	7.8	8.7				
Ackers & Charlton/Lacey	24	36	57	64					1.7	2.0	2.4	2.5
Parker	67	106	184	213	0.9	1.3	2.1	2.4				
Chang	47	82	160	190	0.1	0.0	-0.4	-0.5				
Kellerhals	18	28	48	56	1.7	2.4	3.8	4.2	3.2	3.5	3.9	4.1
AMAFCA/Schumm	50	54	154	156								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	13.8	19.5	29.4	32.7	4	5	8	9	3.0	3.7	4.9	5.3
Average	31	46	85	96	1.7	2.3	3.4	3.8	2.6	3.0	3.6	3.8
Values As Designed	50	54	154	156	0.8	1.5	2.7	3.0	2.4	3.3	3.4	3.8
Difference with Design	-19	-8	-69	-60	0.9	0.9	0.7	0.8	0.2	-0.3	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	832	531	1122	1546	2375	261	234	132	3417	252	895	1054
239	3429	1725	3364	7294	3531	1104	767	678	8987	872	3755	3228
718	18517	6247	10259	46541	5401	5199	2509	3459	27558	4158	17859	13428
957	28752	8631	13394	75480	6005	7725	3352	5135	36845	6296	26354	19815

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	3224	2060	4350	5992	9207	1012	907	513	13247	978	3468	4087
239	5318	2675	5216	11311	5476	1712	1190	1051	13937	1352	5823	5006
718	9571	3229	5303	24057	2792	2687	1297	1788	14245	2149	9231	6941
957	11146	3346	5192	29261	2328	2995	1299	1991	14284	2441	10217	7682

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	476	261	445	843	832	107	93	99	972	109	548	435
239	1877	821	1269	3807	1275	424	287	425	2551	406	2150	1390
718	5799	2401	3840	11779	3724	1303	873	1310	7663	1245	6616	4232
957	8994	3408	5306	19070	4188	1961	1202	2004	10302	1905	10021	6215

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
96	1844	1013	1723	3267	3225	416	359	383	3766	423	2126	1686
239	2911	1273	1968	5903	1978	657	446	659	3955	629	3334	2156
718	2998	1241	1985	6088	1925	673	451	677	3961	643	3420	2188
957	3487	1321	2057	7393	1624	760	466	777	3994	738	3885	2409

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
96	0.0025	0.0038	134	0.41	0.047	0.0008	30	0.036	0.0006	0.0159	0.0008	0.0019	0.0076	0.0005	0.0028	0.0161	0.0065
239	0.0012	0.0022	176	0.54	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0076	0.0003	0.0014	0.0162	0.0063
718	0.0006	0.0012	243	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0076	0.0002	0.0006	0.0162	0.0061
957	0.0004	0.0010	264	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0076	0.0002	0.0005	0.0161	0.0061

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	47.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	325	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	325 ft	Depth	3 ft
Width	177 ft	Side slope	3 ft/ft
Total Volume per Basin		3.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
96	1.1	-0.3	0.1	24.6	0.8	0.8	2.4	0.0070	0.1	1.5	2.0	4.7
239	1.1	-0.4	0.2	24.6	1.5	1.3	3.3	0.0070	0.2	1.5	2.0	4.9
718	1.1	-0.8	0.2	24.6	2.7	1.4	3.4	0.0070	0.3	1.5	2.0	5.0
957	1.1	-0.8	0.2	24.6	3.0	1.6	3.8	0.0070	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.14	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	3
Channel Width (ft)	177	177
Channel XS Area (sq. ft)	837.8	837.8
Channel Perimeter (ft)	179	179

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1733	sq. Yd
Volume	5198	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5198	5198
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24257	50247
Left Levee Volume (cu. Yd)	23872	56215
Right Levee Length (ft)	5198	5198
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24257	50247
Right Levee Volume (cu. Yd)	23872	56215
Total Levee Surface Area (sq. Yd)	48514	100494
Total Levee Volume (cu. Yd)	47744	112430

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8086	19059
Left Levee Lining Volume (cu. Yd)	4043	9530
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8086	19059
Right Levee Lining Volume (cu. Yd)	4043	9530
Total Lining Area (sq. Yd)	16172	38119
Total Lining Volume (cu. Yd)	8086	19060

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	177	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	16	
Volume per structure	190	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 14,250	
Area per structure	59	sq. Yd
Total Area	944	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	5905	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 23,620	
Other Cost	$ -	
Total cost per basin	$ 23,620	
Area per basin	6,389	sq. Yd
Total Area	6,389	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,744	cu. Yd	$ 7.00	$ 334,208	48,514	sq. Yd	$ 9.00	$ 436,626	48,514	sq. Yd	$ 11.67	$ 565,997
Levee - LC Enhancement	Fill	64,686	cu. Yd	$ 7.00	$ 452,802	51,980	sq. Yd	$ 9.00	$ 467,820	64,686	sq. Yd	$ 11.67	$ 754,670
Levee Lining	Riprap	8,086	cu. Yd	$ 75.00	$ 606,450	16,172	sq. Yd	$ -	$ -	16,172	sq. Yd	$ 20.83	$ 336,907
Levee Lining -LC Enhancement	Riprap	10,974	cu. Yd	$ 75.00	$ 823,050	21,947	sq. Yd	$ -	$ -	21,947	sq. Yd	$ 20.83	$ 457,231
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,198	cu. Yd	$ 75.00	$ 389,850	1,733	sq. Yd	$ -	$ -	1,733	sq. Yd	$ 25.00	$ 43,325
Drop Structures	Riprap	16	EA	$ 14,250.00	$ 228,000	944	sq. Yd	$ -	$ -	944	sq. Yd	$ 33.33	$ 31,467
Drop Str. - LC Enhancement	Riprap	16	EA	$ 1,425.00	$ 22,800	94	sq. Yd	$ -	$ -	94	sq. Yd	$ 33.33	$ 3,147
Sedimentation Basins		1	EA	$ 23,620.00	$ 23,620	6,389	sq. Yd	$ -	$ -	6,389	sq. Yd	$ 8.33	$ 53,242
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 436,626	Base Maintenance Cost			$ 1,030,937
						LC Enhancement Cost			$ 467,820	LC Enhancement Cost			$ 1,215,048
						Total Landscape Cost			$ 904,446	Total Maintenance Cost			$ 2,245,986

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,582,128	$ 1,298,652	$ 2,880,780
Contingency Cost (25% of Construction Cost)	$ 395,532	$ 324,663	$ 720,195
Engineering Design Cost (5% of Construction Cost)	$ 79,106	$ 64,933	$ 144,039
Total Construction Cost	$ 2,056,766	$ 1,688,248	$ 3,745,014

Land Cost

Channel Length	5198 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	177	21.1	$100,000	$ 2,110,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.6	$100,000	$ 660,000
Levee LC Enhancement	51	6.1	$100,000	$ 610,000
Other	0	0	$100,000	$ -
Total	283	33.8		$ 3,380,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	27.7	$100,000	$ 2,770,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	33.8	$100,000	$ 3,380,000

Total Cost

Base Total Cost	$ 6,294,330
Total Landscape Enhancement Cost	$ 3,981,116
Total Cost Including LC Enh.	$ 10,275,446

Open Channel

Structure ID	C42010

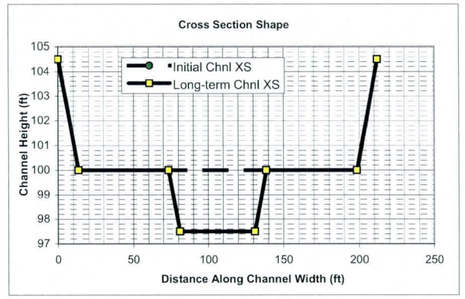
HEC1 ID	415420

Longitudal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0054	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

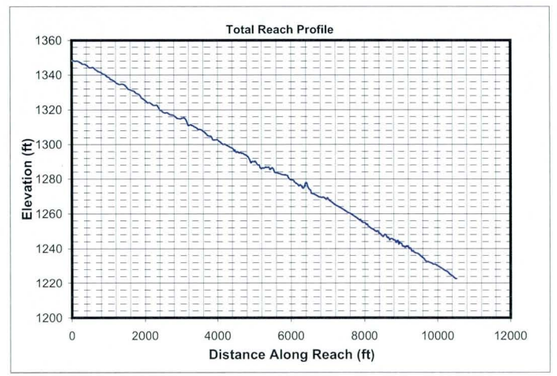
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	185	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	198.5	198.5	198.5	212
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	60	3	50	7	3	60	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	73.5	81	131	138.5	198.5	212
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415	S420							TOTAL
HEC1 Peak-Flow	609	1740							2349
Weighting Factor	1.00	0.43							
Flow into Channel	609	755							1364

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510								TOTAL
Flow Volume (ac. ft)	157.00								157
Sediment Conc. (ppm)	2409								
Sediment Volume (ac. ft)	0.14								0.14
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.14								0.14

Hydrology

Drainage Area	3.057	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1364	cfs	
Long-term Max. Chnl Capacity	7219	cfs	
Q2 Channel	136	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	212	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
136	187.4	71.6	0.4	100.0	100.4	1.9	0.4	187.3	0.4	0.13	0.54
341	189.2	124.5	0.7	100.0	100.7	2.7	0.7	189.0	0.7	0.22	0.59
1023	193.1	242.6	1.3	100.0	101.3	4.2	1.3	192.7	1.3	0.43	0.66
1364	194.7	289.3	1.5	100.0	101.5	4.7	1.5	194.2	1.5	0.51	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
136	56.7	56.3	1.0	97.5	98.6	2.4	1.1	56.4	1.0	0.36	0.43
341	61.5	100.8	1.6	97.5	99.3	3.4	1.8	60.9	1.7	0.61	0.46
1023	191.3	306.8	1.6	97.5	100.9	3.3	3.4	190.2	1.6	1.14	0.46
1364	193.3	366.1	1.9	97.5	101.2	3.7	3.7	192.1	1.9	1.24	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
136	435									435
341	1390									1390
1023	4232									4232
1364	6215									6215

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
136	1.74	1.0989	1.0440	Erosive	Erosive	Erosive	0.2	Stable	4.5	Stable	Stable
341	1.74	1.2667	1.2033	Erosive	Erosive	Erosive	0.3	Stable	6.4	Stable	Stable
1023	1.74	1.4665	1.3932	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1364	1.74	1.5184	1.4425	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	136	341	1023	1364	136	341	1023	1364	136	341	1023	1364
Bray - Equation #1	32	51	92	107	1.4	1.9	2.7	2.9	3.1	3.6	4.2	4.3
Bray - Equation #2	42	67	121	140	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	29	34	4.2	5.9	9.0	10.0				
Ackers & Charlton/Lacey	28	42	66	75					1.8	2.1	2.5	2.7
Parker	80	127	220	254	1.1	1.6	2.5	2.8				
Chang	53	94	182	217	0.1	0.0	-0.3	-0.5				
Kellerhals	21	33	58	66	1.9	2.8	4.3	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	56	61	190	192								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.5	23.3	35.2	39.2	4	6	9	10	2.9	3.7	4.9	5.2
Average	36	53	101	114	2.0	2.7	4.0	4.4	2.7	3.1	3.7	3.9
Values As Designed	56	61	190	192	1.1	1.8	3.4	3.7	2.4	3.4	3.3	3.7
Difference with Design	-21	-8	-89	-78	0.9	0.9	0.6	0.7	0.3	-0.3	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	844	531	1039	1480	2655	220	209	131	3014	238	905	1024
341	3477	1784	3306	6986	4002	999	738	706	8056	845	3913	3165
1023	18792	6608	10513	44593	6178	4796	2496	3714	24867	4133	19106	13254
1364	29192	9169	13643	72336	6879	7138	3351	5543	33273	6293	28369	19562

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	2296	1445	2826	4026	7223	600	569	356	8198	646	2463	2786
341	3783	1941	3597	7600	4354	1087	803	768	8765	919	4257	3443
1023	6815	2396	3813	16172	2240	1739	905	1347	9018	1499	6929	4807
1364	7940	2494	3711	19675	1871	1941	912	1508	9050	1712	7716	5321

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	537	290	456	923	909	108	95	118	929	117	626	464
341	2113	916	1324	4149	1405	430	299	502	2452	440	2462	1499
1023	6246	2636	3972	12110	4312	1275	896	1484	7344	1295	7283	4441
1364	9690	3758	5475	19614	4859	1929	1244	2278	9893	1990	11090	6529

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
136	1462	788	1239	2511	2472	293	257	322	2526	318	1704	1263
341	2299	997	1441	4514	1528	468	325	547	2668	479	2678	1631
1023	2265	956	1441	4392	1564	462	325	538	2663	470	2641	1611
1364	2636	1022	1489	5335	1322	525	338	619	2691	541	3017	1776

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
136	0.0022	0.0032	126	0.38	0.046	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0068	0.0004	0.0024	0.0119	0.0052
341	0.0011	0.0018	165	0.50	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0068	0.0003	0.0012	0.0120	0.0050
1023	0.0005	0.0010	228	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0068	0.0002	0.0005	0.0119	0.0048
1364	0.0004	0.0008	248	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0068	0.0001	0.0004	0.0119	0.0048

Drop Structures

Design Slope	0.0054	ft/ft
Total Drop Needed	69.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	24	
Distance between structs.	439	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	439 ft	Depth	3 ft
Width	212 ft	Side slope	3 ft/ft
Total Volume per Basin		6.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
136	1.1	-0.4	0.1	24.6	1.1	1.0	2.4	0.0054	0.1	1.5	2.5	5.4
341	1.1	-0.5	0.2	24.6	1.8	1.7	3.4	0.0054	0.2	1.5	2.5	5.6
1023	1.1	-1.0	0.2	24.6	3.4	1.6	3.3	0.0054	0.4	1.5	2.5	5.8
1364	1.1	-1.0	0.2	24.6	3.7	1.9	3.7	0.0054	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.93	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.82	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	3
Channel Width (ft)	212	212
Channel XS Area (sq. ft)	1037	1037
Channel Perimeter (ft)	214	214

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	3512	sq. Yd
Volume	10535	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10535	10535
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	49163	101838
Left Levee Volume (cu. Yd)	48383	113934
Right Levee Length (ft)	10535	10535
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	49163	101838
Right Levee Volume (cu. Yd)	48383	113934
Total Levee Surface Area (sq. Yd)	98326	203676
Total Levee Volume (cu. Yd)	96766	227868

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16388	38628
Left Levee Lining Volume (cu. Yd)	8194	19314
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16388	38628
Right Levee Lining Volume (cu. Yd)	8194	19314
Total Lining Area (sq. Yd)	32776	77257
Total Lining Volume (cu. Yd)	16388	38628

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	212	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	24	
Volume per structure	241	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,075	
Area per structure	71	sq. Yd
Total Area	1,696	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9696	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 38,784	
Other Cost	$ -	
Total cost per basin	$ 38,784	
Area per basin	10,340	sq. Yd
Total Area	10,340	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	96,766	cu. Yd	$ 7.00	$ 677,362	98,326	sq. Yd	$ 9.00	$ 884,934	98,326	sq. Yd	$ 11.67	$ 1,147,137
Levee - LC Enhancement	Fill	131,102	cu. Yd	$ 7.00	$ 917,714	105,350	sq. Yd	$ 9.00	$ 948,150	131,102	sq. Yd	$ 11.67	$ 1,529,523
Levee Lining	Riprap	16,388	cu. Yd	$ 75.00	$ 1,229,100	32,776	sq. Yd	$ -	$ -	32,776	sq. Yd	$ 20.83	$ 682,824
Levee Lining -LC Enhancement	Riprap	22,240	cu. Yd	$ 75.00	$ 1,668,000	44,481	sq. Yd	$ -	$ -	44,481	sq. Yd	$ 20.83	$ 926,690
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	10,535	cu. Yd	$ 75.00	$ 790,125	3,512	sq. Yd	$ -	$ -	3,512	sq. Yd	$ 25.00	$ 87,800
Drop Structures	Riprap	24	EA	$ 18,075.00	$ 433,800	1,696	sq. Yd	$ -	$ -	1,696	sq. Yd	$ 33.33	$ 56,533
Drop Str. - LC Enhancement	Riprap	24	EA	$ 1,807.50	$ 43,380	170	sq. Yd	$ -	$ -	170	sq. Yd	$ 33.33	$ 5,653
Sedimentation Basins		1	EA	$ 38,784.00	$ 38,784	10,340	sq. Yd	$ -	$ -	10,340	sq. Yd	$ 8.33	$ 86,167
Other					$ -				$ -				$ -

Base Landscape Cost	$ 884,934	Base Maintenance Cost	$ 2,060,461
LC Enhancement Cost	$ 948,150	LC Enhancement Cost	$ 2,461,866
Total Landscape Cost	$ 1,833,084	Total Maintenance Cost	$ 4,522,327

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 3,169,171	$ 2,629,094	$ 5,798,265
Contingency Cost (25% of Construction Cost)	$ 792,293	$ 657,274	$ 1,449,566
Engineering Design Cost (5% of Construction Cost)	$ 158,459	$ 131,455	$ 289,913
Total Construction Cost	$ 4,119,922	$ 3,417,822	$ 7,537,745

Land Cost

Channel Length	10535 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	212	51.3	$100,000	$ 5,130,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.3	$100,000	$ 1,330,000
Levee LC Enhancement	51	12.3	$100,000	$ 1,230,000
Other	0	0	$100,000	$ -
Total	318	76.9		$ 7,690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	64.6	$100,000	$ 6,460,000
LC Enhancement Cost	acre	12.3	$100,000	$ 1,230,000
Total Land Cost	acre	76.9	$100,000	$ 7,690,000

Total Cost

Base Total Cost	$ 13,525,317
Total Landscape Enhancement Cost	$ 8,057,839
Total Cost Including LC Enh.	$ 21,583,156

Open Channel

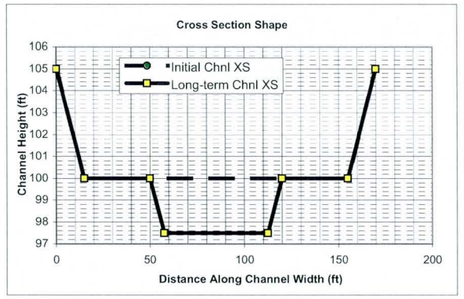
Structure ID	C42020	HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0057	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

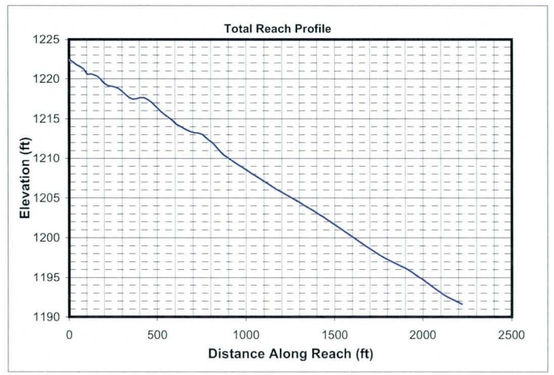
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	140	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	155	155	155	170
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	35	3	55	7.5	3	35	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	50	57.5	112.5	120	155	170
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	1714									1714
Weighting Factor	1.00									
Flow into Channel	1714									1714

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	157.00									157
Sediment Conc. (ppm)	1776									
Sediment Volume (ac. ft)	0.11									0.11
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.11									0.11

Hydrology

Drainage Area	4.058	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1714	cfs	
Long-term Max. Chnl Capacity	7166	cfs	
Q2 Channel	171	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	170	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	143.2	70.5	0.5	100.0	100.5	2.4	0.5	143.0	0.5	0.18	0.61
429	145.4	122.9	0.8	100.0	100.9	3.5	0.9	145.2	0.8	0.31	0.67
1286	150.5	240.8	1.6	100.0	101.7	5.3	1.7	150.0	1.6	0.59	0.74
1714	152.5	287.6	1.9	100.0	102.0	6.0	2.0	151.8	1.9	0.70	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
171	62.1	65.9	1.1	97.5	98.6	2.6	1.1	61.8	1.1	0.40	0.44
429	67.3	117.9	1.8	97.5	99.4	3.6	1.9	66.6	1.8	0.69	0.48
1286	147.7	312.2	2.1	97.5	101.1	4.1	3.6	146.5	2.1	1.28	0.50
1714	150.3	373.6	2.5	97.5	101.5	4.6	4.0	149.0	2.5	1.42	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
171	464									464
429	1499									1499
1286	4441									4441
1714	6529									6529

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
171	1.74	1.1773	1.1185	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
429	1.74	1.3440	1.2768	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
1286	1.74	1.5415	1.4644	Erosive	Erosive	Erosive	0.4	Stable	9.6	Stable	Stable
1714	1.74	1.5925	1.5128	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	171	429	1286	1714	171	429	1286	1714	171	429	1286	1714
Bray - Equation #1	36	58	104	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	136	158	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.6	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	73	82					1.9	2.2	2.6	2.8
Parker	90	142	246	284	1.2	1.7	2.7	3.0				
Chang	63	110	213	253	0.1	-0.1	-0.5	-0.7				
Kellerhals	24	37	65	75	2.1	3.1	4.8	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	62	67	147	149								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.8	25.2	38.0	42.3	5	7	10	11	3.2	4.0	5.2	5.6
Average	40	60	108	122	2.1	2.9	4.3	4.7	2.8	3.2	3.9	4.1
Values As Designed	62	67	147	149	1.1	1.9	3.6	4.0	2.6	3.6	4.1	4.6
Difference with Design	-22	-7	-39	-27	1.0	1.0	0.7	0.7	0.2	-0.4	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1714	961	1952	3377	2746	527	416	327	5019	449	1920	1764
429	7031	2952	5347	15865	3997	2024	1214	1418	12954	1639	7478	5629
1286	37698	10317	14959	100343	6052	9254	3760	6607	39410	8032	33806	24567
1714	58385	14164	19883	162210	6727	13716	4984	9665	52638	11395	49386	36650

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	3711	2080	4224	7309	5945	1141	901	708	10864	971	4156	3819
429	6087	2556	4629	13736	3461	1752	1051	1228	11216	1419	6475	4874
1286	10880	2978	4317	28959	1747	2671	1085	1907	11374	2318	9757	7090
1714	12638	3066	4304	35111	1456	2969	1079	2092	11394	2467	10690	7933

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	785	408	660	1396	1089	165	137	177	1289	170	920	654
429	3089	1263	1817	6281	1663	632	412	722	3367	643	3541	2130
1286	11017	3939	5697	23425	4117	2173	1280	2508	10190	2263	12260	7170
1714	17016	5521	7482	37746	4629	3235	1736	3745	13663	2544	18334	10514

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
171	1699	883	1428	3021	2358	356	297	383	2790	368	1992	1416
429	2675	1094	1573	5438	1440	547	357	625	2915	557	3066	1844
1286	3180	1137	1644	6760	1188	627	369	724	2941	653	3538	2069
1714	3683	1195	1619	8170	1002	700	376	811	2957	551	3969	2276

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
171	0.0015	0.0025	154	0.47	0.048	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0063	0.0004	0.0017	0.0139	0.0054
429	0.0008	0.0014	202	0.61	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0063	0.0002	0.0009	0.0139	0.0053
1286	0.0003	0.0008	278	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0063	0.0001	0.0004	0.0138	0.0052
1714	0.0003	0.0006	301	0.92	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0001	0.0003	0.0138	0.0051

Drop Structures

Design Slope	0.0057	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	320	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	320 ft	Depth	3 ft
Width	170 ft	Side slope	3 ft/ft
Total Volume per Basin		3.45	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
171	1.1	-0.4	0.1	24.6	1.1	1.1	2.6	0.0057	0.1	1.5	2.5	5.4
429	1.1	-0.5	0.2	24.6	1.9	1.8	3.6	0.0057	0.2	1.5	2.5	5.6
1286	1.1	-0.9	0.2	24.6	3.6	2.1	4.1	0.0057	0.4	1.5	2.5	5.9
1714	1.1	-1.0	0.3	24.6	4.0	2.5	4.6	0.0057	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	191	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	157.0	ac. ft

Freeboard

Max. Flow Depth	2.0	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.01	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	1.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	3
Channel Width (ft)	170	170
Channel XS Area (sq. ft)	931.2	931.2
Channel Perimeter (ft)	172	172

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2238	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	746	sq. Yd
Volume	2238	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2238	2238
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	11439	23126
Left Levee Volume (cu. Yd)	12019	27851
Right Levee Length (ft)	2238	2238
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	11439	23126
Right Levee Volume (cu. Yd)	12019	27851
Total Levee Surface Area (sq. Yd)	22878	46252
Total Levee Volume (cu. Yd)	24038	55702

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2238	2238
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3979	8952
Left Levee Lining Volume (cu. Yd)	1989	4476
Right Levee Length (ft)	2238	2238
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3979	8952
Right Levee Lining Volume (cu. Yd)	1989	4476
Total Lining Area (sq. Yd)	7957	17904
Total Lining Volume (cu. Yd)	3978	8952

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	170	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.5	ft
Structure Height	12.5	ft
Number of Structures	7	
Volume per structure	236	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 17,700	
Area per structure	57	sq. Yd
Total Area	397	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	5566	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 22,264	
Other Cost	$ -	
Total cost per basin	$ 22,264	
Area per basin	6,038	sq. Yd
Total Area	12,076	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	24,038	cu. Yd	$ 7.00	$ 168,266	22,878	sq. Yd	$ 9.00	$ 205,902	22,878	sq. Yd	$ 11.67	$ 266,910
Levee - LC Enhancement	Fill	31,664	cu. Yd	$ 7.00	$ 221,648	23,374	sq. Yd	$ 9.00	$ 210,366	31,664	sq. Yd	$ 11.67	$ 369,413
Levee Lining	Riprap	3,978	cu. Yd	$ 75.00	$ 298,350	7,957	sq. Yd	$ -	$ -	7,957	sq. Yd	$ 20.83	$ 165,778
Levee Lining -LC Enhancement	Riprap	4,974	cu. Yd	$ 75.00	$ 373,050	9,947	sq. Yd	$ -	$ -	9,947	sq. Yd	$ 20.83	$ 207,222
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,238	cu. Yd	$ 75.00	$ 167,850	746	sq. Yd	$ -	$ -	746	sq. Yd	$ 25.00	$ 18,650
Drop Structures	Riprap	7	EA	$ 17,700.00	$ 123,900	397	sq. Yd	$ -	$ -	397	sq. Yd	$ 33.33	$ 13,233
Drop Str. - LC Enhancement	Riprap	7	EA	$ 1,770.00	$ 12,390	40	sq. Yd	$ -	$ -	40	sq. Yd	$ 33.33	$ 1,323
Sedimentation Basins		2	EA	$ 22,264.00	$ 44,528	12,076	sq. Yd	$ -	$ -	12,076	sq. Yd	$ 8.33	$ 100,633
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 205,902	Base Maintenance Cost			$ 565,204
						LC Enhancement Cost			$ 210,366	LC Enhancement Cost			$ 577,959
						Total Landscape Cost			$ 416,268	Total Maintenance Cost			$ 1,143,163

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 802,894	$ 607,088	$ 1,409,982
Contingency Cost (25% of Construction Cost)	$ 200,724	$ 151,772	$ 352,496
Engineering Design Cost (5% of Construction Cost)	$ 40,145	$ 30,354	$ 70,499
Total Construction Cost	$ 1,043,762	$ 789,214	$ 1,832,977

Land Cost

Channel Length	2238 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	170	8.7	$100,000	$ 870,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	3	$100,000	$ 300,000
Levee LC Enhancement	54	2.8	$100,000	$ 280,000
Other	0	0	$100,000	$ -
Total	282	14.5		$ 1,450,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	11.7	$100,000	$ 1,170,000
LC Enhancement Cost	acre	2.8	$100,000	$ 280,000
Total Land Cost	acre	14.5	$100,000	$ 1,450,000

Total Cost

Base Total Cost	$ 2,984,869
Total Landscape Enhancement Cost	$ 1,857,539
Total Cost Including LC Enh.	$ 4,842,408

Online Basin

HEC1 ID	RR500

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.6	sq. mi
Total Sediment Yield Volume	6.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	6.9	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1300	1530
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	23.9	28.1
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	1.9	4.3

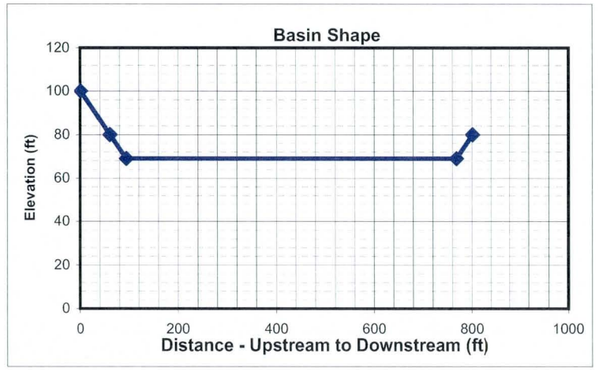
			Base	LC Enhanced
Bottom Length (ft)	1234	Allocated Storage Volume (ac. ft)	204.4	203.8
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	226.3	227.4
		Total Excavation Volume (ac. ft)	465.2	508.5

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	12	13
Volume	0.00	38.71	78.49	119.35	161.30	182.69	204.35	226.30	248.52	271.03
Outflow	0.0	85.6	121.0	148.2	171.1	181.5	191.3	200.7	209.6	218.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	227.0	257	257.0
Peak Inflow (cfs)	1743	2063	2063.0
Peak Outflow (cfs)	181	186	186.0
Stage at Peak Outflow (ft)	8.9	9.4	9.4
Volume at Peak Outflow (ac. ft)	180.8	192.34	192.3

Volume Check

Total Volume needed	199.2	ac. ft
Total Volume Provided	204.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.4	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	427000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1300	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	1630	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	750523	820380
Excavated Area (sq. Yd)	115556	163000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	98	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1089	sq. Yd
Material Volume	545	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		750,523	cu. Yd	$ 4.00	$ 3,002,092	115,556	sq. Yd	$ 9.00	$ 1,040,004	115,556	sq. Yd	$ 8.33	$ 962,967
Basin - LC Enhancement		69,857	cu. Yd	$ 4.00	$ 279,428	47,444	sq. Yd	$ 9.00	$ 426,996	47,444	sq. Yd	$ 8.33	$ 395,367
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,040,004	Base Maintenance Cost			$ 1,001,483
						LC Enh. Landscape Cost			$ 426,996	LC Enh. Maintenance Cost			$ 402,738
						Total Landscape Cost			$ 1,467,000	Total Maintenance Cost			$ 1,404,221

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,130,967	$ 279,428	$ 3,410,395
Contingency Cost (25% of Construction Cost)	$ 782,742	$ 69,857	$ 852,599
Engineering Design Cost (5% of Construction Cost)	$ 156,548	$ 13,971	$ 170,520
Total Construction Cost	$ 4,070,257	$ 363,256	$ 4,433,514

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	9.8	$100,000	$ 980,000
Basin	23.9	$100,000	$ 2,390,000
Other		$100,000	$ -
Total	33.7	$100,000	$ 3,370,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.9	$100,000	$ 2,390,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 8,501,744
Total LC Enhancement Cost	$ 2,172,990
Total Cost Including LC Enh.	$ 10,674,734

Open Channel

Structure ID	C51010

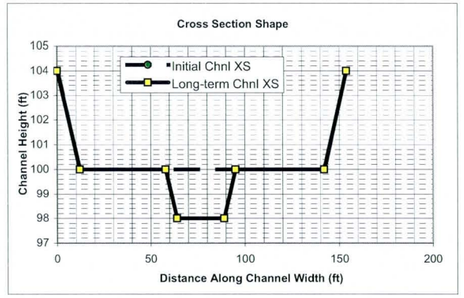
HEC1 ID	500510

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

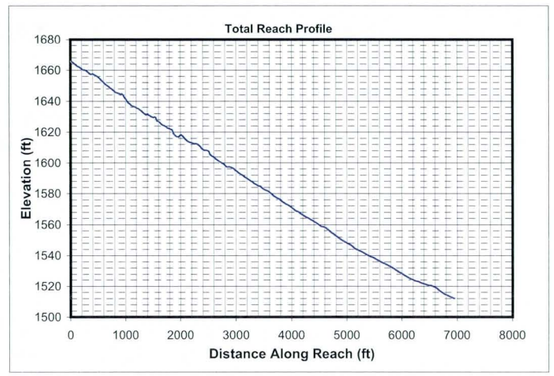
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	130	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	142	142	142	154
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	46	3	25	6	3	47	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	58	64	89	95	142	154
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.22							
Flow into Channel	186	462							648

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.409	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	648	cfs	
Long-term Max. Chnl Capacity	5020	cfs	
Q2 Channel	65	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	131.6	33.0	0.3	100.0	100.3	2.0	0.3	131.5	0.3	0.14	0.69
162	132.8	57.5	0.4	100.0	100.4	2.8	0.4	132.6	0.4	0.25	0.75
486	135.3	111.9	0.8	100.0	100.8	4.3	0.8	135.1	0.8	0.47	0.84
648	136.3	133.4	1.0	100.0	101.0	4.9	1.0	136.0	1.0	0.56	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
65	30.5	24.1	0.8	98.0	98.9	2.7	0.9	30.2	0.8	0.49	0.53
162	34.4	43.9	1.3	98.0	99.5	3.7	1.5	33.9	1.3	0.84	0.57
486	134.7	146.4	1.1	98.0	100.6	3.3	2.6	133.8	1.1	1.48	0.56
648	136.0	174.6	1.3	98.0	100.8	3.7	2.8	135.1	1.3	1.60	0.58

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
65										0
162										0
486										0
648										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
65	1.74	0.9696	0.9211	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
162	1.74	1.1376	1.0807	Erosive	Erosive	Erosive	0.2	Stable	7.2	Stable	Stable
486	1.74	1.3374	1.2705	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
648	1.74	1.3894	1.3199	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	65	162	486	648	65	162	486	648	65	162	486	648
Bray - Equation #1	21	35	62	72	1.1	1.4	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	28	46	81	95	1.2	1.6	2.3	2.5	1.9	2.2	2.6	2.7
Hey	6	10	19	23	3.1	4.5	6.8	7.5				
Ackers & Charlton/Lacey	21	30	48	55					1.6	1.9	2.2	2.4
Parker	55	87	151	175	0.8	1.1	1.8	2.0				
Chang	40	70	137	163	0.0	-0.1	-0.4	-0.5				
Kellerhals	14	23	40	46	1.4	2.1	3.2	3.6	3.1	3.4	3.8	3.9
AMAFCA/Schumm	30	34	134	135								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	11.4	16.0	24.2	27.0	3	4	6	7	2.9	3.7	4.9	5.2
Average	24	36	71	80	1.4	2.0	2.9	3.2	2.5	2.9	3.5	3.6
Values As Designed	30	34	134	135	0.9	1.5	2.6	2.8	2.7	3.7	3.3	3.7
Difference with Design	-7	2	-63	-55	0.6	0.5	0.3	0.3	-0.2	-0.8	0.1	-0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	761	501	1148	1481	2173	278	241	121	3761	259	808	1048
162	3129	1591	3320	6992	3208	1139	762	604	9809	850	3343	3159
486	16989	5698	9891	44691	4871	5338	2459	3051	29973	3924	15680	12960
648	26392	7853	12961	72516	5408	7930	3278	4518	40055	5903	23048	19078

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	4359	2870	6570	8482	12440	1593	1382	690	21534	1484	4623	6003
162	7167	3643	7603	16013	7346	2608	1744	1382	22465	1946	7657	7234
486	12969	4350	7551	34116	3719	4075	1877	2329	22881	2995	11970	9894
648	15110	4496	7420	41518	3096	4540	1876	2586	22933	3380	13195	10923

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	482	248	444	935	600	124	96	102	989	113	554	426
162	1853	738	1200	4092	928	448	270	397	2548	410	2035	1356
486	4850	2012	3499	10151	3289	1206	796	1050	7586	1083	5447	3725
648	7528	2858	4841	16445	3695	1814	1095	1610	10192	1651	8241	5452

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
65	2762	1420	2543	5354	3438	708	547	582	5665	647	3174	2440
162	4243	1691	2747	9371	2125	1026	619	910	5835	939	4660	3106
486	3702	1536	2671	7749	2511	921	608	801	5791	827	4158	2843
648	4310	1636	2771	9415	2115	1039	627	922	5835	945	4718	3121

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
65	0.0030	0.0048	139	0.42	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0024	0.0087	0.0006	0.0033	0.0221	0.0084
162	0.0015	0.0028	182	0.56	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0087	0.0004	0.0017	0.0221	0.0081
486	0.0007	0.0015	252	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0087	0.0002	0.0007	0.0221	0.0079
648	0.0005	0.0012	274	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0087	0.0002	0.0006	0.0221	0.0079

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	91.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	31	
Distance between structs.	225	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	225 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		2.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
65	1.1	-0.3	0.1	24.6	0.9	0.8	2.7	0.0090	0.1	1.5	2.0	4.7
162	1.1	-0.4	0.2	24.6	1.5	1.3	3.7	0.0090	0.2	1.5	2.0	4.9
486	1.1	-0.8	0.2	24.6	2.6	1.1	3.3	0.0090	0.3	1.5	2.0	5.0
648	1.1	-0.8	0.2	24.6	2.8	1.3	3.7	0.0090	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.30	ac. ft
Deposited(+)/Eroded(-) Volume	0.47	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	3
Channel Width (ft)	154	154
Channel XS Area (sq. ft)	630	630
Channel Perimeter (ft)	156	156

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2321	sq. Yd
Volume	6964	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6964	6964
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	30177	62676
Left Levee Volume (cu. Yd)	26824	64481
Right Levee Length (ft)	6964	6964
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	30177	62676
Right Levee Volume (cu. Yd)	26824	64481
Total Levee Surface Area (sq. Yd)	60354	125352
Total Levee Volume (cu. Yd)	53648	128962

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10059	23213
Left Levee Lining Volume (cu. Yd)	5030	11607
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10059	23213
Right Levee Lining Volume (cu. Yd)	5030	11607
Total Lining Area (sq. Yd)	20118	46427
Total Lining Volume (cu. Yd)	10060	23214

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	154	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	31	
Volume per structure	150	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,250	
Area per structure	51	sq. Yd
Total Area	1,591	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3485	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,940	
Other Cost	$ -	
Total cost per basin	$ 13,940	
Area per basin	3,844	sq. Yd
Total Area	3,844	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	53,648	cu. Yd	$ 7.00	$ 375,536	60,354	sq. Yd	$ 9.00	$ 543,186	60,354	sq. Yd	$ 11.67	$ 704,130
Levee - LC Enhancement	Fill	75,314	cu. Yd	$ 7.00	$ 527,198	64,998	sq. Yd	$ 9.00	$ 584,982	75,314	sq. Yd	$ 11.67	$ 878,663
Levee Lining	Riprap	10,060	cu. Yd	$ 75.00	$ 754,500	20,118	sq. Yd	$ -	$ -	20,118	sq. Yd	$ 20.83	$ 419,130
Levee Lining -LC Enhancement	Riprap	13,154	cu. Yd	$ 75.00	$ 986,550	26,308	sq. Yd	$ -	$ -	26,308	sq. Yd	$ 20.83	$ 548,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,964	cu. Yd	$ 75.00	$ 522,300	2,321	sq. Yd	$ -	$ -	2,321	sq. Yd	$ 25.00	$ 58,025
Drop Structures	Riprap	31	EA	$ 11,250.00	$ 348,750	1,591	sq. Yd	$ -	$ -	1,591	sq. Yd	$ 33.33	$ 53,033
Drop Str. - LC Enhancement	Riprap	31	EA	$ 1,125.00	$ 34,875	159	sq. Yd	$ -	$ -	159	sq. Yd	$ 33.33	$ 5,303
Sedimentation Basins		1	EA	$ 13,940.00	$ 13,940	3,844	sq. Yd	$ -	$ -	3,844	sq. Yd	$ 8.33	$ 32,033
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 543,186	Base Maintenance Cost			$ 1,266,351
						LC Enhancement Cost			$ 584,982	LC Enhancement Cost			$ 1,432,059
						Total Landscape Cost			$ 1,128,168	Total Maintenance Cost			$ 2,698,411

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,015,026	$ 1,548,623	$ 3,563,649
Contingency Cost (25% of Construction Cost)	$ 503,757	$ 387,156	$ 890,912
Engineering Design Cost (5% of Construction Cost)	$ 100,751	$ 77,431	$ 178,182
Total Construction Cost	$ 2,619,534	$ 2,013,210	$ 4,632,744

Land Cost

Channel Length	6964 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	154	24.6	$100,000	$ 2,460,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.3	$100,000	$ 830,000
Levee LC Enhancement	48	7.7	$100,000	$ 770,000
Other	0	0	$100,000	$ -
Total	254	40.6		$ 4,060,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	32.9	$100,000	$ 3,290,000
LC Enhancement Cost	acre	7.7	$100,000	$ 770,000
Total Land Cost	acre	40.6	$100,000	$ 4,060,000

Total Cost

Base Total Cost	$ 7,719,071
Total Landscape Enhancement Cost	$ 4,800,251
Total Cost Including LC Enh.	$ 12,519,322

Open Channel

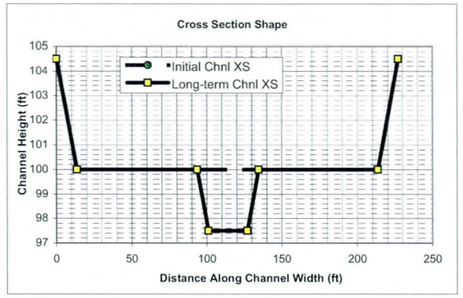
Structure ID	C51020	HEC1 ID	500510

Longitudal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

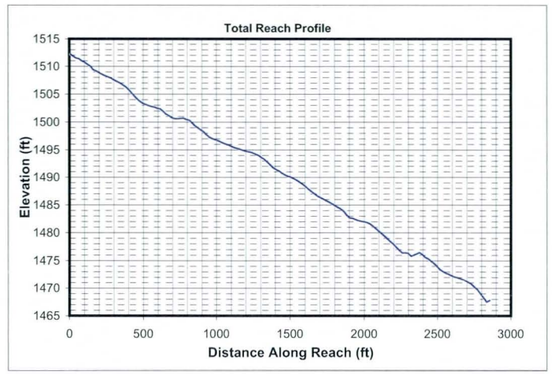
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	26	7	3	79	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	127	134.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510							TOTAL
HEC1 Peak-Flow	186	2099							2285
Weighting Factor	1.00	0.53							
Flow into Channel	186	1112							1298

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51010	500510_S51010							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	3121	2356							
Sediment Volume (ac. ft)	0.30	0.23							0.53
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.30	0.00							0.30

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1298	cfs	
Long-term Max. Chnl Capacity	7362	cfs	
Q2 Channel	130	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	202.1	66.5	0.3	100.0	100.3	2.0	0.3	202.0	0.3	0.12	0.60
325	203.6	115.5	0.6	100.0	100.6	2.8	0.6	203.4	0.6	0.21	0.66
974	207.0	224.7	1.1	100.0	101.1	4.3	1.1	206.6	1.1	0.41	0.73
1298	208.3	267.8	1.3	100.0	101.3	4.8	1.3	207.9	1.3	0.49	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
130	35.1	43.7	1.2	97.5	98.9	3.0	1.4	34.7	1.3	0.54	0.47
325	41.4	80.9	2.0	97.5	99.9	4.0	2.4	40.6	2.0	0.91	0.50
974	207.5	298.1	1.4	97.5	101.1	3.3	3.6	206.3	1.4	1.33	0.48
1298	209.2	355.5	1.7	97.5	101.3	3.7	3.8	208.0	1.7	1.43	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51010	500510_S51010								
130	426	200								626
325	1356	617								1973
974	3725	1919								5644
1298	5452	2800								8252

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
130	1.74	1.0528	1.0002	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
325	1.74	1.2208	1.1598	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
974	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
1298	1.74	1.4735	1.3998	Erosive	Erosive	Erosive	0.3	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	130	325	974	1298	130	325	974	1298	130	325	974	1298
Bray - Equation #1	31	50	89	104	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	41	66	117	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.6
Parker	78	124	214	248	1.0	1.5	2.4	2.7				
Chang	54	94	183	218	0.1	0.0	-0.4	-0.6				
Kellerhals	21	32	56	65	1.9	2.7	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	35	41	207	208								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	15.9	22.4	33.9	37.7	4	6	9	10	3.0	3.8	5.0	5.4
Average	32	50	101	114	1.9	2.6	3.8	4.2	2.7	3.1	3.7	3.9
Values As Designed	35	41	206	208	1.4	2.4	3.6	3.8	3.0	4.0	3.3	3.7
Difference with Design	-2	9	-106	-94	0.5	0.2	0.3	0.4	-0.3	-0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	1058	676	1406	1945	3095	322	292	167	4254	317	1138	1334
325	4369	2209	4266	9191	4609	1380	971	867	11222	1102	4811	4091
974	23661	8042	13120	58830	7041	6530	3194	4463	34451	5293	23043	17061
1298	36787	11124	17110	95529	7822	9713	4272	6637	46066	8029	34065	25196

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	3025	1931	4019	5559	8846	920	834	477	12159	906	3252	3812
325	4995	2526	4877	10508	5269	1577	1110	992	12830	1260	5501	4677
974	9017	3065	5000	22420	2683	2488	1217	1701	13129	2017	8782	6502
1298	10515	3180	4891	27304	2236	2776	1221	1897	13167	2295	9737	7202

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	742	354	555	1417	714	160	121	172	1080	160	871	577
325	2780	1037	1500	6018	1129	565	336	632	2776	585	3110	1861
974	6404	2715	4270	12512	4662	1367	963	1491	8189	1352	7434	4669
1298	9945	3877	5886	20289	5248	2071	1338	2297	11029	2074	11331	6853

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
130	2121	1011	1586	4051	2041	458	345	491	3087	458	2489	1649
325	3178	1186	1715	6880	1291	646	384	723	3174	668	3556	2127
974	2440	1035	1627	4768	1777	521	367	568	3121	515	2833	1779
1298	2843	1108	1682	5799	1500	592	382	656	3152	593	3239	1959

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
130	0.0024	0.0037	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0069	0.0004	0.0027	0.0153	0.0061
325	0.0012	0.0021	174	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0010	0.0069	0.0003	0.0013	0.0153	0.0059
974	0.0005	0.0011	240	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0153	0.0057
1298	0.0004	0.0009	261	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0153	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	319	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	319 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
130	1.1	-0.4	0.1	24.6	1.4	1.3	3.0	0.0060	0.2	1.5	2.5	5.5
325	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	2.5	5.7
974	1.1	-1.0	0.1	24.6	3.6	1.4	3.3	0.0060	0.4	1.5	2.5	5.8
1298	1.1	-1.1	0.2	24.6	3.8	1.7	3.7	0.0060	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.64	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	0.44	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1044.5	1044.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	958	sq. Yd
Volume	2874	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2874	2874
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13412	27782
Left Levee Volume (cu. Yd)	13199	31082
Right Levee Length (ft)	2874	2874
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13412	27782
Right Levee Volume (cu. Yd)	13199	31082
Total Levee Surface Area (sq. Yd)	26824	55564
Total Levee Volume (cu. Yd)	26398	62164

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4471	10538
Left Levee Lining Volume (cu. Yd)	2235	5269
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4471	10538
Right Levee Lining Volume (cu. Yd)	2235	5269
Total Lining Area (sq. Yd)	8941	21076
Total Lining Volume (cu. Yd)	4470	10538

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	9	
Volume per structure	245	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,375	
Area per structure	76	sq. Yd
Total Area	681	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	7518	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 30,072	
Other Cost	$ -	
Total cost per basin	$ 30,072	
Area per basin	8,054	sq. Yd
Total Area	8,054	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	26,398	cu. Yd	$ 7.00	$ 184,786	26,824	sq. Yd	$ 9.00	$ 241,416	26,824	sq. Yd	$ 11.67	$ 312,947
Levee - LC Enhancement	Fill	35,766	cu. Yd	$ 7.00	$ 250,362	28,740	sq. Yd	$ 9.00	$ 258,660	35,766	sq. Yd	$ 11.67	$ 417,270
Levee Lining	Riprap	4,470	cu. Yd	$ 75.00	$ 335,250	8,941	sq. Yd	$ -	$ -	8,941	sq. Yd	$ 20.83	$ 186,278
Levee Lining -LC Enhancement	Riprap	6,068	cu. Yd	$ 75.00	$ 455,100	12,135	sq. Yd	$ -	$ -	12,135	sq. Yd	$ 20.83	$ 252,806
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,874	cu. Yd	$ 75.00	$ 215,550	958	sq. Yd	$ -	$ -	958	sq. Yd	$ 25.00	$ 23,950
Drop Structures	Riprap	9	EA	$ 18,375.00	$ 165,375	681	sq. Yd	$ -	$ -	681	sq. Yd	$ 33.33	$ 22,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,837.50	$ 16,538	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,270
Sedimentation Basins		1	EA	$ 30,072.00	$ 30,072	8,054	sq. Yd	$ -	$ -	8,054	sq. Yd	$ 8.33	$ 67,117
Other					$ -				$ -				$ -

Base Landscape Cost	$ 241,416	Base Maintenance Cost	$ 612,991
LC Enhancement Cost	$ 258,660	LC Enhancement Cost	$ 672,346
Total Landscape Cost	$ 500,076	Total Maintenance Cost	$ 1,285,337

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 931,033	$ 722,000	$ 1,653,033
Contingency Cost (25% of Construction Cost)	$ 232,758	$ 180,500	$ 413,258
Engineering Design Cost (5% of Construction Cost)	$ 46,552	$ 36,100	$ 82,652
Total Construction Cost	$ 1,210,343	$ 938,599	$ 2,148,942

Land Cost

Channel Length	2874 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	15	$100,000	$ 1,500,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	333	22		$ 2,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	18.6	$100,000	$ 1,860,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	22	$100,000	$ 2,200,000

Total Cost

Base Total Cost	$ 3,924,750
Total Landscape Enhancement Cost	$ 2,209,605
Total Cost Including LC Enh.	$ 6,134,355

Open Channel

Structure ID	C51030

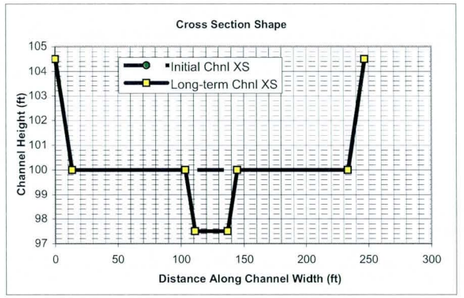
HEC1 ID	500510

Longitudal Geometry

Length	1483.7	ft
U/S Elev	1468.2	ft
D/S Elev	1450.0	ft
Initial Channel Slope	0.0123	ft/ft
Long-term Channel Slope	0.0055	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

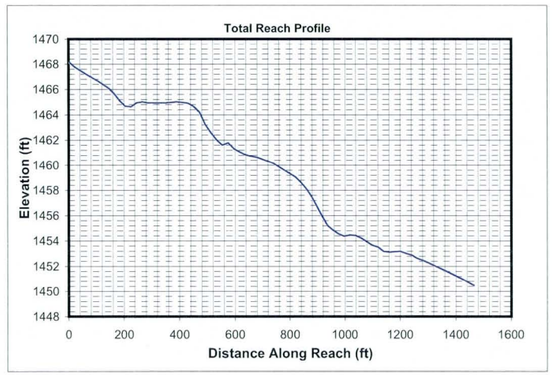
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	220	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	233.5	233.5	233.5	247
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	90	3	26	7	3	89	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	103.5	111	137	144.5	233.5	247
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR500	S510								TOTAL
HEC1 Peak-Flow	186	2099								2285
Weighting Factor	1.00	0.59								
Flow into Channel	186	1238								1424

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51020									TOTAL
Flow Volume (ac. ft)	257.00									257
Sediment Conc. (ppm)	2127									
Sediment Volume (ac. ft)	0.21									0.21
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.21									0.21

Hydrology

Drainage Area	1.84	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1424	cfs	
Long-term Max. Chnl Capacity	7651	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	247	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	222.2	78.1	0.4	100.0	100.4	1.8	0.4	222.1	0.4	0.12	0.54
356	223.9	135.6	0.6	100.0	100.6	2.6	0.6	223.7	0.6	0.21	0.59
1068	227.5	263.9	1.2	100.0	101.2	4.0	1.2	227.1	1.2	0.41	0.66
1424	228.9	314.4	1.4	100.0	101.4	4.5	1.4	228.4	1.4	0.48	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
142	35.9	47.8	1.3	97.5	99.1	3.0	1.6	35.4	1.4	0.54	0.45
356	223.3	172.3	0.8	97.5	100.4	2.1	2.9	222.4	0.8	1.00	0.41
1068	227.9	335.9	1.5	97.5	101.1	3.2	3.6	226.8	1.5	1.25	0.46
1424	229.7	400.4	1.7	97.5	101.4	3.6	3.9	228.5	1.8	1.34	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)								TOTAL
	500510_C51020								
142	577								577
356	1861								1861
1068	4669								4669
1424	6853								6853

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
142	1.74	1.0731	1.0194	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
356	1.74	1.2411	1.1791	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
1068	1.74	1.4418	1.3697	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1424	1.74	1.4940	1.4193	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	142	356	1068	1424	142	356	1068	1424	142	356	1068	1424
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	144	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	225	259	1.1	1.6	2.5	2.8				
Chang	55	97	188	224	0.1	0.0	-0.4	-0.5				
Kellerhals	21	34	59	68	2.0	2.9	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	35	223	227	229								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	16.8	23.6	35.7	39.7	4	6	10	11	3.0	3.8	4.9	5.3
Average	34	70	106	120	2.0	2.7	4.0	4.4	2.7	3.1	3.7	3.9
Values As Designed	35	222	227	228	1.6	2.9	3.6	3.9	3.0	2.1	3.2	3.6
Difference with Design	-1	-152	-120	-109	0.4	-0.2	0.4	0.5	-0.3	1.1	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	850	544	1074	1472	3002	216	210	123	3226	247	894	1078
356	3509	1858	3535	6956	4549	1022	777	701	8687	868	3950	3310
1068	19011	6955	11416	44536	7038	4968	2672	3788	26894	4222	19558	13732
1424	29559	9668	14774	72325	7836	7404	3597	5677	35998	6427	29120	20217

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	2215	1417	2799	3834	7821	562	548	321	8406	643	2330	2809
356	3657	1936	3684	7249	4741	1065	810	731	9053	904	4116	3449
1068	6604	2416	3966	15471	2445	1726	928	1316	9342	1467	6794	4770
1424	7701	2519	3849	18843	2041	1929	937	1479	9379	1675	7587	5267

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	749	356	549	1417	720	156	119	177	1037	160	884	575
356	1152	609	1047	1860	2979	207	203	222	2374	261	1287	1109
1068	6226	2698	4187	11877	4913	1289	937	1473	7843	1301	7289	4549
1424	9674	3866	5764	19266	5538	1962	1309	2280	10578	1998	11151	6671

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	1953	928	1429	3691	1876	407	309	460	2703	416	2303	1498
356	1200	635	1091	1939	3104	215	211	231	2474	272	1341	1156
1068	2163	937	1455	4126	1707	448	325	512	2725	452	2532	1580
1424	2520	1007	1502	5020	1443	511	341	594	2756	520	2905	1738

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
142	0.0024	0.0035	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0067	0.0004	0.0026	0.0122	0.0053
356	0.0012	0.0020	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0067	0.0003	0.0013	0.0123	0.0050
1068	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0002	0.0006	0.0122	0.0049
1424	0.0004	0.0009	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0067	0.0001	0.0005	0.0122	0.0049

Drop Structures

Design Slope	0.0055	ft/ft
Total Drop Needed	10.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	371	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.76	sq. mi
Total Sediment Yield Volume	1.44	ac ft

Sedimentation Basins

Length	371 ft	Depth	3 ft
Width	247 ft	Side slope	3 ft/ft
Total Volume per Basin		5.93	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
142	1.1	-0.5	0.1	24.6	1.6	1.4	3.0	0.0055	0.2	1.5	1.0	3.5
356	1.1	-1.0	0.1	24.6	2.9	0.8	2.1	0.0055	0.3	1.5	1.0	3.7
1068	1.1	-1.1	0.1	24.6	3.6	1.5	3.2	0.0055	0.4	1.5	1.0	3.8
1424	1.1	-1.1	0.2	24.6	3.9	1.8	3.6	0.0055	0.4	1.5	1.0	3.9

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.64	ac. ft
Outflowing Sediment Volume	0.17	ac. ft
Deposited(+)/Eroded(-) Volume	1.48	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1484	1484
Side Slope (?H:1V)	3	3
Channel Width (ft)	247	247
Channel XS Area (sq. ft)	1134.5	1134.5
Channel Perimeter (ft)	249	249

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1484	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	495	sq. Yd
Volume	1154	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1484	1484
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	6925	14345
Left Levee Volume (cu. Yd)	6815	16049
Right Levee Length (ft)	1484	1484
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	6925	14345
Right Levee Volume (cu. Yd)	6815	16049
Total Levee Surface Area (sq. Yd)	13850	28690
Total Levee Volume (cu. Yd)	13630	32098

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1484	1484
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2308	5441
Left Levee Lining Volume (cu. Yd)	1154	2721
Right Levee Length (ft)	1484	1484
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2308	5441
Right Levee Lining Volume (cu. Yd)	1154	2721
Total Lining Area (sq. Yd)	4617	10883
Total Lining Volume (cu. Yd)	2308	5442

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	247	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	4	
Volume per structure	266	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 19,950	
Area per structure	82	sq. Yd
Total Area	329	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9567	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 38,268	
Other Cost	$ -	
Total cost per basin	$ 38,268	
Area per basin	10,180	sq. Yd
Total Area	10,180	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	13,630	cu. Yd	$ 7.00	$ 95,410	13,850	sq. Yd	$ 9.00	$ 124,650	13,850	sq. Yd	$ 11.67	$ 161,583	
Levee - LC Enhancement	Fill	18,468	cu. Yd	$ 7.00	$ 129,276	14,840	sq. Yd	$ 9.00	$ 133,560	18,468	sq. Yd	$ 11.67	$ 215,460	
Levee Lining	Riprap	2,308	cu. Yd	$ 75.00	$ 173,100	4,617	sq. Yd	$ -	$ -	4,617	sq. Yd	$ 20.83	$ 96,185	
Levee Lining -LC Enhancement	Riprap	3,134	cu. Yd	$ 75.00	$ 235,050	6,266	sq. Yd	$ -	$ -	6,266	sq. Yd	$ 20.83	$ 130,537	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	1,154	cu. Yd	$ 75.00	$ 86,550	495	sq. Yd	$ -	$ -	495	sq. Yd	$ 25.00	$ 12,375	
Drop Structures	Riprap	4	EA	$ 19,950.00	$ 79,800	329	sq. Yd	$ -	$ -	329	sq. Yd	$ 33.33	$ 10,967	
Drop Str. - LC Enhancement	Riprap	4	EA	$ 1,995.00	$ 7,980	33	sq. Yd	$ -	$ -	33	sq. Yd	$ 33.33	$ 1,097	
Sedimentation Basins		1	EA	$ 38,268.00	$ 38,268	10,180	sq. Yd	$ -	$ -	10,180	sq. Yd	$ 8.33	$ 84,833	
Other					$ -				$ -				$ -	
Base Landscape Cost									$ 124,650	Base Maintenance Cost			$ 365,944	
LC Enhancement Cost									$ 133,560	LC Enhancement Cost			$ 347,094	
Total Landscape Cost									$ 258,210	Total Maintenance Cost			$ 713,037	

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 473,128	$ 372,306	$ 845,434
Contingency Cost (25% of Construction Cost)	$ 118,282	$ 93,077	$ 211,359
Engineering Design Cost (5% of Construction Cost)	$ 23,656	$ 18,615	$ 42,272
Total Construction Cost	$ 615,066	$ 483,998	$ 1,099,064

Land Cost

Channel Length	1484 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	247	8.4	$100,000	$ 840,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	1.9	$100,000	$ 190,000
Levee LC Enhancement	51	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	353	12		$ 1,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	10.3	$100,000	$ 1,030,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	12	$100,000	$ 1,200,000

Total Cost

Base Total Cost	$ 2,135,660
Total Landscape Enhancement Cost	$ 1,134,652
Total Cost Including LC Enh.	$ 3,270,311

Open Channel

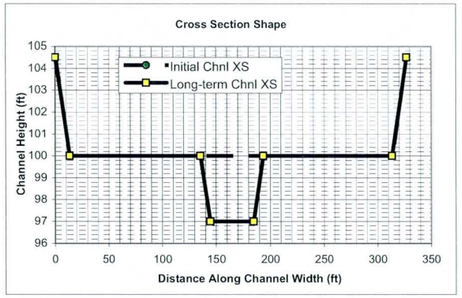
Structure ID	C51040	HEC1 ID	500510

Longitudnal Geometry

Length	2206.6	ft
U/S Elev	1450.0	ft
D/S Elev	1424.5	ft
Initial Channel Slope	0.0116	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

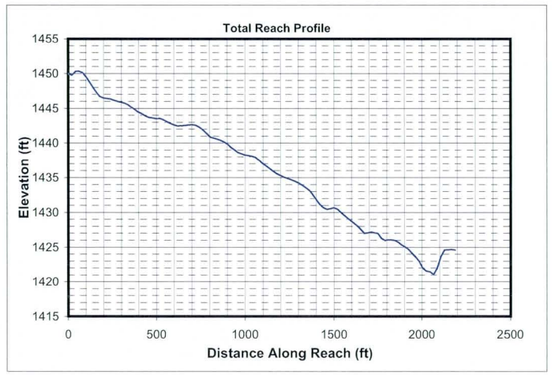
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	122	3	40	7.5	3	120	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	135.5	144.5	184.5	193.5	313.5	327
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C510									TOTAL
HEC1 Peak-Flow	2072									2072
Weighting Factor	1.00									
Flow into Channel	2072									2072

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51030									TOTAL
Flow Volume (ac. ft)	257.00									257
Sediment Conc. (ppm)	1738									
Sediment Volume (ac. ft)	0.17									0.17
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.17									0.17

Hydrology

Drainage Area	1.84	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2072	cfs	
Long-term Max. Chnl Capacity	10275	cfs	
Q2 Channel	207	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	302.4	112.5	0.4	100.0	100.4	1.8	0.4	302.2	0.4	0.12	0.53
518	304.1	195.3	0.6	100.0	100.6	2.7	0.6	303.9	0.6	0.20	0.58
1554	307.9	379.6	1.2	100.0	101.2	4.1	1.2	307.5	1.2	0.39	0.65
2072	309.4	451.9	1.5	100.0	101.5	4.6	1.5	308.9	1.5	0.46	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	50.0	70.4	1.4	97.0	98.6	2.9	1.6	49.4	1.4	0.49	0.43
518	56.9	128.6	2.3	97.0	99.7	4.0	2.7	56.1	2.3	0.83	0.47
1554	308.1	488.3	1.6	97.0	101.1	3.2	4.1	306.7	1.6	1.29	0.44
2072	310.0	581.7	1.9	97.0	101.4	3.6	4.4	308.6	1.9	1.38	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51030									
207	575									575
518	1109									1109
1554	4549									4549
2072	6671									6671

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
207	1.74	1.0908	1.0363	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
518	1.74	1.2592	1.1962	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable
1554	1.74	1.4604	1.3874	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
2072	1.74	1.5128	1.4371	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	207	518	1554	2072	207	518	1554	2072	207	518	1554	2072
Bray - Equation #1	40	64	114	133	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	175	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	99	156	271	313	1.3	1.9	2.9	3.3				
Chang	67	118	229	273	0.1	0.0	-0.5	-0.7				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	50	56	307	309								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	19.6	27.7	41.8	46.5	5	7	11	12	3.2	4.0	5.2	5.6
Average	41	63	132	148	2.3	3.1	4.6	5.1	2.8	3.3	3.9	4.1
Values As Designed	49	56	307	309	1.6	2.7	4.1	4.4	2.9	4.0	3.2	3.6
Difference with Design	-8	7	-175	-161	0.7	0.4	0.5	0.7	-0.1	-0.7	0.7	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1185	752	1462	2040	4084	293	286	175	4300	336	1253	1470
518	4894	2569	4810	9653	6183	1391	1057	989	11587	1193	5528	4532
1554	26573	9629	15530	61955	9546	6772	3637	5325	35881	5851	27413	18919
2072	41357	13391	20102	100706	10618	10100	4896	7981	48029	8925	40845	27905

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	2122	1346	2618	3653	7312	525	513	314	7699	602	2244	2632
518	3505	1840	3445	6914	4428	996	757	708	8299	854	3959	3246
1554	6344	2299	3708	14791	2279	1617	868	1271	8566	1397	6545	4517
2072	7405	2398	3599	18032	1901	1808	877	1429	8600	1598	7314	4996

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	984	472	715	1813	976	197	153	236	1302	206	1165	747
518	3755	1407	1926	7873	1519	712	433	884	3363	732	4263	2443
1554	8273	3581	5447	15543	6542	1648	1212	1995	9866	1702	9739	5959
2072	12865	5137	7478	25240	7371	2514	1698	3089	13316	2619	14931	8751

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1761	845	1280	3245	1748	353	274	422	2331	369	2086	1338
518	2690	1007	1379	5639	1088	510	310	633	2409	525	3054	1749
1554	1975	855	1300	3711	1562	394	289	476	2355	406	2325	1423
2072	2303	920	1339	4519	1320	450	304	553	2384	469	2673	1567

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
207	0.0023	0.0033	122	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0059	0.0003	0.0025	0.0115	0.0049
518	0.0012	0.0019	160	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0059	0.0002	0.0012	0.0116	0.0047
1554	0.0005	0.0010	222	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0005	0.0116	0.0045
2072	0.0004	0.0008	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0059	0.0001	0.0004	0.0116	0.0045

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	14.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	441	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.86	sq. mi
Total Sediment Yield Volume	1.63	ac ft

Sedimentation Basins

Length	441 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		9.47	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
207	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	3.0	6.1
518	1.1	-0.7	0.2	24.6	2.7	2.3	4.0	0.0050	0.3	1.5	3.0	6.4
1554	1.1	-1.2	0.1	24.6	4.1	1.6	3.2	0.0050	0.4	1.5	3.0	6.5
2072	1.1	-1.2	0.2	24.6	4.4	1.9	3.6	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	186	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.80	ac. ft
Outflowing Sediment Volume	0.17	ac. ft
Deposited(+)/Eroded(-) Volume	1.63	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2207	2207
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1557.8	1557.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2207	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	736	sq. Yd
Volume	2452	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2207	2207
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	10299	21334
Left Levee Volume (cu. Yd)	10136	23868
Right Levee Length (ft)	2207	2207
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	10299	21334
Right Levee Volume (cu. Yd)	10136	23868
Total Levee Surface Area (sq. Yd)	20598	42668
Total Levee Volume (cu. Yd)	20272	47736

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2207	2207
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3433	8092
Left Levee Lining Volume (cu. Yd)	1717	4046
Right Levee Length (ft)	2207	2207
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3433	8092
Right Levee Lining Volume (cu. Yd)	1717	4046
Total Lining Area (sq. Yd)	6866	16185
Total Lining Volume (cu. Yd)	3434	8092

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.0	ft
Structure Height	10.0	ft
Number of Structures	5	
Volume per structure	363	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,225	
Area per structure	109	sq. Yd
Total Area	545	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15278	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 61,112	
Other Cost	$ -	
Total cost per basin	$ 61,112	
Area per basin	16,035	sq. Yd
Total Area	16,035	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	20,272	cu. Yd	$ 7.00	$ 141,904	20,598	sq. Yd	$ 9.00	$ 185,382	20,598	sq. Yd	$ 11.67	$ 240,310
Levee - LC Enhancement	Fill	27,464	cu. Yd	$ 7.00	$ 192,248	22,070	sq. Yd	$ 9.00	$ 198,630	27,464	sq. Yd	$ 11.67	$ 320,413
Levee Lining	Riprap	3,434	cu. Yd	$ 75.00	$ 257,550	6,866	sq. Yd	$ -	$ -	6,866	sq. Yd	$ 20.83	$ 143,046
Levee Lining -LC Enhancement	Riprap	4,658	cu. Yd	$ 75.00	$ 349,350	9,318	sq. Yd	$ -	$ -	9,318	sq. Yd	$ 20.83	$ 194,134
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,452	cu. Yd	$ 75.00	$ 183,900	736	sq. Yd	$ -	$ -	736	sq. Yd	$ 25.00	$ 18,400
Drop Structures	Riprap	5	EA	$ 27,225.00	$ 136,125	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 33.33	$ 18,167
Drop Str. - LC Enhancement	Riprap	5	EA	$ 2,722.50	$ 13,613	55	sq. Yd	$ -	$ -	55	sq. Yd	$ 33.33	$ 1,817
Sedimentation Basins		1	EA	$ 61,112.00	$ 61,112	16,035	sq. Yd	$ -	$ -	16,035	sq. Yd	$ 8.33	$ 133,625
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 185,382	Base Maintenance Cost			$ 553,548
						LC Enhancement Cost			$ 198,630	LC Enhancement Cost			$ 516,364
						Total Landscape Cost			$ 384,012	Total Maintenance Cost			$ 1,069,912

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 780,591	$ 555,211	$ 1,335,802
Contingency Cost (25% of Construction Cost)	$ 195,148	$ 138,803	$ 333,950
Engineering Design Cost (5% of Construction Cost)	$ 39,030	$ 27,761	$ 66,790
Total Construction Cost	$ 1,014,768	$ 721,774	$ 1,736,542

Land Cost

Channel Length	2207 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	16.6	$100,000	$ 1,660,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	2.8	$100,000	$ 280,000
Levee LC Enhancement	51	2.6	$100,000	$ 260,000
Other	0	0	$100,000	$ -
Total	433	22		$ 2,200,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.4	$100,000	$ 1,940,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	22	$100,000	$ 2,200,000

Total Cost

Base Total Cost	$ 3,693,698
Total Landscape Enhancement Cost	$ 1,696,768
Total Cost Including LC Enh.	$ 5,390,466

Open Channel

Structure ID	RR51025

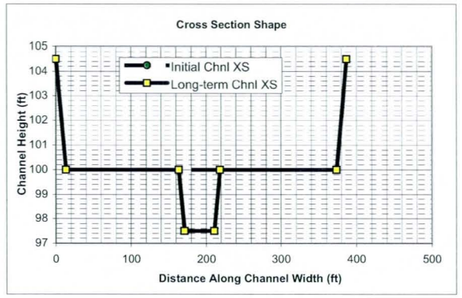
HEC1 ID	510520

Longitudal Geometry

Length	7246.8	ft
U/S Elev	1421.8	ft
D/S Elev	1323.7	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

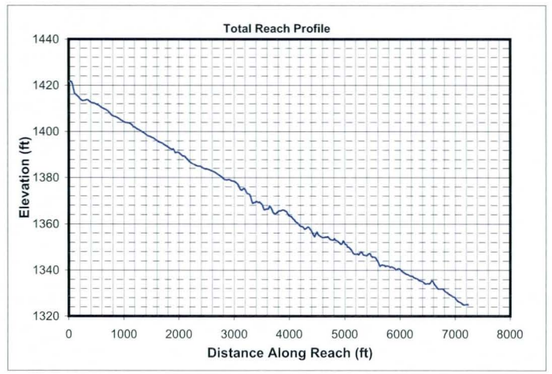
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	150	3	40	7	3	155	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	163.5	171	211	218.5	373.5	387
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C510	S520								TOTAL
HEC1 Peak-Flow	2072	1288								3360
Weighting Factor	1.00	0.00								
Flow into Channel	2072	0								2072

Reach Sediment Inflow Characteristics

U/S Contributing ID	500510_C51040									TOTAL
Flow Volume (ac. ft)	257.00									257
Sediment Conc. (ppm)	1749									
Sediment Volume (ac. ft)	0.17									0.17
Weighting Factor										
Weighted Sed. Vol. (ac. ft)	0.00									0.00

Hydrology

Drainage Area	2.1	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2072	cfs	
Long-term Max. Chnl Capacity	11692	cfs	
Q2 Channel	207	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	362.0	115.4	0.3	100.0	100.3	1.8	0.3	361.9	0.3	0.10	0.56
518	363.5	200.1	0.6	100.0	100.6	2.6	0.6	363.3	0.6	0.17	0.61
1554	366.8	388.2	1.1	100.0	101.1	4.0	1.1	366.4	1.1	0.33	0.69
2072	368.0	462.0	1.3	100.0	101.3	4.5	1.3	367.6	1.3	0.40	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
207	50.0	70.4	1.4	97.5	99.1	2.9	1.6	49.4	1.4	0.49	0.43
518	363.5	269.8	0.7	97.5	100.4	1.9	2.9	362.5	0.7	0.91	0.39
1554	367.9	524.2	1.4	97.5	101.1	3.0	3.6	366.7	1.4	1.13	0.44
2072	369.6	624.1	1.7	97.5	101.4	3.3	3.9	368.3	1.7	1.21	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500510_C51040									
207	747									747
518	2443									2443
1554	5959									5959
2072	8751									8751

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
207	1.74	1.0429	0.9907	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
518	1.74	1.2115	1.1509	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
1554	1.74	1.4133	1.3426	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
2072	1.74	1.4659	1.3926	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	207	518	1554	2072	207	518	1554	2072	207	518	1554	2072
Bray - Equation #1	40	64	114	133	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	175	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	99	156	271	313	1.3	1.9	2.9	3.3				
Chang	67	118	229	273	0.1	0.0	-0.5	-0.7				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	50	363	367	369								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	19.6	27.7	41.8	46.5	5	7	11	12	3.2	4.0	5.2	5.6
Average	41	94	138	154	2.3	3.1	4.6	5.1	2.8	3.3	3.9	4.1
Values As Designed	49	363	367	368	1.6	2.9	3.6	3.9	2.9	1.9	3.0	3.3
Difference with Design	-8	-269	-229	-214	0.7	0.2	1.0	1.2	-0.1	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1336	869	1759	2333	4899	354	345	188	5469	404	1392	1759
518	5527	2964	5781	11053	7409	1678	1274	1087	14703	1400	6182	5369
1554	30066	11096	18637	71104	11410	8175	4377	5918	45488	6757	30676	22155
2072	46825	15427	24123	115683	12680	12197	5891	8884	60881	10278	45694	32597

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	2392	1555	3149	4178	8773	634	618	337	9792	724	2493	3150
518	3958	2123	4141	7916	5306	1202	912	778	10531	1003	4427	3845
1554	7178	2649	4449	16975	2724	1952	1045	1413	10860	1613	7324	5289
2072	8384	2762	4319	20713	2270	2184	1055	1591	10901	1840	8182	5837

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	984	472	715	1813	976	197	153	236	1302	206	1165	747
518	1384	735	1119	2137	4336	207	219	248	2870	313	1498	1370
1554	7519	3420	5404	13720	7259	1505	1165	1801	9770	1557	8886	5637
2072	11703	4938	7337	22304	8195	2318	1653	2823	13220	2394	13713	8236

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
207	1761	845	1280	3245	1748	353	274	422	2331	369	2086	1338
518	991	527	802	1531	3106	148	157	178	2056	225	1073	981
1554	1795	817	1290	3276	1733	359	278	430	2332	372	2121	1346
2072	2096	884	1314	3994	1467	415	296	505	2367	429	2455	1475

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
207	0.0026	0.0038	122	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0059	0.0003	0.0028	0.0135	0.0054
518	0.0013	0.0022	161	0.49	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0059	0.0002	0.0014	0.0136	0.0052
1554	0.0006	0.0011	223	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0006	0.0135	0.0050
2072	0.0005	0.0010	243	0.74	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0004	0.0059	0.0001	0.0005	0.0135	0.0050

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	61.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	21	
Distance between structs.	345	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.33	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		8.75	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
207	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	2.5	5.5
518	1.1	-1.1	0.1	24.6	2.9	0.7	1.9	0.0050	0.3	1.5	2.5	5.6
1554	1.1	-1.1	0.1	24.6	3.6	1.4	3.0	0.0050	0.4	1.5	2.5	5.8
2072	1.1	-1.1	0.2	24.6	3.9	1.7	3.3	0.0050	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	965	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	358.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.33	ac. ft
Outflowing Sediment Volume	0.20	ac. ft
Deposited(+)/Eroded(-) Volume	0.14	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7247	7247
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1799.5	1799.5
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7247	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2416	sq. Yd
Volume	7247	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7247	7247
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	33819	70054
Left Levee Volume (cu. Yd)	33283	78375
Right Levee Length (ft)	7247	7247
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	33819	70054
Right Levee Volume (cu. Yd)	33283	78375
Total Levee Surface Area (sq. Yd)	67638	140108
Total Levee Volume (cu. Yd)	66566	156750

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7247	7247
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11273	26572
Left Levee Lining Volume (cu. Yd)	5637	13286
Right Levee Length (ft)	7247	7247
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11273	26572
Right Levee Lining Volume (cu. Yd)	5637	13286
Total Lining Area (sq. Yd)	22546	53145
Total Lining Volume (cu. Yd)	11274	26572

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	21	
Volume per structure	401	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 30,075	
Area per structure	129	sq. Yd
Total Area	2,709	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	14117	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 56,468	
Other Cost	$ -	
Total cost per basin	$ 56,468	
Area per basin	14,839	sq. Yd
Total Area	14,839	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	66,566	cu. Yd	$ 7.00	$ 465,962	67,638	sq. Yd	$ 9.00	$ 608,742	67,638	sq. Yd	$ 11.67	$ 789,110
Levee - LC Enhancement	Fill	90,184	cu. Yd	$ 7.00	$ 631,288	72,470	sq. Yd	$ 9.00	$ 652,230	90,184	sq. Yd	$ 11.67	$ 1,052,147
Levee Lining	Riprap	11,274	cu. Yd	$ 75.00	$ 845,550	22,546	sq. Yd	$ -	$ -	22,546	sq. Yd	$ 20.83	$ 469,713
Levee Lining -LC Enhancement	Riprap	15,298	cu. Yd	$ 75.00	$ 1,147,350	30,598	sq. Yd	$ -	$ -	30,598	sq. Yd	$ 20.83	$ 637,468
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	7,247	cu. Yd	$ 75.00	$ 543,525	2,416	sq. Yd	$ -	$ -	2,416	sq. Yd	$ 25.00	$ 60,400
Drop Structures	Riprap	21	EA	$ 30,075.00	$ 631,575	2,709	sq. Yd	$ -	$ -	2,709	sq. Yd	$ 33.33	$ 90,300
Drop Str. - LC Enhancement	Riprap	21	EA	$ 3,007.50	$ 63,158	271	sq. Yd	$ -	$ -	271	sq. Yd	$ 33.33	$ 9,030
Sedimentation Basins		1	EA	$ 56,468.00	$ 56,468	14,839	sq. Yd	$ -	$ -	14,839	sq. Yd	$ 8.33	$ 123,658
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 608,742	Base Maintenance Cost			$ 1,533,181
						LC Enhancement Cost			$ 652,230	LC Enhancement Cost			$ 1,698,644
						Total Landscape Cost			$ 1,260,972	Total Maintenance Cost			$ 3,231,826

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,543,080	$ 1,841,796	$ 4,384,876
Contingency Cost (25% of Construction Cost)	$ 635,770	$ 460,449	$ 1,096,219
Engineering Design Cost (5% of Construction Cost)	$ 127,154	$ 92,090	$ 219,244
Total Construction Cost	$ 3,306,004	$ 2,394,334	$ 5,700,338

Land Cost

Channel Length	7247 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	64.4	$100,000	$ 6,440,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	9.2	$100,000	$ 920,000
Levee LC Enhancement	51	8.5	$100,000	$ 850,000
Other	0	0	$100,000	$ -
Total	493	82.1		$ 8,210,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	73.6	$100,000	$ 7,360,000
LC Enhancement Cost	acre	8.5	$100,000	$ 850,000
Total Land Cost	acre	82.1	$100,000	$ 8,210,000

Total Cost

Base Total Cost	$ 12,807,927
Total Landscape Enhancement Cost	$ 5,595,208
Total Cost Including LC Enh.	$ 18,403,136

Open Channel

Structure ID	RR51030

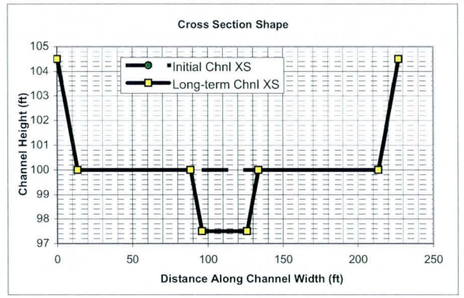
HEC1 ID	510520

Longitudnal Geometry

Length	13567.2	ft
U/S Elev	1323.7	ft
D/S Elev	1174.3	ft
Initial Channel Slope	0.0110	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

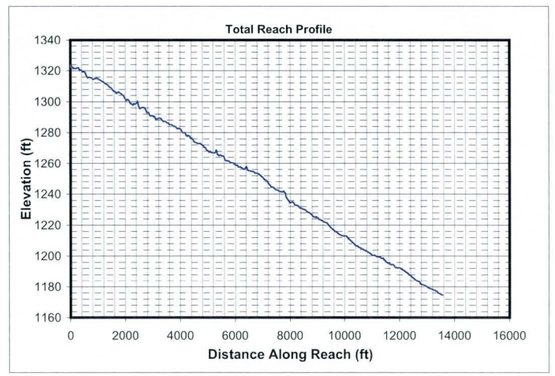
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	30	7	3	80	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	96	126	133.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S520									TOTAL
HEC1 Peak-Flow	1288									1288
Weighting Factor	1.00									
Flow into Channel	1288									1288

Reach Sediment Inflow Characteristics

U/S Contributing ID	510520_RR51025									TOTAL
Flow Volume (ac. ft)	358.00									358
Sediment Conc. (ppm)	1475									
Sediment Volume (ac. ft)	0.20									0.20
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.20									0.20

Hydrology

Drainage Area	1.48	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	1288	cfs	
Long-term Max. Chnl Capacity	6828	cfs	
Q2 Channel	129	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
129	202.3	73.1	0.4	100.0	100.4	1.8	0.4	202.2	0.4	0.11	0.52
322	204.0	127.0	0.6	100.0	100.6	2.5	0.6	203.8	0.6	0.20	0.57
966	207.7	247.4	1.2	100.0	101.2	3.9	1.2	207.3	1.2	0.38	0.63
1288	209.1	294.9	1.4	100.0	101.4	4.4	1.4	208.7	1.4	0.45	0.65

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
129	38.9	47.9	1.2	97.5	98.9	2.7	1.4	38.4	1.2	0.44	0.42
322	45.0	88.0	2.0	97.5	99.9	3.7	2.4	44.2	2.0	0.74	0.46
966	207.6	313.5	1.5	97.5	101.1	3.1	3.6	206.5	1.5	1.12	0.44
1288	209.5	373.9	1.8	97.5	101.4	3.4	3.9	208.2	1.8	1.21	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	510520_RR51025									
129	747									747
322	1370									1370
966	5637									5637
1288	8236									8236

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
129	1.74	1.0818	1.0278	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
322	1.74	1.2497	1.1872	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
966	1.74	1.4500	1.3775	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1288	1.74	1.5021	1.4270	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	129	322	966	1288	129	322	966	1288	129	322	966	1288
Bray - Equation #1	31	50	89	104	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	117	136	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.6
Parker	78	123	214	247	1.0	1.5	2.4	2.7				
Chang	50	88	172	205	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	65	1.9	2.7	4.2	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	38	44	207	208								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	16.4	23.2	35.0	38.9	4	6	9	10	2.8	3.5	4.6	5.0
Average	33	50	100	112	1.9	2.6	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	38	44	206	208	1.4	2.4	3.6	3.9	2.7	3.7	3.1	3.4
Difference with Design	-6	5	-107	-96	0.5	0.3	0.3	0.4	-0.1	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	660	421	773	1110	2561	149	152	91	2433	189	683	838
322	2725	1472	2805	5244	3919	759	599	544	6638	667	3087	2587
966	14738	5594	9268	33530	6116	3754	2115	3014	20656	3259	15540	10690
1288	22907	7797	11953	54424	6821	5601	2858	4536	27666	4967	23217	15704

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	1902	1212	2227	3198	7375	430	437	262	7008	545	1967	2415
322	3139	1697	3232	6042	4516	875	691	627	7648	769	3557	2981
966	5660	2148	3560	12877	2349	1442	812	1158	7933	1252	5968	4105
1288	6598	2246	3443	15677	1965	1613	823	1307	7969	1431	6688	4524

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	540	274	429	964	689	107	89	127	797	115	639	433
322	2043	830	1158	4141	1094	398	261	490	2075	422	2368	1389
966	4912	2186	3367	9136	4263	982	739	1183	6108	1016	5799	3608
1288	7627	3140	4597	14809	4816	1502	1040	1838	8251	1560	8900	5280

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	1555	788	1234	2776	1985	309	255	365	2295	330	1840	1249
322	2354	956	1334	4771	1260	459	301	565	2391	486	2728	1601
966	1887	839	1293	3509	1637	377	284	454	2346	390	2227	1386
1288	2197	905	1324	4266	1387	433	299	529	2377	449	2564	1521

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
129	0.0024	0.0034	117	0.36	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0069	0.0004	0.0027	0.0110	0.0050
322	0.0012	0.0019	154	0.47	0.048	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0069	0.0003	0.0013	0.0110	0.0048
966	0.0005	0.0010	213	0.65	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0110	0.0046
1288	0.0004	0.0009	232	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0110	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	81.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	485	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.48	sq. mi
Total Sediment Yield Volume	2.81	ac ft

Sedimentation Basins

Length	485 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		7.14	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
129	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	2.5	5.5
322	1.1	-0.7	0.2	24.6	2.4	2.0	3.7	0.0050	0.3	1.5	2.5	5.7
966	1.1	-1.1	0.1	24.6	3.6	1.5	3.1	0.0050	0.4	1.5	2.5	5.8
1288	1.1	-1.1	0.2	24.6	3.9	1.8	3.4	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	965	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	358.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.01	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	2.80	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	13567	13567
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1054.5	1054.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	13567	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4522	sq. Yd
Volume	13567	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	13567	13567
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	63313	131148
Left Levee Volume (cu. Yd)	62308	146725
Right Levee Length (ft)	13567	13567
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	63313	131148
Right Levee Volume (cu. Yd)	62308	146725
Total Levee Surface Area (sq. Yd)	126626	262296
Total Levee Volume (cu. Yd)	124616	293450

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	13567	13567
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	21104	49746
Left Levee Lining Volume (cu. Yd)	10552	24873
Right Levee Length (ft)	13567	13567
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	21104	49746
Right Levee Lining Volume (cu. Yd)	10552	24873
Total Lining Area (sq. Yd)	42208	99491
Total Lining Volume (cu. Yd)	21104	49746

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	28	
Volume per structure	244	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,300	
Area per structure	76	sq. Yd
Total Area	2,119	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	11519	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 46,076	
Other Cost	$ -	
Total cost per basin	$ 46,076	
Area per basin	12,221	sq. Yd
Total Area	24,442	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	124,616	cu. Yd	$ 7.00	$ 872,312	126,626	sq. Yd	$ 9.00	$ 1,139,634	126,626	sq. Yd	$ 11.67	$ 1,477,303
Levee - LC Enhancement	Fill	168,834	cu. Yd	$ 7.00	$ 1,181,838	135,670	sq. Yd	$ 9.00	$ 1,221,030	168,834	sq. Yd	$ 11.67	$ 1,969,730
Levee Lining	Riprap	21,104	cu. Yd	$ 75.00	$ 1,582,800	42,208	sq. Yd	$ -	$ -	42,208	sq. Yd	$ 20.83	$ 879,343
Levee Lining -LC Enhancement	Riprap	28,642	cu. Yd	$ 75.00	$ 2,148,150	57,283	sq. Yd	$ -	$ -	57,283	sq. Yd	$ 20.83	$ 1,193,394
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	13,567	cu. Yd	$ 75.00	$ 1,017,525	4,522	sq. Yd	$ -	$ -	4,522	sq. Yd	$ 25.00	$ 113,050
Drop Structures	Riprap	28	EA	$ 18,300.00	$ 512,400	2,119	sq. Yd	$ -	$ -	2,119	sq. Yd	$ 33.33	$ 70,633
Drop Str. - LC Enhancement	Riprap	28	EA	$ 1,830.00	$ 51,240	212	sq. Yd	$ -	$ -	212	sq. Yd	$ 33.33	$ 7,063
Sedimentation Basins		2	EA	$ 46,076.00	$ 92,152	24,442	sq. Yd	$ -	$ -	24,442	sq. Yd	$ 8.33	$ 203,683
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,139,634	Base Maintenance Cost			$ 2,744,013
						LC Enhancement Cost			$ 1,221,030	LC Enhancement Cost			$ 3,170,187
						Total Landscape Cost			$ 2,360,664	Total Maintenance Cost			$ 5,914,199

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,077,189	$ 3,381,228	$ 7,458,417
Contingency Cost (25% of Construction Cost)	$ 1,019,297	$ 845,307	$ 1,864,604
Engineering Design Cost (5% of Construction Cost)	$ 203,859	$ 169,061	$ 372,921
Total Construction Cost	$ 5,300,346	$ 4,395,596	$ 9,695,942

Land Cost

Channel Length	13567 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	70.7	$100,000	$ 7,070,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	17.1	$100,000	$ 1,710,000
Levee LC Enhancement	51	15.9	$100,000	$ 1,590,000
Other	0	0	$100,000	$ -
Total	333	103.7		$ 10,370,000

Total Cost

Base Total Cost	$ 17,963,992
Total Landscape Enhancement Cost	$ 10,376,813
Total Cost Including LC Enh.	$ 28,340,806

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	87.8	$100,000	$ 8,780,000
LC Enhancement Cost	acre	15.9	$100,000	$ 1,590,000
Total Land Cost	acre	103.7	$100,000	$ 10,370,000

Open Channel

Structure ID	S51010

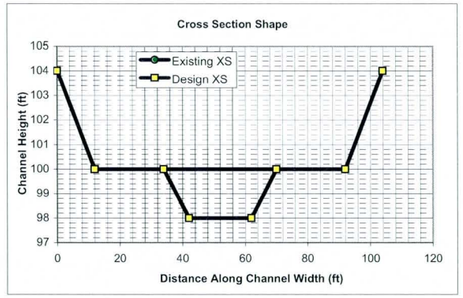
HEC1 ID	S51010

Longitudal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0072	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

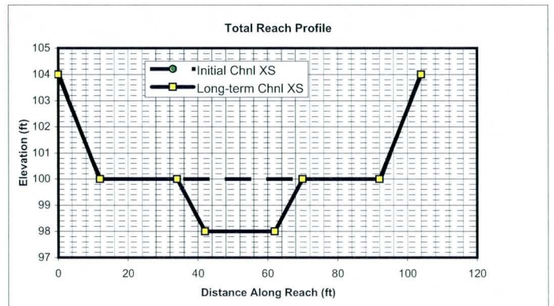
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	4	80	4	4	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	92	92	92	104
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	22	4	20	6	4	22	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	34	42	62	70	92	104
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510									TOTAL
HEC1 Peak-Flow	2099									2099
Weighting Factor	0.21									
Flow into Channel	441									441

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	3006	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	104	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	81.8	23.5	0.3	100.0	100.3	1.9	0.3	81.7	0.3	0.13	0.62
110	83.2	40.9	0.5	100.0	100.5	2.7	0.5	83.0	0.5	0.23	0.68
331	86.1	80.1	0.9	100.0	101.0	4.1	1.0	85.8	0.9	0.43	0.75
441	87.3	95.7	1.1	100.0	101.1	4.6	1.1	86.9	1.1	0.52	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	26.9	19.5	0.7	98.0	98.8	2.3	0.8	26.7	0.7	0.37	0.47
110	31.6	36.0	1.1	98.0	99.4	3.1	1.4	31.2	1.2	0.63	0.50
331	84.1	102.9	1.2	98.0	100.6	3.2	2.6	83.4	1.2	1.16	0.51
441	85.6	123.2	1.4	98.0	100.8	3.6	2.8	84.9	1.5	1.26	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
44										0
110										0
331										0
441										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.0105	0.9600	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
110	1.74	1.1770	1.1181	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
331	1.74	1.3744	1.3057	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
441	1.74	1.4254	1.3541	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**44**	**110**	**331**	**441**	**44**	**110**	**331**	**441**	**44**	**110**	**331**	**441**
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	29	52	101	120	0.1	0.1	-0.1	-0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	27	31	84	85								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	10.3	14.5	21.8	24.3	3	4	6	6	2.5	3.1	4.1	4.4
Average	20	30	55	62	1.3	1.8	2.6	2.8	2.3	2.7	3.2	3.3
Values As Designed	27	31	83	85	0.8	1.4	2.6	2.8	2.3	3.1	3.2	3.6
Difference with Design	-7	-2	-29	-23	0.4	0.3	0.0	0.0	0.0	-0.4	0.0	-0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	379	249	531	699	1225	119	110	57	1697	121	401	508
110	1558	815	1632	3286	1839	517	370	304	4482	408	1710	1538
331	8346	2967	5083	20775	2849	2441	1226	1577	13769	1912	8176	6284
441	12923	4102	6614	33578	3180	3622	1642	2346	18413	2883	12069	9216

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	3192	2092	4471	5884	10306	1004	922	478	14272	1017	3375	4274
110	5244	2743	5492	11058	6188	1740	1245	1021	15082	1374	5753	5176
331	9362	3328	5702	23303	3196	2738	1375	1768	15445	2145	9171	7048
441	10872	3451	5564	28248	2676	3047	1381	1973	15491	2425	10153	7753

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	210	117	202	367	421	47	42	42	462	49	240	200
110	789	366	589	1561	685	183	132	177	1217	174	913	617
331	2534	1094	1797	5081	1916	583	406	571	3667	552	2913	1919
441	3914	1555	2474	8186	2168	878	562	876	4935	841	4413	2800

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1764	987	1699	3091	3545	395	352	352	3890	413	2016	1682
110	2655	1230	1983	5252	2305	616	443	597	4094	585	3071	2076
331	2843	1227	2015	5699	2149	654	455	640	4114	620	3268	2153
441	3292	1308	2081	6887	1824	739	472	737	4151	707	3713	2356

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0028	0.0042	130	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0021	0.0099	0.0007	0.0033	0.0170	0.0074
110	0.0014	0.0025	171	0.52	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0099	0.0004	0.0017	0.0171	0.0071
331	0.0006	0.0013	235	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0099	0.0003	0.0007	0.0170	0.0069
441	0.0005	0.0011	255	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0099	0.0002	0.0006	0.0170	0.0069

Drop Structures

Design Slope	0.0072	ft/ft
Total Drop Needed	16.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	272	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	272 ft	Depth	3 ft
Width	104 ft	Side slope	3 ft/ft
Total Volume per Basin		1.72	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	-0.3	0.1	24.6	0.8	0.7	2.3	0.0072	0.1	1.5	2.0	4.7
110	1.1	-0.4	0.1	24.6	1.4	1.2	3.1	0.0072	0.2	1.5	2.0	4.8
331	1.1	-0.8	0.1	24.6	2.6	1.2	3.2	0.0072	0.3	1.5	2.0	5.0
441	1.1	-0.8	0.2	24.6	2.8	1.5	3.6	0.0072	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	443	cfs
Stage at Peak Flow	102.3	ft
Flow Volume	28.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	0.72	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	3
Channel Width (ft)	104	104
Channel XS Area (sq. ft)	424	424
Channel Perimeter (ft)	106	106

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	545	sq. Yd
Volume	1634	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1634	1634
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	7081	14706
Left Levee Volume (cu. Yd)	6294	15130
Right Levee Length (ft)	1634	1634
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	7081	14706
Right Levee Volume (cu. Yd)	6294	15130
Total Levee Surface Area (sq. Yd)	14162	29412
Total Levee Volume (cu. Yd)	12588	30260

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2360	5447
Left Levee Lining Volume (cu. Yd)	1180	2723
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2360	5447
Right Levee Lining Volume (cu. Yd)	1180	2723
Total Lining Area (sq. Yd)	4720	10893
Total Lining Volume (cu. Yd)	2360	5446

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	104	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	6	
Volume per structure	104	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,800	
Area per structure	35	sq. Yd
Total Area	208	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2775	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,100	
Other Cost	$ -	
Total cost per basin	$ 11,100	
Area per basin	3,146	sq. Yd
Total Area	6,292	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	12,588	cu. Yd	$ 7.00	$ 88,116	14,162	sq. Yd	$ 9.00	$ 127,458	14,162	sq. Yd	$ 11.67	$ 165,223
Levee - LC Enhancement	Fill	17,672	cu. Yd	$ 7.00	$ 123,704	15,250	sq. Yd	$ 9.00	$ 137,250	17,672	sq. Yd	$ 11.67	$ 206,173
Levee Lining	Riprap	2,360	cu. Yd	$ 75.00	$ 177,000	4,720	sq. Yd	$ -	$ -	4,720	sq. Yd	$ 20.83	$ 98,343
Levee Lining -LC Enhancement	Riprap	3,086	cu. Yd	$ 75.00	$ 231,450	6,173	sq. Yd	$ -	$ -	6,173	sq. Yd	$ 20.83	$ 128,602
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,634	cu. Yd	$ 75.00	$ 122,550	545	sq. Yd	$ -	$ -	545	sq. Yd	$ 25.00	$ 13,625
Drop Structures	Riprap	6	EA	$ 7,800.00	$ 46,800	208	sq. Yd	$ -	$ -	208	sq. Yd	$ 33.33	$ 6,933
Drop Str. - LC Enhancement	Riprap	6	EA	$ 780.00	$ 4,680	21	sq. Yd	$ -	$ -	21	sq. Yd	$ 33.33	$ 693
Sedimentation Basins		2	EA	$ 11,100.00	$ 22,200	6,292	sq. Yd	$ -	$ -	6,292	sq. Yd	$ 8.33	$ 52,433
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 127,458	Base Maintenance Cost			$ 336,558
						LC Enhancement Cost			$ 137,250	LC Enhancement Cost			$ 335,469
						Total Landscape Cost			$ 264,708	Total Maintenance Cost			$ 672,026

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 456,666	$ 359,834	$ 816,500
Contingency Cost (25% of Construction Cost)	$ 114,167	$ 89,959	$ 204,125
Engineering Design Cost (5% of Construction Cost)	$ 22,833	$ 17,992	$ 40,825
Total Construction Cost	$ 593,666	$ 467,784	$ 1,061,450

Land Cost

Channel Length	1634 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	104	3.9	$100,000	$ 390,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2	$100,000	$ 200,000
Levee LC Enhancement	48	1.8	$100,000	$ 180,000
Other	0	0	$100,000	$ -
Total	204	7.7		$ 770,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

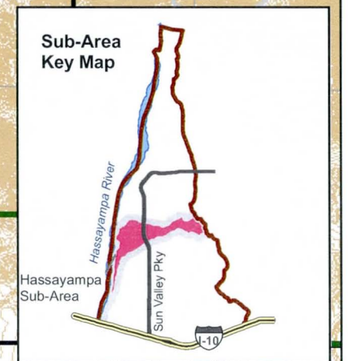
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.9	$100,000	$ 590,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	7.7	$100,000	$ 770,000

Total Cost

Base Total Cost	$ 1,647,681
Total Landscape Enhancement Cost	$ 1,120,503
Total Cost Including LC Enh.	$ 2,768,184

The Alternative C is the notation used for the alternative concept using no basins at the alluvial fan apices accompanied by concrete companion channels in the down fan direction.

0 1 2
Miles



C450 C440 C420 C530 C520 C430 C415 C410 C510 D415 4 5

RR41510 C42010 C42020 C41510 RR41010 C51060 C51020 C51010 S51010

Hassayampa River

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs ($1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR41010	Excavated Chl.	2125	30	449	0	1.1	149	7	$ 2,970	$ 10,363	$ 551	$ 1,230	$ 15,114	20%	69%	4%	8%	10%
C41510	Excavated Chl.	3899	11	76	0	0.3	216	6	$ 1,080	$ 1,898	$ 260	$ 471	$ 3,709	29%	51%	7%	13%	3%
C51010	Excavated Chl.	2525	40	1316	0	1.3	166	6	$ 3,990	$ 28,953	$ 808	$ 1,645	$ 35,396	11%	82%	2%	5%	24%
C51020	Excavated Chl.	3175	17	182	0	0.5	176	6	$ 1,710	$ 4,349	$ 362	$ 711	$ 7,132	24%	61%	5%	10%	5%
C51060	Excavated Chl.	3301	16	62	0	0.5	196	6	$ 1,630	$ 1,765	$ 371	$ 764	$ 4,530	36%	39%	8%	17%	3%
D415	Offline Basin	2530	21	336	0	1200	780	11	$ 2,149	$ 3,084	$ 936	$ 895	$ 7,064	30%	44%	13%	13%	5%
RR41510	Excavated Chl.	2878	31	576	0	1	176	6	$ 3,100	$ 13,021	$ 655	$ 1,263	$ 18,038	17%	72%	4%	7%	12%
C42010	Excavated Chl.	3285	65	1690	0	2	186	6	$ 6,530	$ 37,270	$ 1,433	$ 2,683	$ 47,916	14%	78%	3%	6%	33%
C42020	Excavated Chl.	3218	14	115	0	0.4	184	7	$ 1,380	$ 2,905	$ 300	$ 703	$ 5,288	26%	55%	6%	13%	4%
S51010	Excavated Chl.	441	7	27	0	0.3	104	4	$ 700	$ 752	$ 88	$ 229	$ 1,769	40%	43%	5%	13%	1%
		TOTAL	252	4829	0				$25,239	$104,359	$ 5,764	$ 10,595	**$ 145,956**	17%	72%	4%	7%	100%
All Channels			231	4493	0	7.4			$23,090	$101,275	$ 4,828	$ 9,699	$ 138,892	17%	73%	3%	7%	95%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			21	336	0				$ 2,149	$ 3,084	$ 936	$ 895	$ 7,064	30%	44%	13%	13%	5%
Channel Cost per mile (in $1000)			$18,769		Basins Cost per ac. ft. (in $1000)				$2.79									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	33%	29%	0%				34%	30%	29%	58%	33%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	43%	5%	0%				37%	5%	37%	37%	23%
Total % increase	34%	27%	0%				34%	29%	31%	56%	32%

SUN VALLEY ADMP
Step 2 - Alt. C
Hassayampa Sub-area

- Hassayampa Sub-area

FEMA Floodplains

- Floodplain
- Floodway
- Alluvial Fan Apices
- Concentration Point
- Step 2 Excavated Corridors ROW
- Step 2 Basins

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR41010	Excavated Chl.	2125	30	449	0	1.1	149	7	$ 2,970	$ 10,363	$ 551	$ 1,230	$ 15,114	20%	69%	4%	8%	10%
C41510	Excavated Chl.	3899	11	76	0	0.3	216	6	$ 1,080	$ 1,898	$ 260	$ 471	$ 3,709	29%	51%	7%	13%	3%
C51010	Excavated Chl.	2525	40	1316	0	1.3	166	6	$ 3,990	$ 28,953	$ 808	$ 1,645	$ 35,396	11%	82%	2%	5%	24%
C51020	Excavated Chl.	3175	17	182	0	0.5	176	6	$ 1,710	$ 4,349	$ 362	$ 711	$ 7,132	24%	61%	5%	10%	5%
C51060	Excavated Chl.	3301	16	62	0	0.5	196	6	$ 1,630	$ 1,765	$ 371	$ 764	$ 4,530	36%	39%	8%	17%	3%
D415	Offline Basin	2530	21	336	0	1200	780	11	$ 2,149	$ 3,084	$ 936	$ 895	$ 7,064	30%	44%	13%	13%	5%
RR41510	Excavated Chl.	2878	31	576	0	1	176	6	$ 3,100	$ 13,021	$ 655	$ 1,263	$ 18,038	17%	72%	4%	7%	12%
C42010	Excavated Chl.	3285	65	1690	0	2	186	6	$ 6,530	$ 37,270	$ 1,433	$ 2,683	$ 47,916	14%	78%	3%	6%	33%
C42020	Excavated Chl.	3218	14	115	0	0.4	184	7	$ 1,380	$ 2,905	$ 300	$ 703	$ 5,288	26%	55%	6%	13%	4%
S51010	Excavated Chl.	441	7	27	0	0.3	104	4	$ 700	$ 752	$ 88	$ 229	$ 1,769	40%	43%	5%	13%	1%
	TOTAL	252	4829	0					$ 25,239	$ 104,359	$ 5,764	$ 10,595	**$ 145,956**	17%	72%	4%	7%	100%
All Channels		231	4493	0	7.4				$ 23,090	$ 101,275	$ 4,828	$ 9,699	$ 138,892	17%	73%	3%	7%	95%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		21	336	0					$ 2,149	$ 3,084	$ 936	$ 895	$ 7,064	30%	44%	13%	13%	5%
Channel Cost per mile (in $1000)		$18,769		Basins Cost per ac. ft. (in $1000)					$2.79									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RR41010	Excavated Chl.	2125	41	621	0	1.1	322	7	$ 4,110	$ 14,482	$ 767	$ 2,049	$ 21,408	19%	68%	4%	10%	11%
C41510	Excavated Chl.	3899	14	90	0	0.3	386	6	$ 1,390	$ 2,355	$ 317	$ 698	$ 4,759	29%	49%	7%	15%	2%
C51010	Excavated Chl.	2525	54	1717	0	1.3	336	6	$ 5,370	$ 38,030	$ 1,059	$ 2,652	$ 47,111	11%	81%	2%	6%	24%
C51020	Excavated Chl.	3175	23	231	0	0.5	346	6	$ 2,280	$ 5,649	$ 466	$ 1,127	$ 9,521	24%	59%	5%	12%	5%
C51060	Excavated Chl.	3301	21	75	0	0.5	366	6	$ 2,130	$ 2,267	$ 463	$ 1,131	$ 5,991	36%	38%	8%	19%	3%
D415	Offline Basin	2530	30	353	0	1460	880	11	$ 2,950	$ 3,232	$ 1,285	$ 1,224	$ 8,690	34%	37%	15%	14%	5%
RR41510	Excavated Chl.	2878	41	736	0	1	346	6	$ 4,130	$ 16,863	$ 842	$ 2,014	$ 23,849	17%	71%	4%	8%	12%
C42010	Excavated Chl.	3285	86	2127	0	2	356	6	$ 8,610	$ 47,408	$ 1,812	$ 4,206	$ 62,036	14%	76%	3%	7%	32%
C42020	Excavated Chl.	3218	18	146	0	0.4	357	7	$ 1,840	$ 3,788	$ 387	$ 1,064	$ 7,079	26%	54%	5%	15%	4%
S51010	Excavated Chl.	441	10	39	0	0.3	262	4	$ 980	$ 1,068	$ 127	$ 348	$ 2,524	39%	42%	5%	14%	1%
	TOTAL	338	6135	0					$ 33,790	$ 135,141	$ 7,524	$ 16,513	**$ 192,968**	18%	70%	4%	9%	100%
All Channels		308	5782	0	7.4				$ 30,840	$ 131,909	$ 6,239	$ 15,289	$ 184,278	17%	72%	3%	8%	95%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		30	353	0					$ 2,950	$ 3,232	$ 1,285	$ 1,224	$ 8,690	34%	37%	15%	14%	5%
Channel Cost per mile (in $1000)		$24,902		Basins Cost per ac. ft. (in $1000)					$3.64									
All Channels % increase		33%	29%	0%					34%	30%	29%	58%	33%					
All Online Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
All Offline Basins % increase		43%	5%	0%					37%	5%	37%	37%	23%					
Total % increase		34%	27%	0%					34%	29%	31%	56%	32%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1019			4.5	1.54	193	48	16	7	1.163	1.167	1.167	1.167	96	96	96	96
S410	BASIN	638			4.4	0.64	97	24	8	4	1.414	1.416	1.416	1.416	48	48	48	48
C410	COMBINE	1372			4.5	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
410415	ROUTE	1344	100.1	17.96	4.6	2.18	262	66	22	9	1.117	1.12	1.12	1.12	130	130	130	130
S415	BASIN	791			4.1	0.45	61	15	5	2	1.256	1.256	1.256	1.256	30	30	30	30
C415R	COMBINE	1370			4.5	2.63	298	75	25	11	1.052	1.055	1.055	1.055	148	148	148	148
S500	BASIN	1743			4.7	3.64	454	115	38	17	1.16	1.171	1.171	1.171	225	227	227	227
500415	ROUTE	1703	100.5	36.55	5	3.64	453	115	38	17	1.159	1.171	1.171	1.171	225	227	227	227
S510	BASIN	1844			4.2	1.84	216	54	18	8	1.093	1.093	1.093	1.093	107	107	107	107
C415L	COMBINE	2017			4.4	5.48	603	152	51	22	1.023	1.032	1.032	1.032	299	301	301	301
C415	COMBINE	2953			4.4	8.11	803	202	67	29	0.92	0.928	0.928	0.928	398	401	401	401
D415	DIVERT	1633			4.4	8.11	540	137	46	20	0.619	0.627	0.627	0.627	268	271	271	271
415420	ROUTE	1597	100.7	54.8	4.7	8.11	540	137	46	20	0.619	0.627	0.627	0.627	268	271	271	271
S420	BASIN	1576			4.3	1.77	200	50	17	7	1.05	1.05	1.05	1.05	99	99	99	99
C420	COMBINE	2076			4.5	9.88	670	169	56	24	0.631	0.638	0.638	0.638	332	336	336	336
S430	BASIN	1207			4.1	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
430440	ROUTE	1057	103.2	35.01	4.5	0.8	110	27	9	4	1.281	1.281	1.281	1.281	54	54	54	54
S440	BASIN	1237			4.2	1.07	130	32	11	5	1.129	1.129	1.129	1.129	64	64	64	64
C440	COMBINE	1581			4.4	1.86	213	53	18	8	1.062	1.062	1.062	1.062	106	106	106	106
440450	ROUTE	1402	102.1	32.92	4.6	1.86	213	53	18	8	1.062	1.062	1.062	1.062	105	106	106	106
S450	BASIN	1467			4.5	2.52	279	70	23	10	1.028	1.028	1.028	1.028	138	138	138	138
S435	BASIN	822			4	0.39	57	14	5	2	1.347	1.347	1.347	1.347	28	28	28	28
435450	ROUTE	443	102.3	29.82	4.9	0.39	57	14	5	2	1.346	1.347	1.347	1.347	28	28	28	28
C450	COMBINE	2589			4.6	4.78	463	116	39	17	0.901	0.902	0.902	0.902	230	230	230	230
S520	BASIN	1272			4.4	1.48	183	46	15	7	1.152	1.152	1.152	1.152	91	91	91	91
S530	BASIN	1563			4.5	2.23	258	64	21	9	1.076	1.076	1.076	1.076	128	128	128	128

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S400	BASIN	1047			12.5	1.54	184	48	16	7	1.11	1.145	1.146	1.146	91	94	94	94
S410	BASIN	526			12.4	0.64	80	21	7	3	1.167	1.202	1.203	1.203	40	41	41	41
C410	COMBINE	1524			12.5	2.18	262	67	23	10	1.115	1.15	1.15	1.15	130	134	134	134
410415	ROUTE	1481	100.2	19.91	12.6	2.18	262	67	23	10	1.114	1.15	1.15	1.15	130	134	134	134
S415	BASIN	624			12.1	0.45	50	13	4	2	1.032	1.032	1.032	1.032	25	25	25	25
C415R	COMBINE	1539			12.6	2.63	309	79	26	11	1.091	1.12	1.121	1.121	153	157	157	157
S500	BASIN	2063			12.7	3.64	476	129	43	19	1.218	1.321	1.323	1.323	236	256	257	257
500415	ROUTE	1981	100.6	41.49	13	3.64	476	129	43	19	1.217	1.321	1.323	1.323	236	256	257	257
S510	BASIN	2099			12.2	1.84	213	53	18	8	1.074	1.074	1.074	1.074	105	105	105	105
C415L	COMBINE	2537			12.3	5.48	681	180	60	26	1.156	1.225	1.226	1.226	338	358	358	358
C415	COMBINE	3899			12.3	8.11	979	257	86	37	1.122	1.178	1.179	1.179	485	510	510	510
D415	DIVERT	2530			12.3	8.11	616	166	56	24	0.706	0.762	0.763	0.763	306	330	330	330
415420	ROUTE	2393	101.1	74.4	12.6	8.11	616	166	56	24	0.706	0.762	0.763	0.763	305	330	330	330
S420	BASIN	1740			12.3	1.77	198	50	17	7	1.043	1.043	1.043	1.043	98	98	98	98
C420	COMBINE	3218			12.5	9.88	805	213	71	31	0.757	0.804	0.805	0.805	399	423	424	424
S430	BASIN	1090			12.1	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
430440	ROUTE	932	102.9	32.24	12.5	0.8	95	24	8	3	1.109	1.109	1.109	1.109	47	47	47	47
S440	BASIN	1205			12.2	1.07	119	30	10	4	1.04	1.04	1.04	1.04	59	59	59	59
C440	COMBINE	1700			12.4	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
440450	ROUTE	1502	102.1	34.54	12.5	1.86	211	53	18	8	1.055	1.055	1.055	1.055	105	105	105	105
S450	BASIN	1624			12.5	2.52	287	72	24	10	1.058	1.058	1.058	1.058	142	142	142	142
S435	BASIN	656			12	0.39	47	12	4	2	1.107	1.107	1.107	1.107	23	23	23	23
435450	ROUTE	378	102.1	25.11	12.8	0.39	47	12	4	2	1.106	1.107	1.107	1.107	23	23	23	23
C450	COMBINE	3338			12.6	4.78	536	134	45	19	1.042	1.043	1.043	1.043	266	266	266	266
S520	BASIN	1288			12.4	1.48	174	43	14	6	1.091	1.091	1.091	1.091	86	86	86	86
S530	BASIN	1697			12.5	2.23	257	64	21	9	1.074	1.074	1.074	1.074	127	127	127	127

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR41010	Excavated	0.0143	0.0030	1.10	3	6.5	0.020	2125	90.5	258.6	2.9	2.9	4.8	1.7	89	8.2	0.85	0.90
C41510	Excavated	0.0137	0.0030	0.30	3	6.0	0.020	3899	158.5	465.7	2.9	3.0	4.5	1.5	157	8.4	0.86	0.84
C51010	Excavated	0.0222	0.0030	1.30	3	6.0	0.020	2525	107.7	307.4	2.9	2.9	4.4	1.6	106	8.2	0.85	0.82
C51020	Excavated	0.0153	0.0030	0.50	3	6.0	0.020	3175	119.7	367.9	3.1	3.1	4.7	1.3	118	8.6	0.86	0.88
C51060	Excavated	0.0055	0.0030	0.50	3	6.0	0.020	3301	138.6	399.5	2.9	2.9	4.5	1.5	137	8.3	0.85	0.85
RR41510	Excavated	0.0162	0.0030	1.00	3	6.0	0.020	2878	119.6	346.8	2.9	2.9	4.7	1.3	118	8.3	0.85	0.88
C42010	Excavated	0.0120	0.0030	2.00	3	6.0	0.020	3285	129.3	387.4	3.0	3.0	4.6	1.4	128	8.5	0.86	0.87
C42020	Excavated	0.0139	0.0030	0.40	3	6.5	0.020	3218	125.0	377.4	3.0	3.1	4.7	1.8	123	8.5	0.86	0.89
S51010	Excavated	0.0171	0.0035	0.30	3	4.0	0.020	441	48.7	75.0	1.5	1.6	3.0	1.0	48	5.9	0.83	0.65

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
D415	Offline Basin	0.0150	1200	780	11.0	189.5	180.0	180.0	1369	0	5.8	5.2

Open Channel

Structure ID	RR41010

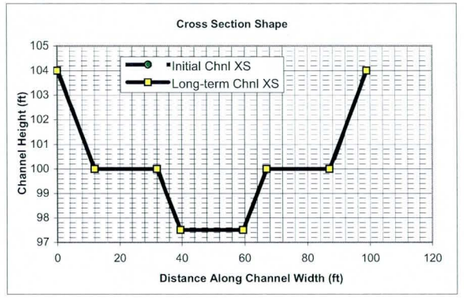
HEC1 ID	410415

Longitudnal Geometry

Length	5561.5	ft
U/S Elev	1533.5	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

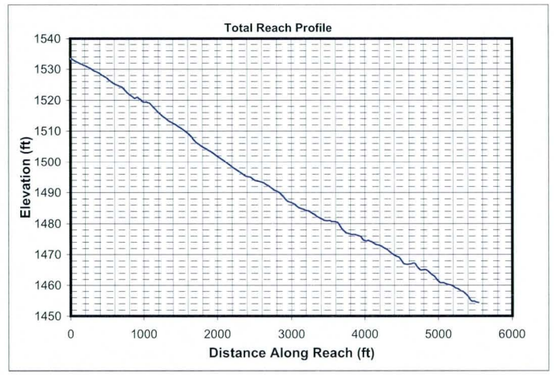
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	20	3	20	6.5	3	20	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	32	39.5	59.5	67	87	99
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	20	3	20	6.5	3	20	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	32	39.5	59.5	67	87	99
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C410	S415							TOTAL
HEC1 Peak-Flow	1524	791							2315
Weighting Factor	1.00	0.76							
Flow into Channel	1524	601							2125

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	2.523	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2125	cfs	
Long-term Max. Chnl Capacity	4372	cfs	
Q2 Channel	213	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	99	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
213	30.6	42.1	1.4	97.5	99.2	5.0	1.7	30.1	1.4	0.31	0.75
531	78.9	106.6	1.4	97.5	100.5	5.0	3.0	78.0	1.4	0.56	0.75
1594	87.3	214.5	2.5	97.5	101.8	7.4	4.3	85.9	2.5	0.81	0.83
2125	90.5	258.6	2.9	97.5	102.3	8.2	4.8	88.9	2.9	0.90	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
213	30.6	42.1	1.4	97.5	99.2	5.0	1.7	30.1	1.4	0.31	0.75
531	78.9	106.6	1.4	97.5	100.5	5.0	3.0	78.0	1.4	0.56	0.75
1594	87.3	214.5	2.5	97.5	101.8	7.4	4.3	85.9	2.5	0.81	0.83
2125	90.5	258.6	2.9	97.5	102.3	8.2	4.8	88.9	2.9	0.90	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
213										0
531										0
1594										0
2125										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
213	1.74	1.4991	1.4242	Erosive	Erosive	Erosive	0.4	Erosive	4.5	Stable	Stable
531	1.74	1.4918	1.4172	Erosive	Erosive	Erosive	0.3	Erosive	5.9	Stable	Stable
1594	1.74	1.6777	1.5938	Erosive	Erosive	Erosive	0.4	Erosive	7.9	Stable	Stable
2125	1.74	1.7247	1.6384	Erosive	Erosive	Erosive	0.4	Erosive	8.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	213	531	1594	2125	213	531	1594	2125	213	531	1594	2125
Bray - Equation #1	40	65	116	135	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	53	85	152	177	1.7	2.4	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	38	44	4.9	7.0	10.6	11.8				
Ackers & Charlton/Lacey	34	50	80	90					2.0	2.3	2.7	2.9
Parker	100	158	274	317	1.3	1.9	3.0	3.3				
Chang	57	100	197	235	0.3	0.2	0.0	-0.2				
Kellerhals	26	41	72	83	2.3	3.3	5.2	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	30	78	86	89								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	16.1	22.7	34.3	38.2	4	6	9	10	4.8	6.1	8.0	8.6
Average	39	64	107	123	2.2	3.0	4.4	4.9	3.2	3.7	4.5	4.7
Values As Designed	30	78	86	89	1.7	3.0	4.3	4.8	5.0	5.0	7.4	8.2
Difference with Design	9	-14	21	34	0.5	0.0	0.1	0.1	-1.9	-1.3	-2.9	-3.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1470	1761	2647	15211	1139	1543	675	1100	6761	1283	5380	3543
531	3641	4235	6664	37124	2911	3831	1702	2735	16898	3164	13379	8753
1594	18777	14290	20327	224426	4495	19462	4939	11296	50978	7150	55206	39213
2125	28692	19479	27529	357128	5054	30401	6487	16154	68020	7706	78991	58695

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	2567	3074	4621	26556	1988	2694	1179	1920	11804	2240	9393	6185
531	2542	2958	4654	25926	2033	2675	1189	1910	11801	2210	9343	6113
1594	4371	3326	4732	52243	1046	4530	1150	2629	11867	1664	12851	9128
2125	5009	3401	4806	62350	882	5308	1133	2820	11876	1345	13791	10247

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	1470	1434	1469	1469	398	639	675	1100	614	96	1403	979
531	3641	3451	3705	3584	1012	1594	1702	2735	1531	251	3477	2426
1594	18777	11968	10346	21668	1757	6171	4939	11296	4811	236	16069	9822
2125	28692	16399	13869	34480	2017	8794	6487	16154	6453	237	23647	14294

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
213	2567	2504	2564	2564	695	1115	1179	1920	1072	168	2450	1709
531	2542	2410	2588	2503	707	1113	1189	1910	1069	175	2428	1694
1594	4371	2786	2408	5044	409	1436	1150	2629	1120	55	3741	2286
2125	5009	2863	2421	6020	352	1535	1133	2820	1127	41	4128	2496

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
213	0.0004	0.0003	261	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0058	0.0003	0.0010	0.0029	0.0023
531	0.0004	0.0003	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0058	0.0002	0.0005	0.0030	0.0023
1594	0.0002	0.0001	348	1.06	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0058	0.0001	0.0002	0.0029	0.0023
2125	0.0002	0.0001	376	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0058	0.0001	0.0002	0.0029	0.0023

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	62.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	21	
Distance between structs.	265	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.34	sq. mi
Total Sediment Yield Volume	0.65	ac ft

Sedimentation Basins

Length	265 ft	Depth	3 ft
Width	99 ft	Side slope	3 ft/ft
Total Volume per Basin		1.59	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
213	1.1	0.4	0.3	24.6	1.7	1.4	5.0	0.0030	0.3	0.0	1.0	2.5
531	1.1	0.7	0.3	24.6	3.0	1.4	5.0	0.0030	0.6	0.0	1.0	3.2
1594	1.1	1.5	0.8	24.6	4.3	2.5	7.4	0.0030	0.9	0.0	1.0	4.9
2125	1.1	1.8	0.9	24.6	4.8	2.9	8.2	0.0030	1.0	0.0	1.0	5.6

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1481	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	4.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.65	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	0.52	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5561	5561
Side Slope (?H:1V)	3	6
Channel Width (ft)	99	138
Channel XS Area (sq. ft)	416.8	543.55
Channel Perimeter (ft)	101	139

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	723935	1001410
Excavated Area (sq. Yd)	61171	85269

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5561	5561
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	15447	30277
Lining Volume (cu. Yd)	2575	5046

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5561	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	927	sq. Yd
Volume	2781	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5561	5561
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5561	5561
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	99	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.4	ft
Structure Height	17.4	ft
Number of Structures	21	
Volume per structure	32	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,960	
Area per structure	6	sq. Yd
Total Area	116	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2565	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 10,260	
Other Cost	$ -	
Total cost per basin	$ 10,260	
Area per basin	2,913	sq. Yd
Total Area	5,826	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	723,935	cu. Yd	$ 10.00	$ 7,239,350	61,171	sq. Yd	$ 9.00	$ 550,539	61,171	sq. Yd	$ 8.33	$ 509,758
Exc. Chl - LC Enhancement	Excavated	277,475	cu. Yd	$ 10.00	$ 2,774,750	24,098	sq. Yd	$ 9.00	$ 216,882	24,098	sq. Yd	$ 8.33	$ 200,817
Channel Lining	Concrete	2,575	cu. Yd	$ 155.00	$ 399,125	15,447	sq. Yd	$ -	$ -	15,447	sq. Yd	$ 41.67	$ 643,625
Channel Lining - LC Enhancement	Concrete	2,471	cu. Yd	$ 155.00	$ 383,005	14,830	sq. Yd	$ -	$ -	14,830	sq. Yd	$ 41.67	$ 617,917
Toe Protection	Riprap	2,781	cu. Yd	$ 75.00	$ 208,575	927	sq. Yd	$ -	$ -	927	sq. Yd	$ 25.00	$ 23,175
Drop Structures	Concrete	21	EA	$ 4,960.00	$ 104,160	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 41.67	$ 4,833
Drop Str. - LC Enhancement	Concrete	21	EA	$ 496.00	$ 10,416	12	sq. Yd	$ -	$ -	12	sq. Yd	$ 41.67	$ 483
Sedimentation Basins		2	EA	$ 10,260.00	$ 20,520	5,826	sq. Yd	$ -	$ -	5,826	sq. Yd	$ 8.33	$ 48,550
Other					$ -				$ -				$ -
Base Landscape Cost									$ 550,539	Base Maintenance Cost			$ 1,229,942
LC Enhancement Cost									$ 216,882	LC Enhancement Cost			$ 819,217
Total Landscape Cost									$ 767,421	Total Maintenance Cost			$ 2,049,158

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 7,971,730	$ 3,168,171	$ 11,139,901
Contingency Cost (25% of Construction Cost)	$ 1,992,933	$ 792,043	$ 2,784,975
Engineering Design Cost (5% of Construction Cost)	$ 398,587	$ 158,409	$ 556,995
Total Construction Cost	$ 10,363,249	$ 4,118,622	$ 14,481,871

Land Cost

Channel Length	5561 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	17.1	$100,000	$ 1,710,000
LC Enhancement Buffer	50	6.4	$100,000	$ 640,000
Channel	99	12.6	$100,000	$ 1,260,000
Channel LC Enhancement	39	5	$100,000	$ 500,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	322	41.1		$ 4,110,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	29.7	$100,000	$ 2,970,000
LC Enhancement Cost	acre	11.4	$100,000	$ 1,140,000
Total Land Cost	acre	41.1	$100,000	$ 4,110,000

Total Cost

Base Total Cost	$ 15,113,730
Total Landscape Enhancement Cost	$ 6,294,721
Total Cost Including LC Enh.	$ 21,408,451

Open Channel

Structure ID	C41510

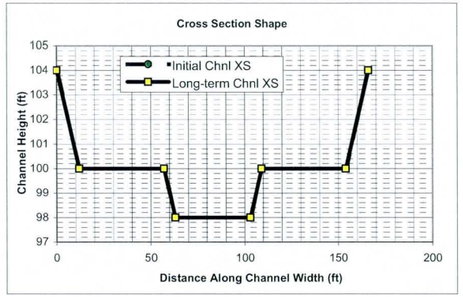
HEC1 ID	410415

Longitudal Geometry

Length	1567.1	ft
U/S Elev	1454.2	ft
D/S Elev	1432.7	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

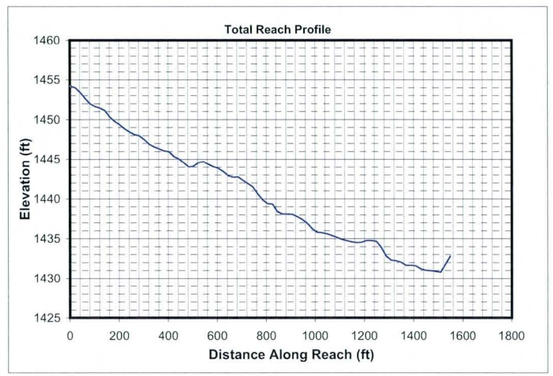
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	45	3	40	6	3	45	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	57	63	103	109	154	166
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	45	3	40	6	3	45	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	57	63	103	109	154	166
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C415									TOTAL
HEC1 Peak-Flow	3899									3899
Weighting Factor	1.00									
Flow into Channel	3899									3899

Reach Sediment Inflow Characteristics

U/S Contributing ID	410415_RR41010	500415_C51060								TOTAL
Flow Volume (ac. ft)	134.00	257.00								391
Sediment Conc. (ppm)	2496	2521								
Sediment Volume (ac. ft)	0.13	0.24								0.37
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.13	0.24								0.37

Hydrology

Drainage Area	1.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3899	cfs	
Long-term Max. Chnl Capacity	7539	cfs	
Q2 Channel	390	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	166	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
390	50.4	74.0	1.5	98.0	99.6	5.3	1.6	49.9	1.5	0.31	0.76
975	147.2	196.8	1.3	98.0	100.7	5.0	2.7	146.4	1.3	0.51	0.75
2924	155.3	388.7	2.5	98.0	102.0	7.5	4.0	154.0	2.5	0.75	0.83
3899	158.5	465.7	2.9	98.0	102.5	8.4	4.5	157.0	3.0	0.84	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
390	50.4	74.0	1.5	98.0	99.6	5.3	1.6	49.9	1.5	0.31	0.76
975	147.2	196.8	1.3	98.0	100.7	5.0	2.7	146.4	1.3	0.51	0.75
2924	155.3	388.7	2.5	98.0	102.0	7.5	4.0	154.0	2.5	0.75	0.83
3899	158.5	465.7	2.9	98.0	102.5	8.4	4.5	157.0	3.0	0.84	0.86

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	410415_RR4101 0	500415_C5106 0								
390	979	1588								2566
975	2426	3746								6172
2924	9822	15336								25157
3899	14294	22428								36722

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
390	1.74	1.5170	1.4412	Erosive	Erosive	Erosive	0.4	Erosive	4.4	Stable	Stable
975	1.74	1.4868	1.4125	Erosive	Erosive	Erosive	0.3	Erosive	5.6	Stable	Stable
2924	1.74	1.6809	1.5969	Erosive	Erosive	Erosive	0.4	Erosive	7.6	Stable	Stable
3899	1.74	1.7307	1.6442	Erosive	Erosive	Erosive	0.5	Erosive	8.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	390	975	2924	3899	390	975	2924	3899	390	975	2924	3899
Bray - Equation #1	55	89	160	186	1.9	2.6	3.8	4.2	3.6	4.1	4.8	5.0
Bray - Equation #2	72	118	210	244	2.1	2.9	4.1	4.6	2.5	2.8	3.3	3.5
Hey	17	29	52	61	6.2	8.8	13.4	14.9				
Ackers & Charlton/Lacey	44	65	103	116					2.2	2.5	3.0	3.2
Parker	136	214	372	429	1.6	2.4	3.8	4.3				
Chang	83	146	285	339	0.3	0.1	-0.4	-0.6				
Kellerhals	36	56	97	112	3.0	4.3	6.6	7.4	3.7	4.1	4.5	4.7
AMAFCA/Schumm	50	147	154	157								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	20.2	28.5	43.0	47.9	5	8	11	13	5.6	7.1	9.3	10.0
Average	53	91	149	171	2.7	3.7	5.5	6.1	3.5	4.1	5.0	5.3
Values As Designed	50	146	154	157	1.6	2.7	4.0	4.5	5.3	5.0	7.5	8.4
Difference with Design	3	-56	-5	14	1.1	1.0	1.5	1.6	-1.7	-0.8	-2.5	-3.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	2890	3302	4796	28364	1910	2896	1252	2114	11731	2394	10043	6518
975	6673	7805	12134	63443	5296	6849	3153	5021	29287	5562	23865	15372
2924	35392	26528	37026	396070	7945	34966	9158	21084	88406	11841	100376	69890
3899	54580	36219	50307	637214	8840	55164	12021	30285	117967	12599	144357	105414

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	2750	3142	4564	26989	1818	2755	1191	2012	11163	2278	9556	6202
975	2540	2971	4618	24147	2016	2607	1200	1911	11147	2117	9083	5851
2924	4490	3366	4698	50249	1008	4436	1162	2675	11216	1502	12735	8867
3899	5193	3446	4787	60633	841	5249	1144	2882	11225	1199	13736	10030

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	2890	2712	2680	2897	692	1215	1252	2114	1134	157	2728	1861
975	6673	6385	6855	6480	1874	2932	3153	5021	2804	474	6370	4457
2924	35392	22322	19134	40455	3174	11503	9158	21084	8833	423	30080	18323
3899	54580	30639	25721	65086	3610	16469	12021	30285	11848	417	44540	26838

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	2750	2581	2550	2757	658	1156	1191	2012	1079	149	2596	1771
975	2540	2430	2609	2466	713	1116	1200	1911	1067	181	2425	1696
2924	4490	2832	2427	5133	403	1459	1162	2675	1121	54	3816	2325
3899	5193	2915	2447	6193	343	1567	1144	2882	1127	40	4238	2554

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
390	0.0004	0.0002	264	0.81	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0048	0.0003	0.0009	0.0030	0.0021
975	0.0004	0.0003	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0048	0.0002	0.0005	0.0030	0.0020
2924	0.0002	0.0001	345	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0048	0.0001	0.0002	0.0030	0.0020
3899	0.0002	0.0001	374	1.14	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0048	0.0001	0.0002	0.0030	0.0020

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	16.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	261	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.20	ac ft

Sedimentation Basins

Length	261 ft	Depth	3 ft	
Width	166 ft	Side slope	3 ft/ft	
Total Volume per Basin		2.73	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
390	1.1	0.4	0.4	24.6	1.6	1.5	5.3	0.0030	0.3	0.0	1.0	2.5
975	1.1	0.7	0.3	24.6	2.7	1.3	5.0	0.0030	0.5	0.0	1.0	3.1
2924	1.1	1.4	0.8	24.6	4.0	2.5	7.5	0.0030	0.8	0.0	1.0	4.8
3899	1.1	1.7	1.0	24.6	4.5	3.0	8.4	0.0030	1.0	0.0	1.0	5.4

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1481	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	134.0	ac. ft

Freeboard

Max. Flow Depth	4.5	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.5	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.57	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	0.44	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1567	1567
Side Slope (?H:1V)	3	6
Channel Width (ft)	166	202
Channel XS Area (sq. ft)	708	816
Channel Perimeter (ft)	168	203

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	122080	145912
Excavated Area (sq. Yd)	28902	35170

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	1567	1567
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	4353	8531
Lining Volume (cu. Yd)	726	1422

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1567	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	261	sq. Yd
Volume	784	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1567	1567
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1567	1567
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	166	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.7	ft
Structure Height	17.7	ft
Number of Structures	6	
Volume per structure	54	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,370	
Area per structure	9	sq. Yd
Total Area	55	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4404	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,616	
Other Cost	$ -	
Total cost per basin	$ 17,616	
Area per basin	4,817	sq. Yd
Total Area	4,817	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	122,080	cu. Yd	$ 10.00	$ 1,220,800	28,902	sq. Yd	$ 9.00	$ 260,118	28,902	sq. Yd	$ 8.33	$ 240,850
Exc. Chl - LC Enhancement	Excavated	23,832	cu. Yd	$ 10.00	$ 238,320	6,268	sq. Yd	$ 9.00	$ 56,412	6,268	sq. Yd	$ 8.33	$ 52,233
Channel Lining	Concrete	726	cu. Yd	$ 155.00	$ 112,530	4,353	sq. Yd	$ -	$ -	4,353	sq. Yd	$ 41.67	$ 181,375
Channel Lining - LC Enhancement	Concrete	696	cu. Yd	$ 155.00	$ 107,880	4,178	sq. Yd	$ -	$ -	4,178	sq. Yd	$ 41.67	$ 174,083
Toe Protection	Riprap	784	cu. Yd	$ 75.00	$ 58,800	261	sq. Yd	$ -	$ -	261	sq. Yd	$ 25.00	$ 6,525
Drop Structures	Concrete	6	EA	$ 8,370.00	$ 50,220	55	sq. Yd	$ -	$ -	55	sq. Yd	$ 41.67	$ 2,292
Drop Str. - LC Enhancement	Concrete	6	EA	$ 837.00	$ 5,022	6	sq. Yd	$ -	$ -	6	sq. Yd	$ 41.67	$ 229
Sedimentation Basins		1	EA	$ 17,616.00	$ 17,616	4,817	sq. Yd	$ -	$ -	4,817	sq. Yd	$ 8.33	$ 40,142
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 260,118	Base Maintenance Cost			$ 471,183
						LC Enhancement Cost			$ 56,412	LC Enhancement Cost			$ 226,546
						Total Landscape Cost			$ 316,530	Total Maintenance Cost			$ 697,729

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,459,966	$ 351,222	$ 1,811,188
Contingency Cost (25% of Construction Cost)	$ 364,992	$ 87,806	$ 452,797
Engineering Design Cost (5% of Construction Cost)	$ 72,998	$ 17,561	$ 90,559
Total Construction Cost	$ 1,897,956	$ 456,589	$ 2,354,544

Land Cost

Channel Length	1567	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	4.8	$100,000	$ 480,000
LC Enhancement Buffer	50	1.8	$100,000	$ 180,000
Channel	166	6	$100,000	$ 600,000
Channel LC Enhancement	36	1.3	$100,000	$ 130,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	386	13.9		$ 1,390,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	10.8	$100,000	$ 1,080,000
LC Enhancement Cost	acre	3.1	$100,000	$ 310,000
Total Land Cost	acre	13.9	$100,000	$ 1,390,000

Total Cost

Base Total Cost	$ 3,709,257
Total Landscape Enhancement Cost	$ 1,049,546
Total Cost Including LC Enh.	$ 4,758,804

Open Channel

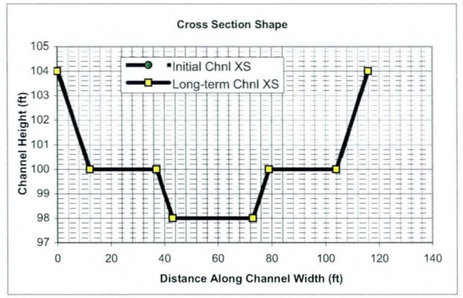
Structure ID	C51010	HEC1 ID	500415

Longitudal Geometry

Length	6963.7	ft
U/S Elev	1666.0	ft
D/S Elev	1511.6	ft
Initial Channel Slope	0.0222	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

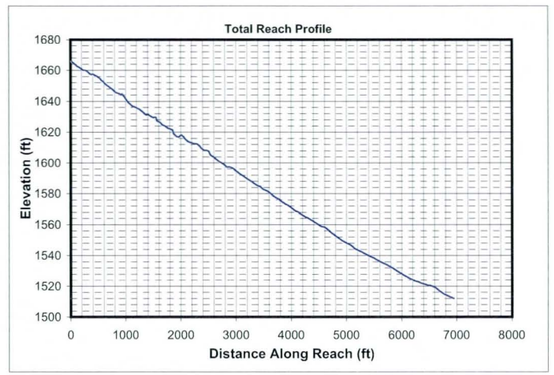
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	3	30	6	3	25	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	43	73	79	104	116
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	3	30	6	3	25	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	43	73	79	104	116
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S500	S510							TOTAL
HEC1 Peak-Flow	2063	2099							4162
Weighting Factor	1.00	0.22							
Flow into Channel	2063	462							2525

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	4.049	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2525	cfs	
Long-term Max. Chnl Capacity	5132	cfs	
Q2 Channel	253	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	116	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
253	39.5	51.7	1.3	98.0	99.5	4.9	1.5	39.0	1.3	0.28	0.75
631	96.4	128.0	1.3	98.0	100.6	4.9	2.6	95.6	1.3	0.49	0.75
1894	104.5	255.7	2.4	98.0	101.9	7.4	3.9	103.3	2.5	0.73	0.83
2525	107.7	307.4	2.9	98.0	102.4	8.2	4.4	106.3	2.9	0.82	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
253	39.5	51.7	1.3	98.0	99.5	4.9	1.5	39.0	1.3	0.28	0.75
631	96.4	128.0	1.3	98.0	100.6	4.9	2.6	95.6	1.3	0.49	0.75
1894	104.5	255.7	2.4	98.0	101.9	7.4	3.9	103.3	2.5	0.73	0.83
2525	107.7	307.4	2.9	98.0	102.4	8.2	4.4	106.3	2.9	0.82	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
253										0
631										0
1894										0
2525										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
253	1.74	1.4824	1.4083	Erosive	Erosive	Erosive	0.3	Erosive	4.2	Stable	Stable
631	1.74	1.4856	1.4113	Erosive	Erosive	Erosive	0.3	Erosive	5.5	Stable	Stable
1894	1.74	1.6749	1.5912	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable
2525	1.74	1.7231	1.6369	Erosive	Erosive	Erosive	0.4	Erosive	8.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	253	631	1894	2525	253	631	1894	2525	253	631	1894	2525
Bray - Equation #1	44	71	127	148	1.7	2.3	3.3	3.6	3.4	3.9	4.5	4.7
Bray - Equation #2	58	93	167	194	1.8	2.5	3.6	3.9	2.4	2.7	3.1	3.3
Hey	13	22	41	48	5.3	7.5	11.3	12.6				
Ackers & Charlton/Lacey	37	54	86	97					2.0	2.3	2.8	3.0
Parker	109	173	299	345	1.4	2.0	3.2	3.6				
Chang	63	112	219	261	0.3	0.2	-0.1	-0.3				
Kellerhals	29	45	78	90	2.5	3.6	5.6	6.2	3.5	3.9	4.3	4.5
AMAFCA/Schumm	39	96	103	106								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.2	24.2	36.5	40.7	5	6	10	11	5.0	6.3	8.3	9.0
Average	43	71	118	135	2.3	3.2	4.7	5.2	3.3	3.8	4.6	4.9
Values As Designed	39	96	103	106	1.5	2.6	3.9	4.4	4.9	4.9	7.4	8.2
Difference with Design	4	-24	14	29	0.8	0.6	0.8	0.9	-1.6	-1.1	-2.8	-3.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
253	1683	2213	3780	33032	1837	2426	809	1276	15637	2097	8628	6674
631	4280	5359	9472	83776	4530	6584	2033	3229	39096	5301	21811	16861
1894	22330	17987	29325	513308	6821	38326	5908	13448	117669	20061	87798	79362
2525	34247	24492	40247	820483	7618	60118	7758	19271	156958	21367	124856	119765

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
253	2473	3251	5553	48534	2699	3564	1189	1875	22976	3081	12678	9807
631	2515	3150	5567	49237	2662	3870	1195	1898	22978	3116	12819	9910
1894	4375	3524	5745	100561	1336	7508	1157	2635	23052	3930	17200	15548
2525	5032	3599	5914	120554	1119	8833	1140	2832	23062	3139	18345	17597

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
253	1683	1700	1773	1644	493	748	809	1276	725	127	1613	1145
631	4280	4126	4433	4170	1220	1888	2033	3229	1815	310	4093	2872
1894	22330	14347	12343	25548	2100	7346	5908	13448	5715	285	19108	11680
2525	34247	19668	16546	40837	2403	10486	7758	19271	7666	283	28197	17033

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
253	2473	2497	2605	2416	725	1099	1189	1875	1065	186	2371	1682
631	2515	2425	2606	2451	717	1109	1195	1898	1067	182	2405	1688
1894	4375	2811	2418	5005	411	1439	1157	2635	1120	56	3743	2288
2525	5032	2890	2431	6000	353	1541	1140	2832	1126	42	4143	2503

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
253	0.0004	0.0003	317	0.97	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0055	0.0003	0.0010	0.0030	0.0023
631	0.0004	0.0003	319	0.97	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0055	0.0002	0.0005	0.0030	0.0022
1894	0.0002	0.0001	434	1.32	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0055	0.0001	0.0002	0.0030	0.0022
2525	0.0002	0.0001	468	1.43	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0055	0.0001	0.0002	0.0030	0.0022

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	133.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	45	
Distance between structs.	155	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.41	sq. mi
Total Sediment Yield Volume	0.78	ac ft

Sedimentation Basins

Length	155 ft	Depth	3 ft
Width	116 ft	Side slope	3 ft/ft
Total Volume per Basin		1.08	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
253	1.1	0.4	0.3	24.6	1.5	1.3	4.9	0.0030	0.3	0.0	1.0	2.4
631	1.1	0.6	0.3	24.6	2.6	1.3	4.9	0.0030	0.5	0.0	1.0	3.0
1894	1.1	1.4	0.8	24.6	3.9	2.5	7.4	0.0030	0.8	0.0	1.0	4.6
2525	1.1	1.7	0.9	24.6	4.4	2.9	8.2	0.0030	0.9	0.0	1.0	5.3

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1981	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	4.4	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.6	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.78	ac. ft
Outflowing Sediment Volume	0.24	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6964	6964
Side Slope (?H:1V)	3	6
Channel Width (ft)	116	152
Channel XS Area (sq. ft)	488	596
Channel Perimeter (ft)	118	153

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2123163	2770870
Excavated Area (sq. Yd)	89758	117614

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	6964	6964
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	19344	37915
Lining Volume (cu. Yd)	3224	6319

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6964	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1161	sq. Yd
Volume	3482	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6964	6964
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6964	6964
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	116	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.4	ft
Structure Height	17.4	ft
Number of Structures	45	
Volume per structure	37	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 5,735	
Area per structure	6	sq. Yd
Total Area	290	sq. Yd

Sedimentation Basins		
Include Sed. Basins (Yes/No)	Yes	
Number of basins	3	
Total Volume per Basin	1742	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,968	
Other Cost	$ -	
Total cost per basin	$ 6,968	
Area per basin	1,995	sq. Yd
Total Area	5,985	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,123,163	cu. Yd	$ 10.00	$ 21,231,630	89,758	sq. Yd	$ 9.00	$ 807,822	89,758	sq. Yd	$ 8.33	$ 747,983
Exc. Chl - LC Enhancement	Excavated	647,707	cu. Yd	$ 10.00	$ 6,477,070	27,856	sq. Yd	$ 9.00	$ 250,704	27,856	sq. Yd	$ 8.33	$ 232,133
Channel Lining	Concrete	3,224	cu. Yd	$ 155.00	$ 499,720	19,344	sq. Yd	$ -	$ -	19,344	sq. Yd	$ 41.67	$ 806,000
Channel Lining - LC Enhancement	Concrete	3,095	cu. Yd	$ 155.00	$ 479,725	18,571	sq. Yd	$ -	$ -	18,571	sq. Yd	$ 41.67	$ 773,792
Toe Protection	Riprap	3,482	cu. Yd	$ 75.00	$ 261,150	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 25.00	$ 29,025
Drop Structures	Concrete	45	EA	$ 5,735.00	$ 258,075	290	sq. Yd	$ -	$ -	290	sq. Yd	$ 41.67	$ 12,083
Drop Str. - LC Enhancement	Concrete	45	EA	$ 573.50	$ 25,808	29	sq. Yd	$ -	$ -	29	sq. Yd	$ 41.67	$ 1,208
Sedimentation Basins		3	EA	$ 6,968.00	$ 20,904	5,985	sq. Yd	$ -	$ -	5,985	sq. Yd	$ 8.33	$ 49,875
Other					$ -				$ -				$ -

Base Landscape Cost	$ 807,822	Base Maintenance Cost	$ 1,644,967
LC Enhancement Cost	$ 250,704	LC Enhancement Cost	$ 1,007,133
Total Landscape Cost	$ 1,058,526	Total Maintenance Cost	$ 2,652,100

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 22,271,479	$ 6,982,603	$ 29,254,082
Contingency Cost (25% of Construction Cost)	$ 5,567,870	$ 1,745,651	$ 7,313,520
Engineering Design Cost (5% of Construction Cost)	$ 1,113,574	$ 349,130	$ 1,462,704
Total Construction Cost	$ 28,952,923	$ 9,077,383	$ 38,030,306

Land Cost

Channel Length	6964 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	21.4	$100,000	$ 2,140,000
LC Enhancement Buffer	50	8	$100,000	$ 800,000
Channel	116	18.5	$100,000	$ 1,850,000
Channel LC Enhancement	36	5.8	$100,000	$ 580,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	336	53.7		$ 5,370,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	39.9	$100,000	$ 3,990,000
LC Enhancement Cost	acre	13.8	$100,000	$ 1,380,000
Total Land Cost	acre	53.7	$100,000	$ 5,370,000

Total Cost

Base Total Cost	$ 35,395,711
Total Landscape Enhancement Cost	$ 11,715,221
Total Cost Including LC Enh.	$ 47,110,932

Open Channel

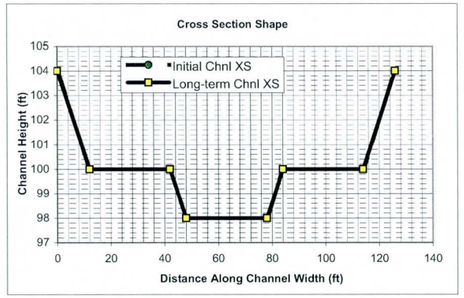
Structure ID	C51020	HEC1 ID	500415

Longitudal Geometry

Length	2873.8	ft
U/S Elev	1512.2	ft
D/S Elev	1468.2	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

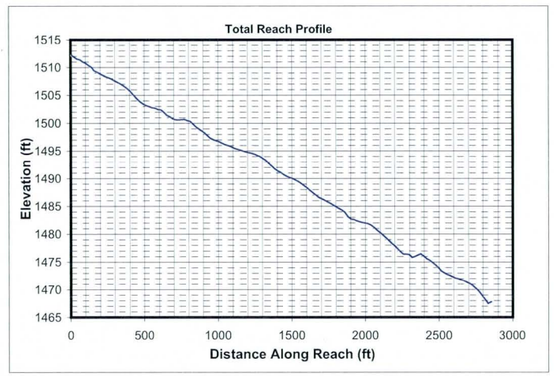
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	30	6	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	48	78	84	114	126
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	30	6	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	48	78	84	114	126
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S500	S510							TOTAL
HEC1 Peak-Flow	2063	2099							4162
Weighting Factor	1.00	0.53							
Flow into Channel	2063	1112							3175

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51010	500415_S51010							TOTAL
Flow Volume (ac. ft)	257.00	257.00							514
Sediment Conc. (ppm)	2503	2224							
Sediment Volume (ac. ft)	0.24	0.22							0.46
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.24	0.22							0.46

Hydrology

Drainage Area	0.982	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3175	cfs	
Long-term Max. Chnl Capacity	5543	cfs	
Q2 Channel	318	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	126	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
318	40.8	60.1	1.5	98.0	99.7	5.3	1.7	40.3	1.5	0.32	0.76
794	107.6	153.5	1.4	98.0	100.8	5.2	2.8	106.7	1.4	0.52	0.76
2381	116.3	306.1	2.6	98.0	102.2	7.8	4.2	114.9	2.7	0.78	0.84
3175	119.7	367.9	3.1	98.0	102.7	8.6	4.7	118.1	3.1	0.88	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
318	40.8	60.1	1.5	98.0	99.7	5.3	1.7	40.3	1.5	0.32	0.76
794	107.6	153.5	1.4	98.0	100.8	5.2	2.8	106.7	1.4	0.52	0.76
2381	116.3	306.1	2.6	98.0	102.2	7.8	4.2	114.9	2.7	0.78	0.84
3175	119.7	367.9	3.1	98.0	102.7	8.6	4.7	118.1	3.1	0.88	0.86

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51010	500415_S51010								
318	1145	194								1339
794	2872	579								3451
2381	11680	1848								13528
3175	17033	2644								19677

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
318	1.74	1.5190	1.4430	Erosive	Erosive	Erosive	0.4	Erosive	4.5	Stable	Stable
794	1.74	1.5076	1.4322	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Stable	Stable
2381	1.74	1.6975	1.6126	Erosive	Erosive	Erosive	0.4	Erosive	7.8	Stable	Stable
3175	1.74	1.7355	1.6487	Erosive	Erosive	Erosive	0.5	Erosive	8.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	318	794	2381	3175	318	794	2381	3175	318	794	2381	3175
Bray - Equation #1	50	80	143	167	1.8	2.5	3.5	3.9	3.5	4.0	4.7	4.9
Bray - Equation #2	65	105	188	219	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	25	47	55	5.8	8.1	12.4	13.8				
Ackers & Charlton/Lacey	40	59	94	106					2.1	2.4	2.9	3.1
Parker	122	194	335	387	1.5	2.2	3.5	3.9				
Chang	73	129	252	300	0.3	0.2	-0.2	-0.4				
Kellerhals	32	51	88	101	2.7	3.9	6.1	6.8	3.6	4.0	4.4	4.6
AMAFCA/Schumm	40	107	115	118								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	18.7	26.4	39.8	44.4	5	7	11	12	5.3	6.7	8.8	9.5
Average	47	79	131	151	2.5	3.5	5.1	5.6	3.4	4.0	4.8	5.1
Values As Designed	40	107	115	118	1.7	2.8	4.2	4.7	5.3	5.2	7.8	8.6
Difference with Design	7	-28	17	33	0.8	0.7	0.9	1.0	-1.9	-1.2	-3.0	-3.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2351	2712	4069	27411	1649	2541	1014	1719	11289	2162	8870	5981
794	5748	6538	10242	65863	4278	6250	2557	4242	28210	5278	21891	14645
2381	30046	21964	31661	404378	6482	34059	7389	17525	85029	11275	89950	67251
3175	46108	29916	43398	646813	7245	53417	9694	25081	113440	12045	128608	101433

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2748	3169	4754	32030	1927	2969	1185	2009	13191	2526	10365	6988
794	2687	3056	4787	30784	1999	2921	1195	1983	13185	2467	10232	6845
2381	4681	3422	4933	63002	1010	5306	1151	2730	13248	1757	14014	10478
3175	5388	3496	5071	75580	847	6242	1133	2931	13256	1407	15028	11853

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2351	2198	2175	2372	561	987	1014	1719	924	126	2220	1514
794	5748	5294	5497	5700	1444	2448	2557	4242	2302	339	5445	3729
2381	30046	18292	15550	34994	2458	9548	7389	17525	7208	312	25248	15325
3175	46108	25047	20983	55974	2806	13645	9694	25081	9663	311	37207	22411

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
318	2748	2569	2541	2772	656	1154	1185	2009	1080	148	2595	1769
794	2687	2474	2569	2664	675	1144	1195	1983	1076	158	2545	1743
2381	4681	2850	2423	5452	383	1488	1151	2730	1123	49	3934	2388
3175	5388	2927	2452	6541	328	1594	1133	2931	1129	36	4348	2619

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
318	0.0004	0.0002	280	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0051	0.0003	0.0009	0.0029	0.0021
794	0.0004	0.0002	275	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0051	0.0002	0.0004	0.0030	0.0021
2381	0.0002	0.0001	374	1.14	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021
3175	0.0001	0.0001	404	1.23	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	35.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	239	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.18	sq. mi
Total Sediment Yield Volume	0.34	ac ft

Sedimentation Basins

Length	239 ft	Depth	3 ft
Width	126 ft	Side slope	3 ft/ft
Total Volume per Basin		1.86	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
318	1.1	0.4	0.4	24.6	1.7	1.5	5.3	0.0030	0.3	0.0	1.0	2.6
794	1.1	0.7	0.4	24.6	2.8	1.4	5.2	0.0030	0.5	0.0	1.0	3.2
2381	1.1	1.5	0.8	24.6	4.2	2.7	7.8	0.0030	0.9	0.0	1.0	4.9
3175	1.1	1.8	1.0	24.6	4.7	3.1	8.6	0.0030	1.0	0.0	1.0	5.7

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1981	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	4.7	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.80	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	0.55	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2874	2874
Side Slope (?H:1V)	3	6
Channel Width (ft)	126	162
Channel XS Area (sq. ft)	528	636
Channel Perimeter (ft)	128	163

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	293911	373324
Excavated Area (sq. Yd)	40236	51732

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	2874	2874
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	7983	15647
Lining Volume (cu. Yd)	1331	2608

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2874	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	479	sq. Yd
Volume	1437	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2874	2874
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2874	2874
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	126	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	15.4	ft
Structure Height	18.4	ft
Number of Structures	12	
Volume per structure	43	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,665	
Area per structure	7	sq. Yd
Total Area	84	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3001	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,004	
Other Cost	$ -	
Total cost per basin	$ 12,004	
Area per basin	3,353	sq. Yd
Total Area	3,353	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	293,911	cu. Yd	$ 10.00	$ 2,939,110	40,236	sq. Yd	$ 9.00	$ 362,124	40,236	sq. Yd	$ 8.33	$ 335,300
Exc. Chl - LC Enhancement	Excavated	79,413	cu. Yd	$ 10.00	$ 794,130	11,496	sq. Yd	$ 9.00	$ 103,464	11,496	sq. Yd	$ 8.33	$ 95,800
Channel Lining	Concrete	1,331	cu. Yd	$ 155.00	$ 206,305	7,983	sq. Yd	$ -	$ -	7,983	sq. Yd	$ 41.67	$ 332,625
Channel Lining - LC Enhancement	Concrete	1,277	cu. Yd	$ 155.00	$ 197,935	7,664	sq. Yd	$ -	$ -	7,664	sq. Yd	$ 41.67	$ 319,333
Toe Protection	Riprap	1,437	cu. Yd	$ 75.00	$ 107,775	479	sq. Yd	$ -	$ -	479	sq. Yd	$ 25.00	$ 11,975
Drop Structures	Concrete	12	EA	$ 6,665.00	$ 79,980	84	sq. Yd	$ -	$ -	84	sq. Yd	$ 41.67	$ 3,500
Drop Str. - LC Enhancement	Concrete	12	EA	$ 666.50	$ 7,998	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 41.67	$ 350
Sedimentation Basins		1	EA	$ 12,004.00	$ 12,004	3,353	sq. Yd	$ -	$ -	3,353	sq. Yd	$ 8.33	$ 27,942
Other					$ -				$ -				$ -
Base Landscape Cost									$ 362,124	Base Maintenance Cost			$ 711,342
LC Enhancement Cost									$ 103,464	LC Enhancement Cost			$ 415,483
Total Landscape Cost									$ 465,588	Total Maintenance Cost			$ 1,126,825

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,345,174	$ 1,000,063	$ 4,345,237
Contingency Cost (25% of Construction Cost)	$ 836,294	$ 250,016	$ 1,086,309
Engineering Design Cost (5% of Construction Cost)	$ 167,259	$ 50,003	$ 217,262
Total Construction Cost	$ 4,348,726	$ 1,300,082	$ 5,648,808

Land Cost

Channel Length	2874 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	8.8	$100,000	$ 880,000
LC Enhancement Buffer	50	3.3	$100,000	$ 330,000
Channel	126	8.3	$100,000	$ 830,000
Channel LC Enhancement	36	2.4	$100,000	$ 240,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	346	22.8		$ 2,280,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.1	$100,000	$ 1,710,000
LC Enhancement Cost	acre	5.7	$100,000	$ 570,000
Total Land Cost	acre	22.8	$100,000	$ 2,280,000

Total Cost

Base Total Cost	$ 7,132,192
Total Landscape Enhancement Cost	$ 2,389,029
Total Cost Including LC Enh.	$ 9,521,221

Open Channel

Structure ID	C51060

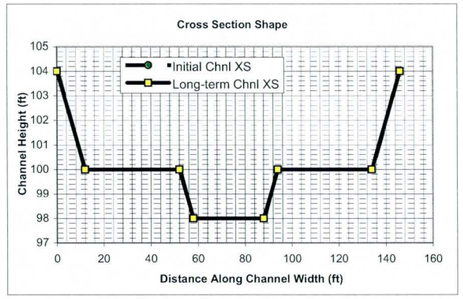
HEC1 ID	500415

Longitudal Geometry

Length	2541.7	ft
U/S Elev	1468.2	ft
D/S Elev	1454.2	ft
Initial Channel Slope	0.0055	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

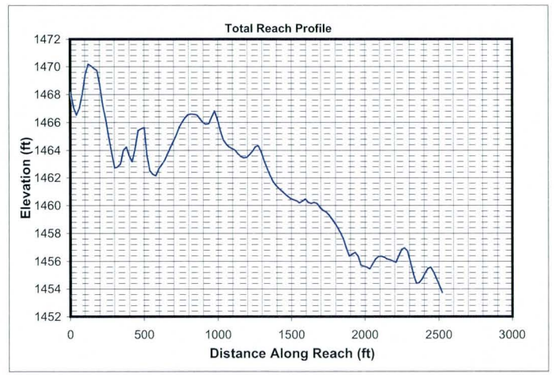
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	30	6	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	58	88	94	134	146
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	30	6	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	58	88	94	134	146
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S500	S510							TOTAL
HEC1 Peak-Flow	2063	2099							4162
Weighting Factor	1.00	0.59							
Flow into Channel	2063	1238							3301

Reach Sediment Inflow Characteristics

U/S Contributing ID	500415_C51020								TOTAL
Flow Volume (ac. ft)	257.00								257
Sediment Conc. (ppm)	2619								
Sediment Volume (ac. ft)	0.25								0.25
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.25								0.25

Hydrology

Drainage Area	1.08	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3301	cfs	
Long-term Max. Chnl Capacity	6365	cfs	
Q2 Channel	330	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	146	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
330	41.1	61.7	1.5	98.0	99.7	5.4	1.7	40.5	1.5	0.33	0.76
825	127.5	168.2	1.3	98.0	100.8	4.9	2.8	126.6	1.3	0.52	0.75
2476	135.5	333.1	2.5	98.0	102.0	7.4	4.0	134.2	2.5	0.76	0.83
3301	138.6	399.5	2.9	98.0	102.5	8.3	4.5	137.2	2.9	0.85	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
330	41.1	61.7	1.5	98.0	99.7	5.4	1.7	40.5	1.5	0.33	0.76
825	127.5	168.2	1.3	98.0	100.8	4.9	2.8	126.6	1.3	0.52	0.75
2476	135.5	333.1	2.5	98.0	102.0	7.4	4.0	134.2	2.5	0.76	0.83
3301	138.6	399.5	2.9	98.0	102.5	8.3	4.5	137.2	2.9	0.85	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	500415_C51020									
330	1514									1514
825	3729									3729
2476	15325									15325
3301	22411									22411

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
330	1.74	1.5252	1.4489	Erosive	Erosive	Erosive	0.4	Erosive	4.6	Stable	Stable
825	1.74	1.4829	1.4088	Erosive	Erosive	Erosive	0.3	Erosive	5.7	Stable	Stable
2476	1.74	1.6757	1.5920	Erosive	Erosive	Erosive	0.4	Erosive	7.6	Stable	Stable
3301	1.74	1.7251	1.6388	Erosive	Erosive	Erosive	0.4	Erosive	8.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	330	825	2476	3301	330	825	2476	3301	330	825	2476	3301
Bray - Equation #1	51	82	146	170	1.8	2.5	3.6	3.9	3.6	4.0	4.7	4.9
Bray - Equation #2	66	108	192	224	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	26	48	56	5.8	8.3	12.6	14.0				
Ackers & Charlton/Lacey	41	60	96	108					2.1	2.5	3.0	3.1
Parker	125	197	342	395	1.5	2.2	3.5	4.0				
Chang	75	132	258	307	0.3	0.2	-0.3	-0.4				
Kellerhals	33	52	90	103	2.8	4.0	6.2	6.9	3.6	4.0	4.5	4.6
AMAFCA/Schumm	41	127	134	137								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	19.0	26.8	40.4	45.0	5	7	11	12	5.4	6.8	8.9	9.6
Average	48	82	136	156	2.5	3.5	5.2	5.7	3.4	4.0	4.9	5.1
Values As Designed	40	127	134	137	1.7	2.8	4.0	4.5	5.4	4.9	7.4	8.3
Difference with Design	7	-44	2	19	0.8	0.7	1.1	1.2	-1.9	-0.9	-2.6	-3.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	2488	2486	2825	6242	893	1411	1054	1808	2463	316	4075	2369
825	5571	5828	7255	13360	2541	3322	2665	4210	6116	964	9358	5563
2476	29417	20145	20892	82983	4048	13681	7749	17669	18750	1159	42147	23513
3301	45302	27591	28421	133270	4556	19827	10175	25371	25068	1234	61658	34770

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	2797	2794	3175	7015	1003	1585	1184	2032	2768	355	4580	2663
825	2504	2620	3261	6006	1142	1493	1198	1893	2750	433	4207	2501
2476	4408	3019	3131	12435	607	2050	1161	2648	2810	174	6316	3523
3301	5092	3101	3194	14978	512	2228	1144	2851	2817	139	6930	3908

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	2488	2296	2252	2524	574	1035	1054	1808	963	126	2343	1588
825	5571	5369	5814	5402	1605	2464	2665	4210	2370	412	5330	3746
2476	29417	18782	16174	33555	2734	9647	7749	17669	7472	370	25125	15336
3301	45302	25783	21705	53889	3116	13801	10175	25371	10025	365	37179	22428

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
330	2797	2580	2531	2837	645	1163	1184	2032	1082	142	2634	1784
825	2504	2414	2614	2429	721	1108	1198	1893	1065	185	2396	1684
2476	4408	2814	2424	5028	410	1446	1161	2648	1120	55	3765	2298
3301	5092	2898	2439	6057	350	1551	1144	2851	1127	41	4179	2521

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
330	0.0004	0.0002	169	0.52	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0002	0.0050	0.0003	0.0009	0.0029	0.0021
825	0.0004	0.0003	158	0.48	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0003	0.0050	0.0002	0.0005	0.0030	0.0021
2476	0.0002	0.0001	216	0.66	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0021
3301	0.0002	0.0001	234	0.71	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	6.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	847	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.10	sq. mi
Total Sediment Yield Volume	0.19	ac ft

Sedimentation Basins

Length	847 ft	Depth	3 ft
Width	146 ft	Side slope	3 ft/ft
Total Volume per Basin		7.91	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
330	1.1	0.5	0.4	24.6	1.7	1.5	5.4	0.0030	0.3	0.0	1.0	2.6
825	1.1	0.7	0.3	24.6	2.8	1.3	4.9	0.0030	0.5	0.0	1.0	3.1
2476	1.1	1.4	0.8	24.6	4.0	2.5	7.4	0.0030	0.8	0.0	1.0	4.7
3301	1.1	1.7	0.9	24.6	4.5	2.9	8.3	0.0030	1.0	0.0	1.0	5.4

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1981	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	4.5	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.5	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.44	ac. ft
Outflowing Sediment Volume	0.24	ac. ft
Deposited(+)/Eroded(-) Volume	0.20	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2542	2542
Side Slope (?H:1V)	3	6
Channel Width (ft)	146	182
Channel XS Area (sq. ft)	608	716
Channel Perimeter (ft)	148	183

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	100678	121557
Excavated Area (sq. Yd)	41237	51405

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	2542	2542
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	7061	13840
Lining Volume (cu. Yd)	1177	2307

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2542	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	424	sq. Yd
Volume	1271	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2542	2542
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2542	2542
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	146	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.5	ft
Structure Height	17.5	ft
Number of Structures	3	
Volume per structure	47	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,285	
Area per structure	8	sq. Yd
Total Area	24	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12761	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 51,044	
Other Cost	$ -	
Total cost per basin	$ 51,044	
Area per basin	13,744	sq. Yd
Total Area	13,744	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	100,678	cu. Yd	$ 10.00	$ 1,006,780	41,237	sq. Yd	$ 9.00	$ 371,133	41,237	sq. Yd	$ 8.33	$ 343,642
Exc. Chl - LC Enhancement	Excavated	20,879	cu. Yd	$ 10.00	$ 208,790	10,168	sq. Yd	$ 9.00	$ 91,512	10,168	sq. Yd	$ 8.33	$ 84,733
Channel Lining	Concrete	1,177	cu. Yd	$ 155.00	$ 182,435	7,061	sq. Yd	$ -	$ -	7,061	sq. Yd	$ 41.67	$ 294,208
Channel Lining - LC Enhancement	Concrete	1,130	cu. Yd	$ 155.00	$ 175,150	6,779	sq. Yd	$ -	$ -	6,779	sq. Yd	$ 41.67	$ 282,458
Toe Protection	Riprap	1,271	cu. Yd	$ 75.00	$ 95,325	424	sq. Yd	$ -	$ -	424	sq. Yd	$ 25.00	$ 10,600
Drop Structures	Concrete	3	EA	$ 7,285.00	$ 21,855	24	sq. Yd	$ -	$ -	24	sq. Yd	$ 41.67	$ 1,000
Drop Str. - LC Enhancement	Concrete	3	EA	$ 728.50	$ 2,186	2	sq. Yd	$ -	$ -	2	sq. Yd	$ 41.67	$ 100
Sedimentation Basins		1	EA	$ 51,044.00	$ 51,044	13,744	sq. Yd	$ -	$ -	13,744	sq. Yd	$ 8.33	$ 114,533
Other					$ -				$ -				$ -
Base Landscape Cost									$ 371,133	Base Maintenance Cost			$ 763,983
LC Enhancement Cost									$ 91,512	LC Enhancement Cost			$ 367,292
Total Landscape Cost									$ 462,645	Total Maintenance Cost			$ 1,131,275

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,357,439	$ 386,126	$ 1,743,565
Contingency Cost (25% of Construction Cost)	$ 339,360	$ 96,531	$ 435,891
Engineering Design Cost (5% of Construction Cost)	$ 67,872	$ 19,306	$ 87,178
Total Construction Cost	$ 1,764,671	$ 501,963	$ 2,266,634

Land Cost

Channel Length	2542 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	7.8	$100,000	$ 780,000
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	146	8.5	$100,000	$ 850,000
Channel LC Enhancement	36	2.1	$100,000	$ 210,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	366	21.3		$ 2,130,000

Total Cost

Base Total Cost	$ 4,529,787
Total Landscape Enhancement Cost	$ 1,460,767
Total Cost Including LC Enh.	$ 5,990,554

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	16.3	$100,000	$ 1,630,000
LC Enhancement Cost	acre	5	$100,000	$ 500,000
Total Land Cost	acre	21.3	$100,000	$ 2,130,000

Offline Basin

HEC1 ID	D415

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

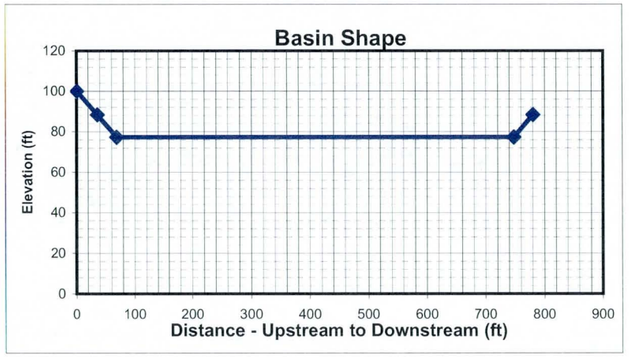
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.015	0.015
Basin Length (ft)	1200	1360
Basin Width (ft)	780	780
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	744.9	709.8
Top Area (acres)	21.5	24.4
U/S-D/S Height Difference (ft)	11.7	11.7
Excess Area on Upstream (acres)	1.0	2.2

			Base	LC Enhanced
Bottom Length (ft)	1134	Allocated Storage Volume (ac. ft)	189.5	188.9
Bottom Width (ft)	678.9	Total Available Volume (ac. ft) (incl. Freeboard)	209.9	210.7
		Total Excavation Volume (ac. ft)	335.7	353.3

Stage-Storage-Discharge

Stage (ft)	0										
Inflow (cfs)	0	200	400	600	800	1000	1231	1400	2000	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	169	769	1769	2769



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2953	3899	3899
Peak flow after diversion (cfs)	1633	2530	2530
Diverted Peak Flow (cfs)	1320	1369	1369
Total Diverted Flow Volume (ac. ft)	130.0	180	180.0
Peak Stage	5.8	ft	

Volume Check			***Stage Check***	
Total Volume needed	180.0	ac. ft	Depth Needed	6.8
Total Volume Provided	189.5	ac. ft	Depth Provided	11

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 512+67

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	348800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1200	ft
Base Total ROW Width	780	ft
LC Enh. Total ROW Length	1460	ft
LC Enh. Total ROW Length	880	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	541596	569991
Excavated Area (sq. Yd)	104000	142756

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	72	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	798	sq. Yd
Material Volume	399	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	1100	ft
Unit Cost	160	per ft
Cost per outlet	$176,000	
Other Cost	$ -	
Total Cost	$176,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		541,596	cu. Yd	$ 4.00	$ 2,166,384	104,000	sq. Yd	$ 9.00	$ 936,000	104,000	sq. Yd	$ 8.33	$ 866,667
Basin - LC Enhanced		28,395	cu. Yd	$ 4.00	$ 113,580	38,756	sq. Yd	$ 9.00	$ 348,804	38,756	sq. Yd	$ 8.33	$ 322,967
Inlet	Riprap	399	sq. Yd	$ 75.00	$ 29,925	798	sq. Yd	$ -	$ -	798	sq. Yd	$ 33.33	$ 26,600
Inlet - LC Enhanced (20%Total)					$ 5,985				$ -				$ 5,320
Outlet	Pipe	1	EA	$ 176,000	$ 176,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 8,800				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 936,000	Base Maintenance Cost			$ 895,483
						LC Enh. Landscape Cost			$ 348,804	LC Enh. Maintenance Cost			$ 328,398
						Total Landscape Cost			$1,284,804	Total Maintenance Cost			$ 1,223,881

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 2,372,309	$ 113,580	$ 2,485,889
Contingency Cost (25% of Construction Cost)	$ 593,077	$ 28,395	$ 621,472
Engineering Design Cost (5% of Construction Cost)	$ 118,615	$ 5,679	$ 124,294
Total Construction Cost	$ 3,084,002	$ 147,654	$ 3,231,656

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	8.0	$100,000	$ 800,735
Basin	21.5	$100,000	$ 2,150,000
Other		$100,000	$ -
Total	29.5	$100,000	$ 2,950,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	21.5	$100,000	$ 2,148,760
LC Enhancement Cost	acre	8.0	$100,000	$ 801,240
Total Land Cost	acre	29.5	$100,000	$ 2,950,000

Total Cost

Base Total Cost	$ 7,064,245
Total LC Enhancement Cost	$ 1,626,095
Total Cost Including LC Enh.	$ 8,690,341

Open Channel

Structure ID	RR41510

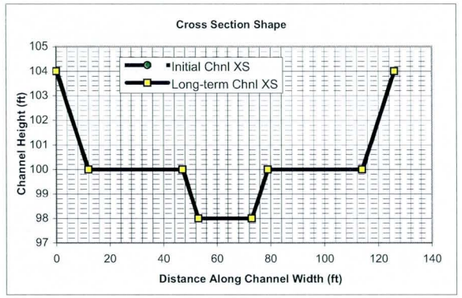
HEC1 ID	415420

Longitudal Geometry

Length	5198.2	ft
U/S Elev	1432.5	ft
D/S Elev	1348.4	ft
Initial Channel Slope	0.0162	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

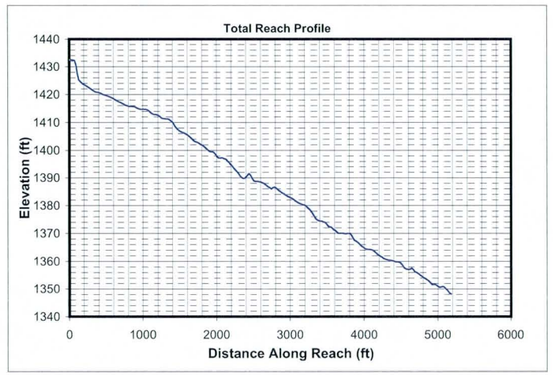
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	20	6	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	53	73	79	114	126
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	20	6	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	53	73	79	114	126
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420							TOTAL
HEC1 Peak-Flow	2530	1740							4270
Weighting Factor	1.00	0.20							
Flow into Channel	2530	348							2878

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	8.11	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	2878	cfs	
Long-term Max. Chnl Capacity	5198	cfs	
Q2 Channel	288	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	126	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
288	32.6	51.8	1.6	98.0	100.0	5.6	2.0	32.0	1.6	0.37	0.77
720	108.3	145.1	1.3	98.0	100.9	5.0	2.9	107.3	1.4	0.54	0.75
2159	116.4	288.7	2.5	98.0	102.2	7.5	4.2	115.1	2.5	0.78	0.83
2878	119.6	346.8	2.9	98.0	102.7	8.3	4.7	118.1	2.9	0.88	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
288	32.6	51.8	1.6	98.0	100.0	5.6	2.0	32.0	1.6	0.37	0.77
720	108.3	145.1	1.3	98.0	100.9	5.0	2.9	107.3	1.4	0.54	0.75
2159	116.4	288.7	2.5	98.0	102.2	7.5	4.2	115.1	2.5	0.78	0.83
2878	119.6	346.8	2.9	98.0	102.7	8.3	4.7	118.1	2.9	0.88	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
288										0
720										0
2159										0
2878										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
288	1.74	1.5443	1.4671	Erosive	Erosive	Erosive	0.4	Erosive	5.0	Stable	Stable
720	1.74	1.4883	1.4139	Erosive	Erosive	Erosive	0.3	Erosive	5.8	Stable	Stable
2159	1.74	1.6791	1.5951	Erosive	Erosive	Erosive	0.4	Erosive	7.7	Stable	Stable
2878	1.74	1.7277	1.6413	Erosive	Erosive	Erosive	0.5	Erosive	8.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	288	720	2159	2878	288	720	2159	2878	288	720	2159	2878
Bray - Equation #1	47	76	136	158	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	100	179	208	1.9	2.6	3.7	4.1	2.4	2.7	3.2	3.3
Hey	14	24	44	52	5.5	7.9	11.9	13.3				
Ackers & Charlton/Lacey	39	57	90	102					2.1	2.4	2.9	3.0
Parker	117	184	319	369	1.5	2.1	3.4	3.8				
Chang	69	121	237	282	0.3	0.2	-0.2	-0.3				
Kellerhals	31	48	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	32	107	115	118								
Moody & Odem	27	27	27	27	1.3	1.3	1.3	1.3				
BUREC	18.0	25.4	38.4	42.7	5	7	10	11	5.2	6.5	8.6	9.3
Average	45	77	127	146	2.5	3.4	5.0	5.5	3.4	3.9	4.7	5.0
Values As Designed	32	107	115	118	2.0	2.9	4.2	4.7	5.6	5.0	7.5	8.3
Difference with Design	14	-30	12	28	0.5	0.5	0.8	0.8	-2.2	-1.0	-2.7	-3.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	2266	2481	3738	29530	1413	2500	909	1617	11111	2172	8670	6037
720	4920	5850	9526	60182	4283	5643	2318	3702	27723	4780	19915	13531
2159	25788	19784	29204	370767	6470	30851	6730	15437	83575	12389	82190	62108
2878	39617	26985	39792	593760	7224	48472	8837	22135	111503	13219	117623	93560

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	2921	3198	4819	38067	1822	3223	1172	2085	14323	2800	11176	7782
720	2537	3016	4912	31032	2209	2910	1195	1909	14295	2465	10269	6977
2159	4432	3400	5020	63727	1112	5303	1157	2653	14365	2129	14127	10675
2878	5107	3479	5129	76541	931	6248	1139	2853	14374	1704	15163	12061

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	2266	2006	1933	2357	476	918	909	1617	845	98	2119	1413
720	4920	4688	5045	4803	1380	2160	2318	3702	2071	347	4699	3285
2159	25788	16344	14074	29588	2362	8427	6730	15437	6518	316	21992	13416
2878	39617	22421	18895	47384	2697	12042	8837	22135	8743	314	32479	19597

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	2921	2586	2492	3038	613	1184	1172	2085	1089	126	2731	1822
720	2537	2417	2601	2476	712	1114	1195	1909	1068	179	2423	1694
2159	4432	2809	2419	5086	406	1449	1157	2653	1120	54	3780	2306
2878	5107	2890	2436	6108	348	1552	1139	2853	1127	40	4187	2526

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
288	0.0003	0.0002	299	0.91	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0053	0.0003	0.0009	0.0029	0.0022
720	0.0004	0.0003	274	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0053	0.0002	0.0005	0.0030	0.0022
2159	0.0002	0.0001	373	1.14	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0053	0.0001	0.0002	0.0030	0.0021
2878	0.0002	0.0001	403	1.23	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0053	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	68.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	23	
Distance between structs.	226	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.36	sq. mi
Total Sediment Yield Volume	0.67	ac ft

Sedimentation Basins

Length	226 ft	Depth	3 ft
Width	126 ft	Side slope	3 ft/ft
Total Volume per Basin		1.75	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
288	1.1	0.5	0.4	24.6	2.0	1.6	5.6	0.0030	0.4	0.0	1.0	2.8
720	1.1	0.7	0.3	24.6	2.9	1.4	5.0	0.0030	0.6	0.0	1.0	3.2
2159	1.1	1.5	0.8	24.6	4.2	2.5	7.5	0.0030	0.9	0.0	1.0	4.9
2878	1.1	1.8	0.9	24.6	4.7	2.9	8.3	0.0030	1.0	0.0	1.0	5.5

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2393	cfs
Stage at Peak Flow	101.1	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	4.7	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.67	ac. ft
Outflowing Sediment Volume	0.31	ac. ft
Deposited(+)/Eroded(-) Volume	0.36	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5198	5198
Side Slope (?H:1V)	3	6
Channel Width (ft)	126	162
Channel XS Area (sq. ft)	508	616
Channel Perimeter (ft)	128	163

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	929039	1187328
Excavated Area (sq. Yd)	72772	93564

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5198	5198
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	14439	28300
Lining Volume (cu. Yd)	2407	4717

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5198	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	866	sq. Yd
Volume	2599	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5198	5198
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5198	5198
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	126	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.6	ft
Structure Height	17.6	ft
Number of Structures	23	
Volume per structure	41	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,355	
Area per structure	7	sq. Yd
Total Area	161	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	2823	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,292	
Other Cost	$ -	
Total cost per basin	$ 11,292	
Area per basin	3,164	sq. Yd
Total Area	3,164	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	929,039	cu. Yd	$ 10.00	$ 9,290,390	72,772	sq. Yd	$ 9.00	$ 654,948	72,772	sq. Yd	$ 8.33	$ 606,433
Exc. Chl - LC Enhancement	Excavated	258,289	cu. Yd	$ 10.00	$ 2,582,890	20,792	sq. Yd	$ 9.00	$ 187,128	20,792	sq. Yd	$ 8.33	$ 173,267
Channel Lining	Concrete	2,407	cu. Yd	$ 155.00	$ 373,085	14,439	sq. Yd	$ -	$ -	14,439	sq. Yd	$ 41.67	$ 601,625
Channel Lining - LC Enhancement	Concrete	2,310	cu. Yd	$ 155.00	$ 358,050	13,861	sq. Yd	$ -	$ -	13,861	sq. Yd	$ 41.67	$ 577,542
Toe Protection	Riprap	2,599	cu. Yd	$ 75.00	$ 194,925	866	sq. Yd	$ -	$ -	866	sq. Yd	$ 25.00	$ 21,650
Drop Structures	Concrete	23	EA	$ 6,355.00	$ 146,165	161	sq. Yd	$ -	$ -	161	sq. Yd	$ 41.67	$ 6,708
Drop Str. - LC Enhancement	Concrete	23	EA	$ 635.50	$ 14,617	16	sq. Yd	$ -	$ -	16	sq. Yd	$ 41.67	$ 671
Sedimentation Basins		1	EA	$ 11,292.00	$ 11,292	3,164	sq. Yd	$ -	$ -	3,164	sq. Yd	$ 8.33	$ 26,367
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 654,948	Base Maintenance Cost			$ 1,262,783
						LC Enhancement Cost			$ 187,128	LC Enhancement Cost			$ 751,479
						Total Landscape Cost			$ 842,076	Total Maintenance Cost			$ 2,014,263

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 10,015,857	$ 2,955,557	$ 12,971,414
Contingency Cost (25% of Construction Cost)	$ 2,503,964	$ 738,889	$ 3,242,853
Engineering Design Cost (5% of Construction Cost)	$ 500,793	$ 147,778	$ 648,571
Total Construction Cost	$ 13,020,614	$ 3,842,223	$ 16,862,838

Land Cost

Channel Length	5198 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	16	$100,000	$ 1,600,000
LC Enhancement Buffer	50	6	$100,000	$ 600,000
Channel	126	15	$100,000	$ 1,500,000
Channel LC Enhancement	36	4.3	$100,000	$ 430,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	346	41.3		$ 4,130,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	10.3	$100,000	$ 1,030,000
Total Land Cost	acre	41.3	$100,000	$ 4,130,000

Total Cost

Base Total Cost	$ 18,038,345
Total Landscape Enhancement Cost	$ 5,810,831
Total Cost Including LC Enh.	$ 23,849,176

Open Channel

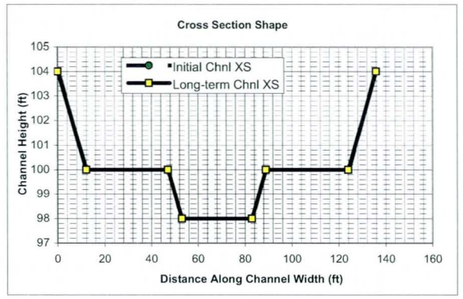
Structure ID	C42010	HEC1 ID	415420

Longitudnal Geometry

Length	10534.9	ft
U/S Elev	1348.4	ft
D/S Elev	1222.4	ft
Initial Channel Slope	0.0120	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	30	6	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	53	83	89	124	136
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	35	3	30	6	3	35	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	47	53	83	89	124	136
Y	104	100	100	98	98	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D415	S420								TOTAL
HEC1 Peak-Flow	2530	1740								4270
Weighting Factor	1.00	0.43								
Flow into Channel	2530	755								3285

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_RR41510									TOTAL
Flow Volume (ac. ft)	330.00									330
Sediment Conc. (ppm)	2526									
Sediment Volume (ac. ft)	0.31									0.31
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.31									0.31

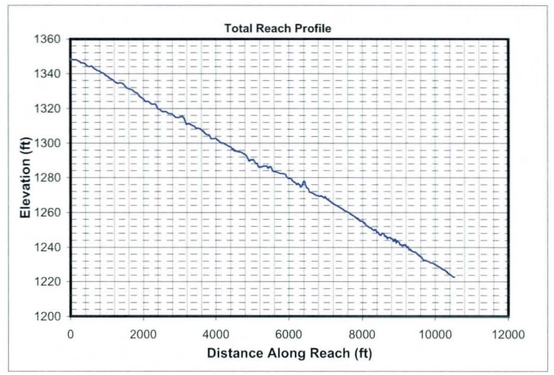
Hydrology

Drainage Area	8.877	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3285	cfs	
Long-term Max. Chnl Capacity	5954	cfs	
Q2 Channel	329	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		



Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
329	41.0	61.5	1.5	98.0	99.7	5.3	1.7	40.5	1.5	0.33	0.76
821	117.6	162.4	1.4	98.0	100.8	5.1	2.8	116.7	1.4	0.52	0.76
2464	126.0	322.7	2.6	98.0	102.1	7.6	4.1	124.7	2.6	0.77	0.84
3285	129.3	387.4	3.0	98.0	102.6	8.5	4.6	127.8	3.0	0.87	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
329	41.0	61.5	1.5	98.0	99.7	5.3	1.7	40.5	1.5	0.33	0.76
821	117.6	162.4	1.4	98.0	100.8	5.1	2.8	116.7	1.4	0.52	0.76
2464	126.0	322.7	2.6	98.0	102.1	7.6	4.1	124.7	2.6	0.77	0.84
3285	129.3	387.4	3.0	98.0	102.6	8.5	4.6	127.8	3.0	0.87	0.86

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_RR41510									
329	1413									1413
821	3285									3285
2464	13416									13416
3285	19597									19597

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
329	1.74	1.5244	1.4482	Erosive	Erosive	Erosive	0.4	Erosive	4.6	Stable	Stable
821	1.74	1.4972	1.4223	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Stable	Stable
2464	1.74	1.6886	1.6041	Erosive	Erosive	Erosive	0.4	Erosive	7.7	Stable	Stable
3285	1.74	1.7374	1.6505	Erosive	Erosive	Erosive	0.5	Erosive	8.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	329	821	2464	3285	329	821	2464	3285	329	821	2464	3285
Bray - Equation #1	50	82	146	170	1.8	2.5	3.6	3.9	3.6	4.0	4.7	4.9
Bray - Equation #2	66	107	192	223	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	26	48	56	5.8	8.3	12.5	14.0				
Ackers & Charlton/Lacey	41	60	96	108					2.1	2.5	2.9	3.1
Parker	125	197	341	394	1.5	2.2	3.5	4.0				
Chang	75	131	257	306	0.3	0.2	-0.3	-0.4				
Kellerhals	33	52	89	103	2.8	4.0	6.2	6.9	3.6	4.0	4.5	4.6
AMAFCA/Schumm	41	117	125	128								
Moody & Odem	28	28	28	28	1.3	1.3	1.3	1.3				
BUREC	18.9	26.7	40.3	44.9	5	7	11	12	5.4	6.8	8.9	9.6
Average	49	83	136	156	2.6	3.5	5.2	5.8	3.4	4.0	4.9	5.1
Values As Designed	40	117	125	128	1.7	2.8	4.1	4.6	5.3	5.1	7.6	8.5
Difference with Design	9	-34	11	28	0.8	0.7	1.1	1.1	-1.9	-1.0	-2.8	-3.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
329	2471	2730	3808	19934	1450	2248	1049	1797	8025	1787	7685	4817
821	5775	6500	9642	45138	3972	5371	2649	4305	20034	4182	18395	11451
2464	30346	22027	29393	278822	6045	25709	7674	17912	60522	7181	77500	51194
3285	46652	30053	39859	446918	6756	40412	10072	25674	80767	7691	111499	76941

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
329	2791	3083	4300	22513	1638	2538	1184	2029	9063	2019	8680	5440
821	2609	2936	4356	20391	1794	2426	1197	1945	9050	1889	8310	5173
2464	4570	3317	4426	41986	910	3871	1156	2697	9114	1081	11670	7709
3285	5269	3394	4502	50474	763	4564	1137	2900	9122	869	12592	8690

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
329	2471	2283	2242	2505	572	1029	1049	1797	958	126	2328	1578
821	5775	5420	5728	5671	1537	2499	2649	4305	2372	374	5494	3802
2464	30346	18833	16090	35032	2614	9767	7674	17912	7449	341	25670	15612
3285	46652	25817	21664	56151	2981	13965	10072	25674	9989	338	37902	22837

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
329	2791	2579	2532	2829	646	1162	1184	2029	1082	143	2629	1782
821	2609	2449	2588	2562	694	1129	1197	1945	1072	169	2482	1718
2464	4570	2836	2423	5275	394	1471	1156	2697	1122	51	3865	2351
3285	5269	2916	2447	6342	337	1577	1137	2900	1128	38	4281	2579

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
329	0.0004	0.0002	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0050	0.0003	0.0009	0.0029	0.0021
821	0.0004	0.0003	239	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0050	0.0002	0.0005	0.0030	0.0021
2464	0.0002	0.0001	326	0.99	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0021
3285	0.0002	0.0001	352	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	94.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	32	
Distance between structs.	329	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.77	sq. mi
Total Sediment Yield Volume	1.46	ac ft

Sedimentation Basins

Length	329 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.80	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
329	1.1	0.5	0.4	24.6	1.7	1.5	5.3	0.0030	0.3	0.0	1.0	2.6
821	1.1	0.7	0.4	24.6	2.8	1.4	5.1	0.0030	0.5	0.0	1.0	3.1
2464	1.1	1.5	0.8	24.6	4.1	2.6	7.6	0.0030	0.9	0.0	1.0	4.9
3285	1.1	1.8	1.0	24.6	4.6	3.0	8.5	0.0030	1.0	0.0	1.0	5.6

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2393	cfs
Stage at Peak Flow	101.1	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	4.6	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.4	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	1.77	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	1.45	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	10535	10535
Side Slope (?H:1V)	3	6
Channel Width (ft)	136	172
Channel XS Area (sq. ft)	568	676
Channel Perimeter (ft)	138	173

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2725889	3430922
Excavated Area (sq. Yd)	159196	201336

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	10535	10535
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	29264	57357
Lining Volume (cu. Yd)	4877	9560

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10535	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1756	sq. Yd
Volume	5268	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10535	10535
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	10535	10535
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	136	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	15.0	ft
Structure Height	18.0	ft
Number of Structures	32	
Volume per structure	45	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,975	
Area per structure	8	sq. Yd
Total Area	242	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	4517	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 18,068	
Other Cost	$ -	
Total cost per basin	$ 18,068	
Area per basin	4,975	sq. Yd
Total Area	9,950	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,725,889	cu. Yd	$ 10.00	$ 27,258,890	159,196	sq. Yd	$ 9.00	$ 1,432,764	159,196	sq. Yd	$ 8.33	$ 1,326,633
Exc. Chl - LC Enhancement	Excavated	705,033	cu. Yd	$ 10.00	$ 7,050,330	42,140	sq. Yd	$ 9.00	$ 379,260	42,140	sq. Yd	$ 8.33	$ 351,167
Channel Lining	Concrete	4,877	cu. Yd	$ 155.00	$ 755,935	29,264	sq. Yd	$ -	$ -	29,264	sq. Yd	$ 41.67	$ 1,219,333
Channel Lining - LC Enhancement	Concrete	4,683	cu. Yd	$ 155.00	$ 725,865	28,093	sq. Yd	$ -	$ -	28,093	sq. Yd	$ 41.67	$ 1,170,542
Toe Protection	Riprap	5,268	cu. Yd	$ 75.00	$ 395,100	1,756	sq. Yd	$ -	$ -	1,756	sq. Yd	$ 25.00	$ 43,900
Drop Structures	Concrete	32	EA	$ 6,975.00	$ 223,200	242	sq. Yd	$ -	$ -	242	sq. Yd	$ 41.67	$ 10,083
Drop Str. - LC Enhancement	Concrete	32	EA	$ 697.50	$ 22,320	24	sq. Yd	$ -	$ -	24	sq. Yd	$ 41.67	$ 1,008
Sedimentation Basins		2	EA	$ 18,068.00	$ 36,136	9,950	sq. Yd	$ -	$ -	9,950	sq. Yd	$ 8.33	$ 82,917
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,432,764	Base Maintenance Cost	$ 2,682,867
LC Enhancement Cost	$ 379,260	LC Enhancement Cost	$ 1,522,717
Total Landscape Cost	$ 1,812,024	Total Maintenance Cost	$ 4,205,583

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 28,669,261	$ 7,798,515	$ 36,467,776
Contingency Cost (25% of Construction Cost)	$ 7,167,315	$ 1,949,629	$ 9,116,944
Engineering Design Cost (5% of Construction Cost)	$ 1,433,463	$ 389,926	$ 1,823,389
Total Construction Cost	$ 37,270,039	$ 10,138,070	$ 47,408,109

Land Cost

Channel Length	10535 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	32.4	$100,000	$ 3,240,000
LC Enhancement Buffer	50	12.1	$100,000	$ 1,210,000
Channel	136	32.9	$100,000	$ 3,290,000
Channel LC Enhancement	36	8.7	$100,000	$ 870,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	356	86.1		$ 8,610,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	65.3	$100,000	$ 6,530,000
LC Enhancement Cost	acre	20.8	$100,000	$ 2,080,000
Total Land Cost	acre	86.1	$100,000	$ 8,610,000

Total Cost

Base Total Cost	$ 47,915,670
Total Landscape Enhancement Cost	$ 14,120,046
Total Cost Including LC Enh.	$ 62,035,716

Open Channel

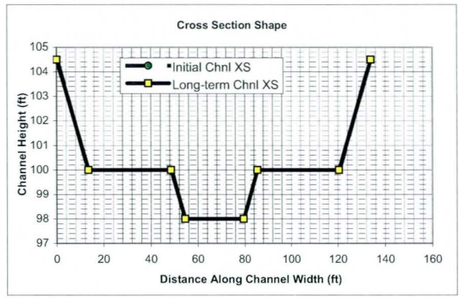
Structure ID	C42020	HEC1 ID	415420

Longitudal Geometry

Length	2237.8	ft
U/S Elev	1222.4	ft
D/S Elev	1191.3	ft
Initial Channel Slope	0.0139	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	10



Initial Channel XS Geometry

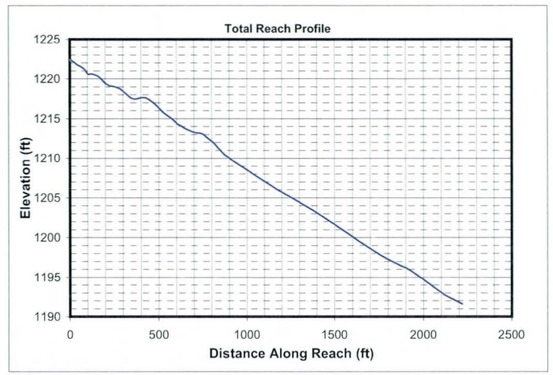
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	35	3	25	6.5	3	35	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	48.5	54.5	79.5	85.5	120.5	134
Y	104.5	100	100	98	98	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	35	3	25	6.5	3	35	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	48.5	54.5	79.5	85.5	120.5	134
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C420									TOTAL
HEC1 Peak-Flow	3218									3218
Weighting Factor	1.00									
Flow into Channel	3218									3218

Reach Sediment Inflow Characteristics

U/S Contributing ID	415420_C42010									TOTAL
Flow Volume (ac. ft)	330.00									330
Sediment Conc. (ppm)	2579									
Sediment Volume (ac. ft)	0.32									0.32
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.32									0.32

Hydrology

Drainage Area	9.88	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	3218	cfs	
Long-term Max. Chnl Capacity	6660	cfs	
Q2 Channel	322	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	134	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
322	37.0	58.3	1.6	98.0	99.9	5.5	1.9	36.4	1.6	0.36	0.77
805	113.2	157.9	1.4	98.0	100.9	5.1	2.9	112.2	1.4	0.54	0.76
2414	121.7	314.2	2.6	98.0	102.2	7.7	4.2	120.3	2.6	0.79	0.84
3218	125.0	377.4	3.0	98.0	102.7	8.5	4.7	123.4	3.1	0.89	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
322	37.0	58.3	1.6	98.0	99.9	5.5	1.9	36.4	1.6	0.36	0.77
805	113.2	157.9	1.4	98.0	100.9	5.1	2.9	112.2	1.4	0.54	0.76
2414	121.7	314.2	2.6	98.0	102.2	7.7	4.2	120.3	2.6	0.79	0.84
3218	125.0	377.4	3.0	98.0	102.7	8.5	4.7	123.4	3.1	0.89	0.86

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
	415420_C42010									
322	1578									1578
805	3802									3802
2414	15612									15612
3218	22837									22837

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
322	1.74	1.5406	1.4636	Erosive	Erosive	Erosive	0.4	Erosive	4.8	Stable	Stable
805	1.74	1.5007	1.4257	Erosive	Erosive	Erosive	0.4	Erosive	5.8	Stable	Stable
2414	1.74	1.6915	1.6069	Erosive	Erosive	Erosive	0.4	Erosive	7.8	Stable	Stable
3218	1.74	1.7401	1.6531	Erosive	Erosive	Erosive	0.5	Erosive	8.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	322	805	2414	3218	322	805	2414	3218	322	805	2414	3218
Bray - Equation #1	50	81	144	168	1.8	2.5	3.6	3.9	3.5	4.0	4.7	4.9
Bray - Equation #2	65	106	190	221	2.0	2.7	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	26	47	55	5.8	8.2	12.4	13.9				
Ackers & Charlton/Lacey	41	60	95	107					2.1	2.4	2.9	3.1
Parker	123	195	338	390	1.5	2.2	3.5	4.0				
Chang	74	130	254	302	0.3	0.2	-0.2	-0.4				
Kellerhals	32	51	88	102	2.7	3.9	6.1	6.9	3.6	4.0	4.4	4.6
AMAFCA/Schumm	36	112	120	124								
Moody & Odem	29	29	29	29	1.3	1.3	1.3	1.3				
BUREC	18.8	26.5	40.0	44.6	5	7	11	12	5.4	6.7	8.9	9.5
Average	48	82	135	154	2.6	3.5	5.2	5.7	3.4	4.0	4.8	5.1
Values As Designed	36	112	120	123	1.9	2.9	4.2	4.7	5.5	5.1	7.7	8.5
Difference with Design	12	-31	14	31	0.7	0.6	0.9	1.0	-2.1	-1.1	-2.8	-3.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
322	2524	2736	3941	25951	1466	2506	1022	1806	9868	2111	8655	5690
805	5709	6493	10000	56093	4198	5842	2593	4243	24628	4801	20343	13177
2414	29938	21928	30694	345664	6364	30203	7504	17607	74300	9587	84554	59850
3218	45997	29902	41854	553607	7110	47439	9849	25225	99137	10248	121240	90146

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
322	2910	3154	4543	29918	1690	2889	1178	2082	11376	2434	9979	6559
805	2633	2994	4612	25867	1936	2694	1196	1957	11358	2214	9381	6076
2414	4602	3371	4718	53135	978	4643	1154	2707	11421	1474	12998	9200
3218	5303	3447	4825	63825	820	5469	1135	2908	11429	1181	13978	10393

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
322	2524	2252	2172	2604	536	1027	1022	1806	943	112	2361	1578
805	5709	5316	5596	5628	1492	2458	2593	4243	2327	359	5425	3740
2414	29938	18448	15755	34680	2538	9598	7504	17607	7300	328	25276	15361
3218	45997	25285	21228	55543	2896	13722	9849	25225	9788	326	37295	22469

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
322	2910	2597	2504	3002	618	1184	1178	2082	1088	129	2722	1819
805	2633	2452	2581	2595	688	1134	1196	1957	1073	165	2502	1725
2414	4602	2836	2422	5331	390	1475	1154	2707	1122	50	3885	2361
3218	5303	2915	2447	6404	334	1582	1135	2908	1128	38	4300	2590

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
322	0.0003	0.0002	275	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0051	0.0003	0.0009	0.0029	0.0021
805	0.0004	0.0003	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0051	0.0002	0.0005	0.0030	0.0021
2414	0.0002	0.0001	353	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021
3218	0.0002	0.0001	381	1.16	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	24.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	249	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.00	sq. mi
Total Sediment Yield Volume	1.90	ac ft

Sedimentation Basins

Length	249 ft	Depth	3 ft
Width	134 ft	Side slope	3 ft/ft
Total Volume per Basin		2.06	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
322	1.1	0.5	0.4	24.6	1.9	1.6	5.5	0.0030	0.4	0.0	1.0	2.7
805	1.1	0.7	0.4	24.6	2.9	1.4	5.1	0.0030	0.6	0.0	1.0	3.2
2414	1.1	1.5	0.8	24.6	4.2	2.6	7.7	0.0030	0.9	0.0	1.0	5.0
3218	1.1	1.8	1.0	24.6	4.7	3.1	8.5	0.0030	1.0	0.0	1.0	5.7

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2393	cfs
Stage at Peak Flow	101.1	ft
Flow Volume	330.0	ac. ft

Freeboard

Max. Flow Depth	4.7	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.8	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	2.22	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	1.90	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2238	2238
Side Slope (?H:1V)	3	6
Channel Width (ft)	134	173
Channel XS Area (sq. ft)	604.2	730.95
Channel Perimeter (ft)	136	174

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	185484	235399
Excavated Area (sq. Yd)	33321	43019

Bank And Channel Lining	Base	LC Enhanced	***Toe Protection***		
Lining Type	Concrete		Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)			(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes			
			Protection Length	2238	ft
Lining Length (ft)	2238	2238	Thickness	1.5	ft
Lining Width (ft)	28	55	Protection Depth	6	ft
Lining Thickness (ft)	0.5	0.5	Tie-in Length/Depth	3.0	ft
			Total Depth	9.0	ft
Lining Area (sq. Yd)	6963	13677	Area needed	373	sq. Yd
Lining Volume (cu. Yd)	1161	2280	Volume	1119	cu. Yd

Levee	Base	LC Enhanced	***Levee Lining***	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None	Lining Type	None	None
Left Levee Length (ft)	0	0	(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Top Width (ft)	14	20			
Left Levee Side Slope (ft/ft)	N/A	6	Left Levee Length (ft)	2238	2238
Left Levee Height (ft)	0	1	Left Levee Lining Width (ft)	0	0
Left Levee Surface Area (sq. Yd)	0	0	Left Levee Lining Thickness (ft)	0	0
Left Levee Volume (cu. Yd)	0	0	Left Levee Lining Area (sq. Yd)	0	0
Right Levee Length (ft)	0	0	Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Top Width (ft)	14	20	Right Levee Length (ft)	2238	2238
Right Levee Side Slope (ft/ft)	N/A	6	Right Levee Lining Width (ft)	0	0
Right Levee Height (ft)	0	1	Right Levee Lining Thickness (ft)	0	0
Right Levee Surface Area (sq. Yd)	0	0	Right Levee Lining Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0	Right Levee Lining Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0	Total Lining Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0	Total Lining Volume (cu. Yd)	0	0

Drop Structures			***Sedimentation Basins***		
Structure Type	Concrete		Include Sed. Basins	Yes	
(Riprap, Gabions, Soil cement, Concrete,None)			(Yes/No)		
Structure Length	134	ft	Number of basins	4	
LC Enhancement Ratio	1.1				
Structure Thickness	0.5	ft	Total Volume per Basin	3323	cu. Yd
Drop Height	3	ft	Unit excavation cost	$ 4.00	cu. Yd
Scour Depth	15.1	ft	Excavation cost per basin	$ 13,292	
Structure Height	18.1	ft			
Number of Structures	9		Other Cost	$ -	
Volume per structure	45	cu. Yd	Total cost per basin	$ 13,292	
Unit Cost	$ 155.00	cu. Yd			
Other Cost	$ -		Area per basin	3,702	sq. Yd
Cost per structure	$ 6,975		Total Area	14,808	sq. Yd
Area per structure	7	sq. Yd			
Total Area	67	sq. Yd			

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	185,484	cu. Yd	$ 10.00	$ 1,854,840	33,321	sq. Yd	$ 9.00	$ 299,889	33,321	sq. Yd	$ 8.33	$ 277,675
Exc. Chl - LC Enhancement	Excavated	49,915	cu. Yd	$ 10.00	$ 499,150	9,698	sq. Yd	$ 9.00	$ 87,282	9,698	sq. Yd	$ 8.33	$ 80,817
Channel Lining	Concrete	1,161	cu. Yd	$ 155.00	$ 179,955	6,963	sq. Yd	$ -	$ -	6,963	sq. Yd	$ 41.67	$ 290,125
Channel Lining - LC Enhancement	Concrete	1,119	cu. Yd	$ 155.00	$ 173,445	6,714	sq. Yd	$ -	$ -	6,714	sq. Yd	$ 41.67	$ 279,750
Toe Protection	Riprap	1,119	cu. Yd	$ 75.00	$ 83,925	373	sq. Yd	$ -	$ -	373	sq. Yd	$ 25.00	$ 9,325
Drop Structures	Concrete	9	EA	$ 6,975.00	$ 62,775	67	sq. Yd	$ -	$ -	67	sq. Yd	$ 41.67	$ 2,792
Drop Str. - LC Enhancement	Concrete	9	EA	$ 697.50	$ 6,278	7	sq. Yd	$ -	$ -	7	sq. Yd	$ 41.67	$ 279
Sedimentation Basins		4	EA	$ 13,292.00	$ 53,168	14,808	sq. Yd	$ -	$ -	14,808	sq. Yd	$ 8.33	$ 123,400
Other					$ -				$ -				$ -

Base Landscape Cost	$ 299,889	Base Maintenance Cost	$ 703,317
LC Enhancement Cost	$ 87,282	LC Enhancement Cost	$ 360,846
Total Landscape Cost	$ 387,171	Total Maintenance Cost	$ 1,064,163

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,234,663	$ 678,873	$ 2,913,536
Contingency Cost (25% of Construction Cost)	$ 558,666	$ 169,718	$ 728,384
Engineering Design Cost (5% of Construction Cost)	$ 111,733	$ 33,944	$ 145,677
Total Construction Cost	$ 2,905,062	$ 882,534	$ 3,787,596

Land Cost

Channel Length	2238 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	6.9	$100,000	$ 690,000
LC Enhancement Buffer	50	2.6	$100,000	$ 260,000
Channel	134	6.9	$100,000	$ 690,000
Channel LC Enhancement	39	2	$100,000	$ 200,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	357	18.4		$ 1,840,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	13.8	$100,000	$ 1,380,000
LC Enhancement Cost	acre	4.6	$100,000	$ 460,000
Total Land Cost	acre	18.4	$100,000	$ 1,840,000

Total Cost

Base Total Cost	$ 5,288,268
Total Landscape Enhancement Cost	$ 1,790,662
Total Cost Including LC Enh.	$ 7,078,930

Open Channel

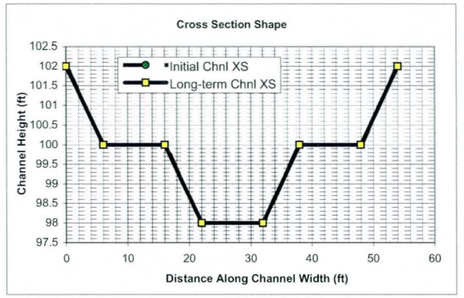
Structure ID	S51010	HEC1 ID	S51010

Longitudal Geometry

Length	1633.7	ft
U/S Elev	1542.3	ft
D/S Elev	1514.3	ft
Initial Channel Slope	0.0171	ft/ft
Long-term Channel Slope	0.0035	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

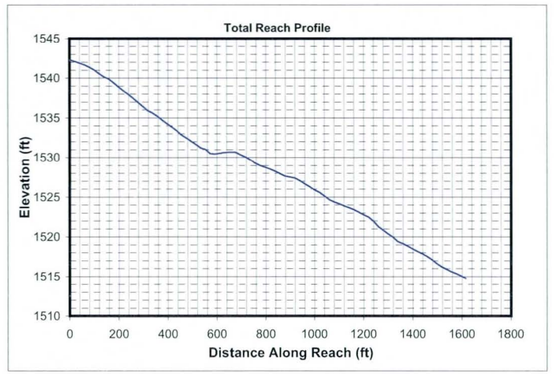
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	10	3	10	4	3	10	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	16	22	32	38	48	54
Y	102	100	100	98	98	100	100	102

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	10	3	10	4	3	10	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	16	22	32	38	48	54
Y	102	100	100	98	98	100	100	102



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S510									TOTAL
HEC1 Peak-Flow	2099									2099
Weighting Factor	0.21									
Flow into Channel	441									441

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.393	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calc.)

Design Peak Flow	441	cfs	
Long-term Max. Chnl Capacity	987	cfs	
Q2 Channel	44	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	54	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	15.9	12.1	0.8	98.0	98.9	3.7	0.9	15.6	0.8	0.21	0.73
110	19.8	22.8	1.1	98.0	99.6	4.8	1.6	19.3	1.2	0.34	0.79
331	47.0	62.2	1.3	98.0	100.7	5.3	2.7	46.1	1.3	0.59	0.81
441	48.7	75.0	1.5	98.0	101.0	5.9	3.0	47.8	1.6	0.65	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
44	15.9	12.1	0.8	98.0	98.9	3.7	0.9	15.6	0.8	0.21	0.73
110	19.8	22.8	1.1	98.0	99.6	4.8	1.6	19.3	1.2	0.34	0.79
331	47.0	62.2	1.3	98.0	100.7	5.3	2.7	46.1	1.3	0.59	0.81
441	48.7	75.0	1.5	98.0	101.0	5.9	3.0	47.8	1.6	0.65	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing Reach ID)									TOTAL
44										0
110										0
331										0
441										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
44	1.74	1.3151	1.2493	Erosive	Erosive	Erosive	0.3	Erosive	3.3	Stable	Stable
110	1.74	1.4463	1.3740	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Stable	Stable
331	1.74	1.4878	1.4134	Erosive	Erosive	Erosive	0.3	Erosive	6.0	Stable	Stable
441	1.74	1.5347	1.4580	Erosive	Erosive	Erosive	0.4	Erosive	6.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	44	110	331	441	44	110	331	441	44	110	331	441
Bray - Equation #1	18	28	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	66	77	1.0	1.4	2.0	2.2	1.8	2.1	2.4	2.5
Hey	5	8	16	18	2.7	3.8	5.8	6.5				
Ackers & Charlton/Lacey	18	26	41	46					1.5	1.8	2.1	2.2
Parker	46	72	125	144	0.7	1.0	1.5	1.7				
Chang	23	40	79	94	0.3	0.3	0.2	0.2				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.7
AMAFCA/Schumm	16	19	46	48								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	8.7	12.2	18.5	20.6	2	3	5	5	3.5	4.3	5.7	6.1
Average	18	27	48	55	1.3	1.7	2.5	2.8	2.5	2.9	3.5	3.7
Values As Designed	16	19	46	48	0.9	1.6	2.7	3.0	3.7	4.8	5.3	5.9
Difference with Design	2	8	2	8	0.3	0.2	-0.2	-0.2	-1.2	-1.9	-1.8	-2.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	228	377	710	2231	462	292	164	186	1828	224	954	696
110	829	1029	1650	9121	736	955	414	618	4608	763	3094	2165
331	2853	3109	4937	32159	1897	3154	1254	2033	13848	2552	10136	7085
441	4360	4273	6572	51168	2140	4630	1660	2946	18491	3818	14656	10428

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1918	3170	5973	18765	3888	2454	1381	1568	15375	1884	8025	5855
110	2789	3463	5553	30692	2476	3212	1395	2080	15506	2567	10411	7286
331	3200	3487	5537	36073	2127	3538	1406	2280	15533	2862	11369	7947
441	3668	3595	5529	43046	1800	3895	1396	2478	15556	3212	12330	8773

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	228	296	345	207	140	130	164	186	148	68	226	194
110	829	834	909	845	252	389	414	618	401	75	797	579
331	2853	2541	2672	2979	671	1250	1254	2033	1222	174	2684	1848
441	4360	3519	3480	4740	781	1776	1660	2946	1649	174	3996	2644

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
44	1918	2490	2903	1738	1175	1096	1381	1568	1249	576	1902	1636
110	2789	2806	3059	2843	849	1310	1395	2080	1350	254	2682	1947
331	3200	2850	2998	3342	752	1402	1406	2280	1370	196	3011	2073
441	3668	2961	2927	3988	657	1494	1396	2478	1388	146	3362	2224

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
44	0.0008	0.0005	212	0.65	0.051	0.0004	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0099	0.0007	0.0020	0.0034	0.0036
110	0.0005	0.0003	261	0.80	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0099	0.0004	0.0010	0.0034	0.0035
331	0.0004	0.0003	280	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0099	0.0003	0.0004	0.0034	0.0035
441	0.0003	0.0002	302	0.92	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0099	0.0002	0.0004	0.0034	0.0034

Drop Structures

Design Slope	0.0035	ft/ft
Total Drop Needed	22.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	8	
Distance between structs.	204	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.39	sq. mi
Total Sediment Yield Volume	0.75	ac ft

Sedimentation Basins

Length	204 ft	Depth	3 ft
Width	54 ft	Side slope	3 ft/ft
Total Volume per Basin		0.61	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
44	1.1	0.2	0.2	24.6	0.9	0.8	3.7	0.0035	0.2	0.0	1.0	1.8
110	1.1	0.4	0.3	24.6	1.6	1.2	4.8	0.0035	0.3	0.0	1.0	2.4
331	1.1	0.7	0.4	24.6	2.7	1.3	5.3	0.0035	0.5	0.0	1.0	3.1
441	1.1	0.8	0.5	24.6	3.0	1.6	5.9	0.0035	0.6	0.0	1.0	3.5

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	1981	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	257.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.75	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1634	1634
Side Slope (?H:1V)	3	6
Channel Width (ft)	54	78
Channel XS Area (sq. ft)	128	176
Channel Perimeter (ft)	55	78

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	44044	63082
Excavated Area (sq. Yd)	9804	14161

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	1634	1634
Lining Width (ft)	13	24
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	2360	4357
Lining Volume (cu. Yd)	393	726

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1634	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	272	sq. Yd
Volume	635	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1634	1634
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1634	1634
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	54	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	8.4	ft
Structure Height	11.4	ft
Number of Structures	8	
Volume per structure	11	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 1,705	
Area per structure	3	sq. Yd
Total Area	24	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	984	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,936	
Other Cost	$ -	
Total cost per basin	$ 3,936	
Area per basin	1,225	sq. Yd
Total Area	4,900	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	44,044	cu. Yd	$ 10.00	$ 440,440	9,804	sq. Yd	$ 9.00	$ 88,236	9,804	sq. Yd	$ 8.33	$ 81,700
Exc. Chl - LC Enhancement	Excavated	19,038	cu. Yd	$ 10.00	$ 190,380	4,357	sq. Yd	$ 9.00	$ 39,213	4,357	sq. Yd	$ 8.33	$ 36,308
Channel Lining	Concrete	393	cu. Yd	$ 155.00	$ 60,915	2,360	sq. Yd	$ -	$ -	2,360	sq. Yd	$ 41.67	$ 98,333
Channel Lining - LC Enhancement	Concrete	333	cu. Yd	$ 155.00	$ 51,615	1,997	sq. Yd	$ -	$ -	1,997	sq. Yd	$ 41.67	$ 83,208
Toe Protection	Riprap	635	cu. Yd	$ 75.00	$ 47,625	272	sq. Yd	$ -	$ -	272	sq. Yd	$ 25.00	$ 6,800
Drop Structures	Concrete	8	EA	$ 1,705.00	$ 13,640	24	sq. Yd	$ -	$ -	24	sq. Yd	$ 41.67	$ 1,000
Drop Str. - LC Enhancement	Concrete	8	EA	$ 170.50	$ 1,364	2	sq. Yd	$ -	$ -	2	sq. Yd	$ 41.67	$ 100
Sedimentation Basins		4	EA	$ 3,936.00	$ 15,744	4,900	sq. Yd	$ -	$ -	4,900	sq. Yd	$ 8.33	$ 40,833
Other					$ -				$ -				$ -
Base Landscape Cost									$ 88,236	Base Maintenance Cost			$ 228,667
LC Enhancement Cost									$ 39,213	LC Enhancement Cost			$ 119,617
Total Landscape Cost									$ 127,449	Total Maintenance Cost			$ 348,283

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 578,364	$ 243,359	$ 821,723
Contingency Cost (25% of Construction Cost)	$ 144,591	$ 60,840	$ 205,431
Engineering Design Cost (5% of Construction Cost)	$ 28,918	$ 12,168	$ 41,086
Total Construction Cost	$ 751,873	$ 316,367	$ 1,068,240

Land Cost

Channel Length	1634 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	5	$100,000	$ 500,000
LC Enhancement Buffer	50	1.9	$100,000	$ 190,000
Channel	54	2	$100,000	$ 200,000
Channel LC Enhancement	24	0.9	$100,000	$ 90,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	262	9.8		$ 980,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7	$100,000	$ 700,000
LC Enhancement Cost	acre	2.8	$100,000	$ 280,000
Total Land Cost	acre	9.8	$100,000	$ 980,000

Total Cost

Base Total Cost	$ 1,768,776
Total Landscape Enhancement Cost	$ 755,196
Total Cost Including LC Enh.	$ 2,523,972