Duncan, Arizona

Floodplain Analysis and Conceptual Levee Alignment along the Gila River

Delivered By
Northern Arizona University Undergraduate Engineering Students

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Acknowledgments

The Duncan, Arizona Floodplain Analysis and Conceptual Levee Alignment along the Gila River project is part of Northern Arizona University's Senior Capstone Project for civil and environmental engineering. The project was made possible through the faculty of NAU and the project's client Philip Ronnerud, P.E.

Mr. Ronnerud serves as the Greenlee County Engineer, and is a former graduate of NAU. Mr. Ronnerud oversees engineering projects of Duncan, Arizona, and has provided NAU with this capstone project. NAU Crown Engineering has enjoyed working with Mr. Ronnerud and thanks him for his active involvement with the development of this project.

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1.0 Project Description

This floodplain analysis and conceptual levee alignment project is formed in partnership with Philip Ronnerud, P.E. who is the Greenlee County Engineer. Mr. Ronnerud provided NAU Crown Engineering with the project. Based on the request of Mr. Ronnerud, NAU Crown Engineering performed a floodplain analysis of a 1.5 mile reach of the Gila River in Duncan, Arizona. The area of focus is provided in Figure 1.1. The project's objective is to provide insight to Duncan's current risk of flooding based on updated topography and new 100 year flow conditions. This project will also focus on proposing a levee alignment and height specification capable of protecting the Town of Duncan from flood events. Using Autodesk Civil 3D and HEC-RAS engineering software, three models will be produced to achieve the aforementioned objectives:

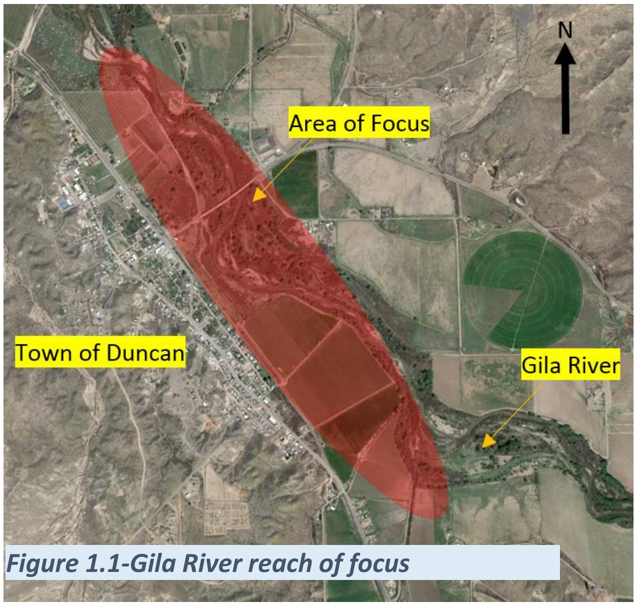

Figure 1.1-Gila River reach of focus

- **Effective Model-** Replication model of original floodplain evaluation that was performed in the area. In the case of Duncan, The Federal Emergency Management Agency (FEMA), produced a series of floodplain studies that began in 1974 and were completed in 2007 [1]. The results of the test are provided in the Flood Insurance Rate Map (FIRM) in Appendix A. Ultimately, the production of the effective model is to ensure that the initial floodplain study was correct and reproducible. The goal is to move beyond this model and create a modern version that is more reflective of new hydraulic/topographical conditions.
- **Corrective Effective Model-** Using recent (2012) Lidar data of the area, an improved model of the study reach was developed. This model is to reflect how the Gila River currently behaves as opposed to the outdated effective model.
- **Proposed Conditions Model-** Based on information provided from the Corrective Effective Model, a new hydraulic model will be developed with the addition of a levee alignment. The goal of this model is to show the impact within the floodplain by assuming a levee placement with a specified height.

The application of these models provide the Town of Duncan with new insight on the neighboring floodplain and exhibit how a levee placement could protect the town from damaging floodwaters. It is important to note that no other components of the proposed levee will be designed. Based on the information provided from this report, it is recommended that a future levee design that fits the prescribed alignment and height be completed. While various solutions are available to mediate the floodplain, this project will act as a vessel for potential implementation of a levee or perhaps create interest in the needed resolution of Duncan's flooding hazard.

2.0 Project Background

Duncan, Arizona is an agricultural-based town of approximately 800 residents, most of whom live along the Gila River [2]. The town is situated in southeast Arizona, near the New Mexico border, and is part of Greenlee County (*refer to Figure 2.1 for location*). The community erected in the 1870's as a result of the mining industry in the nearby towns of Clifton and Morenci. Duncan became noticed by farmers and ranchers for its naturally irrigated lands along the Gila River [2]. Unfortunately, early Duncan residents developed within the Gila River floodplain leading the town to experience significant flooding events throughout its history.

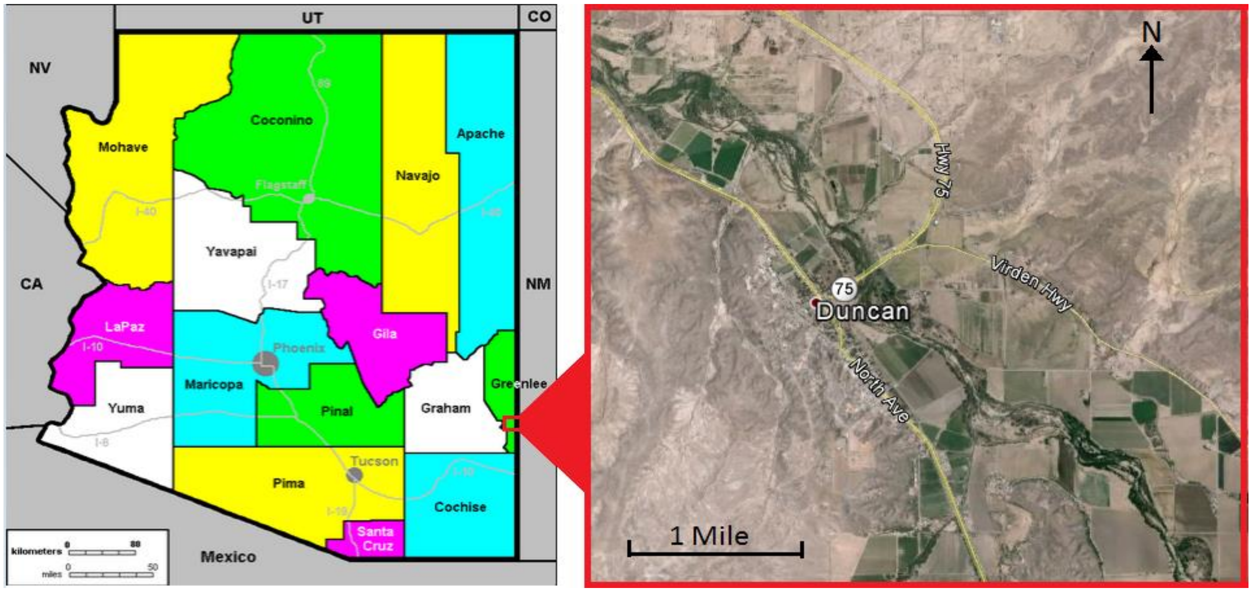

***Figure 2.1**-Project Location [3], [4]*

With the Gila River flowing on average of 200-400 cfs [5], the river is nearly always confined within its channel. For small-scale flooding events, less than 25 years, an agricultural dike guards Duncan from flooding along the focused river reach. Under larger flood events, the dike lacks sufficient containment and breaches, as was the case in 2005 and 1978. The largest flood on record occurred in December of 1978 when the Gila River at Duncan reached a flow of 58,700 cfs [6]. The flood severely damaged local infrastructure and brought siltation and erosion damage to the agricultural properties. Damage was estimated at a total of $9 million (adjusted to the 2015 dollar) [7]. Figures 2.2 and 2.3 depict the conditions of Duncan during a flood.

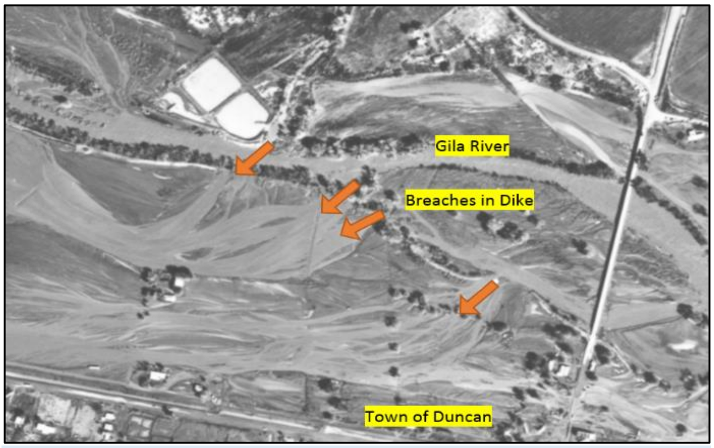

***Figure 2.2**-Aeiral photo of the 1978 Duncan flood [6]*

***Figure 2.3** –Duncan flood in 2005 [6]*

To prevent flooding disasters, FEMA recommends levees be designed for at least 100 year flooding conditions. The 100 year flood for Duncan has recently been change from 28,500 cfs to 47,400 cfs based on a Letter of Map Revision for the upstream Town of Virden. This flood event poses a problem since Duncan's agricultural dike is estimated to receive considerable damage beyond 7,000 cfs and potential failure at 20,000 cfs [5]. As stated in FEMA's Flood Insurance Study of Duncan, "the levees have no effect on 100 and 500-year floods" [1] . Since the levee is considered inadequate for large 100 year floods, FEMA does not recognize it when developing Flood Insurance Rate Maps (FIRM). As a result, much of the town is considered in high risk of flooding under base flood (100 year) conditions *(refer to Appendix A for FIRM).*

2.1 Stakeholders

While this specific project will consist of no physical design to be implemented, it involves multiple stakeholders who have influence or are impacted by the floodplain near Duncan. In the possible implementation of a levee design, these stakeholders will require considerable attention:

Table 2.1*-Stakeholders of Project*

Stakeholder	Role
United States Army Core of Engineers	Since the Army Corps of Engineers oversees all navigable waterways in the United States, therefore they will have the final decision in whether or not the construction of a new levee will be allowed.
Greenlee County Government	The Greenlee County government will need to find the resources to fund the design and construction of a new levee. The county engineer will need to be involved in the permitting process for constructing and certifying the levee. Also, the floodplain administrator will have to remap floodplain and submit to FEMA.
Property Owners in the Floodplain	The property owners who live in the floodplain will benefit from the construction of a certified, accredited levee. These people will no longer need to pay for flood protection because FEMA will redraw the floodplain map with consideration of the levee's protection.
Agriculture	The people in Duncan who have an agriculture-based business will not need to worry about a flood damaging their livelihood.
FEMA	After the levee has been certified by a qualified practicing engineer, FEMA will be in charge of the accreditation of the levee and verifying the floodplain.
Environmentalists	The presence of threatened and endangered species in this area makes it necessary for certain acts, such as the Endangered Species Act, to be followed during the construction of the levee.

2.2 Site Assessment

On September 25th, 2015, NAU Crown Engineering traveled to Duncan, AZ for a field visit to accomplish a number of tasks. First, the group clarified the scope of services on this project. The previous scope had included flow analysis of the Gila River through Duncan, determination of all levee dimensions, and geo-structural design of a levee for this area. The client, Phil Ronnerud, along with the NAU Crown Engineering team members and advisors (Mark Lamer and Thomas Loomis) decided that the levee design project should be split into three capstone projects. The scope of NAU Crown Engineering's work was then narrowed to creating various well-detailed Gila River flow analysis models in HEC-RAS. These models will be used in future capstone projects as a base for the other aspects of levee design.

While in Duncan, the team was also able to view the agricultural dike that is currently in place, and see some of the damage caused by past floods. After seeing the town, it is very obvious how an overtopped dike would cause such extensive damage. While the dike is able to protect Duncan from high re-occurrence flood events, a new levee will also protect Duncan from the high flow, low reoccurrence floods.

The first section of the dike that NAU Crown Engineering visited is shown in Figure 2.4. The dike runs next to, and then ties in to the railroad tracks that go through town. The left side of the picture shows the railroad tracks, and the right side shows the dike that is currently protecting Duncan. At this particular location, the group was able to see how the neighborhood behind the railroad tracks still experiences flooding. Because the dike is not long enough, he levee that will be designed will need to tie in farther upstream or at a higher elevation.

***Figure 2.4**-Section of Agricultural Dike*

The second location that the group was able to view was the intersection of the dike and the bridge. As shown in Figure 2.5, this area of the floodplain is covered heavily in vegetation. The three main types of vegetation in this reach of the Gila River floodplain are: willow, cottonwood trees, and tamarisk (salt cedar). The group was able to see the river flowing at approximately 400 cfs. This flow looked like a trickle through the area of undisturbed floodplain. The client estimated that the floodplain for the Gila River along this stretch is about 1,300 feet wide. Figure 2.6 shows the Gila River as it was flowing on September 25th, 2015. This 400 cfs flow can be compared to the 48,000 cfs flow will be used as the 100 year flood. Imagining a flow rate 120 times greater than what is shown in Figure 8 flowing through the confines of the dike, it is easy to understand how the current dike fails after large storm events. It is also easy to see how these failures cause severe damage to the town.

***Figure 2.5**-Highway 75 Bridge*

After the bridge, the group visited the site of the old wastewater treatment plant. Figure 2.7 shows the surrounding area. Although the river was barely visible at this location, Mr. Ronnerud explained that this area becomes completely submerged in large flood events. This submersion causes potential

***Figure 2.6**-Gila River*

contamination issues in the Gila River. Putting an end to this contamination output will help towns downstream of this wastewater plant to have cleaner, safer water.

The last location that the team visited on this site assessment was the other end of the dike. This side of the dike also ties into the railroad tracks. Figure 2.8 illustrates this tie-in location. This area is flat, and flood water occasionally comes over the dike and floods Highway 70.

Figure 2.7*-Pumping Station for Siphon*

Figure 2.8-Downstream Tie in Location

3.0 Methods and Analysis

3.1 Data Collection

Prior to creating the effective, corrective effective, and proposed conditions models of the Gila River reach, technical information was required to assist in the methodology and generation of the models produced in Civil 3D and HEC-RAS. The following subsections present the obtained data that was implemented.

3.1.1 Hydraulics and Hydrology

The Gila River at Duncan is subject to a watershed area of approximately 3,800 square miles. According to a 2015 hydrology and geomorphology study, Apache Grove, which is 10 miles downstream of Duncan is estimated to receive a 100 year flow of 47,400 cfs [8]. Mr. Ronnerud, the client, requested that a 100 year flow of 48,000 cfs be applied to the hydrologic models produced [6].

3.1.2 Surveying Data

NAU Crown Engineering was not required to collect primary survey data, as LiDAR data over Duncan was provided by the client. The provided LiDAR points feature 164 sq. miles of the Gila River floodplain and were collected over the period of three days, through 137 flight lines by the Riegl LMS Q560. The Lidar study was conducted by Utah State University and further processed by Kimley-Horn and Associates. This information was essential in establishing elevation points to the study reach and its respective cross sections.

3.1.3 Regulations to Follow

It is important for government agencies, including FEMA, to ensure the safety of citizens and their area by making them aware of the risk that is associated with living behind a levee. To reduce this risk, it is necessary to have proper regulatory framework for designing and constructing levees. Before constructing a levee, the design must be certified by a professional engineer or a federal agency that designs levees. For the scope of this project, The *Code of Federal Regulations Section 65.10* and the *Study Guidelines and Specifications for Study Contractors* were used to provide guidance in the floodplain analysis and levee height and alignment of this project [9], [10].

3.2 Analysis of Gila River Reach

The analysis of this project relies on the use of Civil 3D and HEC-RAS. The methodology used and the results from each software are discussed in the following subsections.

3.2.1 Civil 3D

The application of Civil 3D determined the topographical conditions along the investigated reach. This information is crucial for the corrected effective and proposed conditions models. The software was used as a means to define the river reach and its respective cross sections that feature elevation values. To create an existing conditions surface in CIVIL3D, an 18,586 ft. alignment with 24 sample lines was created. Figure 3.1 represents the Civil 3D model from which the data was exported to HEC-RAS for further analysis.

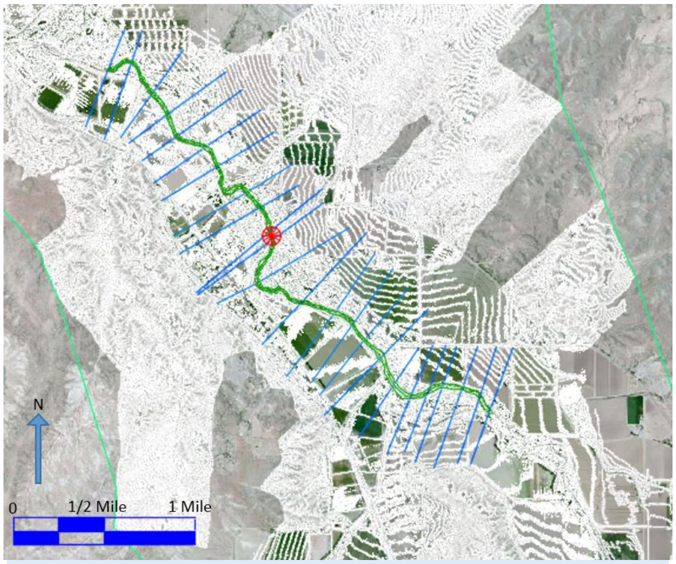

Figure 3.1-Civil 3D Model

3.2.2 HEC-RAS Modeling

HEC-RAS software simulates flooding conditions for a defined waterway's reach and determines hydraulic properties that impact flow. HEC-RAS software was used to produce the effective, corrected effective, and proposed conditions models of the Gila River at Duncan. Each model and its findings are discussed in the following sub-sections.

3.2.2.1 Effective Model

The purpose of the effective model is to replicate the existing model that FEMA created for its 2007 Flood Insurance Study of Duncan [1]. This provides insight to the previous testing method and accuracy of the original model. While the current FIRM of Duncan was produced in 2007, its topographical data is based on survey information collected from 1975-1976 [1]. The client provided an original HEC-2 model from the Arizona Department of Water Resources taken in 1988. Despite the model's date, it reflects data collected from 1975 and was identified as the oldest model on record at Greenlee County.

Through manual input of the provided HEC-2 data, the model was re-produced in HEC-RAS. The client requested that the model match the original water surface elevations within 6 inches of the upstream and downstream ends of defined Gila River reach. Figure 3.2 displays the water surface profile of both the original and reproduced models.

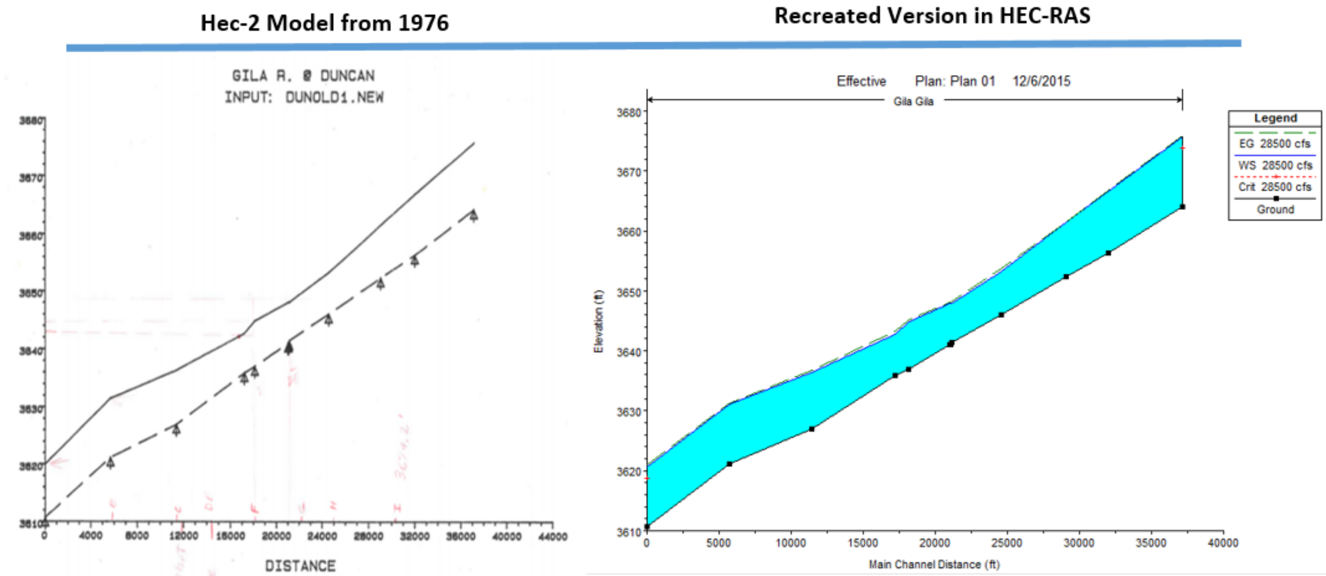

Figure 3.2-Effective Model of the Gila River at Duncan, Arizona

It is important to note that the tested flow of the model used a 100 year flow at 28,500 cfs for the Gila River at Duncan, which has now been updated to 48,000 cfs based on a 2015 hydrology study of the Gila River [8]. In addition to receiving a new 100 year flow condition, the original model also lacked detail in cross section definition and provided limited detail to boundary conditions. While the original model has provided insight to Duncan's flooding conditions for 40 years, it provides an inaccurate analysis of how a 100 year flow would actually behave (*Refer to Appendix D for more detail*).

3.2.2.2 Corrected Effective Model

Moving forward from the outdated effective model, the corrected effective model features updated topographical data from 2012 that is more reflective of current conditions. Furthermore, this model uses a recently determined 100 year flow rate of 48,000 cfs, rather than the original 28,500 cfs flow that used to dictate previous flow models near Duncan.

In total, the corrected effective model features 24 cross sections that span an area of approximately 3.5 miles of the Gila River. Due to the complexity of data points in each cross section, the data filter tool was used to reduce all data points of each cross section to no more than 500 points. Manning's Roughness Coefficient values were assigned to the channel and overbank conditions of the reach. Values are based on aerial photo observations and the application of prescribed values *(Refer to Appendix C)* [11]. Upon determining the characteristics of each cross section, a boundary was defined using a slope of 0.0195 ft/ft and a mixed flow analysis was performed with the flows provided in Table 3.1.

Table 3.1-Corrected Effective flow observations

Flow Recurrence Interval	Flow (cfs)	Observations
Typical	400	▪ All water stays within channel main channel ▪ Water velocities are approximately 1-3 ft./sec
25 Year Flow	28,100	▪ Water overtops several dikes causing 3-7 ft. of flood water in some areas beyond the main channel. ▪ Water velocities are approximately 8ft./sec ▪ Highway 75 Bridge becomes submerged by approximately 3 ft. of water
100 Year Flow	48,000	▪ Floodwaters expand in width ▪ Water velocities are approximately 10 ft./sec ▪ Highway 75 Bridge becomes nearly 5 ft. submerged by water
Record Flow	58,700	• Water velocities are approximately 9 ft./sec • Highway 75 Bridge becomes submerged by 6-7 ft. of water • Nearly all of the existing dike fails

Refer to Appendix D for more details of the model

Just as the original FIRM of Duncan suggests *(see Appendix A)*, the updated floodplain boundary of Duncan shows significant flooding at the 100 year flood event. Figure 3.2 provides a visual of the flood boundary, as well as the defined cross sections used in HEC-RAS.

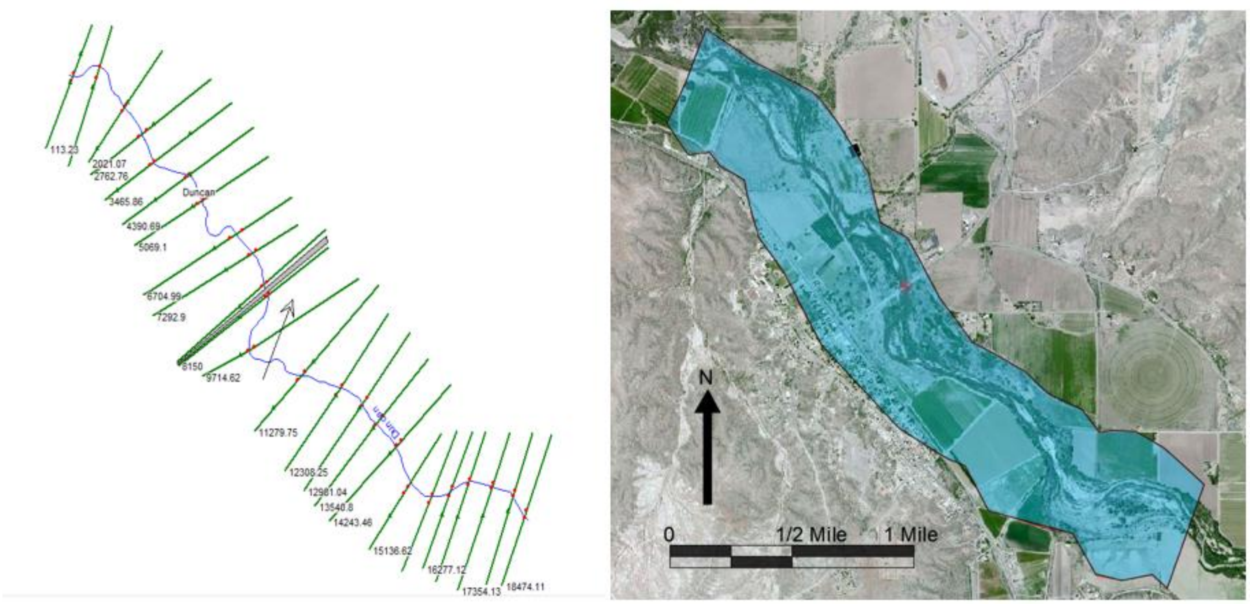

Figure 3.3*-Corrected Effective Model*

3.2.2.3 Proposed Conditions Model

Using the Corrected Effective Model's cross sections, defined reach, and topography, the proposed conditions model depicts the impact of a levee to the Gila River floodplain at Duncan. According the CFR 65.10, levees are to have at least 3 feet of free board from the 100 year floods' water surface elevation and must have at least 4 feet of free board within 100 feet of infrastructures, such as bridges [9]. These conditions were met in the levees height specification. The alignment of the selected levee was chosen to span 1.9 miles across the 3.5 mile reach of the Gila River being studied. The levee placement follows much of the current dike's path to reduce complications in land availability. However unlike the dike in place, the prescribed levee alignment stretches further to prevent flow water from going around the levee and causing backflow. The chosen levee alignment can be seen in in Figure 3.3.

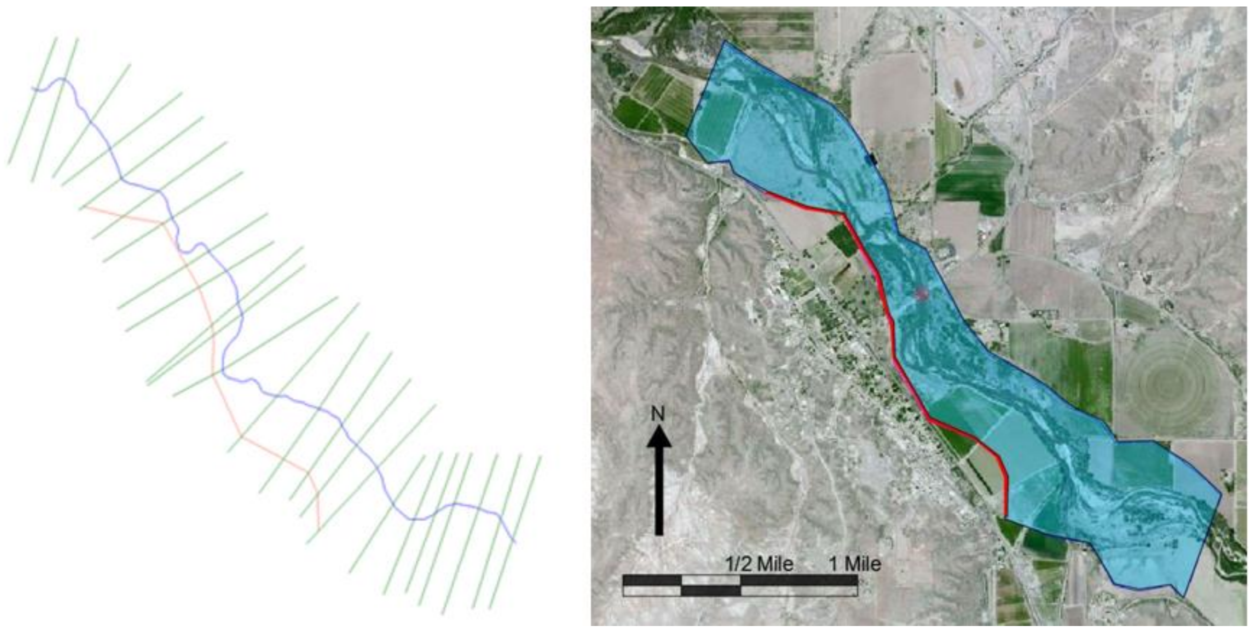

Figure 3.4-*Proposed Conditions Model*

The flows tested for the proposed conditions model are provided in Table 3.2 as well as any notable observations made during each flow.

Table 3.2-Proposed conditions flow observations

Flow Type	Flow (cfs)	Observations
Typical	400	▪ All water stays within channel main channel ▪ Water velocities are approximately 1-3 ft./sec
25 Year Flow	28,100	▪ Levee begins containing water ▪ Water velocities are approximately 7-8 ft./sec
100 Year Flow	48,000	▪ Water velocities are approximately 8-9 ft./sec ▪ 3 ft. of freeboard maintained ▪ Water is partially submerging Highway 75 Bridge
Record Flow	58,700	▪ Floodwaters are contained with only subtle differences in the hydraulics of the river.

**Refer to Appendix D for more details of the model*

While the prescribed levee provides Duncan with adequate protection against 100 year flood events, it may not be the best solution for Duncan. In the past, levee fortifications have been suggested for Duncan but were ultimately turned down due to economics [7]. With that said, the goal of Duncan is to seek the highest level of protection at the lowest possible cost. While the proposal of a levee should not be disregarded altogether, other alternatives may also lead to improved flood control. These alternative are explored in Table 3.3.

Table 3.3- Alternative Proposed Conditions

Flow Recurrence Interval	Description	Observations at the 100 year flow (48,000 cfs)
Agricultural Dike Removal	A ~1.5mile agricultural dike dictates much of the floodplain boundary in Duncan. An analysis was performed to see how the removal of this dike impacts flooding conditions. In HEC-RAS, these changes were made by shifting the dike's elevation points to those of the surrounding ground level.	▪ Velocities slightly increased/decreased along all cross sections in comparison to the corrected effective model. ▪ Water surface elevations tended to drop in most cross sections
Floodplain Restoration	The Duncan floodplain features an over-abundance of vegetation. The most distinguished of which is the salt cedar (tamarisk) and the cotton wood. Salt cedars are invasive to the area and outcompete natural plants. If this overabundance of vegetation were cleared, the floodplain would have a more uniform Manning's Coefficient that would ultimately allow for more efficient flow. In HEC-RAS, these changes were made by labeling Manning's overbank conditions a constant 0.045, which portrays medium to dense brush.	▪ Velocities slightly increased in comparison to the corrected effective model. ▪ Water surface elevations tended to drop in most cross sections
Soil Excavation	On the northeastern portion of Duncan's floodplain, it is evident that less infrastructure is available. Ideally, floodwater should be pushed in this direction to minimized damage in infrastructure. This could be done by clearing out soil and expanding the northeast portion of the floodplain. Specifically, the client requested removing soil from the retired wastewater treatment facility that resides just downstream of the Highway 75 bridge. In HEC-RAS, these changes were made leveling the right overbanks of the cross sections downstream of the bridge.	▪ Floodplain boundary expands in the northern direction just downstream of the Highway 75 Bridge ▪ Water surface elevation differences are negligible across entire reach

**Refer to Appendix D for more details of each model*

4.0 Cost of Implementing the Design

In order to complete this project, the group spent a total of 614.7 hours on a variety of tasks. The tasks were broken down into five sections: meetings, research, cross sections/ survey data, HEC-RAS, and report preparation. Table 4.1 shows a breakdown of these hours that the group spent in each category.

Table 4.1- Breakdown of hours

	Meetings	Research	Cross Sections/ Survey Data	HEC-RAS	Report Preparation	Total
Total Hours	222.9	101.5	84.75	115	90.5	614.7

The hours accumulated in the 'meetings' section consist of a variety of meetings. These meetings include the field visit, time spent acquiring help from people outside of NAU Crown Engineering, and time spent working on the project as a whole group. The 'research' hours are hours that each individual spent finding information. Some examples of the information found during these hours includes: flows/storms associated with this section of the Gila River, other important details about the area of focus, and Manning's values. 'Cross sections/survey data' consists of hours spent in ARC-GIS and CIVIL 3D, trying to get the topography and alignment/cross sections of the Gila River and its floodplain ready to be exported to HEC-RAS for modeling. The hours in the 'HEC-RAS' category are hours spent learning HEC-RAS, and ours spent completing all necessary floodplain models. The 'report preparation' category contains hours spent completing both the 50% and final design reports.

Table 4.2 shows the allocation of hours to each of the four theoretical engineering positions that NAU Crown Engineering has personnel working on the floodplain analysis and conceptual levee alignment along the Gila River.

Table 4.2- Theoretical cost for engineering services

Personnel	Hours	Price per hour ($/hr)	Total Price ($)
Senior Engineer (SENG)	91	95.00	8,645.00
Professional Engineer (PE)	121	55.00	6,655.00
Engineer In Training (EIT)	156	35.00	5,460.00
Intern	247	20.00	4,940.00
Total Hours	615	**TOTAL COST ($)**	**25,700.00**

The SENG spent 91 hours on the project. At $95 an hour, the total cost to have the SENG work on the project comes to $8,645.00. The PE spent 121 hours on the project. At $55 an hour, the cost of services for this personnel comes to $6,655.00. Similarly, the 156 hours that the EIT spent on this project cost $5,460.00, and the 247 hours the intern put into the project comes to $4,940. The sum of all these personnel costs for the completion of a floodplain analysis and conceptual levee alignment comes to $25,700.00.

Since doing design work for the levee was outside the scope of services of NAU Crown Engineering, no construction costs will be provided.

4.1 Project Schedule

The project initiated on September 1st, 2015 and was completed on December 16th, 2015, in accordance with Northern Arizona University's academic calendar. The tasks of the project and their respective deadlines are available in Figure 4.1 below.

Floodplain Analysis and Levee Alignment along the Gila River in Duncan, AZ

ACTIVITY	Begin Date	End Date
Task 1 Data Collection	1-Sep	24-Sep
1.1 Gila River Hydraulics/Hydrology	1-Sep	24-Sep
1.2 Surveying Data	10-Sep	24-Sep
1.3 Relavent Regulations	10-Sep	24-Sep
Task 2 Site Assessment	25-Sep	6-Nov
2.1 Site Visit	25-Sep	25-Sep
2.3 Determination of Manning's Coeff.	26-Sep	16-Oct
Task 3 Floodplain Analysis/Levee Alignment	26-Sep	9-Dec
3.1 AutoCAD Civil 3D (Topography)	26-Sep	11-Oct
3.2 HEC-RAS Testing	5-Oct	9-Dec
-Effective Model	5-Oct	9-Nov
-Corrective Effective Model	16-Oct	30-Nov
-Proposed Conditions Model	16-Oct	7-Dec
Task 4 Project Management	1-Sep	16-Dec
4.1 Client Contact	1-Sep	16-Dec
4.2 Deliverables		
-50% Design Report	22-Oct	
-Presentation at NAU	11-Dec	
-Final Design Report	16-Dec	

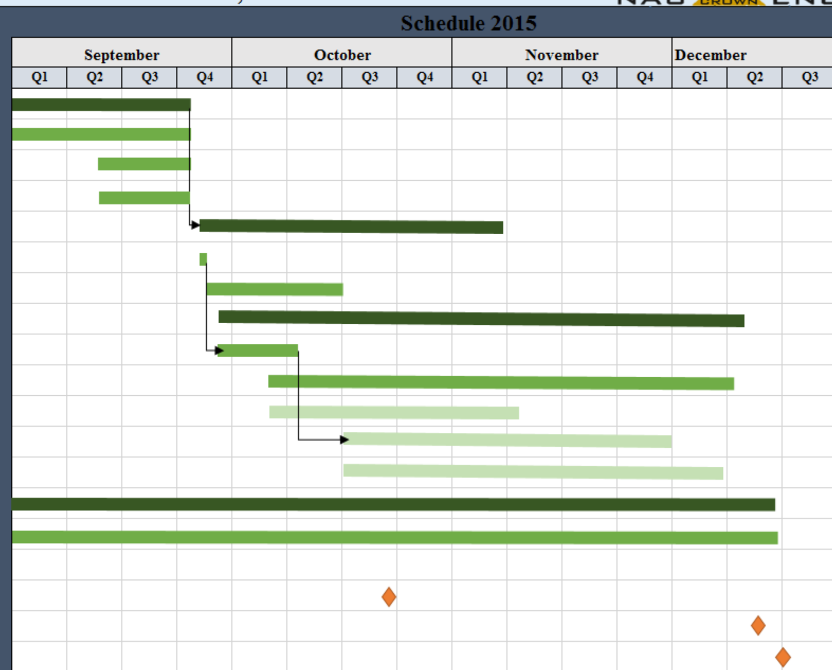

Figure 4.1-Project Gantt Chart

5.0 Summary of Project Costs

Since NAU Crown Engineering was not responsible for the design or construction of the proposed levee, the only project costs are the personnel costs, listed in Table 4.2. It is beyond the scope of the project to determine the estimated cost for the implementation of the 1.9 mile levee proposed.

6.0 Conclusion and Recommendations

If a 100 year flood event were to occur in Duncan today, the town would encounter severe breaches in its current agricultural dike. The dike does not provide enough strength, nor mass to hold back flood waters of 48,000 cfs and is not long enough to prevent water from going into the town around its tie in locations. This is a recurring event in Duncan and can be verified through flood events that occurred in 1978 and 2005. While floodplain remediation methodologies may be used to reduce the intensity of flood waters, nothing better protects the town than the development of a 1.9 mile long levee.

Despite the correction method applied to the floodplain, all models displayed water submersion of the Highway 75 Bridge during 100 year flow conditions. It is recommended that an additional study be placed on the impact that the Highway 75 Bridge has on the flood water and whether there are any methodologies available to prevent the bridge from becoming submerged. Additionally, it is recommended that a more detailed study be performed over the floodplain by applying Flo 2D software in place of HEC-RAS. Since HEC-RAS only analyzes waterways in one dimension, it does not properly reflect how water actually behaves in the floodplain and may yield floodplain characteristics that are inaccurate. Lastly, a field survey should be performed to verify the accuracy of the topography captured by the LiDAR data used in this report. Regardless of any inaccuracies presented in the HEC-RAS models, it is clear that the Town of Duncan is in risk of flooding and requires some form of remediation to help protect against future floods.

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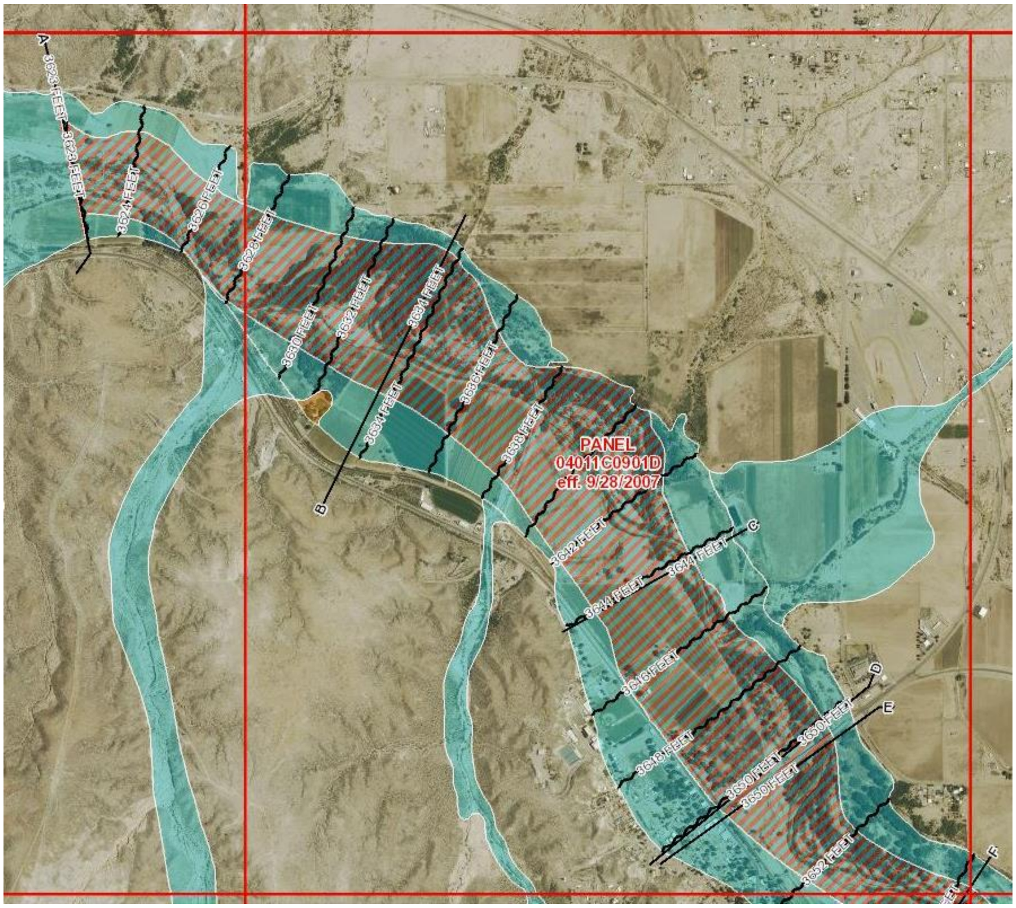
Appendices

Appendix A-FIRM of Duncan Area



Areas in blue, surrounding the Gila River, show projections of how far the 100 year flood will spread. This information is used by FEMA's National Flood Insurance Program to assess flood risk for insurance companies. If a certified levee were in place, the flood risk of Duncan would decrease and insurance rates would lower [12].

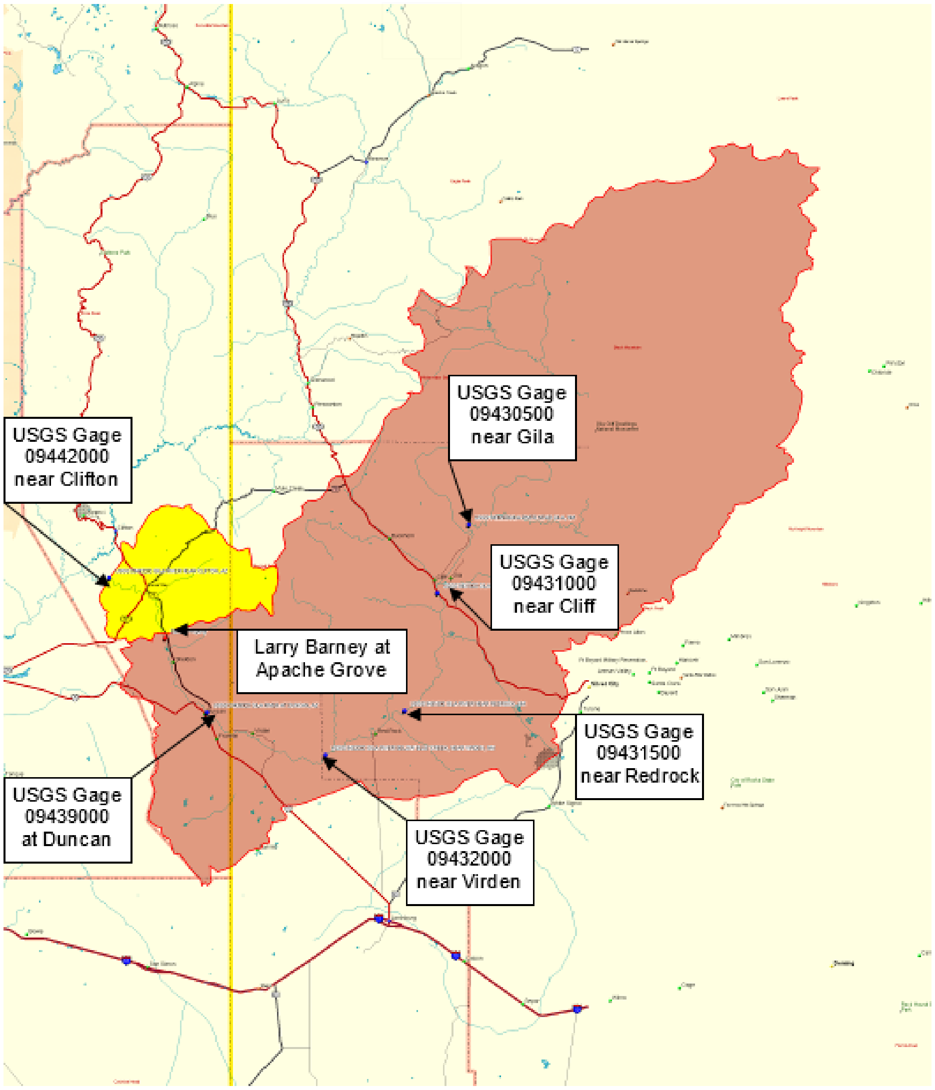
FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Gila River								
A	0	1,308	5,784	4.9	3622.6	3,622.6	3,623.5	0.9
B	5,700	2,083	9,353	3.0	3633.9	3,633.9	3,634.8	0.9
C	11,520	1,411	6,951	4.1	3644.3	3,644.3	3,645.2	0.9
D	14,485	1,830/ 840[2]	8,183	3.5	3650.3	3,650.3	3,651.2	0.9
E	14,595	1,770/ 820[2]	7,813	3.6	3650.4	3,650.4	3,651.3	0.9
F	18,040	905	4,673	6.1	3654.5	3,654.5	3,655.4	0.9
G	22,515	2,071	12,812	2.2	3665.2	3,665.2	3,666.2	1.0
H	25,465	1,302	5,737	5.0	3668.2	3,668.2	3,669.1	0.9
I	30,600	847	3,204	8.9	3676.6	3,676.6	3,677.1	0.5

[1] Feet above Limit of Detailed Study
[2] Width/Width Within City of Duncan

TABLE 8 — FEDERAL EMERGENCY MANAGEMENT AGENCY
GREENLEE COUNTY, ARIZONA
AND INCORPORATED AREAS

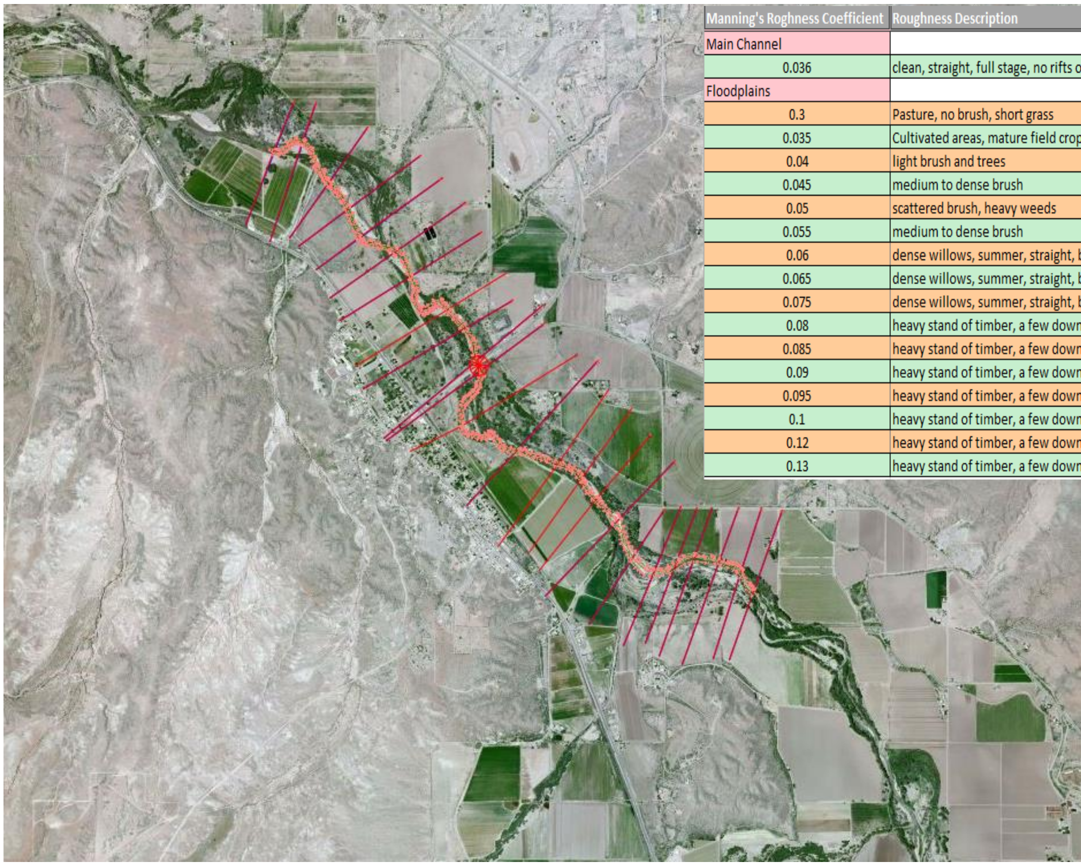
FLOODWAY DATA
GILA RIVER

Appendix B-Watershed Area of the Gila River near Duncan



The area in red indicates the ~3200 square mile watershed that drains into the Gila River at Duncan [8].

Appendix C- Determination of Manning's Roughness Coefficients

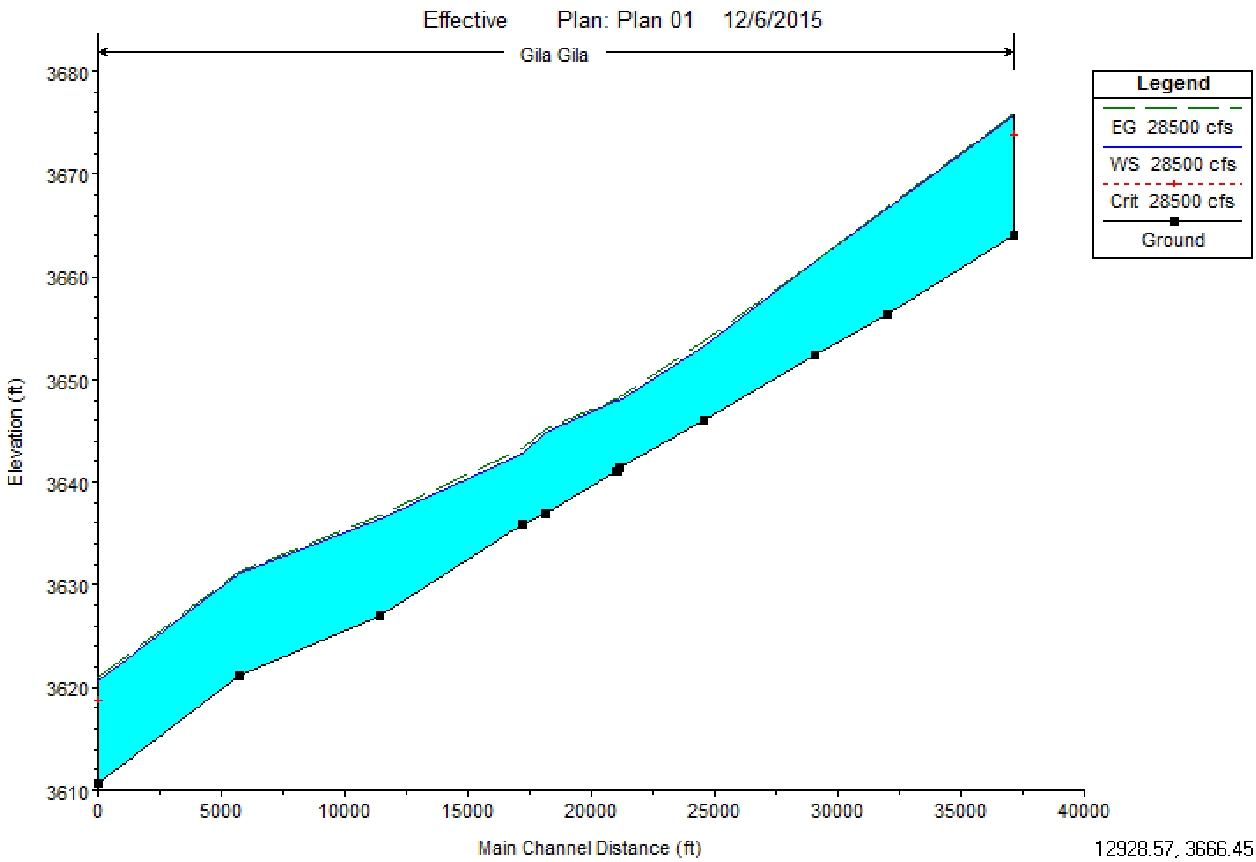


Manning's Roghness Coefficient	Roughness Description
Main Channel	
0.036	clean, straight, full stage, no rifts or deep pools, But more stones and weeds
Floodplains	
0.3	Pasture, no brush, short grass
0.035	Cultivated areas, mature field crops
0.04	light brush and trees
0.045	medium to dense brush
0.05	scattered brush, heavy weeds
0.055	medium to dense brush
0.06	dense willows, summer, straight, but with heavy growth of sprouts
0.065	dense willows, summer, straight, but with heavy growth of sprouts
0.075	dense willows, summer, straight, but with heavy growth of sprouts
0.08	heavy stand of timber, a few down trees, little undergrowth, flood stage below branches
0.085	heavy stand of timber, a few down trees, little undergrowth, flood stage below branches
0.09	heavy stand of timber, a few down trees, little undergrowth, flood stage below branches
0.095	heavy stand of timber, a few down trees, little undergrowth, flood stage below branches
0.1	heavy stand of timber, a few down trees, little undergrowth with flood stage reaching branches
0.12	heavy stand of timber, a few down trees, little undergrowth with flood stage reaching branches
0.13	heavy stand of timber, a few down trees, little undergrowth with flood stage reaching branches

Appendix D- HEC-RAS Models

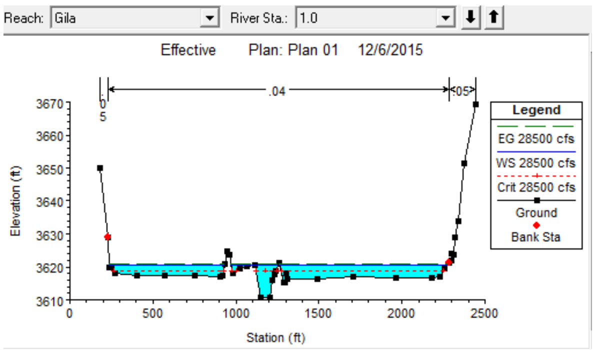
Effective Model

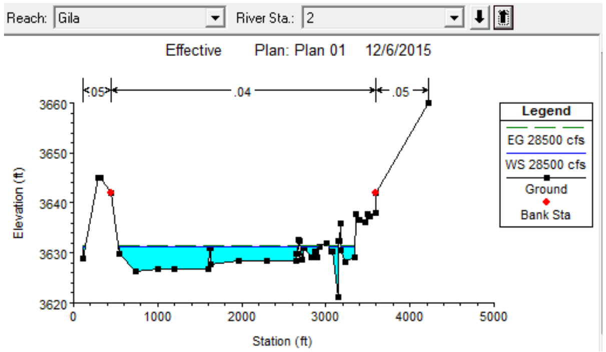
Water Surface Profile

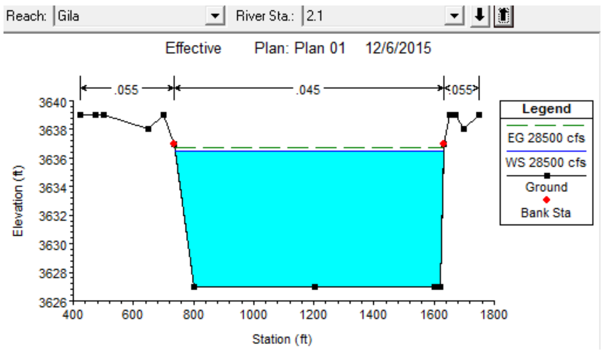


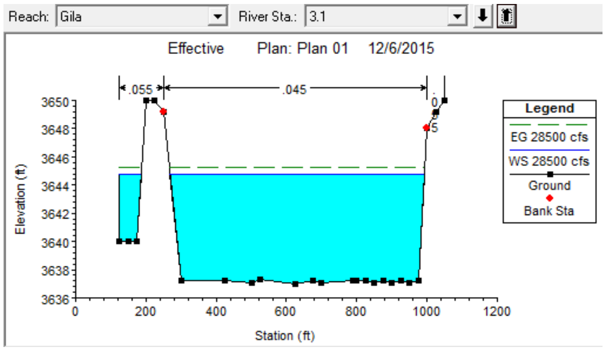
Profile Summary Table

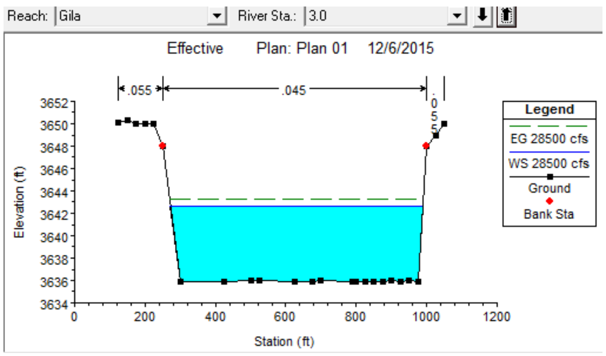
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Gila	9.0	28500 cfs	28500.00	3664.10	3675.72	3673.74	3675.94	0.002211	3.78	7549.38	2365.69	0.37
Gila	8.0	28500 cfs	28500.00	3656.30	3666.68		3666.84	0.001447	3.20	8902.98	2607.09	0.31
Gila	7	28500 cfs	28500.00	3652.30	3661.41		3661.55	0.002266	3.00	9675.41	3091.25	0.30
Gila	6.0	28500 cfs	28500.00	3646.00	3653.28		3653.68	0.001397	5.08	5611.78	798.89	0.34
Gila	5.0	28500 cfs	28500.00	3641.40	3647.90		3648.25	0.001778	4.74	6008.44	951.84	0.33
Gila	4.2	28500 cfs	28500.00	3641.00	3648.01		3648.17	0.000359	3.13	9115.61	1500.23	0.22
Gila	4.1	28500 cfs	28500.00	3641.00	3648.00		3648.15	0.000362	3.13	9098.03	1499.64	0.22
Gila	4	28500 cfs	28500.00	3641.00	3647.98		3648.13	0.000649	3.14	9067.65	1498.61	0.23
Gila	3.1	28500 cfs	28500.00	3637.00	3644.80		3645.21	0.001728	5.19	5613.41	786.26	0.34
Gila	3.0	28500 cfs	28500.00	3635.90	3642.68		3643.26	0.002762	6.06	4699.76	717.05	0.42
Gila	2.1	28500 cfs	28500.00	3627.00	3636.50		3636.69	0.000594	3.50	8140.73	893.18	0.20
Gila	2	28500 cfs	28500.00	3621.20	3631.19		3631.36	0.001684	3.33	8568.19	2658.82	0.33
Gila	1.0	28500 cfs	28500.00	3610.70	3620.67	3618.67	3620.91	0.002003	3.92	7264.90	1998.86	0.36

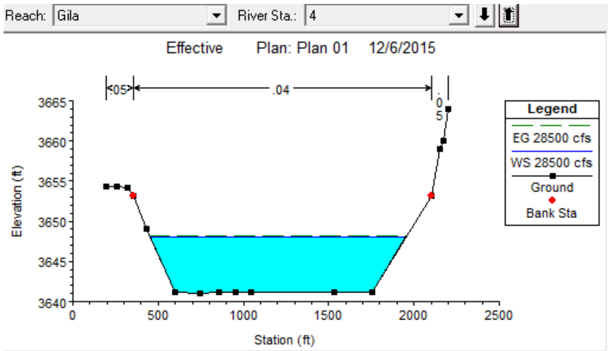

Reach: Gila
River Sta.: 1.0
Effective Plan: Plan 01 12/6/2015
.04
Legend
EG 28500 cfs
WS 28500 cfs
Crit 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

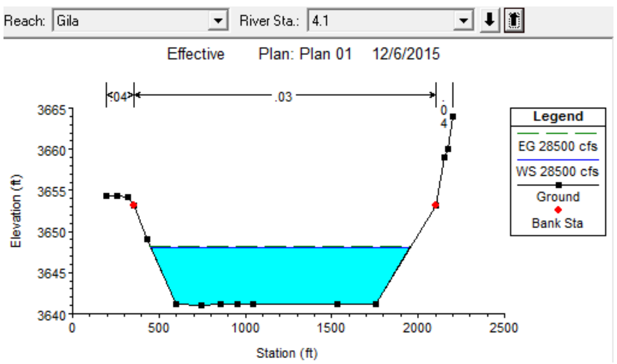

Reach: Gila
River Sta.: 2
Effective Plan: Plan 01 12/6/2015
.04
.05
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

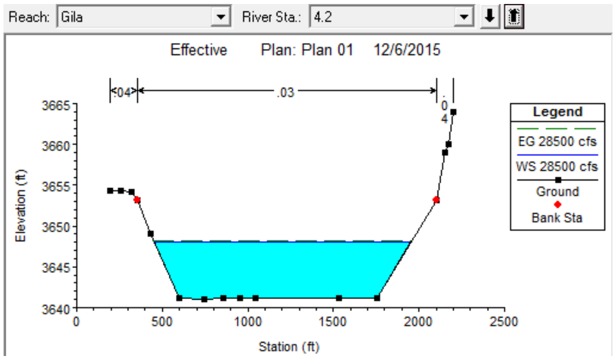

Reach: Gila
River Sta.: 2.1
Effective Plan: Plan 01 12/6/2015
.055
.045
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

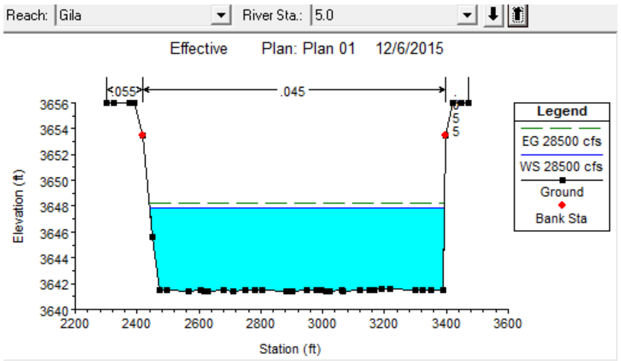

Reach: Gila
River Sta.: 3.1
Effective Plan: Plan 01 12/6/2015
.055
.045
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

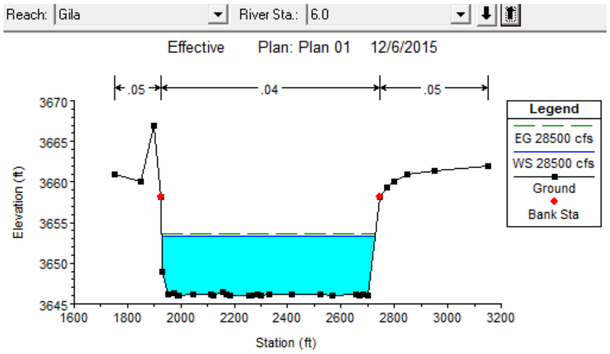

Reach: Gila
River Sta.: 3.0
Effective Plan: Plan 01 12/6/2015
.055
.045
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

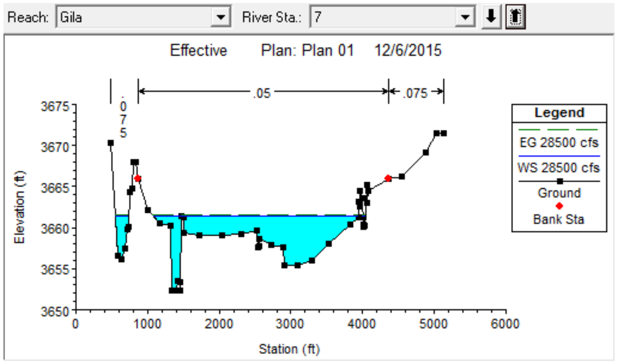

Reach: Gila
River Sta.: 4
Effective Plan: Plan 01 12/6/2015
.04
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

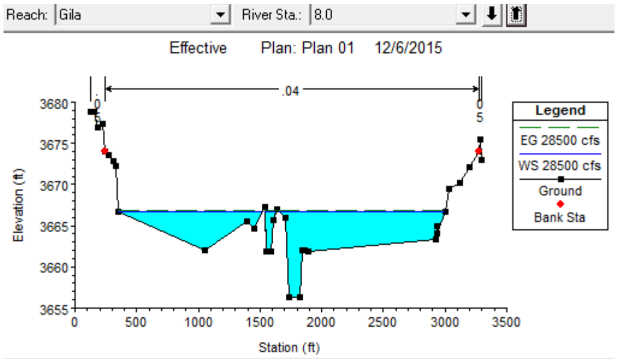

Reach: Gila
River Sta.: 4.1
Effective Plan: Plan 01 12/6/2015
.03
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

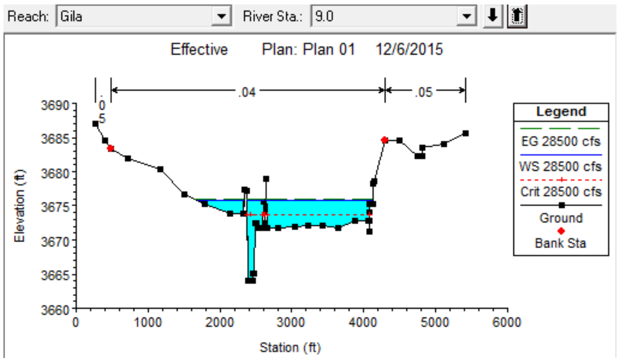

Reach: Gila
River Sta.: 4.2
Effective Plan: Plan 01 12/6/2015
.03
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Gila
River Sta.: 5.0
Effective Plan: Plan 01 12/6/2015
.055
.045
.055
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

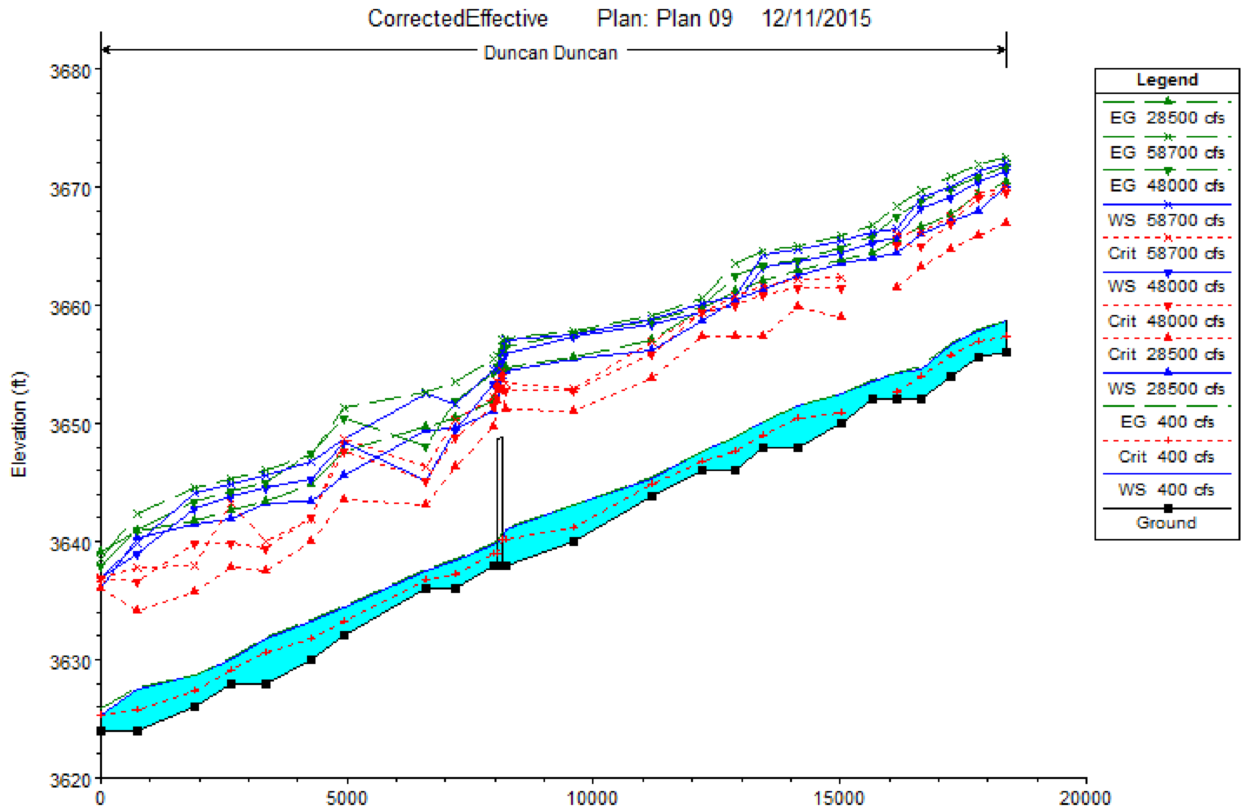

Reach: Gila
River Sta.: 6.0
Effective Plan: Plan 01 12/6/2015
.05
.04
.05
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

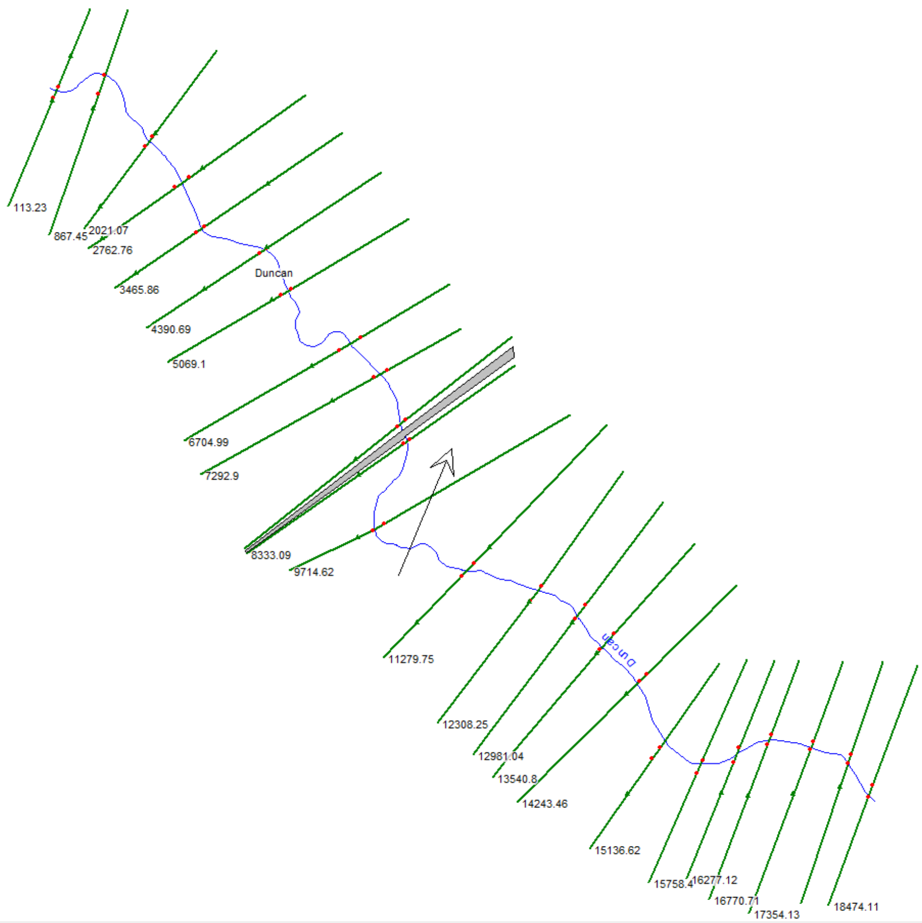

Reach: Gila
River Sta.: 7
Effective Plan: Plan 01 12/6/2015
.075
.05
.075
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Gila
River Sta.: 8.0
Effective Plan: Plan 01 12/6/2015
.05
.04
.05
Legend
EG 28500 cfs
WS 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Gila
River Sta.: 9.0
Effective Plan: Plan 01 12/6/2015
.05
.04
.05
Legend
EG 28500 cfs
WS 28500 cfs
Crit 28500 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

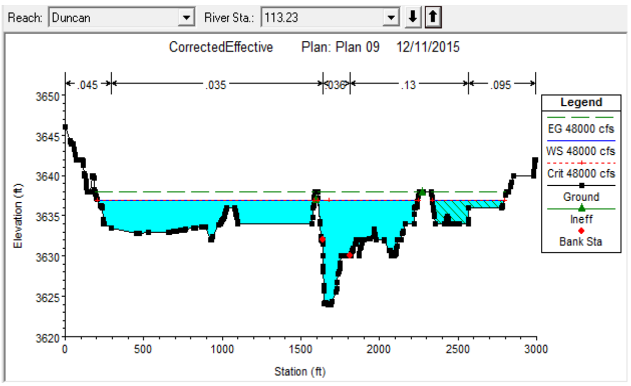
Corrected Effective Model





Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Duncan	18474.11	400 cfs	400.00	3656.00	3658.65	3657.40	3658.72	0.001219	2.14	187.09	102.50	0.28
Duncan	18474.11	28500 cfs	28500.00	3656.00	3670.15	3666.89	3670.47	0.001009	6.48	9370.75	2665.91	0.34
Duncan	18474.11	48000 cfs	48000.00	3656.00	3671.29	3669.49	3671.74	0.001350	8.00	12436.13	2673.23	0.40
Duncan	18474.11	58700 cfs	58700.00	3656.00	3672.13	3669.98	3672.56	0.001250	8.04	14679.82	2681.42	0.39
Duncan	17936.15	400 cfs	400.00	3655.61	3657.85	3656.90	3657.94	0.001745	2.45	163.23	95.86	0.33
Duncan	17936.15	28500 cfs	28500.00	3655.61	3667.97	3665.90	3669.43	0.003672	12.07	4759.88	1795.71	0.65
Duncan	17936.15	48000 cfs	48000.00	3655.61	3670.40	3669.08	3670.94	0.001601	9.13	12151.00	2726.40	0.44
Duncan	17936.15	58700 cfs	58700.00	3655.61	3671.37	3669.42	3671.85	0.001380	8.89	14871.38	2889.96	0.42
Duncan	17354.13	400 cfs	400.00	3654.00	3656.68	3655.75	3656.79	0.002242	2.77	144.31	84.94	0.37
Duncan	17354.13	28500 cfs	28500.00	3654.00	3667.03	3664.68	3667.71	0.001907	8.93	5758.85	2371.97	0.47
Duncan	17354.13	48000 cfs	48000.00	3654.00	3669.07	3666.88	3669.90	0.001945	10.09	8761.83	3016.41	0.49
Duncan	17354.13	58700 cfs	58700.00	3654.00	3669.97	3667.56	3670.87	0.001969	10.61	10204.36	3199.70	0.50
Duncan	16770.71	400 cfs	400.00	3652.00	3654.52	3653.93	3654.82	0.005509	4.39	91.06	52.59	0.59
Duncan	16770.71	28500 cfs	28500.00	3652.00	3666.06	3663.27	3666.57	0.001837	8.00	7227.65	2953.00	0.45
Duncan	16770.71	48000 cfs	48000.00	3652.00	3668.21	3665.02	3668.76	0.001699	8.78	11048.86	3234.97	0.45
Duncan	16770.71	58700 cfs	58700.00	3652.00	3669.13	3666.24	3669.72	0.001683	9.18	12809.98	3322.86	0.45
Duncan	16277.12	400 cfs	400.00	3652.00	3654.21	3652.68	3654.24	0.000413	1.30	308.90	163.54	0.16
Duncan	16277.12	28500 cfs	28500.00	3652.00	3664.37	3661.53	3665.52	0.002273	9.62	5913.32	2518.28	0.51
Duncan	16277.12	48000 cfs	48000.00	3652.00	3665.67	3665.20	3667.50	0.003467	12.82	8129.53	2758.82	0.65
Duncan	16277.12	58700 cfs	58700.00	3652.00	3666.48	3666.00	3668.44	0.003628	13.68	9607.38	3081.77	0.67
Duncan	15758.4	400 cfs	400.00	3652.00	3653.52		3653.69	0.005407	3.35	119.26	102.18	0.55
Duncan	15758.4	28500 cfs	28500.00	3652.00	3664.01		3664.42	0.001315	6.95	10041.78	2591.13	0.39
Duncan	15758.4	48000 cfs	48000.00	3652.00	3665.31		3665.87	0.001755	8.71	13496.29	2703.48	0.46
Duncan	15758.4	58700 cfs	58700.00	3652.00	3666.21		3666.77	0.001698	9.01	16009.85	3071.88	0.45
Duncan	15136.62	400 cfs	400.00	3650.00	3652.52	3650.96	3652.56	0.000862	1.73	238.02	153.59	0.23
Duncan	15136.62	28500 cfs	28500.00	3650.00	3663.50	3658.98	3663.77	0.000735	5.65	12251.68	2696.94	0.29
Duncan	15136.62	48000 cfs	48000.00	3650.00	3664.44	3661.50	3664.92	0.001272	7.84	15173.85	3035.98	0.39
Duncan	15136.62	58700 cfs	58700.00	3650.00	3665.40	3662.32	3665.85	0.001201	8.00	18238.13	3412.26	0.39
Duncan	14243.46	400 cfs	400.00	3648.00	3651.46	3650.47	3651.54	0.001572	2.25	178.12	110.30	0.31
Duncan	14243.46	28500 cfs	28500.00	3648.00	3662.52	3659.81	3662.94	0.001144	7.09	7058.83	3011.71	0.37
Duncan	14243.46	48000 cfs	48000.00	3648.00	3663.61	3661.51	3663.89	0.000918	6.74	15150.97	3069.34	0.33
Duncan	14243.46	58700 cfs	58700.00	3648.00	3664.68	3662.19	3664.94	0.000763	6.49	18571.60	3261.31	0.31
Duncan	13540.8	400 cfs	400.00	3648.00	3650.10	3649.00	3650.19	0.002406	2.39	167.08	129.40	0.37
Duncan	13540.8	28500 cfs	28500.00	3648.00	3661.27	3657.42	3662.00	0.001456	7.50	4775.35	2862.97	0.41
Duncan	13540.8	48000 cfs	48000.00	3648.00	3663.22	3660.88	3663.40	0.000489	4.86	19776.64	2954.72	0.24
Duncan	13540.8	58700 cfs	58700.00	3648.00	3664.31	3661.66	3664.50	0.000468	5.03	23036.08	3012.23	0.24
Duncan	12981.04	400 cfs	400.00	3646.00	3648.77	3647.63	3648.87	0.002347	2.45	163.15	119.64	0.37
Duncan	12981.04	28500 cfs	28500.00	3646.00	3660.38	3657.36	3661.15	0.001598	7.88	4594.14	2775.10	0.43
Duncan	12981.04	48000 cfs	48000.00	3646.00	3659.99	3659.99	3662.51	0.005455	14.21	4293.32	2758.37	0.79
Duncan	12981.04	58700 cfs	58700.00	3646.00	3660.73	3660.73	3663.59	0.005775	15.31	4867.37	2790.26	0.82
Duncan	12308.25	400 cfs	400.00	3646.00	3647.64	3646.71	3647.70	0.001302	1.97	202.60	132.23	0.28
Duncan	12308.25	28500 cfs	28500.00	3646.00	3658.62	3657.31	3659.73	0.002777	9.33	4144.88	2776.88	0.55
Duncan	12308.25	48000 cfs	48000.00	3646.00	3659.47	3659.47	3659.88	0.001595	7.44	14552.60	2789.73	0.42
Duncan	12308.25	58700 cfs	58700.00	3646.00	3660.08	3659.47	3660.54	0.001738	8.06	16263.82	2830.65	0.44

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Duncan	11279.75	400 cfs	400.00	3643.84	3645.34	3644.81	3645.49	0.004121	3.13	127.89	99.53	0.49
Duncan	11279.75	28500 cfs	28500.00	3643.84	3656.21	3653.88	3657.11	0.002243	8.78	6248.53	2439.56	0.50
Duncan	11279.75	48000 cfs	48000.00	3643.84	3658.33	3655.95	3658.63	0.000895	6.34	14926.83	2569.76	0.33
Duncan	11279.75	58700 cfs	58700.00	3643.84	3658.77	3656.87	3659.14	0.001079	7.13	16052.14	2571.59	0.36
Duncan	9714.62	400 cfs	400.00	3640.00	3643.09	3641.23	3643.16	0.000751	2.08	192.52	76.59	0.23
Duncan	9714.62	28500 cfs	28500.00	3640.00	3655.45	3651.09	3655.61	0.000418	4.49	10434.65	2810.92	0.22
Duncan	9714.62	48000 cfs	48000.00	3640.00	3657.37	3652.77	3657.61	0.000478	5.29	13983.95	2876.52	0.25
Duncan	9714.62	58700 cfs	58700.00	3640.00	3657.45	3652.95	3657.79	0.000694	6.39	14117.86	2876.96	0.30
Duncan	8333.09	400 cfs	400.00	3638.00	3641.04	3640.10	3641.25	0.003263	3.65	109.51	56.21	0.46
Duncan	8333.09	28500 cfs	28500.00	3638.00	3654.39	3651.12	3654.72	0.001038	7.25	8309.44	2960.95	0.35
Duncan	8333.09	48000 cfs	48000.00	3638.00	3655.88	3652.74	3656.46	0.001606	9.68	10164.41	3008.92	0.45
Duncan	8333.09	58700 cfs	58700.00	3638.00	3657.06	3653.36	3657.15	0.000267	4.15	27019.72	3068.72	0.18
Duncan	8150		Bridge									
Duncan	8074.69	400 cfs	400.00	3637.95	3639.72	3638.95	3639.84	0.002609	2.79	143.50	94.09	0.40
Duncan	8074.69	28500 cfs	28500.00	3637.95	3650.97	3649.75	3651.89	0.002207	9.73	5235.29	2880.45	0.51
Duncan	8074.69	48000 cfs	48000.00	3637.95	3653.38	3651.50	3654.26	0.001879	10.21	8160.52	3014.81	0.49
Duncan	8074.69	58700 cfs	58700.00	3637.95	3654.51	3652.14	3655.40	0.001782	10.48	9540.30	3056.01	0.48
Duncan	7292.9	400 cfs	400.00	3636.00	3638.43	3637.26	3638.48	0.001215	1.84	217.09	149.47	0.27
Duncan	7292.9	28500 cfs	28500.00	3636.00	3649.59	3646.31	3650.41	0.001581	8.38	5664.24	2949.58	0.43
Duncan	7292.9	48000 cfs	48000.00	3636.00	3649.48	3648.79	3651.90	0.004684	14.34	5546.70	2935.05	0.75
Duncan	7292.9	58700 cfs	58700.00	3636.00	3651.68	3650.31	3653.51	0.003093	13.09	8003.18	3098.78	0.62
Duncan	6704.99	400 cfs	400.00	3636.00	3637.56	3636.77	3637.62	0.001765	2.06	194.21	149.87	0.32
Duncan	6704.99	28500 cfs	28500.00	3636.00	3649.41	3643.13	3649.73	0.000586	5.15	7425.36	2738.86	0.26
Duncan	6704.99	48000 cfs	48000.00	3636.00	3645.15	3645.15	3648.13	0.008937	15.06	4023.76	2222.11	0.96
Duncan	6704.99	58700 cfs	58700.00	3636.00	3652.53	3646.36	3652.64	0.000242	3.87	25242.29	2836.21	0.18
Duncan	5069.1	400 cfs	400.00	3632.00	3634.39	3633.23	3634.50	0.002068	2.68	149.29	87.08	0.36
Duncan	5069.1	28500 cfs	28500.00	3632.00	3645.61	3643.53	3647.61	0.003756	12.47	3159.99	2283.45	0.65
Duncan	5069.1	48000 cfs	48000.00	3632.00	3648.39	3647.62	3650.39	0.003403	13.55	5496.87	2593.68	0.64
Duncan	5069.1	58700 cfs	58700.00	3632.00	3648.68	3648.68	3651.36	0.004511	15.82	5774.11	2601.28	0.74
Duncan	4390.69	400 cfs	400.00	3630.00	3633.25	3631.75	3633.34	0.001429	2.48	175.18	111.79	0.31
Duncan	4390.69	28500 cfs	28500.00	3630.00	3643.42	3640.00	3644.82	0.003933	12.47	3641.58	1506.91	0.66
Duncan	4390.69	48000 cfs	48000.00	3630.00	3645.28	3641.99	3647.43	0.005692	16.33	5264.18	2463.21	0.81
Duncan	4390.69	58700 cfs	58700.00	3630.00	3646.71	3641.90	3647.32	0.001865	9.89	10921.94	2607.85	0.47
Duncan	3465.86	400 cfs	400.00	3628.00	3631.78	3630.64	3631.86	0.001787	2.21	180.90	125.40	0.32
Duncan	3465.86	28500 cfs	28500.00	3628.00	3643.17	3637.50	3643.40	0.000552	5.03	8280.88	1919.84	0.25
Duncan	3465.86	48000 cfs	48000.00	3628.00	3644.63	3639.34	3645.06	0.001032	7.41	11236.87	2469.69	0.35
Duncan	3465.86	58700 cfs	58700.00	3628.00	3645.64	3639.97	3646.06	0.000993	7.62	14153.36	2517.66	0.35
Duncan	2762.76	400 cfs	400.00	3628.00	3630.03	3629.18	3630.17	0.003380	2.95	135.76	91.31	0.43
Duncan	2762.76	28500 cfs	28500.00	3628.00	3641.89	3637.80	3642.72	0.001697	8.18	5381.76	1906.91	0.43
Duncan	2762.76	48000 cfs	48000.00	3628.00	3643.79	3639.89	3644.28	0.001184	7.55	12803.74	2565.03	0.36
Duncan	2762.76	58700 cfs	58700.00	3628.00	3644.90	3643.19	3645.34	0.001041	7.46	15734.06	2675.69	0.35
Duncan	2021.07	400 cfs	400.00	3626.00	3628.67	3627.42	3628.73	0.001225	1.96	216.22	154.35	0.27
Duncan	2021.07	28500 cfs	28500.00	3626.00	3641.41	3635.71	3641.78	0.000735	6.41	9415.49	1953.66	0.30
Duncan	2021.07	48000 cfs	48000.00	3626.00	3642.81	3639.87	3643.42	0.001110	8.41	12013.48	2248.68	0.38
Duncan	2021.07	58700 cfs	58700.00	3626.00	3644.07	3637.94	3644.59	0.000943	8.17	15397.81	2390.15	0.36
Duncan	867.45	400 cfs	400.00	3624.00	3627.53	3625.69	3627.58	0.000830	1.68	237.89	140.74	0.23
Duncan	867.45	28500 cfs	28500.00	3624.00	3640.32	3634.15	3640.85	0.000867	6.45	6155.37	2777.41	0.32
Duncan	867.45	48000 cfs	48000.00	3624.00	3639.02	3636.68	3641.10	0.003835	12.60	4897.05	2589.36	0.67
Duncan	867.45	58700 cfs	58700.00	3624.00	3639.88	3637.83	3642.38	0.004253	13.95	5713.34	2694.42	0.71
Duncan	113.23	400 cfs	400.00	3624.00	3625.33	3625.33	3625.82	0.018385	5.66	70.71	69.23	0.99
Duncan	113.23	28500 cfs	28500.00	3624.00	3636.00	3636.00	3639.12	0.007673	15.44	3265.95	2131.27	0.91
Duncan	113.23	48000 cfs	48000.00	3624.00	3636.95	3636.95	3637.98	0.003553	11.23	8294.49	2469.58	0.63
Duncan	113.23	58700 cfs	58700.00	3624.00	3636.95	3636.95	3638.49	0.005305	13.73	8299.40	2469.75	0.77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River Sta.: 113.23
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Legend
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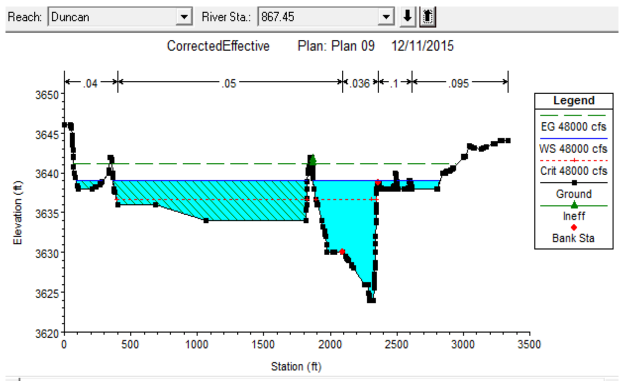
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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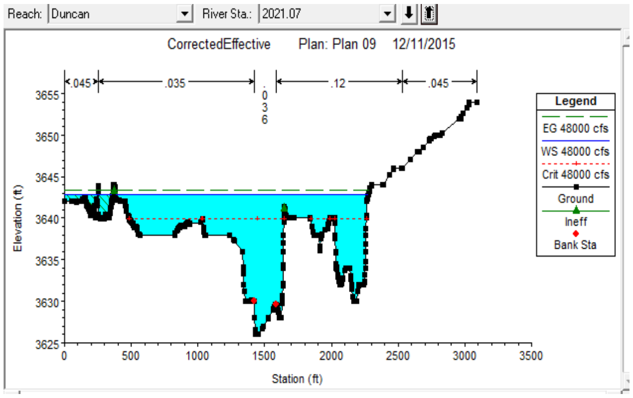
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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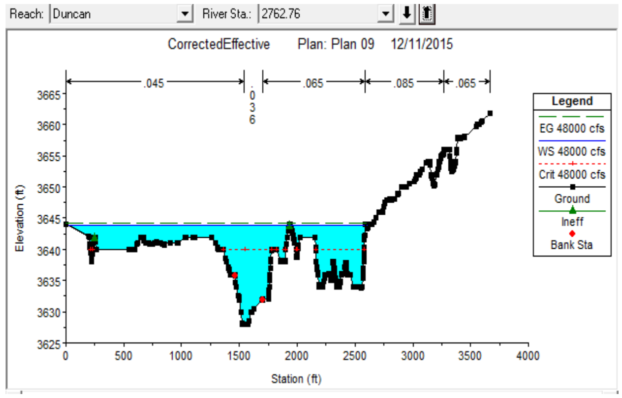
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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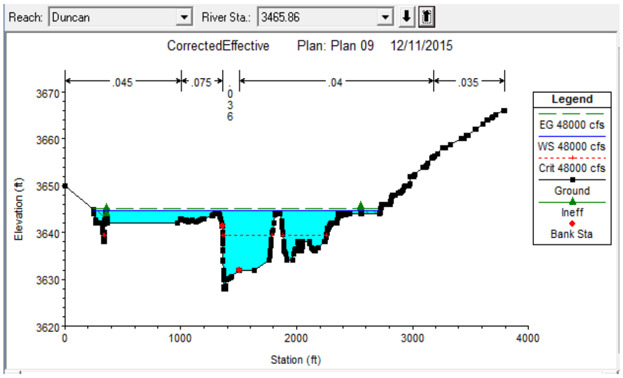
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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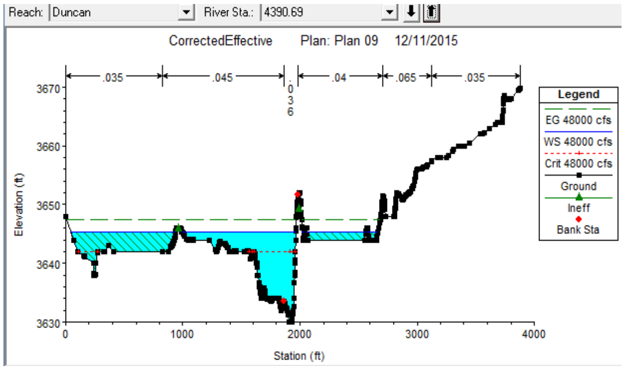
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Legend
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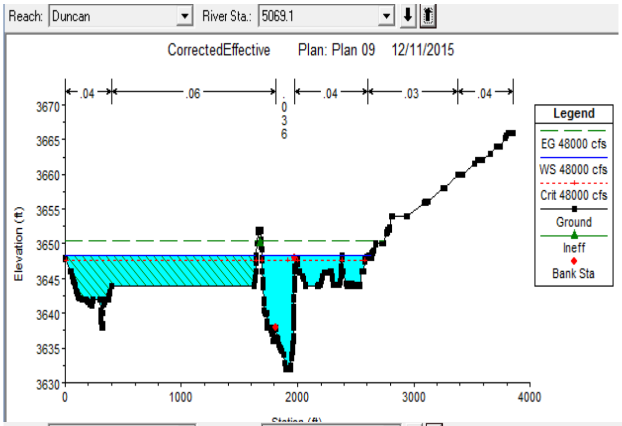
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Crit 48000 cfs
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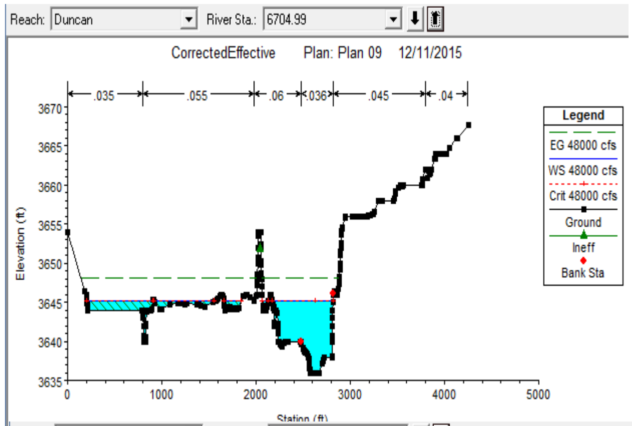
Ineff
Bank Sta
Elevation (ft)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Crit 48000 cfs
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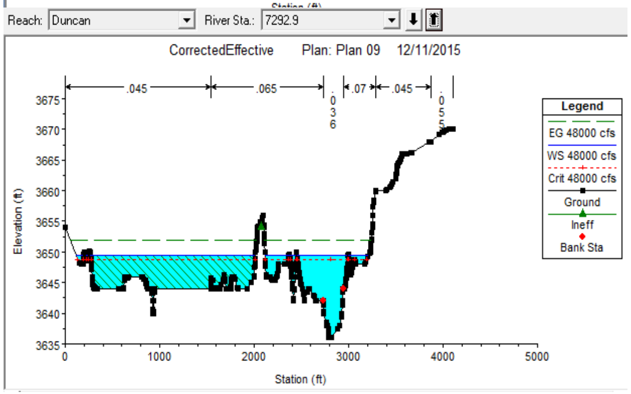
Ineff
Bank Sta
Elevation (ft)


Reach: Duncan
River Sta.: 7292.9
CorrectedEffective Plan: Plan 09 12/11/2015
Legend
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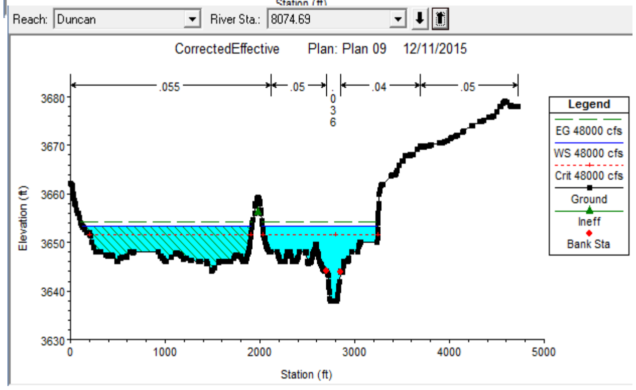
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 8074.69
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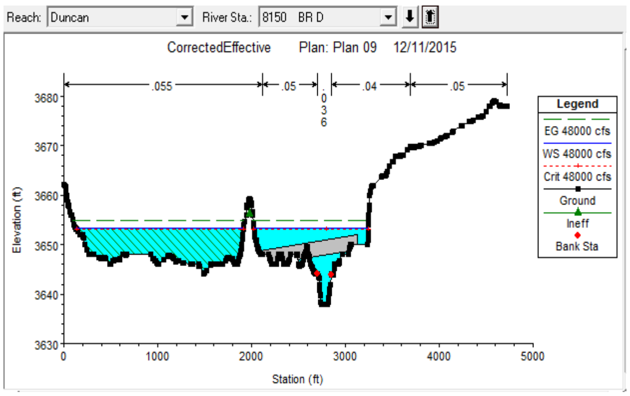
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 8150 BR D
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Legend
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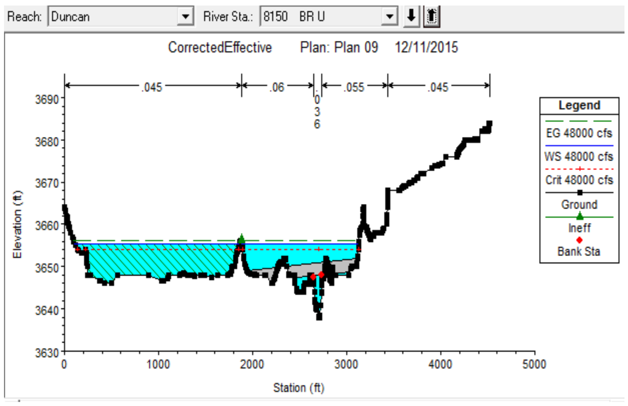
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 8150 BR U
CorrectedEffective Plan: Plan 09 12/11/2015
Legend
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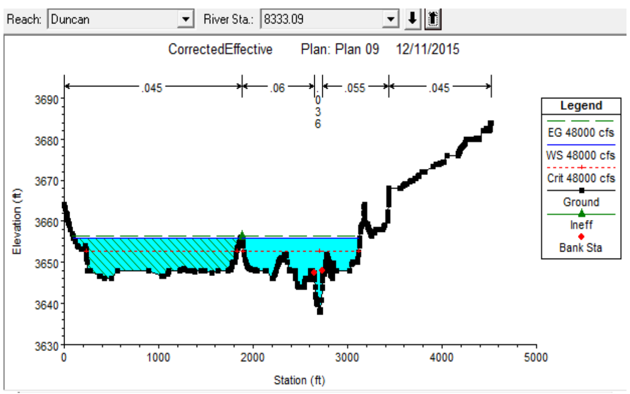
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 8333.09
CorrectedEffective Plan: Plan 09 12/11/2015
Legend
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Crit 48000 cfs
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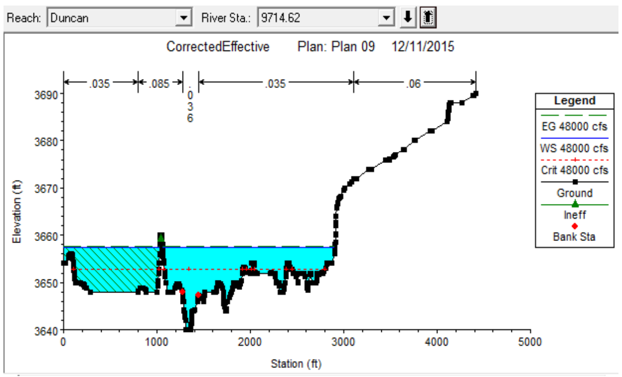
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 9714.62
CorrectedEffective Plan: Plan 09 12/11/2015
Legend
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Crit 48000 cfs
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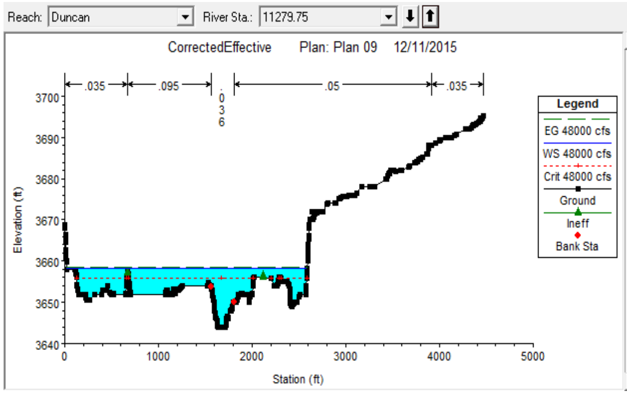
Bank Sta
Elevation (ft)
Station (ft)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.035 .095 .05 .035
Legend
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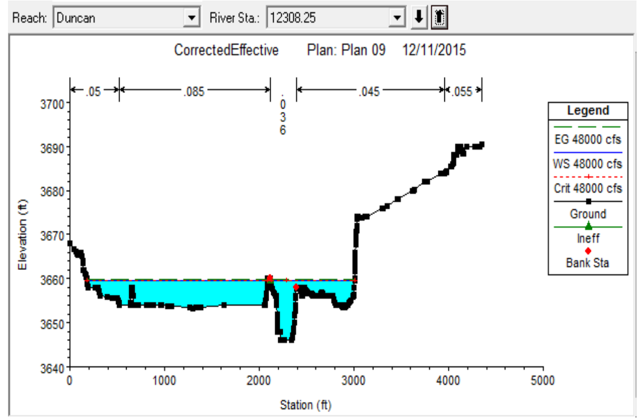
WS 48000 cfs
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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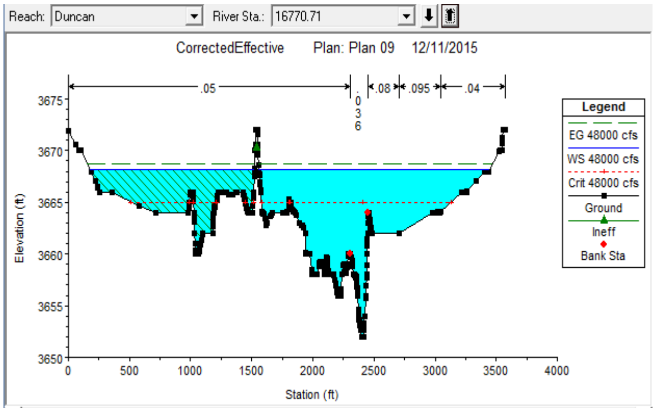
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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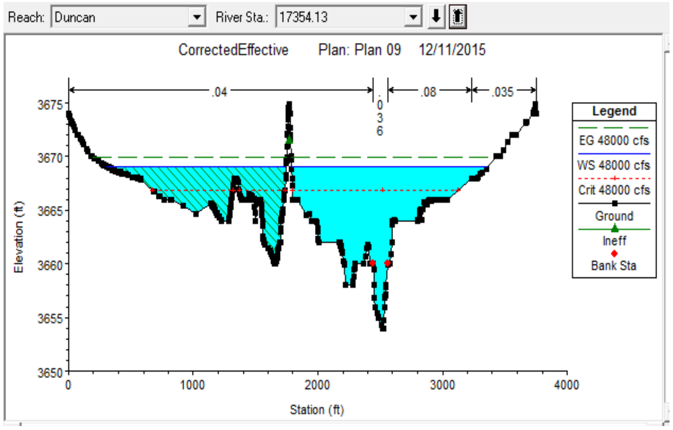
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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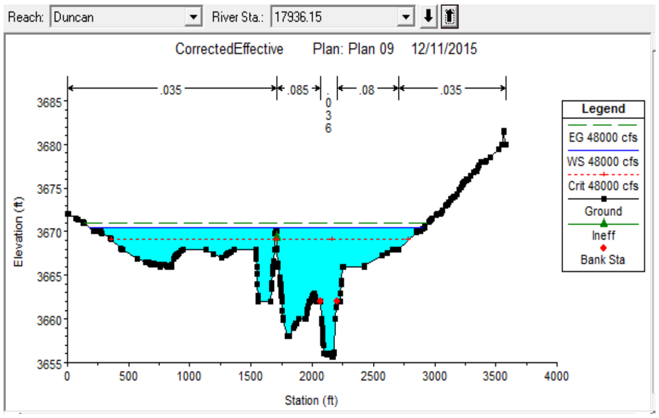
WS 48000 cfs
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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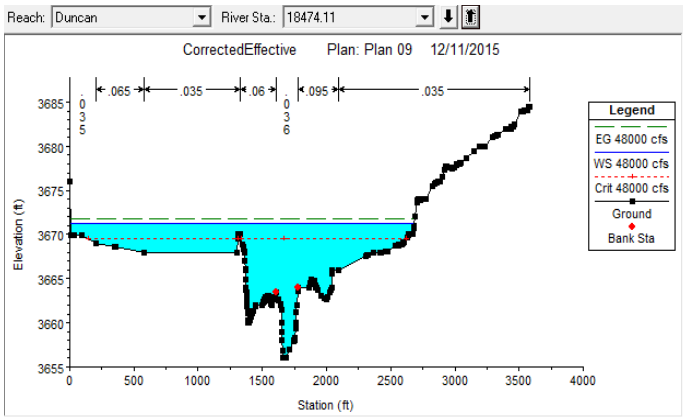
Crit 48000 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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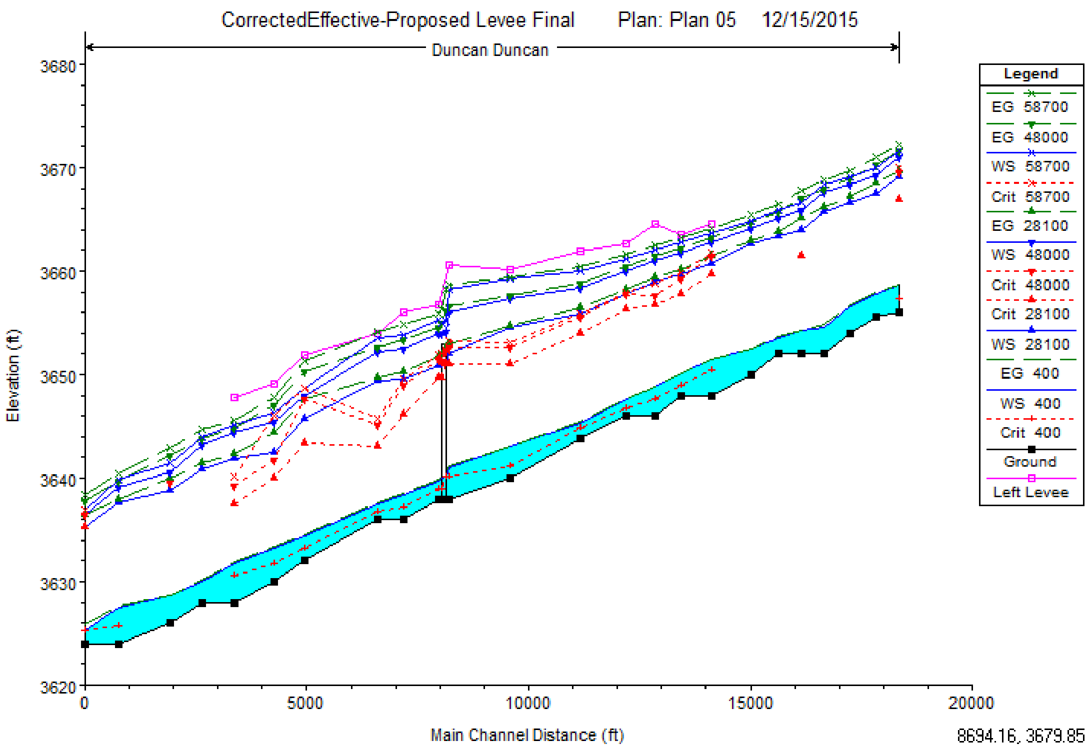
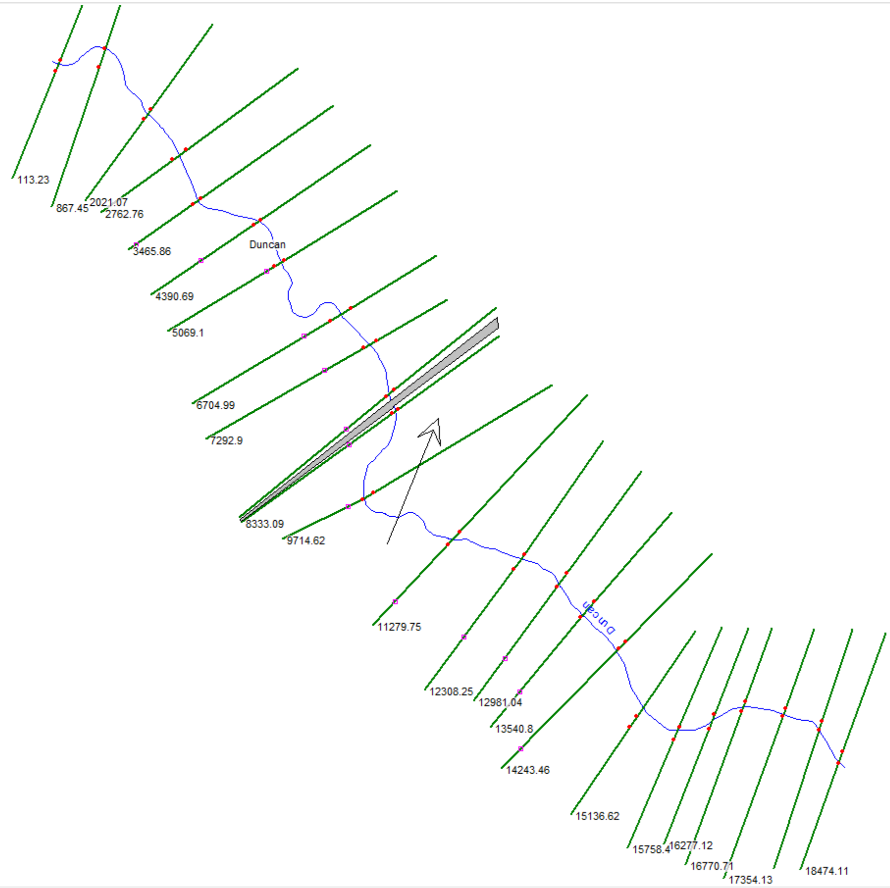
.065 .035 .06 .095 .035
Legend
EG 48000 cfs
WS 48000 cfs
Crit 48000 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

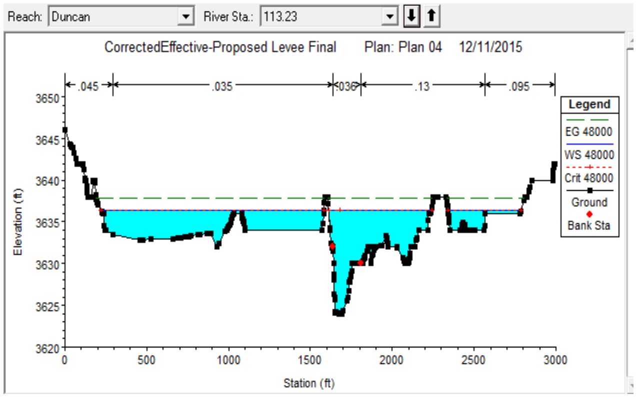
Proposed Conditions Model





Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Duncan	18474.11	400	400.00	3656.00	3658.65	3657.40	3658.72	0.001219	2.14	187.09	102.50	0.28
Duncan	18474.11	28100	28100.00	3656.00	3669.12	3666.85	3669.76	0.001953	8.45	6824.09	2381.45	0.47
Duncan	18474.11	48000	48000.00	3656.00	3671.06	3669.49	3671.57	0.001556	8.48	11821.23	2669.33	0.43
Duncan	18474.11	58700	58700.00	3656.00	3671.67	3669.97	3672.21	0.001613	8.93	13451.12	2673.65	0.44
Duncan	17936.15	400	400.00	3655.61	3657.85		3657.94	0.001745	2.45	163.23	95.86	0.33
Duncan	17936.15	28100	28100.00	3655.61	3667.54		3668.48	0.002841	10.33	5474.25	1576.43	0.57
Duncan	17936.15	48000	48000.00	3655.61	3669.23		3670.34	0.003279	12.29	9154.91	2439.43	0.63
Duncan	17936.15	58700	58700.00	3655.61	3669.97		3671.00	0.003057	12.35	11006.51	2569.13	0.61
Duncan	17354.13	400	400.00	3654.00	3656.68		3656.79	0.002242	2.77	144.31	84.94	0.37
Duncan	17354.13	28100	28100.00	3654.00	3666.67		3667.14	0.001597	8.00	7153.02	2292.07	0.43
Duncan	17354.13	48000	48000.00	3654.00	3668.44		3668.91	0.001532	8.67	11601.59	2835.08	0.43
Duncan	17354.13	58700	58700.00	3654.00	3669.16		3669.64	0.001515	8.95	13726.65	3038.46	0.43
Duncan	16770.71	400	400.00	3652.00	3654.52		3654.82	0.005509	4.39	91.06	52.59	0.59
Duncan	16770.71	28100	28100.00	3652.00	3665.79		3666.17	0.001632	7.39	8406.76	2561.98	0.42
Duncan	16770.71	48000	48000.00	3652.00	3667.66		3668.01	0.001432	7.80	14003.44	3137.22	0.41
Duncan	16770.71	58700	58700.00	3652.00	3668.39		3668.76	0.001408	8.07	16352.23	3252.11	0.41
Duncan	16277.12	400	400.00	3652.00	3654.21		3654.24	0.000413	1.30	308.90	163.54	0.16
Duncan	16277.12	28100	28100.00	3652.00	3663.99	3661.43	3665.15	0.002431	9.71	5709.98	1734.90	0.53
Duncan	16277.12	48000	48000.00	3652.00	3665.88		3667.05	0.002480	10.96	10665.18	2787.41	0.55
Duncan	16277.12	58700	58700.00	3652.00	3666.68		3667.82	0.002422	11.30	13109.25	3093.51	0.55
Duncan	15758.4	400	400.00	3652.00	3653.52		3653.69	0.005407	3.35	119.26	102.18	0.55
Duncan	15758.4	28100	28100.00	3652.00	3663.38		3663.89	0.001729	7.64	8634.86	2162.32	0.44
Duncan	15758.4	48000	48000.00	3652.00	3665.12		3665.74	0.001943	9.06	12990.78	2688.62	0.48
Duncan	15758.4	58700	58700.00	3652.00	3665.92		3666.54	0.001915	9.42	15154.40	2751.49	0.48
Duncan	15136.62	400	400.00	3650.00	3652.52		3652.56	0.000862	1.73	238.02	153.59	0.23
Duncan	15136.62	28100	28100.00	3650.00	3662.59		3663.00	0.001137	6.65	10151.73	2410.85	0.36
Duncan	15136.62	48000	48000.00	3650.00	3664.09		3664.65	0.001527	8.42	14130.59	2936.18	0.43
Duncan	15136.62	58700	58700.00	3650.00	3664.88		3665.46	0.001545	8.84	16570.94	3253.53	0.44
Duncan	14243.46	400	400.00	3648.00	3651.46	3650.46	3651.54	0.001572	2.25	178.12	110.30	0.31
Duncan	14243.46	28100	28100.00	3648.00	3660.79	3659.75	3661.51	0.002476	9.36	6761.85	2904.02	0.53
Duncan	14243.46	48000	48000.00	3648.00	3662.76	3661.43	3663.22	0.001574	8.43	12557.93	2993.27	0.43
Duncan	14243.46	58700	58700.00	3648.00	3663.74	3661.82	3664.14	0.001271	7.99	15506.43	3012.17	0.39
Duncan	13540.8	400	400.00	3648.00	3650.10	3649.01	3650.19	0.002406	2.39	167.08	129.40	0.37
Duncan	13540.8	28100	28100.00	3648.00	3659.68	3657.77	3660.13	0.001413	6.71	8295.92	2037.58	0.39
Duncan	13540.8	48000	48000.00	3648.00	3661.71	3659.34	3662.19	0.001348	7.42	12630.49	2161.99	0.39
Duncan	13540.8	58700	58700.00	3648.00	3662.77	3659.88	3663.24	0.001240	7.56	14913.88	2171.08	0.38
Duncan	12981.04	400	400.00	3646.00	3648.77	3647.63	3648.87	0.002347	2.45	163.15	119.64	0.37
Duncan	12981.04	28100	28100.00	3646.00	3658.99	3656.82	3659.35	0.001281	6.42	8686.96	1937.28	0.37
Duncan	12981.04	48000	48000.00	3646.00	3661.02	3657.71	3661.45	0.001256	7.27	12654.37	1967.19	0.38
Duncan	12981.04	58700	58700.00	3646.00	3662.11	3658.83	3662.56	0.001173	7.47	14817.29	1980.51	0.38
Duncan	12308.25	400	400.00	3646.00	3647.64	3646.71	3647.70	0.001302	1.97	202.60	132.23	0.28
Duncan	12308.25	28100	28100.00	3646.00	3657.73	3656.40	3658.28	0.001984	7.54	7878.53	1954.60	0.46
Duncan	12308.25	48000	48000.00	3646.00	3659.93	3657.78	3660.45	0.001741	7.99	12318.48	2039.85	0.44
Duncan	12308.25	58700	58700.00	3646.00	3661.17	3658.00	3661.67	0.001491	7.98	14887.25	2074.66	0.42

Duncan	11279.75	400	400.00	3643.84	3645.34	3644.79	3645.49	0.004121	3.13	127.89	99.53	0.49
Duncan	11279.75	28100	28100.00	3643.84	3655.86	3653.95	3656.41	0.001681	7.41	7740.15	1921.05	0.43
Duncan	11279.75	48000	48000.00	3643.84	3658.37	3655.63	3658.88	0.001367	7.85	13045.51	2134.16	0.40
Duncan	11279.75	58700	58700.00	3643.84	3659.94	3655.83	3660.38	0.001053	7.49	16412.17	2137.12	0.36
Duncan	9714.62	400	400.00	3640.00	3643.09	3641.23	3643.16	0.000751	2.08	192.52	76.59	0.23
Duncan	9714.62	28100	28100.00	3640.00	3654.52	3651.02	3654.75	0.000660	5.35	9050.87	1833.80	0.28
Duncan	9714.62	48000	48000.00	3640.00	3657.42	3652.70	3657.64	0.000455	5.17	14438.21	1865.33	0.24
Duncan	9714.62	58700	58700.00	3640.00	3659.23	3653.13	3659.43	0.000346	4.88	17809.32	1868.53	0.21
Duncan	8333.09	400	400.00	3638.00	3641.04	3640.10	3641.25	0.003263	3.65	109.51	56.21	0.46
Duncan	8333.09	28100	28100.00	3638.00	3652.05	3651.03	3652.95	0.003181	11.14	5623.49	1234.95	0.60
Duncan	8333.09	48000	48000.00	3638.00	3656.07	3652.61	3656.58	0.001417	9.17	10611.32	1247.91	0.42
Duncan	8333.09	58700	58700.00	3638.00	3658.18	3653.21	3658.63	0.001058	8.66	13334.50	1402.59	0.37
Duncan	8150		Bridge									
Duncan	8074.69	400	400.00	3637.95	3639.72	3638.95	3639.84	0.002609	2.79	143.50	94.09	0.40
Duncan	8074.69	28100	28100.00	3637.95	3650.90	3649.72	3651.76	0.002123	9.50	5410.42	1263.03	0.50
Duncan	8074.69	48000	48000.00	3637.95	3653.96	3651.40	3654.61	0.001382	9.00	9287.88	1270.87	0.42
Duncan	8074.69	58700	58700.00	3637.95	3655.28	3651.98	3655.93	0.001255	9.09	10963.91	1272.18	0.41
Duncan	7292.9	400	400.00	3636.00	3638.43	3637.26	3638.48	0.001215	1.84	217.09	149.47	0.27
Duncan	7292.9	28100	28100.00	3636.00	3649.53	3646.21	3650.33	0.001559	8.30	5668.10	1101.95	0.43
Duncan	7292.9	48000	48000.00	3636.00	3652.50	3648.94	3653.45	0.001532	9.58	9052.52	1149.12	0.44
Duncan	7292.9	58700	58700.00	3636.00	3653.82	3649.61	3654.82	0.001512	10.09	10568.80	1154.16	0.45
Duncan	6704.99	400	400.00	3636.00	3637.56	3636.77	3637.62	0.001765	2.06	194.21	149.87	0.32
Duncan	6704.99	28100	28100.00	3636.00	3649.34	3643.07	3649.66	0.000581	5.11	7428.06	847.92	0.26
Duncan	6704.99	48000	48000.00	3636.00	3652.20	3645.15	3652.72	0.000725	6.60	9870.84	857.37	0.30
Duncan	6704.99	58700	58700.00	3636.00	3653.46	3645.73	3654.08	0.000790	7.28	10949.20	861.13	0.32
Duncan	5069.1	400	400.00	3632.00	3634.39	3633.23	3634.50	0.002068	2.68	149.29	87.08	0.36
Duncan	5069.1	28100	28100.00	3632.00	3645.70	3643.45	3647.59	0.003537	12.16	3247.25	719.78	0.64
Duncan	5069.1	48000	48000.00	3632.00	3647.95	3647.65	3650.23	0.003985	14.35	5131.67	866.75	0.69
Duncan	5069.1	58700	58700.00	3632.00	3648.68	3648.68	3651.33	0.004484	15.77	5819.87	958.91	0.74
Duncan	4390.69	400	400.00	3630.00	3633.25	3631.77	3633.34	0.001429	2.48	175.18	111.79	0.31
Duncan	4390.69	28100	28100.00	3630.00	3642.44	3640.00	3644.48	0.006094	14.73	3023.75	596.49	0.82
Duncan	4390.69	48000	48000.00	3630.00	3645.43	3641.74	3647.12	0.004714	14.95	6315.05	1615.30	0.74
Duncan	4390.69	58700	58700.00	3630.00	3646.30	3645.99	3647.82	0.004230	14.66	7741.20	1660.43	0.71
Duncan	3465.86	400	400.00	3628.00	3631.78	3630.64	3631.86	0.001787	2.21	180.90	125.40	0.32
Duncan	3465.86	28100	28100.00	3628.00	3641.93	3637.45	3642.28	0.000885	5.94	6266.82	874.17	0.31
Duncan	3465.86	48000	48000.00	3628.00	3644.35	3639.34	3644.84	0.001186	7.84	10660.03	2340.34	0.38
Duncan	3465.86	58700	58700.00	3628.00	3645.14	3640.08	3645.66	0.001200	8.19	12520.19	2350.26	0.38
Duncan	2762.76	400	400.00	3628.00	3630.03		3630.17	0.003381	2.95	135.73	91.30	0.43
Duncan	2762.76	28100	28100.00	3628.00	3640.85		3641.44	0.001585	7.43	6378.76	1488.24	0.41
Duncan	2762.76	48000	48000.00	3628.00	3643.25		3643.88	0.001540	8.38	11358.25	2363.98	0.41
Duncan	2762.76	58700	58700.00	3628.00	3644.04		3644.69	0.001564	8.78	13243.08	2448.70	0.42
Duncan	2021.07	400	400.00	3626.00	3628.67		3628.73	0.001225	1.96	216.26	154.36	0.27
Duncan	2021.07	28100	28100.00	3626.00	3638.83		3639.95	0.002416	10.13	5236.07	1271.06	0.53
Duncan	2021.07	48000	48000.00	3626.00	3640.65	3639.60	3642.21	0.003095	12.68	8110.47	1883.41	0.62
Duncan	2021.07	58700	58700.00	3626.00	3641.43		3643.01	0.003086	13.16	9604.53	1956.34	0.62
Duncan	867.45	400	400.00	3624.00	3627.54	3625.68	3627.58	0.000824	1.68	238.51	140.92	0.23
Duncan	867.45	28100	28100.00	3624.00	3637.59		3637.97	0.001048	6.24	7963.58	1913.07	0.34
Duncan	867.45	48000	48000.00	3624.00	3639.18		3639.66	0.001312	7.44	11709.66	2616.54	0.39
Duncan	867.45	58700	58700.00	3624.00	3639.83		3640.37	0.001407	8.00	13457.19	2689.72	0.41
Duncan	113.23	400	400.00	3624.00	3625.31	3625.31	3625.82	0.019150	5.74	69.73	68.94	1.01
Duncan	113.23	28100	28100.00	3624.00	3635.36	3635.36	3636.48	0.004203	10.87	5464.42	2099.13	0.66
Duncan	113.23	48000	48000.00	3624.00	3636.45	3636.45	3637.82	0.005004	12.88	7900.35	2437.61	0.74
Duncan	113.23	58700	58700.00	3624.00	3636.87	3636.87	3638.39	0.005392	13.77	8943.30	2464.54	0.77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CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
.045
.035
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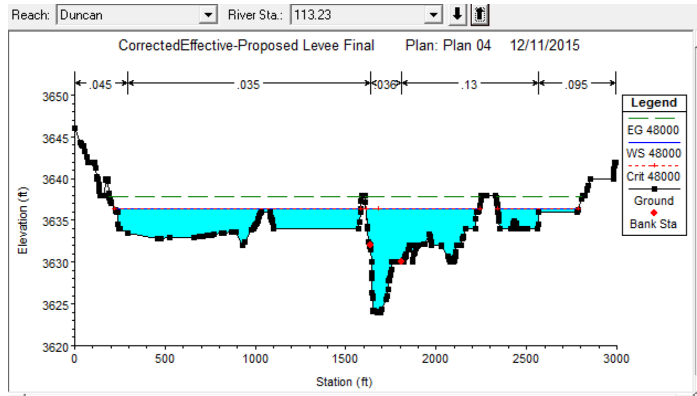
Legend
EG 48000
WS 48000
Crit 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 113.23
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
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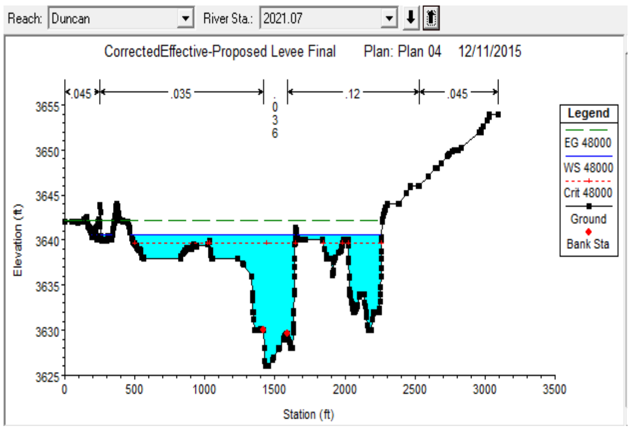
Legend
EG 48000
WS 48000
Crit 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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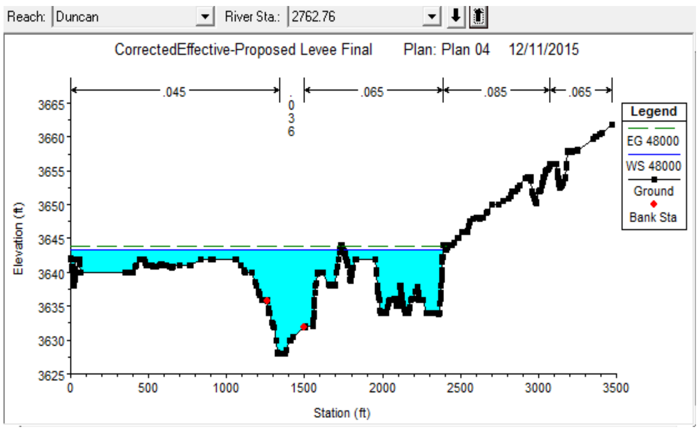
WS 48000
Crit 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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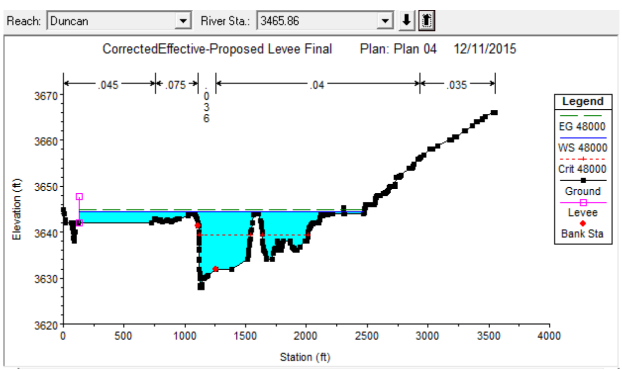
Legend
EG 48000
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
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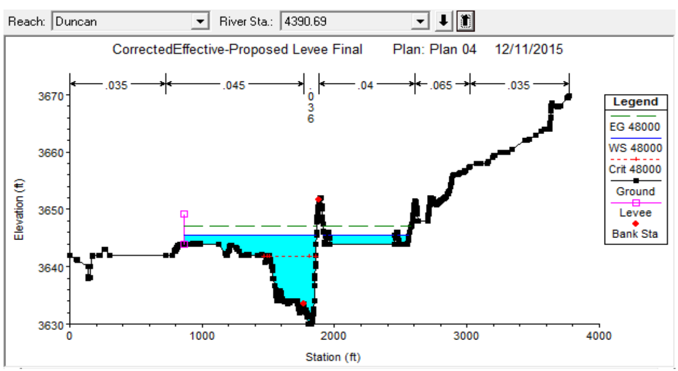
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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.045
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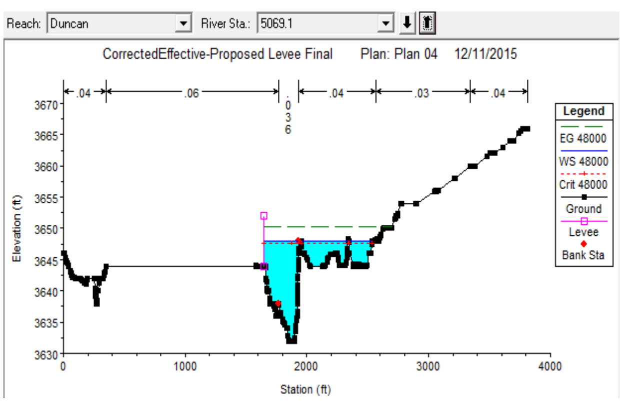
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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.06
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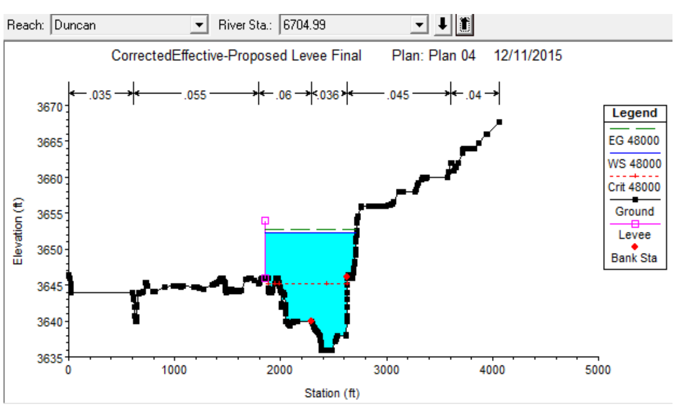
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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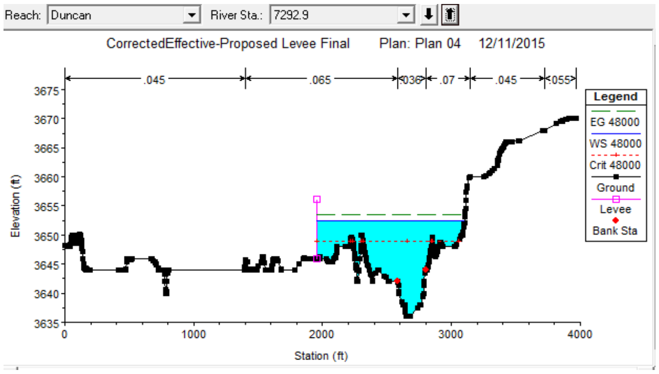
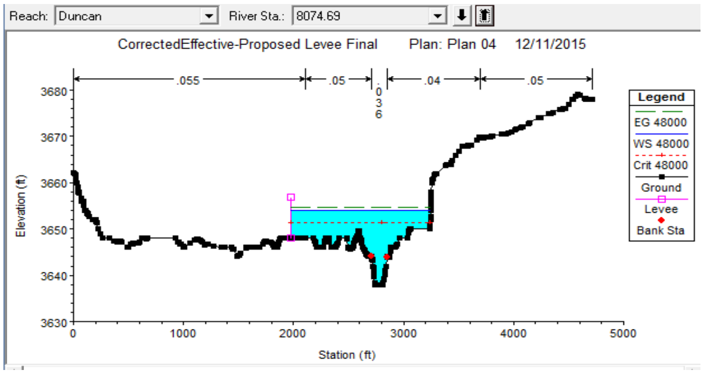
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 7292.9
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 8074.69
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
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WS 48000
Crit 48000
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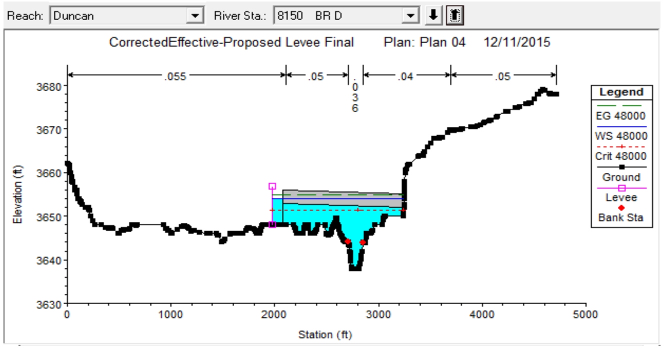
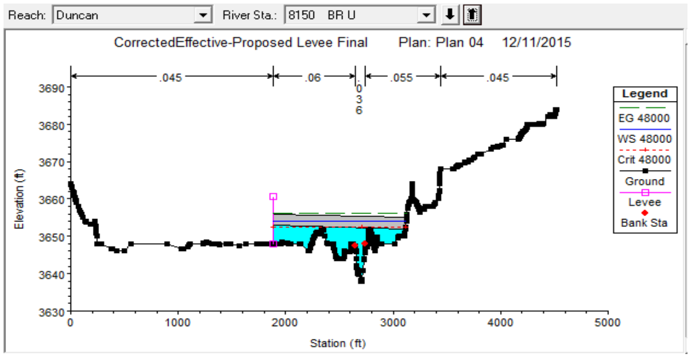
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 8150 BR D
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 8150 BR U
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
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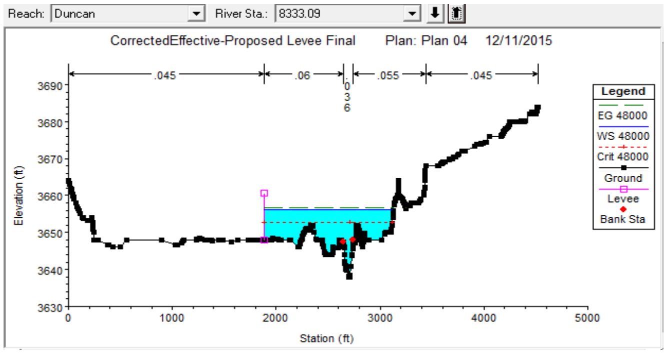
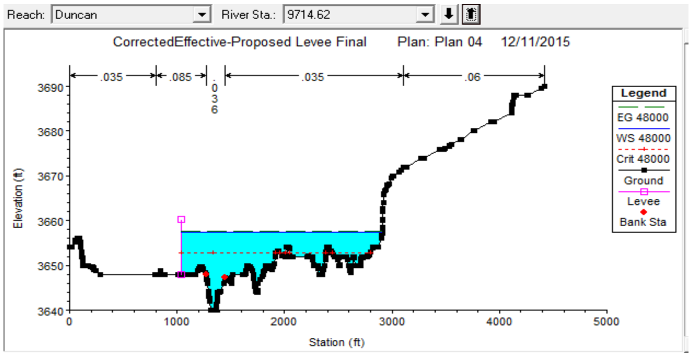
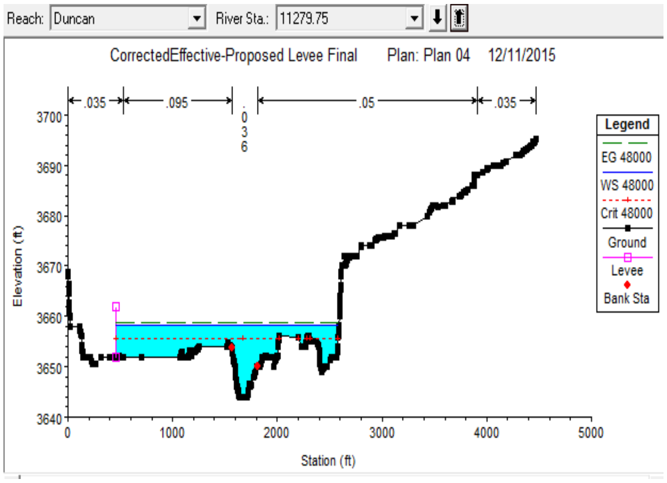
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 8333.09
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 9714.62
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



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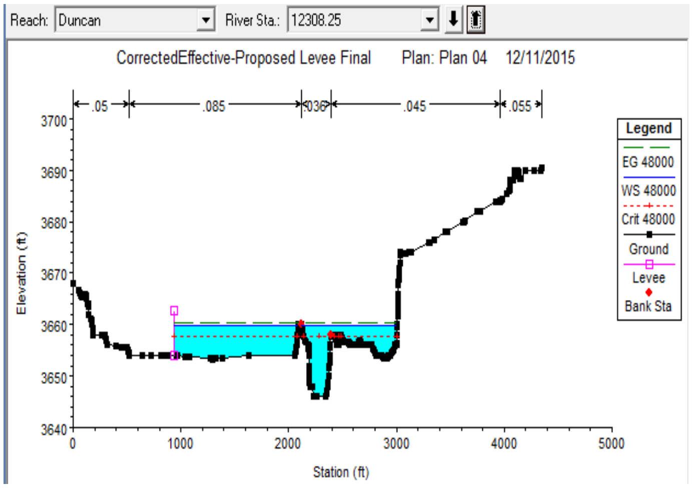
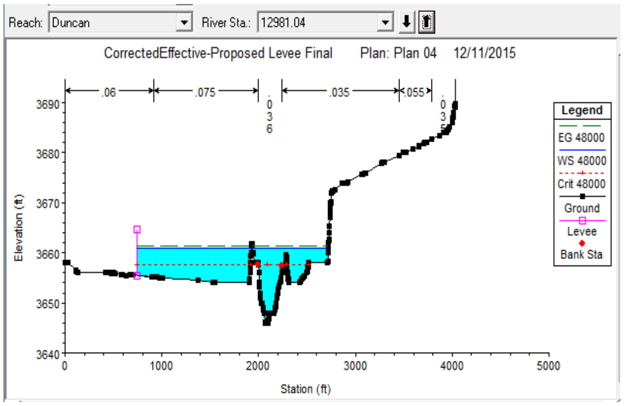
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



Reach: Duncan
River Sta.: 12308.25
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 12981.04
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
.06
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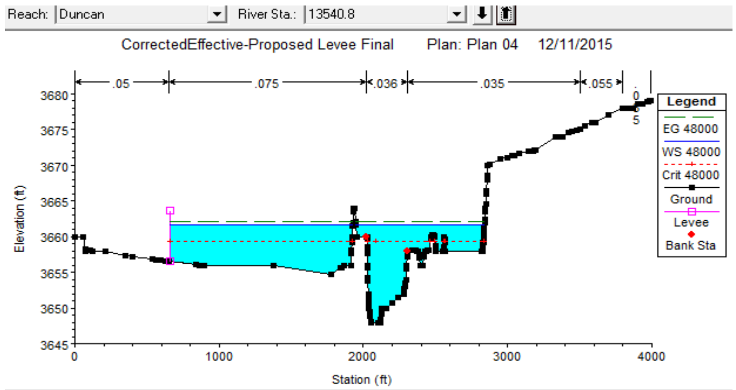
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
River Sta.: 13540.8
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
.05
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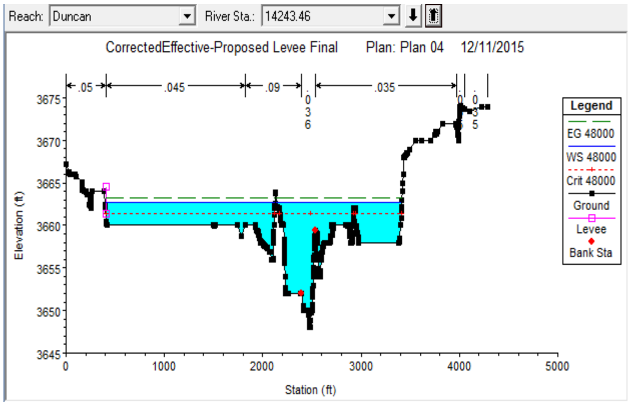
Legend
EG 48000
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
River Sta.: 14243.46
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
.05
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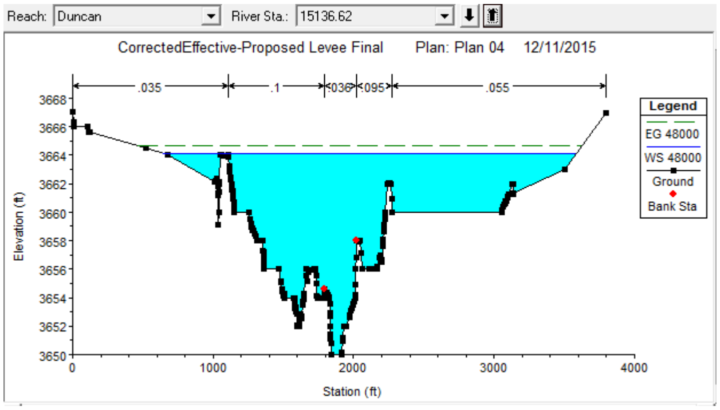
WS 48000
Crit 48000
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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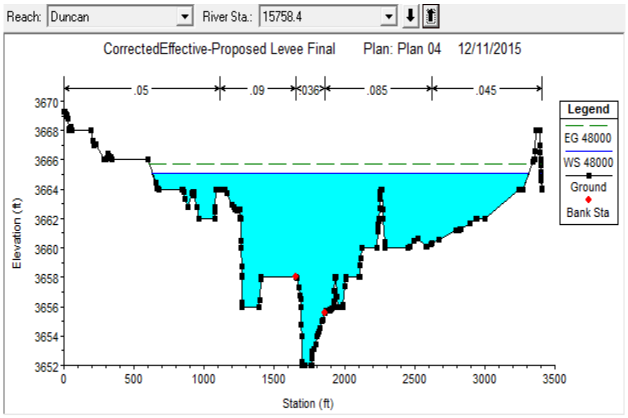
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 15758.4
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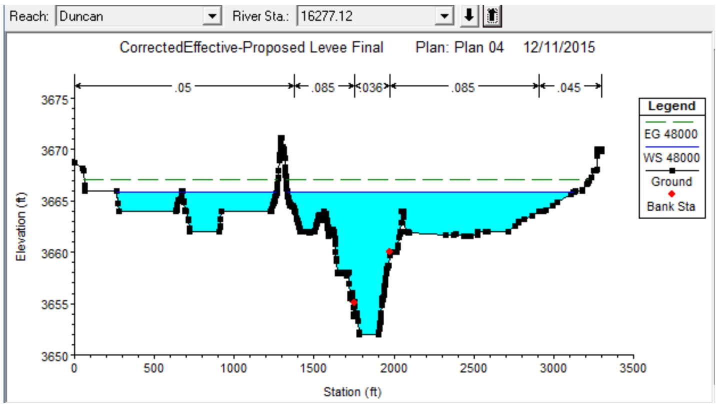
EG 48000
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)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River Sta.: 16277.12
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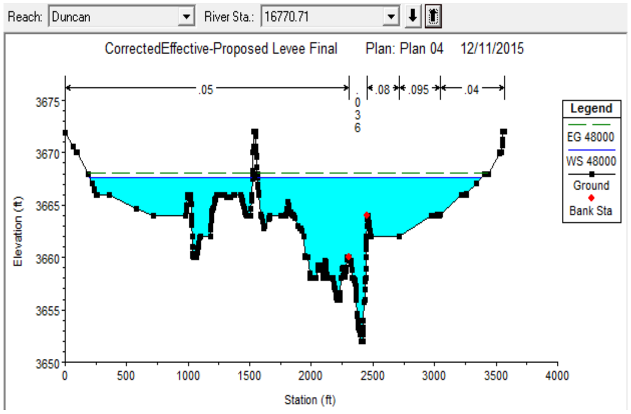
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
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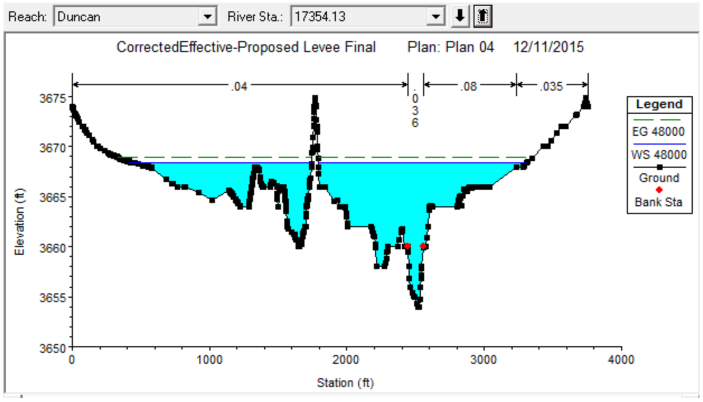
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
River Sta.: 17354.13
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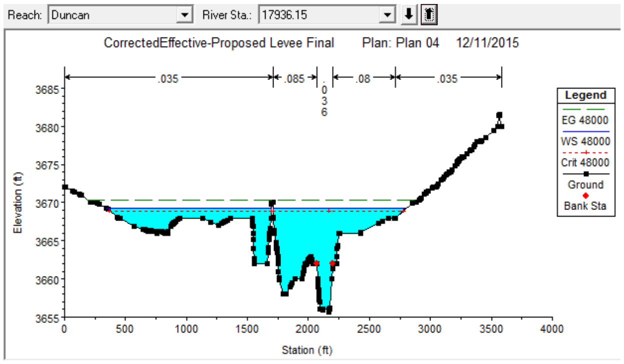
EG 48000
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
River Sta.: 17936.15
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EG 48000
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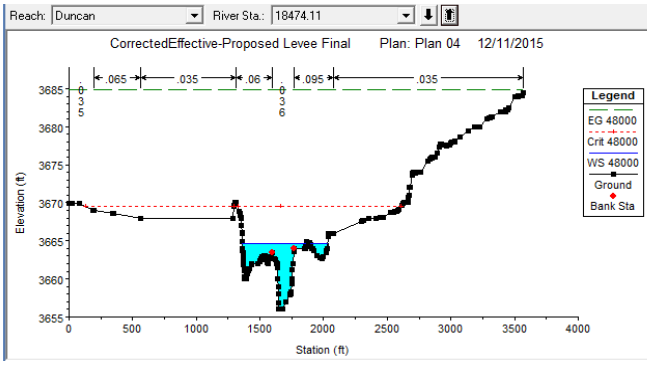
Crit 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)


Reach: Duncan
River Sta.: 18474.11
CorrectedEffective-Proposed Levee Final Plan: Plan 04 12/11/2015
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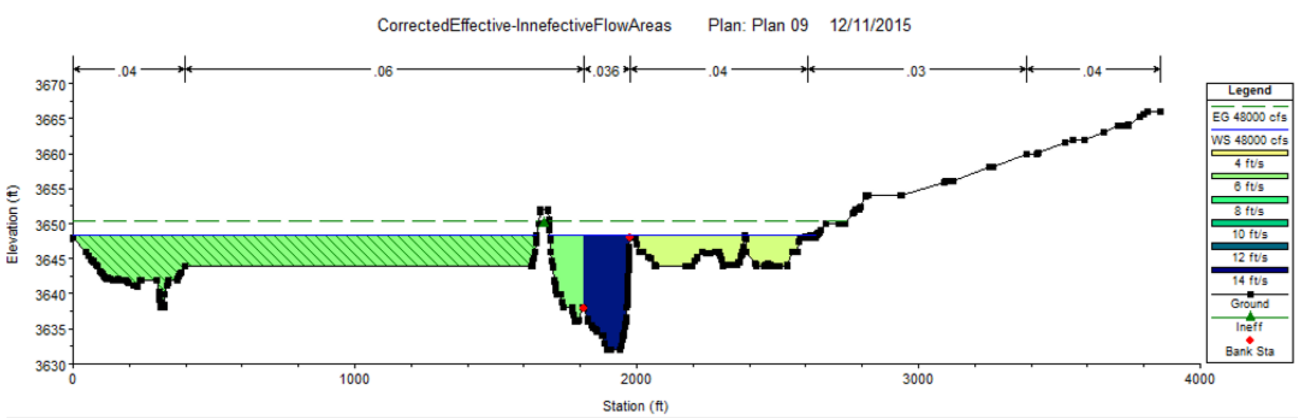
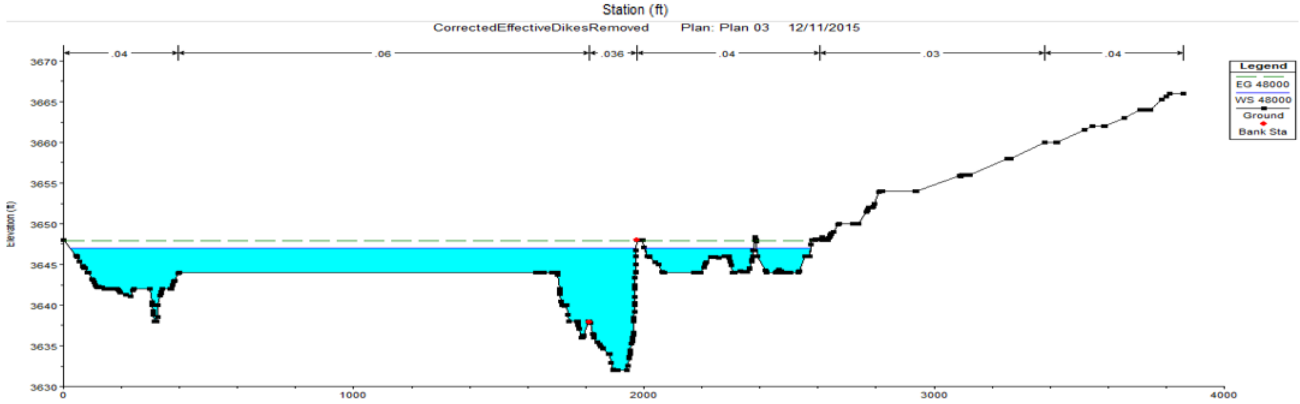
Legend
EG 48000
Crit 48000
WS 48000
Ground
Bank Sta
Elevation (ft)
Station (ft)

Alternative Proposed Conditions

Removal of Agricultural Dike

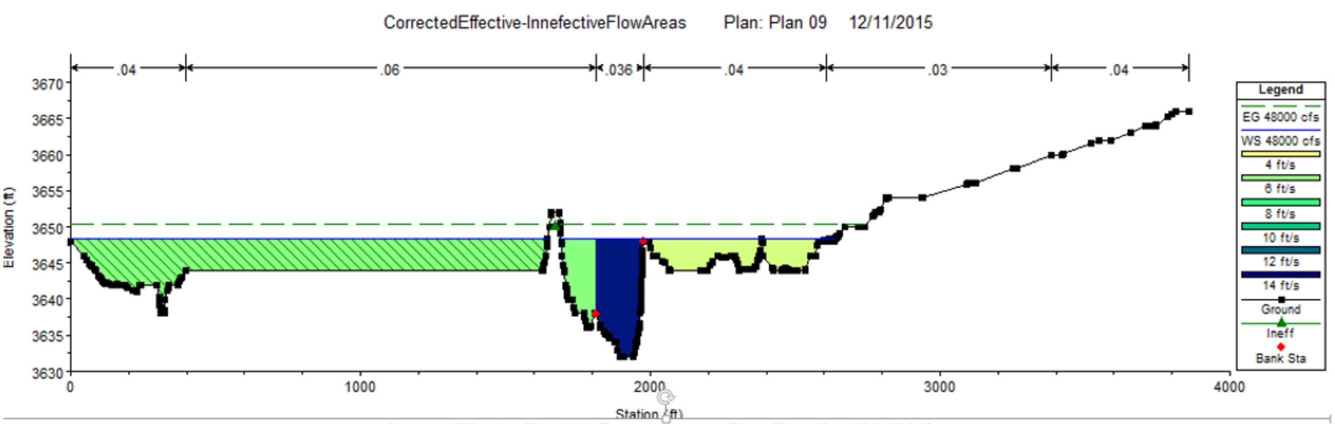
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Duncan	18474.11	48000	48000.00	3656.00	3671.30	3669.49	3671.74	0.001346	7.99	12450.31	2671.00	0.40
Duncan	17936.15	48000	48000.00	3655.61	3670.41	3669.05	3670.95	0.001588	9.10	12188.96	2728.67	0.44
Duncan	17354.13	48000	48000.00	3654.00	3669.08	3666.90	3669.91	0.001937	10.08	8776.07	3018.95	0.49
Duncan	16770.71	48000	48000.00	3652.00	3668.21	3664.87	3668.76	0.001696	8.77	11056.24	3235.34	0.45
Duncan	16277.12	48000	48000.00	3652.00	3665.86	3665.20	3667.55	0.003183	12.41	8466.88	2785.57	0.62
Duncan	15758.4	48000	48000.00	3652.00	3665.58		3666.07	0.001520	8.23	14233.83	2725.00	0.43
Duncan	15136.62	48000	48000.00	3650.00	3664.89	3661.50	3665.27	0.001029	7.22	16597.96	3257.03	0.36
Duncan	14243.46	48000	48000.00	3648.00	3664.30	3661.50	3664.51	0.000626	5.76	17334.00	3258.57	0.28
Duncan	13540.8	48000	48000.00	3648.00	3660.82	3660.82	3663.30	0.005118	13.67	4379.98	2809.82	0.76
Duncan	12981.04	48000	48000.00	3646.00	3660.23	3657.93	3660.61	0.001339	7.15	14180.75	2700.65	0.39
Duncan	12308.25	48000	48000.00	3646.00	3658.96		3659.48	0.002106	8.30	13223.92	2782.07	0.48
Duncan	11279.75	48000	48000.00	3643.84	3655.99		3656.86	0.003084	10.13	9360.21	2264.91	0.58
Duncan	9714.62	48000	48000.00	3640.00	3653.85		3654.12	0.001007	6.35	13007.40	2655.37	0.34
Duncan	8333.09	48000	48000.00	3638.00	3651.50	3650.38	3651.97	0.002627	9.78	11245.58	2844.91	0.54
Duncan	8150		Bridge									
Duncan	8074.69	48000	48000.00	3637.95	3650.58		3651.25	0.002556	10.23	11289.88	3018.23	0.55
Duncan	7292.9	48000	48000.00	3636.00	3649.77		3650.04	0.000874	6.30	15661.73	3030.92	0.32
Duncan	6704.99	48000	48000.00	3636.00	3649.41		3649.62	0.000554	5.01	16601.21	2705.47	0.26
Duncan	5069.1	48000	48000.00	3632.00	3646.97		3647.89	0.002462	10.80	9813.80	2512.46	0.54
Duncan	4390.69	48000	48000.00	3630.00	3645.77		3646.33	0.001880	9.58	10174.11	2489.26	0.47
Duncan	3465.86	48000	48000.00	3628.00	3644.70		3645.10	0.000962	7.18	11856.88	2470.82	0.34
Duncan	2762.76	48000	48000.00	3628.00	3643.90		3644.36	0.001113	7.36	12908.81	2391.48	0.35
Duncan	2021.07	48000	48000.00	3626.00	3640.39	3639.87	3642.73	0.004254	14.66	5370.32	1857.47	0.72
Duncan	867.45	48000	48000.00	3624.00	3639.16	3636.92	3639.66	0.001335	7.50	11481.09	2615.10	0.39
Duncan	113.23	48000	48000.00	3624.00	3636.44	3636.44	3637.82	0.005007	12.88	7898.56	2437.56	0.74

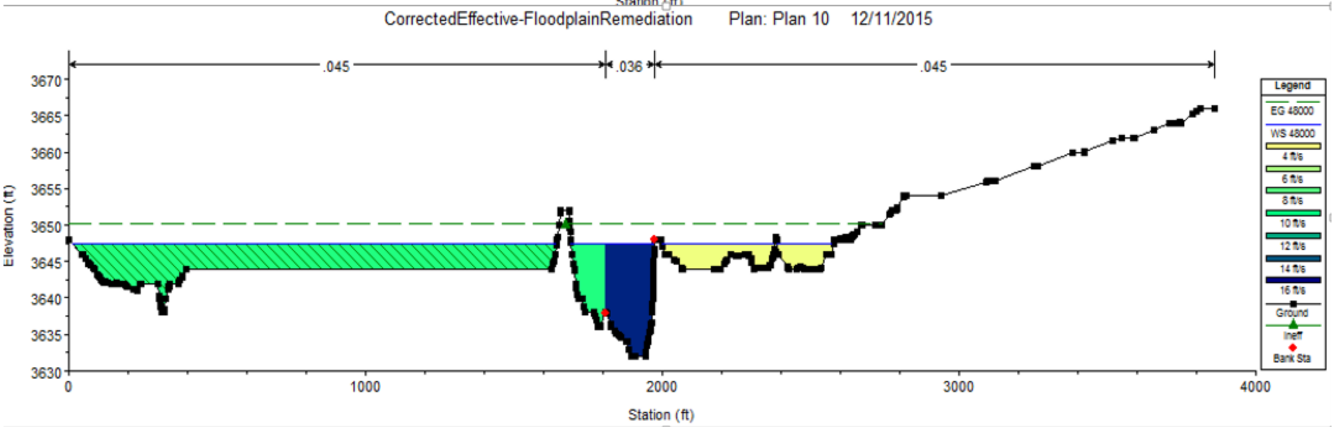




Floodplain Remediation (Manning's Value Adjustment)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Duncan	18474.11	48000	48000.00	3656.00	3671.02	3669.04	3671.52	0.001515	8.35	11710.72	2670.83	0.42
Duncan	17936.15	48000	48000.00	3655.61	3670.06	3667.42	3670.64	0.001740	9.36	11251.25	2678.23	0.46
Duncan	17354.13	48000	48000.00	3654.00	3668.32	3667.05	3669.34	0.002791	11.63	7595.02	2771.61	0.58
Duncan	16770.71	48000	48000.00	3652.00	3667.19	3665.07	3667.82	0.002104	9.20	9187.26	3085.90	0.49
Duncan	16277.12	48000	48000.00	3652.00	3665.25	3664.00	3666.57	0.002892	11.43	7380.30	2692.83	0.59
Duncan	15758.4	48000	48000.00	3652.00	3664.93		3665.32	0.001296	7.32	12484.15	2673.60	0.39
Duncan	15136.62	48000	48000.00	3650.00	3664.38	3659.79	3664.66	0.000809	6.23	14968.62	3011.76	0.31
Duncan	14243.46	48000	48000.00	3648.00	3663.69	3661.17	3663.92	0.000786	6.26	15413.61	3075.62	0.31
Duncan	13540.8	48000	48000.00	3648.00	3663.44	3660.96	3663.55	0.000315	3.95	20413.95	2964.56	0.19
Duncan	12981.04	48000	48000.00	3646.00	3660.17	3660.17	3662.84	0.005637	14.61	4429.04	2765.92	0.80
Duncan	12308.25	48000	48000.00	3646.00	3659.47	3659.47	3659.70	0.000891	5.56	14552.60	2789.73	0.31
Duncan	11279.75	48000	48000.00	3643.84	3658.25	3655.85	3658.50	0.000740	5.74	14722.95	2569.32	0.30
Duncan	9714.62	48000	48000.00	3640.00	3657.13	3652.87	3657.41	0.000654	6.11	13534.58	2875.06	0.29
Duncan	8333.09	48000	48000.00	3638.00	3655.76	3652.25	3656.21	0.001140	8.11	10008.75	3004.90	0.37
Duncan	8150		Bridge									
Duncan	8074.69	48000	48000.00	3637.95	3652.68	3651.43	3653.79	0.002488	11.35	7300.96	2978.84	0.55
Duncan	7292.9	48000	48000.00	3636.00	3649.26	3648.63	3651.25	0.004108	13.26	5310.99	2903.49	0.70
Duncan	6704.99	48000	48000.00	3636.00	3644.96	3644.96	3647.76	0.008736	14.65	3888.22	2172.19	0.95
Duncan	5069.1	48000	48000.00	3632.00	3647.43	3647.43	3650.12	0.004657	15.17	4644.56	2481.11	0.74
Duncan	4390.69	48000	48000.00	3630.00	3646.10	3641.99	3646.73	0.002047	10.12	9744.22	2589.46	0.49
Duncan	3465.86	48000	48000.00	3628.00	3645.09	3639.52	3645.46	0.000905	7.10	12617.98	2484.50	0.33
Duncan	2762.76	48000	48000.00	3628.00	3643.05	3639.89	3644.39	0.002398	10.93	7388.00	2456.69	0.54
Duncan	2021.07	48000	48000.00	3626.00	3642.56	3637.94	3643.04	0.000979	7.81	11535.78	2241.00	0.36
Duncan	867.45	48000	48000.00	3624.00	3638.83	3636.60	3640.88	0.003871	12.52	4727.13	2563.24	0.67
Duncan	113.23	48000	48000.00	3624.00	3636.95	3636.95	3637.84	0.003273	10.78	8294.49	2469.58	0.60

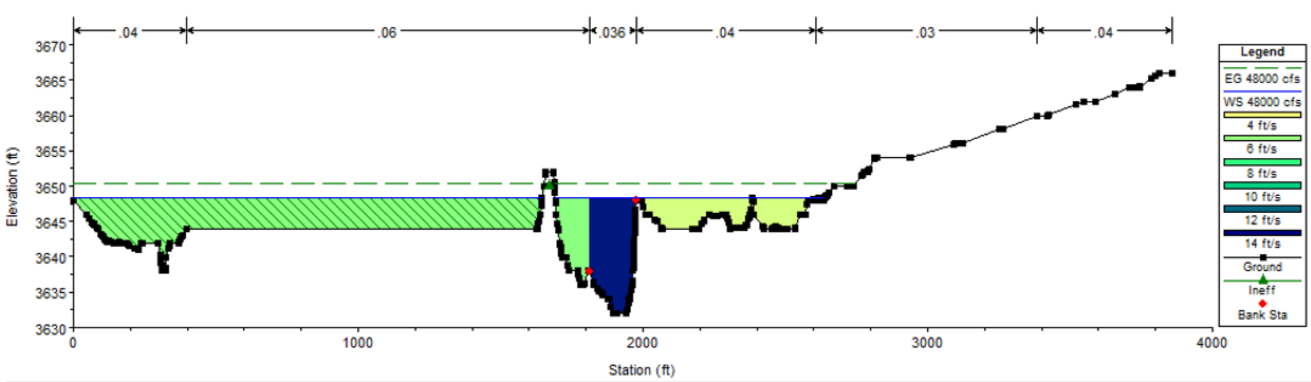




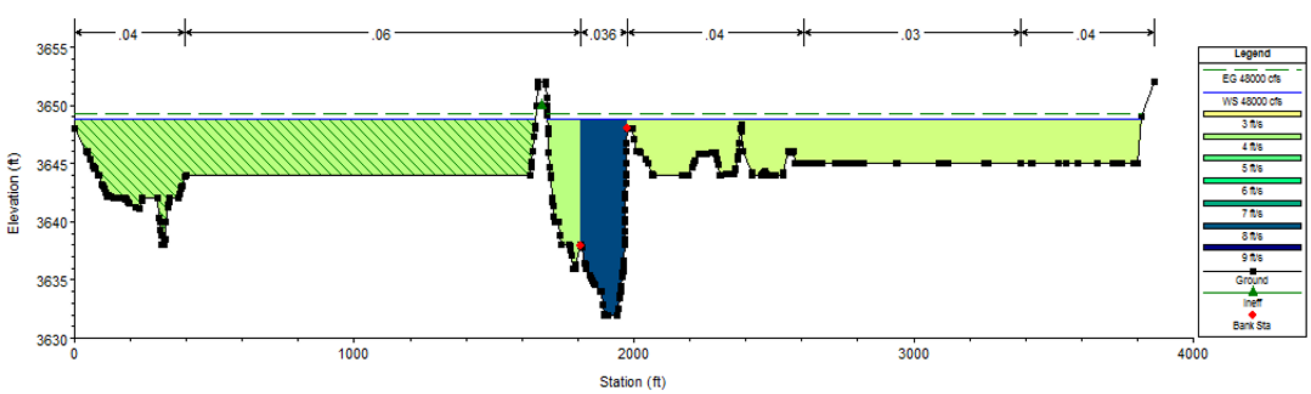
Soil Excavation at Former Waste Water Treatment Facility

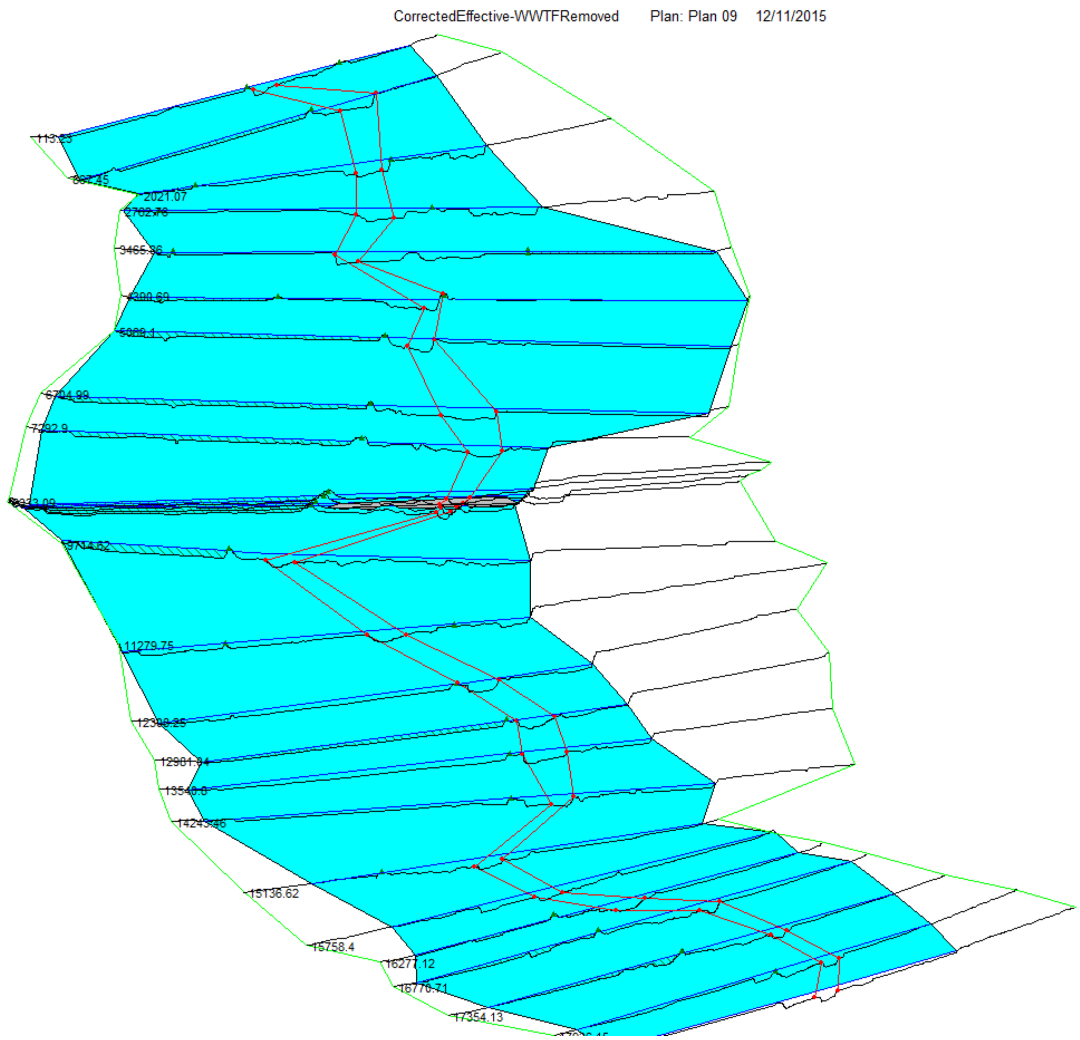
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Duncan	18474.11	48000 cfs	48000.00	3656.00	3671.29	3669.49	3671.74	0.001350	8.00	12436.13	2673.23	0.40
Duncan	17936.15	48000 cfs	48000.00	3655.61	3670.40	3669.08	3670.94	0.001601	9.13	12151.00	2726.40	0.44
Duncan	17354.13	48000 cfs	48000.00	3654.00	3669.07	3666.88	3669.90	0.001945	10.09	8761.83	3016.41	0.49
Duncan	16770.71	48000 cfs	48000.00	3652.00	3668.21	3665.02	3668.76	0.001699	8.78	11048.86	3234.97	0.45
Duncan	16277.12	48000 cfs	48000.00	3652.00	3665.67	3665.20	3667.50	0.003467	12.82	8129.53	2758.82	0.65
Duncan	15758.4	48000 cfs	48000.00	3652.00	3665.31		3665.87	0.001755	8.71	13496.29	2703.48	0.46
Duncan	15136.62	48000 cfs	48000.00	3650.00	3664.44	3661.50	3664.92	0.001272	7.84	15173.85	3035.98	0.39
Duncan	14243.46	48000 cfs	48000.00	3648.00	3663.61	3661.51	3663.89	0.000918	6.74	15150.97	3069.34	0.33
Duncan	13540.8	48000 cfs	48000.00	3648.00	3663.22	3660.88	3663.40	0.000489	4.86	19776.64	2954.72	0.24
Duncan	12981.04	48000 cfs	48000.00	3646.00	3659.99	3659.99	3662.51	0.005455	14.21	4293.32	2758.37	0.79
Duncan	12308.25	48000 cfs	48000.00	3646.00	3659.47	3659.47	3659.88	0.001595	7.44	14552.60	2789.73	0.42
Duncan	11279.75	48000 cfs	48000.00	3643.84	3658.33	3655.95	3658.63	0.000895	6.34	14922.44	2569.75	0.33
Duncan	9714.62	48000 cfs	48000.00	3640.00	3657.37	3652.77	3657.60	0.000479	5.29	13978.53	2876.50	0.25
Duncan	8333.09	48000 cfs	48000.00	3638.00	3655.88	3652.74	3656.46	0.001608	9.69	10158.63	3008.78	0.45
Duncan	8150		Bridge									
Duncan	8074.69	48000 cfs	48000.00	3637.95	3653.42	3651.50	3654.28	0.001855	10.16	8198.17	3016.15	0.48
Duncan	7292.9	48000 cfs	48000.00	3636.00	3650.18	3648.79	3652.19	0.003671	13.21	6316.78	3034.95	0.67
Duncan	6704.99	48000 cfs	48000.00	3636.00	3650.44	3645.15	3650.84	0.000780	6.29	12560.40	4008.48	0.31
Duncan	5069.1	48000 cfs	48000.00	3632.00	3648.76	3647.27	3649.29	0.001189	8.15	10430.50	3769.35	0.38
Duncan	4390.69	48000 cfs	48000.00	3630.00	3644.91	3641.98	3647.48	0.006846	17.63	4913.61	3657.94	0.89
Duncan	3465.86	48000 cfs	48000.00	3628.00	3644.63	3639.34	3645.02	0.000921	7.00	11631.06	3463.31	0.33
Duncan	2762.76	48000 cfs	48000.00	3628.00	3643.79	3639.89	3644.28	0.001184	7.55	12803.74	2565.03	0.36
Duncan	2021.07	48000 cfs	48000.00	3626.00	3642.81	3639.87	3643.42	0.001110	8.41	12013.48	2248.68	0.38
Duncan	867.45	48000 cfs	48000.00	3624.00	3639.02	3636.68	3641.10	0.003835	12.60	4897.05	2589.36	0.67
Duncan	113.23	48000 cfs	48000.00	3624.00	3636.95	3636.95	3637.98	0.003553	11.23	8294.49	2469.58	0.63

CorrectedEffective-InnefectiveFlowAreas Plan: Plan 09 12/11/2015



CorrectedEffective-WWTFRemoved Plan: Plan 09 12/11/2015





**Floodplain model displaying the extended boundary by excavating soil*