DANT DRAINAGE ANALYSIS DRAINAGE REPORT

(DANT DAM TO MOANA CULVERT)

Prepared for:

BIGGEST LITTLE CITY IN THE WORLD
CITY OF RENO

CITY OF RENO

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1 Introduction and Purpose

The Dant Wash is located in southwest Reno. This project's limits (Dant Blvd. to West Moana Lane) are primarily within Township 19, Range 19, Section 26 (Figure 1). The entire Dant Wash above Plumas Street is approximately 1,038 acres or nearly 4 square miles. The embankment for Dant Boulevard acts as a dam and limits the amount of stormwater that is conveyed downstream to the West Moana Lane box culverts. Between Dant Boulevard and West Moana Lane, the Last Chance and Lake Ditches cross the Dant Wash. Generally, these ditches convey irrigation flow from April to October and are empty through the winter months.

In the 2005 event, stormwater downstream of the Dant Boulevard Dam drained to the Last Chance Ditch, eroding upstream areas and depositing sediment within the ditch. At this point, stormwater flows proceeded to flow both upstream and downstream in the ditch causing overtopping problems in the Meadowview Lane (east end) and Manzanita Lane (east of Plumas St.) areas. Flows also presumably overtopped the Last Chance Ditch within the Dant Wash and proceeded downstream to Pheasant Lane. At Pheasant Lane, the culvert headwater increased until stormwater overtopped the roadway. A garage at 2000 Pheasant Lane (next to the culvert crossing) was reported to be flooded. At Lake ditch, stormwater runoff from this event drained into the empty ditch, which conveyed the stormwater without significant problems. In 2006, a cinder block wall was constructed on the ditch near Greenfield Drive. This wall was constructed to minimize overtopping that may have occurred in the 2005 event and reduce general seepage problems in this area.

The purpose of the Dant Drainage Analysis was to determine the feasibility of installing culvert or siphon crossings under Last Chance Ditch, Lake Ditch, and Pheasant Lane in an attempt to separate stormwater flow from the irrigation ditches, minimizing stormwater impacts to the irrigation ditches and reduce ponding and overtopping potential at Pheasant Lane. The main goal of these improvements would be primarily to reduce future flooding downstream of the ditches from stormwater that is diverted through the ditches, and to comply with the City's ordinance of separating major stormwater point source inflows (Dant Wash) from irrigation ditches (ordinance specifies the 100-year event).

2 Existing Condition Results

Existing condition hydrology was not a part of this project's scope. Stormwater runoff values were referenced from previous reports as noted below.

1. Supplemental Engineering Report for Plumas/Moana Storm Drain, Kennedy/Jenks/Chilton, March 1989.
2. Dant Wash Conceptual Drainage Design and Conceptual Estimate of Construction Cost Technical Memorandum, Kennedy/Jenks Consultants, 30 December 2008.

For the existing condition analysis, a 100-year flow of 345 cfs (steady flow) was used based on reference 1. This study (reference 1) was the hydraulic basis for the design and construction of the Dant Boulevard Detention Dam as well as the storm drain improvements in the lower Dant Wash between the West Moana Lane culverts and Virginia Lake as part of the Plumas – Moana Storm Drain Project. These storm drain improvements were constructed by the City of Reno and designed based on the premise that stormwater flow is not diverted from the Dant Wash by either the Last Chance or Lake Ditches during the design storm event.

A HEC-RAS model was developed from just downstream of the Dant Boulevard Dam to just upstream of the West Moana Lane Culverts. Cross sections were cut from the 2 foot contour TIN. The Last Chance and Lake Ditches were modeled as lateral weirs to the Dant Wash to convey (low flow) stormwater out of the model (and out of the Dant Wash). Overtopping of the ditch banks occur at higher flows and allow flow to drain down the Dant Wash as well as the ditches. The lateral weirs were loosely calibrated by adjusting the weir coefficient based on corresponding normal depth calculations that consider the slope of the ditch. This was done to ensure that the model did not artificially consider the lateral weir representations of the ditches more efficient than they really are. The capacity of the Last Chance Ditch to convey stormwater out of the Dant Wash without overtopping was estimated to be 103 cfs. It is important to note however that this capacity is estimated based on the ditch cross section at the Dant Wash and is likely less downstream in the ditch due to constriction points. This is likely the phenomenon that occurred in the 2005 event. The capacity of the Lake Ditch to convey stormwater out of the Dant Wash without overtopping was estimated to be 56 cfs. As overtopping occurs, both of these ditch capacity values increase. Low points in cross sections near the ditch (generated from the TIN) were modeled as blocked obstructions so that the ditch capacities were not double counted. The 27" CMP culvert at Pheasant Lane was included as a culvert in the model as well.

Figure 2 shows the results for a 345 cfs discharge from the dam. Approximately 139 cfs is estimated to be conveyed out of the Dant Wash and down the Last Chance Ditch. This leaves 206 cfs to overtop the Last Chance Ditch bank and proceed down the Dant Wash to Pheasant Lane. The headwater of the 27" CMP culvert at Pheasant Lane ponds to approximately 4593.26 which is 1 ft +/- above the top of roadway. Flow conveyed through the Pheasant Lane culvert drains to the Lake Ditch where it is estimated that approximately 124 cfs is conveyed in the ditch out of the Dant Wash. 82 cfs overtops the ditch bank and proceeds down to the West Moana Lane box culverts. Reference 2 (above) cites the capacity of the West Moana Lane box culvert as approximately 500 cfs. This existing condition flow can easily be conveyed through these culverts given that condition.

Based on information gained from field meetings with Last Chance Ditch and Lake Ditch representatives, these proportions appear reasonable. During the 2005 event, no overtopping of the Lake Ditch was noted in the Dant Wash, however some overtopping may have occurred near Greenfield Drive and likely occurred near Manzanita Lane. The existing condition HEC-RAS results are included in Appendix A and the existing condition meeting minutes and photos are located in Appendix C.

This analysis was run as a subcritical analysis since natural drainage channels rarely experience supercritical flow. Rather than becoming supercritical flow, the channel will likely experience erosion in some reaches that would likely deposit in the ditches as flow is obstructed. 100-year velocities for the drainage range from 4 to 8 feet per second which is expected to induce some erosion. This analysis does not account for sedimentation that could occur in each ditch. If sedimentation in one or both ditches occurs, it is likely that less flow will be conveyed in the ditches (out of the Dant Wash) and more flow will continue downstream within the Dant Wash. A detailed analysis of the downstream portions of the ditches was not part of this scope. It is not fully known how far out of the Dant Wash that these flows can be conveyed. Additionally, immediately downstream (2-3 feet) of the Pheasant lane culvert is a ranch style fence with smaller metal fence attached to it. This has a high potential of accumulating debris, reducing the capacity of the Pheasant Lane culvert and increasing the potential for overtopping of the roadway. For the purposes of this study, the culvert was assumed to be free of debris.

Within the Dant Wash, multiple residences were built (prior to incorporation by the City of Reno) very close to the natural drainage way and in some instances in the bottom of the drainage way. Three of the critical properties are 2055 Meadowview Lane, 2045 Meadowview Lane, and 2000 Pheasant Lane. These three residences are not the only ones that are close to the natural drainage way, however they are 3 of the more critical locations as shown on Figures 3 through 5. Elevations noted on these figures were taken from the 2 foot contour TIN as a reference to the predicted existing condition 100-year water surface elevation. These figures show that the structures at these locations are at risk of flooding during the 100-year event. Additionally, the 2 residences on Meadowview lane are so close to the bottom of the drainage way that only an estimated 5 cfs (approximate) can pass without affecting the structures. It is unknown where in relation to the surrounding ground, the finished floors of these residences are.

3 Critical Locations

<u>Pump House (Figure 2)</u>

- Located near the bottom of the drainage way.
- May be impacted periodically.
- Uninhabited, impacts likely limited to increased maintenance.

<u>2055 Meadowview Lane (Figure 3)</u>

- Located in the bottom of the drainage way.
- Bounded by greater than 10 foot slopes on either side of the residence.
- 2 foot deep +/- v-ditch on the northwest side of the residence.
- Flow exceeding the capacity of the v-ditch has the potential to impact the residence.

<u>2045 Meadowview Lane (Figure 4)</u>

- Located in the bottom of the drainage way.
- Bounded by greater than 10 foot slopes on either side of the residence.
- No defined conveyance channel. Low flows pass through driveway.
- Even minor flows have the potential to impact the residence.

<u>2000 Pheasant Lane (Figure 5)</u>

- Residence located above Pheasant Lane.
- Garage located slightly below Pheasant Lane.
- Headwater from existing 27" CMP culvert can impact garage.
- Potential debris accumulation point at outlet of existing culvert.
- Low flows will pass through culvert without impact if debris not present.

4 Original Project Direction

The original project direction was to determine how much flow could be routed down the Dant Wash separate from the irrigation ditches without adversely impacting residents downstream in the Dant Wash. The general approach was to identify the improvements necessary to convey stormwater flow under Last Chance Ditch, increase the Pheasant Lane culvert capacity, and convey flow under Lake Ditch without other substantial improvements. Prior to this project, these improvements were conceptually identified as a dual 36" RCP under Last Chance Ditch, a dual 12' x 5' RCBC and energy dissipater at Pheasant Lane, and a siphon at Lake Ditch. The main goal of the project was to reduce the flooding in the Meadowview and Manzanita Lane areas originating from irrigation diversion of stormwater runoff (within the Dant Wash) that was experienced in 2005. Based on the findings of the existing condition analysis HEC-RAS modeling, it was determined that the approximately 5 cfs capacity of the drainage near the 2045/2055 Meadowview Lane residences rendered this scope of project infeasible. Additionally, the existing condition analysis estimated that the Meadowview Lane residences currently only experience flow from storm events that create an overtopping condition in the Last Chance Ditch. Smaller events are likely diverted down the Last Chance Ditch (nearly entirely). Any limited project that increases stormwater conveyance under the ditches and through the Pheasant Lane culvert (without additional improvements) is likely to negatively impact the residences at 2045 and 2055 Meadowview Lane.

5 Proposed Alternatives

Multiple alternatives were investigated as a part of this project to determine the scope and preliminary probable cost of improvements needed to convey flow down the Dant Wash without adverse impact to residents near the Dant Wash. The following are 4 alternatives that will convey stormwater down the Dant Wash without adversely affecting the nearby residences. Since these projects will run through private property, residential cooperation will be needed along with construction easements.

Cooperation from the ditch companies will be needed as well. Field meetings have been held with both ditch companies. Norm Dianda and Tony Groux represented Last Chance Ditch. Marty Richard represented the Lake Ditch. All indicated that they would be willing to work with the City to get a project constructed and would like to have input on the final design. Additionally, both ditch representatives indicated a desire for side weir overflow so that irrigation ditches could be drained down the Dant Wash if needed. Although Lake Ditch is downstream of the critical locations, draining irrigation ditch water through private property to the West Moana Lane culverts would need to be evaluated and discussed with the affected residents. A memo summarizing the information gathered from these two meetings is included in Appendix C.

HEC-RAS results for the following proposed alternatives are included in Appendix B.

5.1 Alternative 1 – 35 cfs Conveyance

Alternative 1 was developed as a potential solution to convey low flows down the Dant Wash. During smaller events, this alternative would convey flow down the Dant Wash first and may provide the Meadowview Lane (east end) and Manzanita Lane (east of Plumas) residents relief from nuisance overtopping, however the frequency of this relief is unclear. Figure 6 details the following improvements for this alternative:

- Alternative conceptually conveys 35 cfs +/- under each irrigation ditch (with RCP culverts) and around the critical residences in a storm drain.
  - Comingling of stormwater runoff in the Dant Wash with irrigation flows would be avoided for runoff values less than 35 cfs
  - Ditches normally shut off in the winter months (November through March).
- A 30” RCP culvert crossing under the Last Chance Ditch.
- A 30” RCP storm drain to convey flow past the 2045 and 2055 Meadowview Lane residences.
- Pheasant Lane culvert remains a 27” CMP. If this alternative is taken to final design, serious consideration should be given to reducing debris accumulation at the upstream and downstream end of this culvert. If 35 cfs flows are regularly passed through this area, then those flows will regularly be close to the garage at 2000 Pheasant Lane. Any debris accumulation could make the difference between the garage remaining dry or being flooded.
- A 30” RCP culvert crossing under the Lake Ditch.
- Channel improvements around 1755 Greenfield Drive may be required at final design to ensure 35 cfs does not impact resident.

Alternative 1 is the least expensive of all the alternatives, however it also provides the least benefit for stormwater conveyance. The estimated preliminary probable cost for Alternative 1 is shown on Table 1. Increasing the conveyance above 35 cfs requires replacement of the Pheasant Lane 27” CMP culvert and necessitates conveyance improvements around the 1755 Greenfield Drive residence.

5.2 Alternative 2 – 100 cfs Drainage Channel

Alternative 2 was developed to convey larger flows down the Dant Wash based on available space and minimizing construction impact to nearby residents. This alternative has the potential to provide a factor of safety to the Meadowview Lane and Manzanita Lane residents.

Larger storm events (like the 100-year) would still overtop the irrigation ditches and cause flooding problems however. Figure 7 details the following improvements for this alternative:

- Alternative conceptually conveys 100 cfs +/- under each irrigation ditch (with RCP culverts) and down through the Dant Wash in a drainage channel.
    - Comingling of stormwater runoff in the Dant Wash with irrigation flows would be avoided for runoff values less than 100 cfs.
- A 48" RCP culvert crossing under the Last Chance Ditch.
- A riprap trapezoidal channel from just upstream of Last Chance Ditch to downstream of Lake Ditch past 1755 Greenfield Drive.
    - The channel through the 2045 and 2055 Meadowview lane area will cut into the hillside slightly and still require portions of yard and driveways to be removed.
    - This alternative has the most impact on these residents.
- An upsized 48" RCP culvert crossing for Pheasant Lane.
- A 48" RCP culvert crossing under the Lake Ditch.
- Channel improvements may need to be extended around 1755 Greenfield Drive at final design to ensure 100 cfs does not impact resident.

Alternative 2 provides much more stormwater conveyance, however the large riprap trapezoidal channel may be perceived by area residents to negatively impact the area aesthetics. Additionally, maintenance of the channel would be difficult without access from property owners. The estimated preliminary probable cost for Alternative 2 is shown on Table 2.

5.3 Alternative 3 – 100 cfs Drainage Channel w/ Storm Drain

Alternative 3 was developed as an option for Alternative 2. It attempts to minimize the permanent disturbance to the 2045 and 2055 residences by including substituting a 48"" RCP storm drain for the riprap trapezoidal channel near the residences. Additionally, a 48" RCP storm drain was substituted for the riprap trapezoidal channel near 1755 Greenfield Drive due to the potential aesthetic impacts to this property. This alternative provides the same conveyance levels as Alternative 2 and attempts to balance the impact to the area aesthetics with project cost. Figure 8 details the improvements for this alternative. Table 3 summarizes the preliminary probable cost.

5.4 Alternative 4 – 100 cfs Storm Drain

Alternative 4 was developed to minimize residents exposure to open channel flow and attempt to minimize impacts to the aesthetics of the area. This alternative includes the construction of a 48” RCP storm drain from just upstream of the Last Chance Ditch to downstream of 1755 Greenfield Drive. This alternative would convey stormwater flow sub-surface for the entire reach and discharge just upstream of the West Moana Lane box culverts. This alternative provides the same level of conveyance as Alternative 2 and attempts to eliminate any permanent aesthetic impacts to the area. However project cost does increase with this alternative. Figure 9 details the improvements associated with this alternative and Table 4 summarizes the preliminary probable cost.

6 Summary and Recommendations

Any project constructed within the Dant Wash will face many challenges such as poorly located existing residences (in relation to historic drainage patterns), project cost, residential cooperation, City access to project area, multiple stakeholders (two ditch companies and multiple residents), and impacts to aesthetics to name a few. The challenge to find an acceptable project will likely require compromise from each stakeholder to ensure a viable project. The four alternatives presented in this report attempt to incorporate realistic conditions, consider constructability constraints, and incorporate multiple improvements that may appeal to each stakeholder. Alternative 1 has very little benefit and Alternatives 2 through 4 are much larger than the original project scope which has been determined to be infeasible due to the likely impact to residents within the Dant Wash. These alternatives have been developed to provide a level of protection based on area constraints. Even with the construction of these improvements, the 100-year event will likely still overtop the irrigation ditches, flood residents, and create maintenance issues for the City and ditch companies.

A 100-year stormwater conveyance project through the Dant Wash of 345 cfs (with additional stormwater/irrigation conveyance up to the 500 cfs capacity of the West Moana Lane culverts) would be the optimal drainage project for the area, however a project of that magnitude has many challenges.

- A project of this scope would cost significantly more than the 4 alternatives developed for this project and more than the City currently has budgeted for this area.
- The entire project would bisect private property, requiring substantial easements, or purchasing of land.
    - Due to the low conveyance capacity around the 2045/2055 Meadowview Lane residences, both residences may need to be purchased (approximately $450,000 each) to make the project feasible.
- The aesthetics of a significant project could have the potential to change the rural setting of the area and may not be acceptable to residents who are not impacted by stormwater runoff, but who do have views of the affected area.

In lieu of a 100-year stormwater conveyance project, Alternatives 3 and 4 are the recommended alternatives. The cost for either of these alternatives is substantial, however each alternative incorporates improvements that are likely to be more generally acceptable. The benefits of either of these alternatives are:

1. Conveying higher runoff flows down Dant Wash reduces the likelihood of residents being flooded (and incurring damages) in the Manzanita Lane (east of Plumas) and Meadowview Lane (east end) areas due to irrigation ditch diversion of stormwater runoff.

2. The improvements will have less impact to critical residences by minimizing the final constructed footprint of the improvements.

3. Construction of storm drain will minimize aesthetic impacts to the area which will likely be important to all residents with a view of the now rural/natural area.

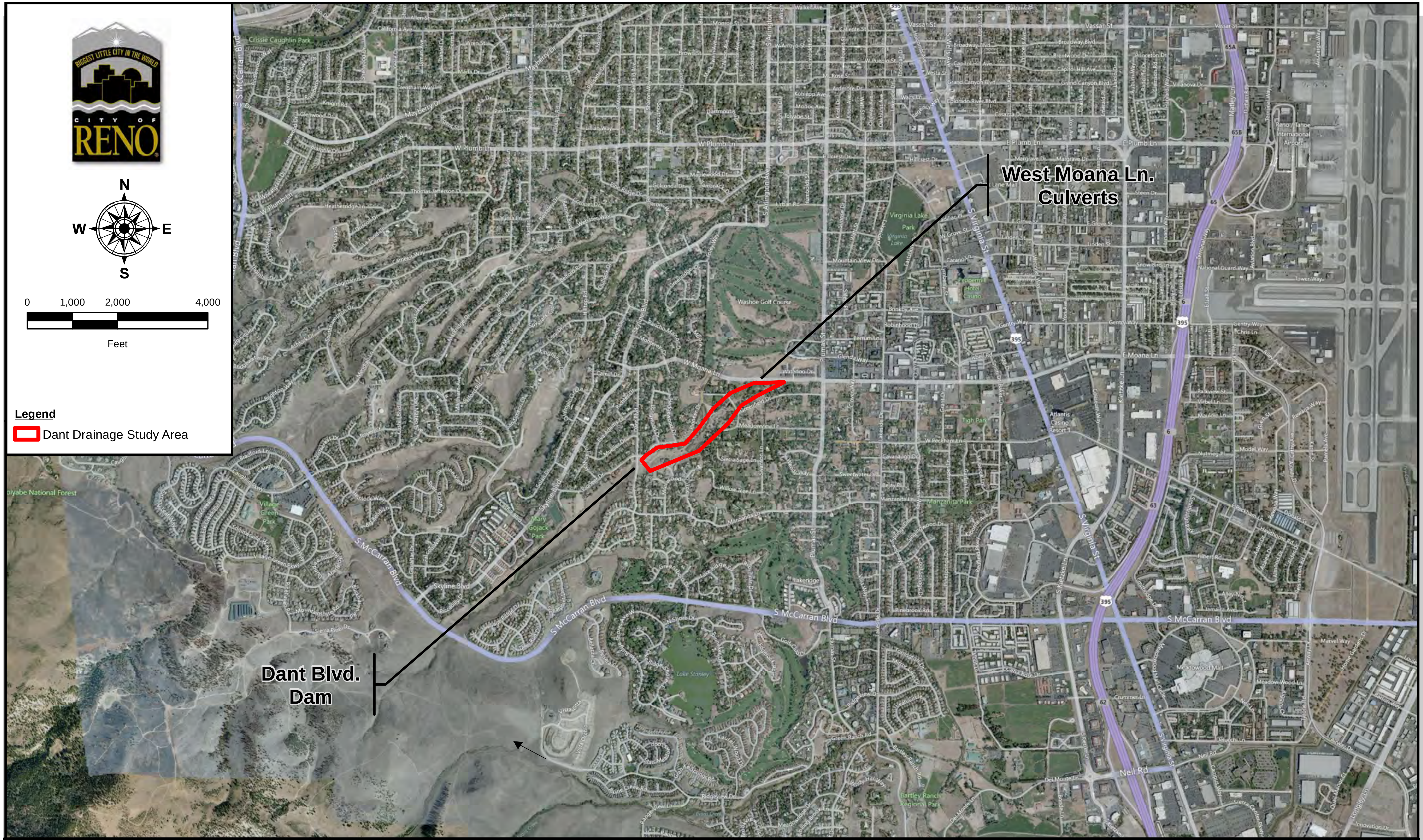
4. An attempt will be made to comply with City of Reno ordinance to separate major stormwater point source inflows (Dant Wash) from irrigation ditches although not at the 100-year event level.

5. The drainage improvements will be maintainable given the necessary easements.

❖ If the purchase of the 2045 and 2055 Meadowview Lane residences were incorporated with these alternatives, more conveyance capacity could be added to the project and two of the most critical locations could be removed from the impacted area.

At the time of final design, it is recommended that public input be sought to determine which improvements are the most acceptable and to determine which homeowners are willing to grant easements and access.

FIGURES



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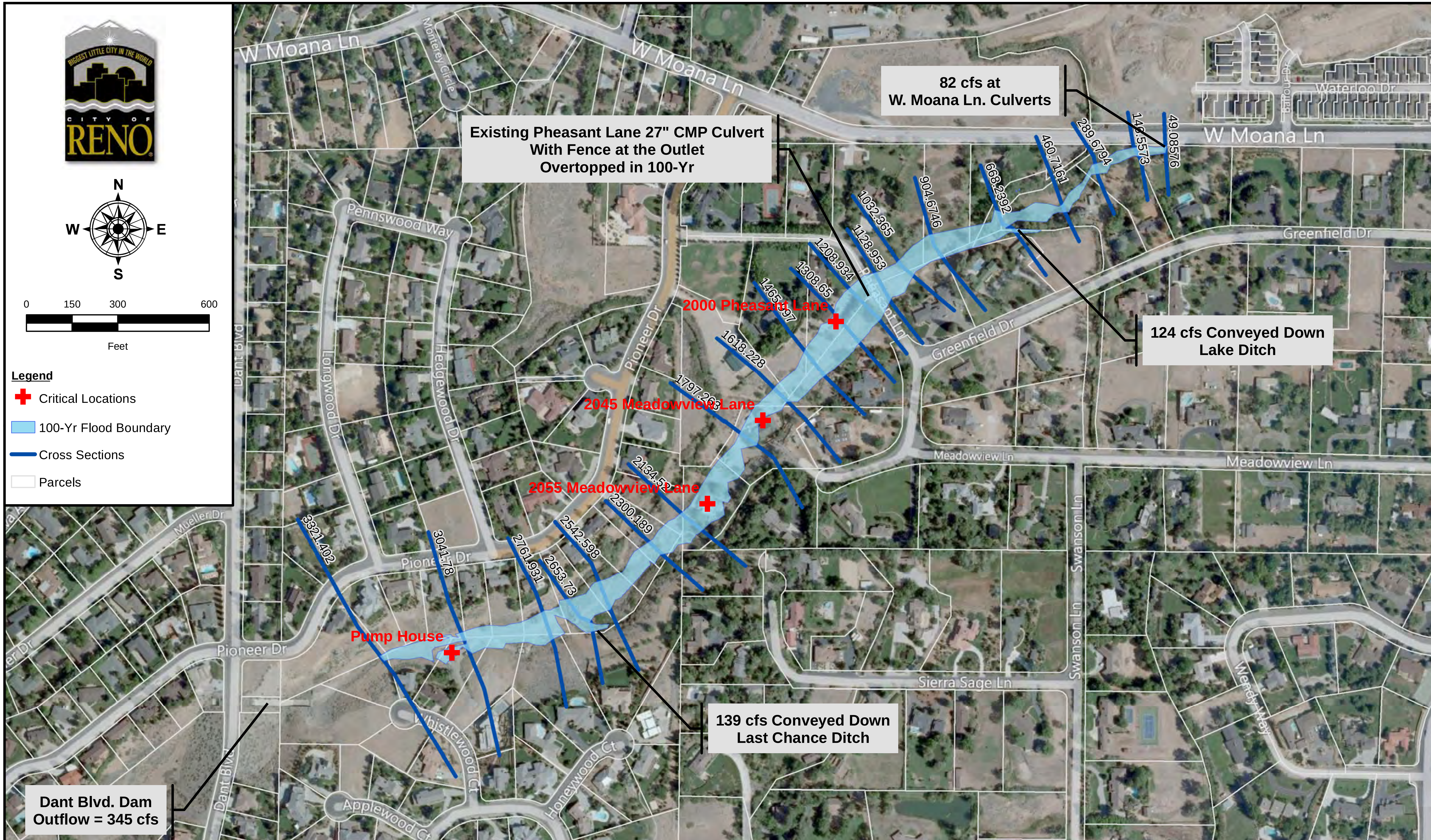
Dant Drainage Analysis
Location Map

Figure 1



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Dant Drainage Analysis
Existing Condition Results

Figure 2

Dant Drainage Analysis
2055 Meadowview Lane

Figure 3

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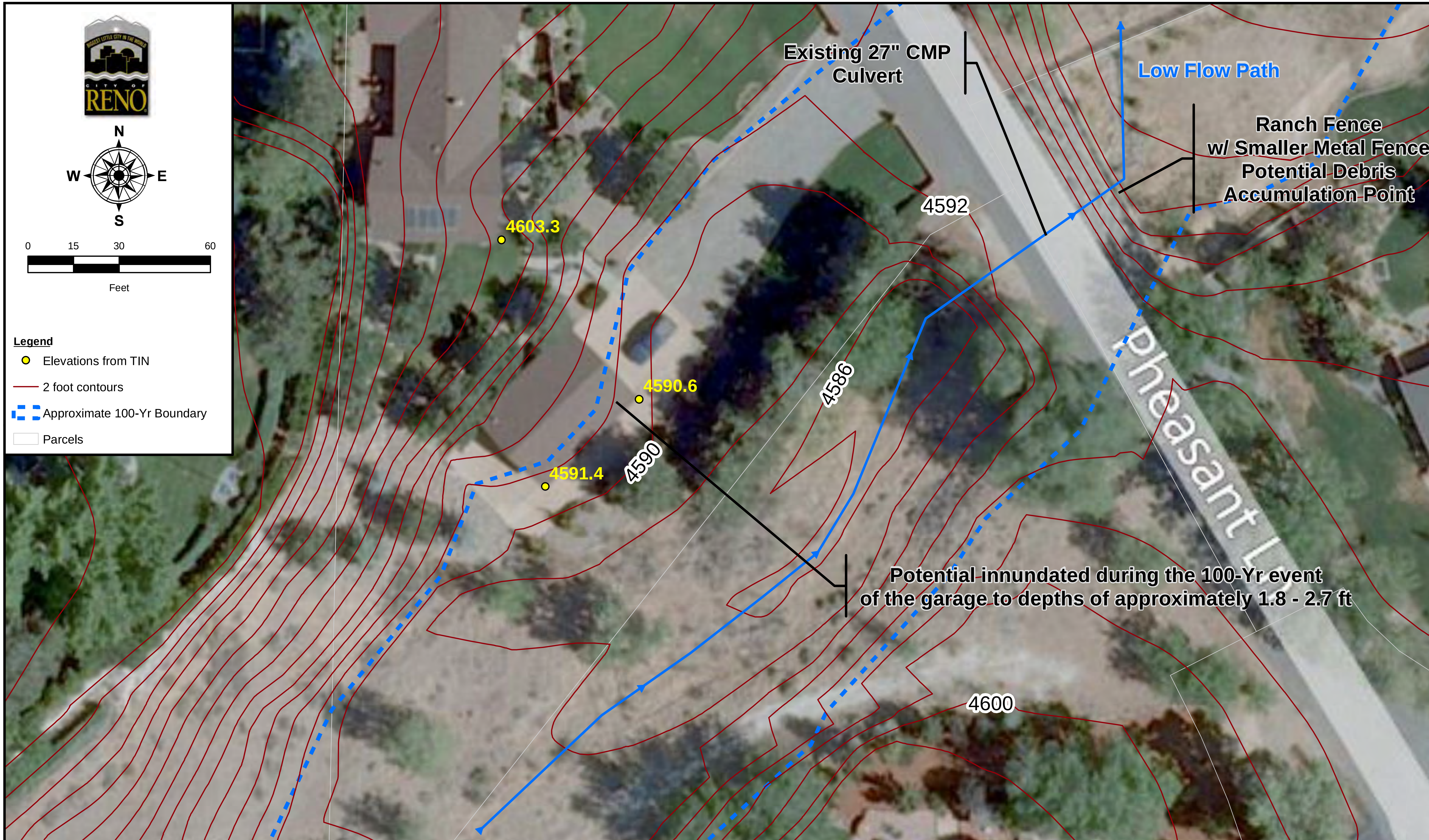
Dant Drainage Analysis
2045 Meadowview Lane

Figure 4



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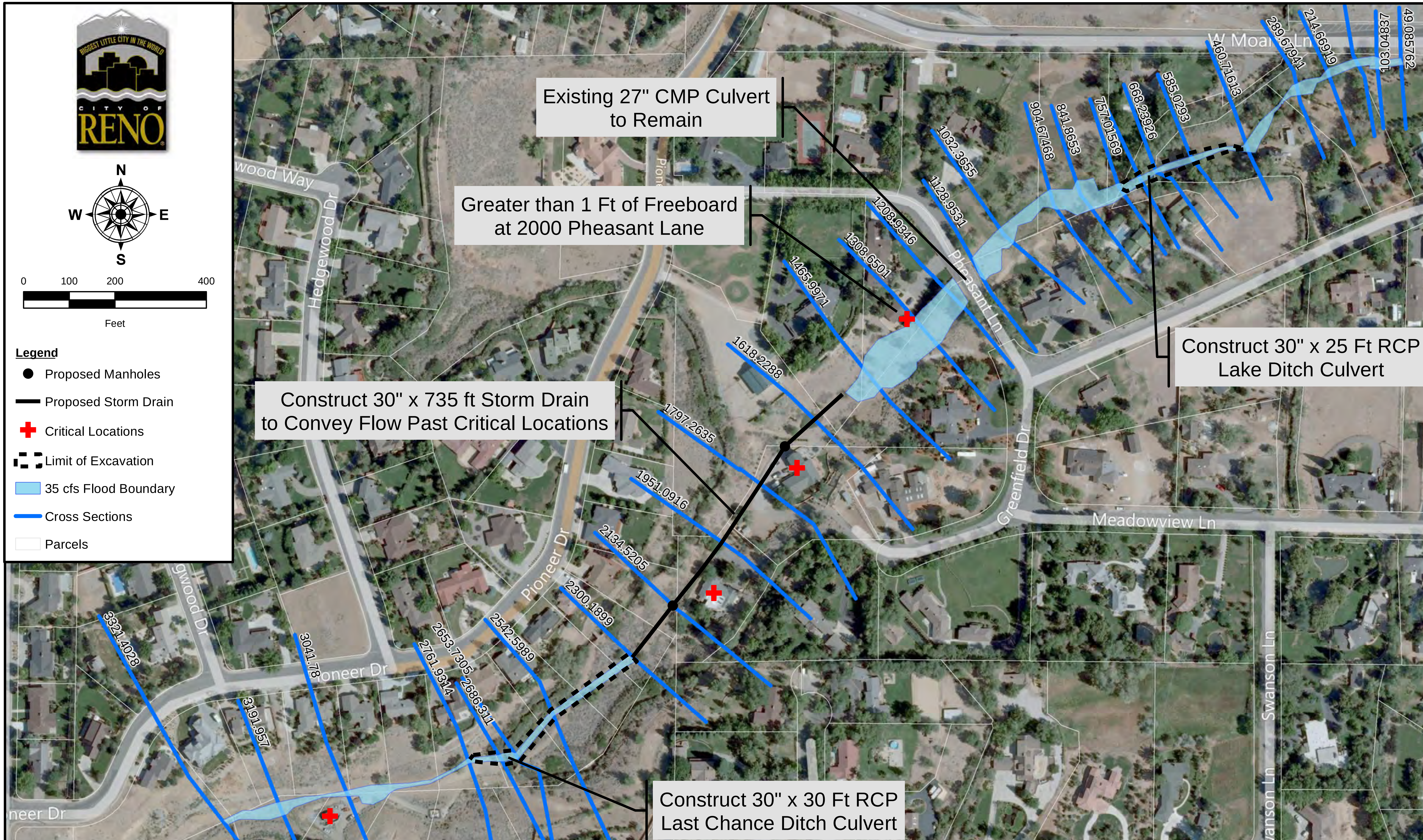
Dant Drainage Analysis
2000 Pheasant Lane

Figure 5



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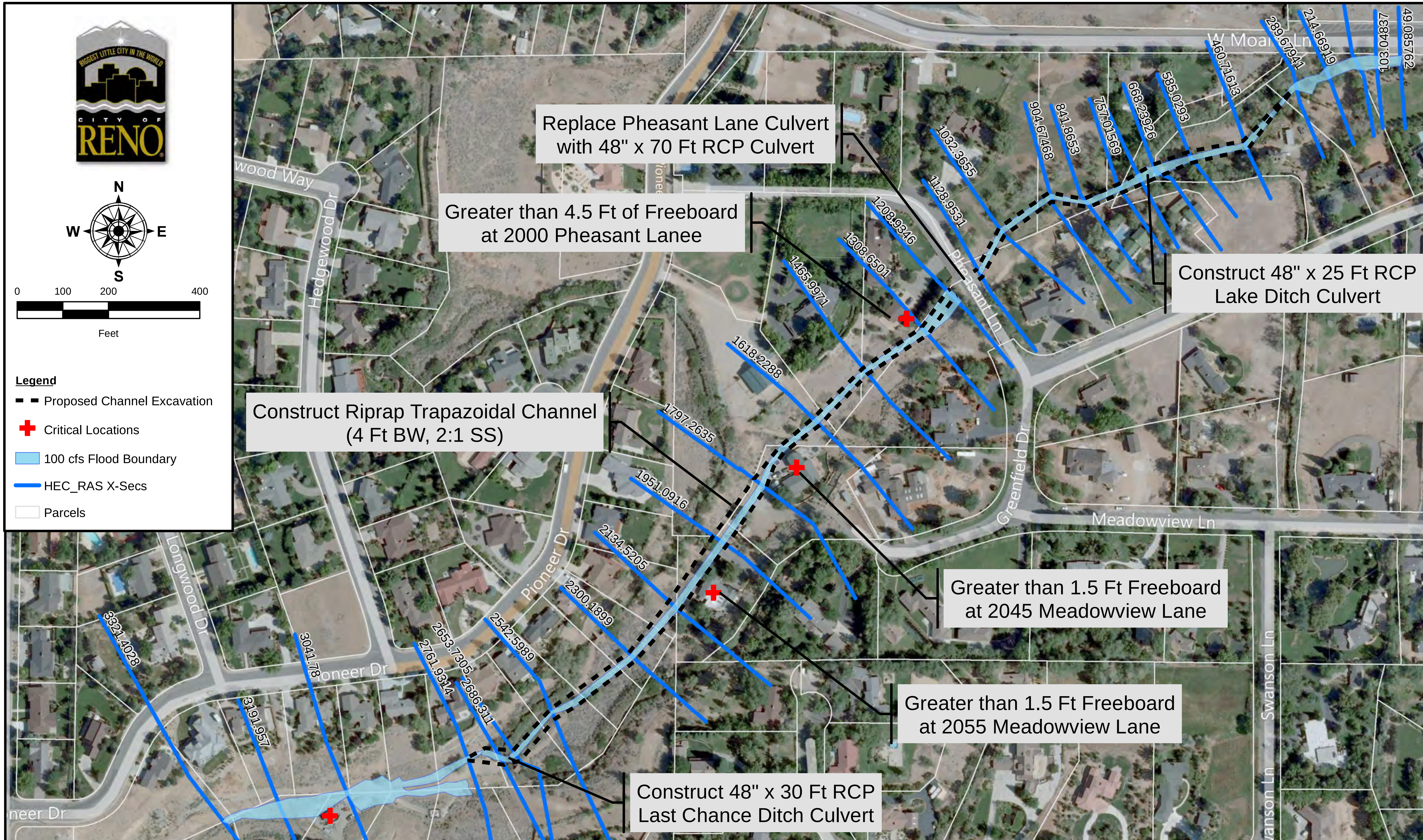
Dant Drainage Analysis
Alternative 1 (35 cfs Conveyance)

Figure 6



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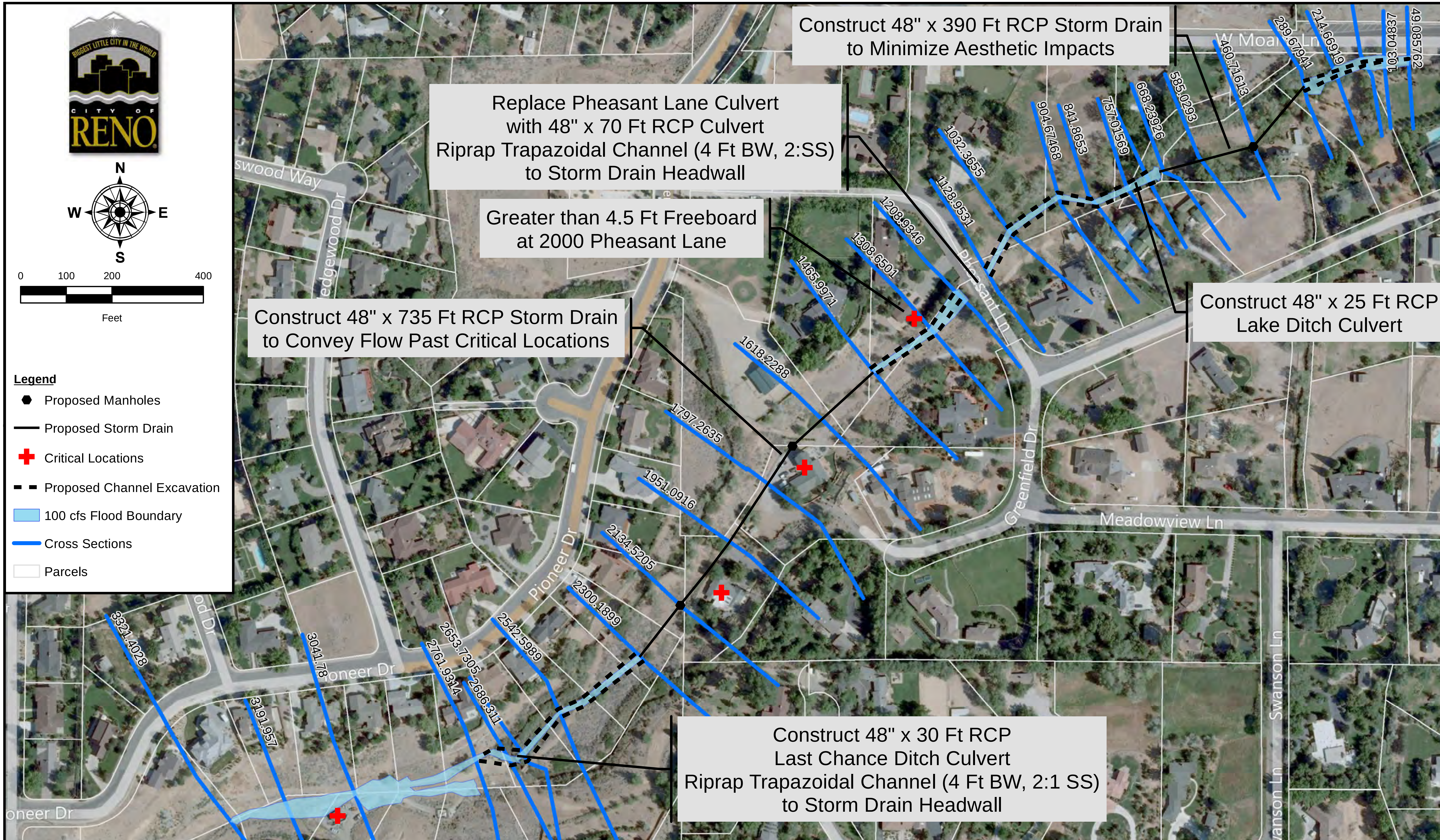
Dant Drainage Analysis
Alternative 2 (100 cfs Drainage Channel)

Figure 7



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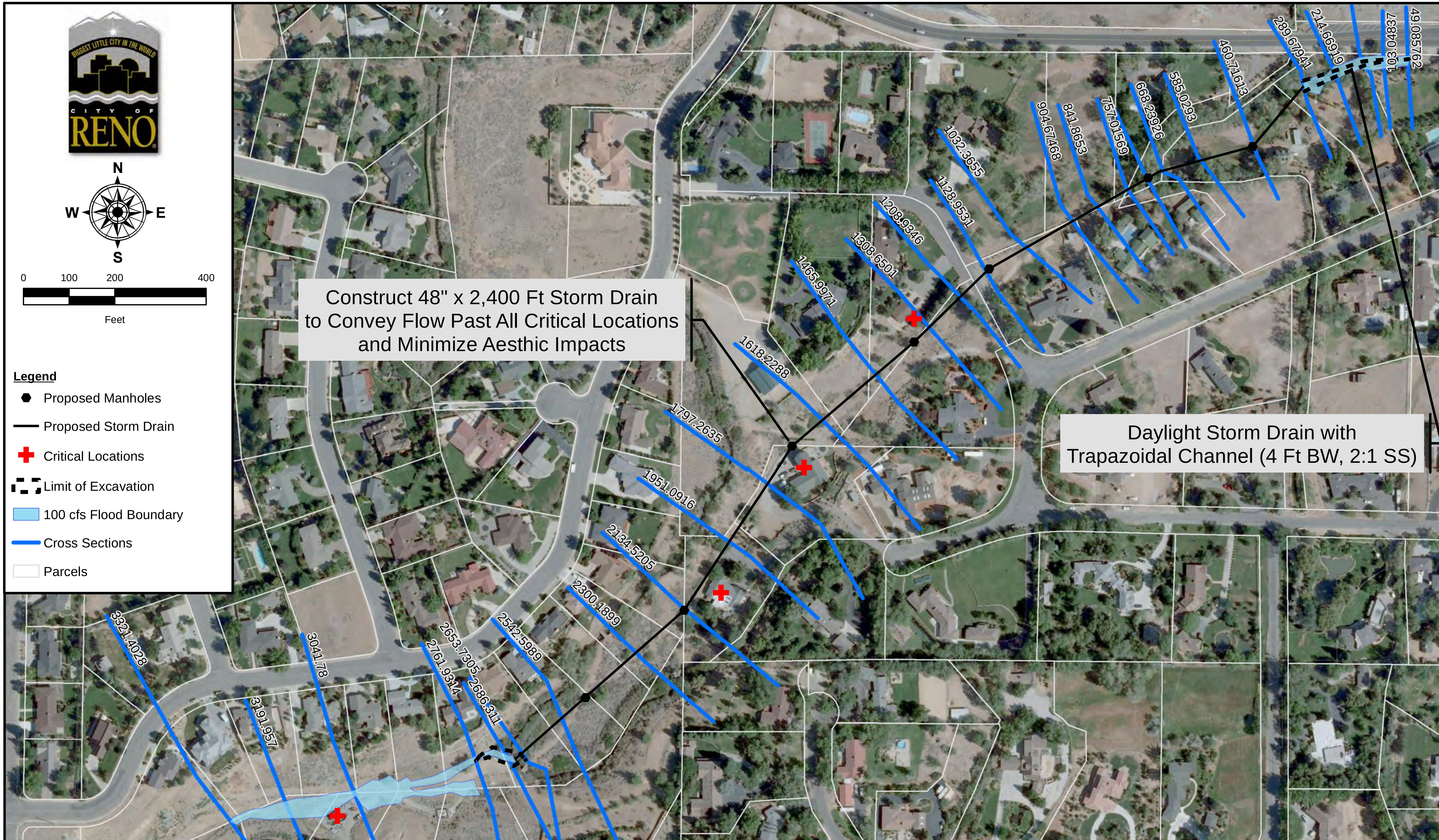
Dant Drainage Analysis

Alternative 3 (100 cfs Drainage Channel w/ Storm Drain)

Figure 8



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Dant Drainage Proposed Alternatives

Alternative 4 Map (100 cfs, Storm Drain from Last Chance Ditch to 1755 Greenfield Dr)

Figure 9

TABLES

Dant Drainage Analysis
Table 1- Alternative 1 Preliminary Probable Cost

Description	Unit Price	Unit	Alternative 1 Total Quantity	Alternative 1 Amount
Drainage Excavation	$ 20.00	CUY	2,590	$ 51,801
Structure Excavation	$ 25.00	CUY	1,258	$ 31,459
Granular Backfill	$ 30.00	CUY	540	$ 16,198
30-IN Reinforced Concrete Pipe, Class III	$ 85.00	LINF	790	$ 67,150
Type 4 Manhole	$ 5,000.00	EA	2	$ 10,000
Castings	$ 4.00	LB	730	$ 2,920
Culvert Headwalls-Concrete	$ 1,400.00	CUY	10	$ 14,140
Culvert Headwalls-Reinforcement	$ 2.00	LB	431	$ 862
Riprap Class 300	$ 60.00	CUY	616	$ 36,977
Riprap Bedding	$ 60.00	CUY	205	$ 12,326
Non-Woven GeoTextile	$ 3.00	SQY	1,059	$ 3,177
			SUBTOTAL	**$ 247,010**
Construction Engineering (10% of Subtotal)	1	LS		$ 24,701
Contingency (20% of Subtotal)	1	LS		$ 49,402
MOBILIZATION (5% of Subtotal)	1	LS		$ 12,350
			TOTAL	**$ 333,000**

Dant Drainage Analysis
Table 2- Alternative 2 Preliminary Probable Cost

Description	Unit Price	Unit	Alternative 2	
			Total Quantity	Amount
Drainage Excavation	$ 20.00	CUY	10,582	$ 211,641
Structure Excavation	$ 25.00	CUY	1,022	$ 25,539
Granular Backfill	$ 30.00	CUY	141	$ 4,222
AC Pavement w/ Base	$ 5.00	SF	800	$ 4,000
48-IN Reinforced Concrete Pipe, Class III	$ 130.00	LINF	125	$ 16,250
Culverts Concrete	$ 1,400.00	CUY	24	$ 33,922
Culverts Reinforcement	$ 2.00	LB	2,256	$ 4,512
Riprap Class 300	$ 60.00	CUY	3,810	$ 228,614
Riprap Bedding	$ 60.00	CUY	1,270	$ 76,205
Non-Woven GeoTextile	$ 3.00	SQY	7,607	$ 22,822
			SUBTOTAL	**$ 627,726**
Construction Engineering (10% of Subtotal)	1	LS		$ 62,773
Contingency (20% of Subtotal)	1	LS		$ 125,545
MOBILIZATION (5% of Subtotal)	1	LS		$ 31,386
			TOTAL	**$ 847,000**

Dant Drainage Analysis
Table 3- Alternative 3 Preliminary Probable Cost

Description	Unit Price	Unit	Alternative 3 Total Quantity	Alternative 3 Amount
Drainage Excavation	$ 20.00	CUY	5,595	$ 111,895
Structure Excavation	$ 25.00	CUY	4,347	$ 108,665
Granular Backfill	$ 30.00	CUY	1,488	$ 44,654
AC Pavement w/ Base	$ 5.00	SF	800	$ 4,000
48-IN Reinforced Concrete Pipe, Class III	$ 130.00	LINF	1,325	$ 172,250
Type 4 Manhole	$ 5,000.00	EA	3	$ 15,000
Castings	$ 4.00	LB	1,095	$ 4,380
Culverts Concrete	$ 1,400.00	CUY	32	$ 44,296
Culverts Reinforcement	$ 2.00	LB	2,944	$ 5,888
Riprap Class 300	$ 60.00	CUY	1,887	$ 113,215
Riprap Bedding	$ 60.00	CUY	629	$ 37,738
Non-Woven GeoTextile	$ 3.00	SY	3,266	$ 9,797
			SUBTOTAL	**$ 671,779**
Construction Engineering (10% of Subtotal)	1	LS		$ 67,178
Contingency (20% of Subtotal)	1	LS		$ 134,356
MOBILIZATION (5% of Subtotal)	1	LS		$ 33,589
			TOTAL	**$ 907,000**

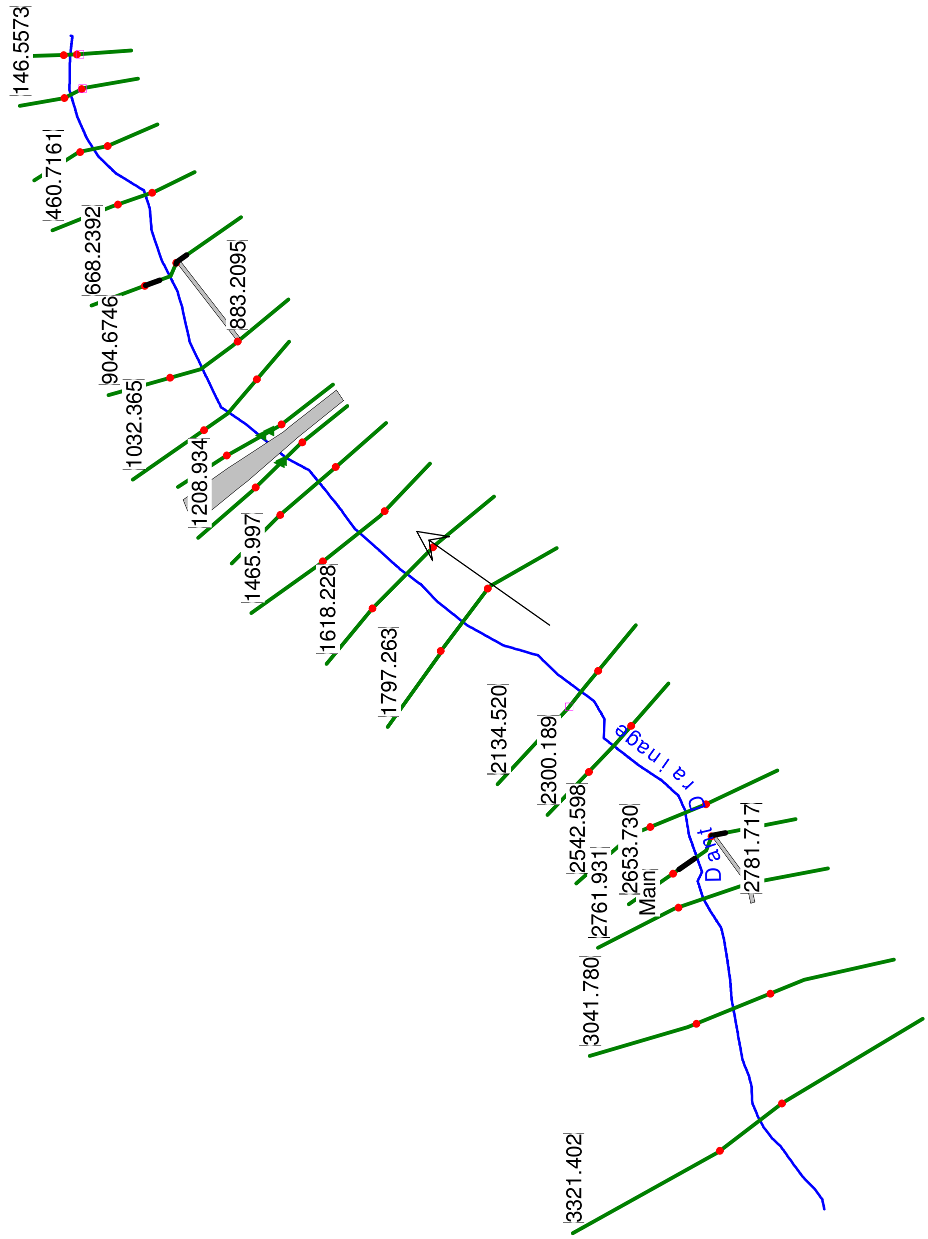
Dant Drainage Analysis
Table 4- Alternative 4 Preliminary Probable Cost

Description	Unit Price	Unit	Alternative 4 Total Quantity	Alternative 4 Amount
Drainage Excavation	$ 20.00	CUY	716	$ 14,316
Structure Excavation	$ 25.00	CUY	8,177	$ 204,434
Granular Backfill	$ 30.00	CUY	2,649	$ 79,479
AC Pavement w/ Base	$ 5.00	SF	800	$ 4,000
48-IN Reinforced Concrete Pipe, Class III	$ 130.00	LINF	2,400	$ 312,000
Type 4 Manhole	$ 5,000.00	EA	7	$ 35,000
Castings	$ 4.00	LB	2,555	$ 10,220
Culverts Concrete	$ 1,400.00	CUY	9	$ 13,174
Culverts Reinforcement	$ 2.00	LB	880	$ 1,760
Riprap Class 300	$ 60.00	CUY	146	$ 8,733
Riprap Bedding	$ 60.00	CUY	49	$ 2,911
Non-Woven GeoTextile	$ 3.00	SQY	256	$ 768
			SUBTOTAL	**$ 686,795**
Construction Engineering (10% of Subtotal)	1	LS		$ 68,680
Contingency (20% of Subtotal)	1	LS		$ 137,359
MOBILIZATION (5% of Subtotal)	1	LS		$ 34,340
			TOTAL	**$ 927,000**

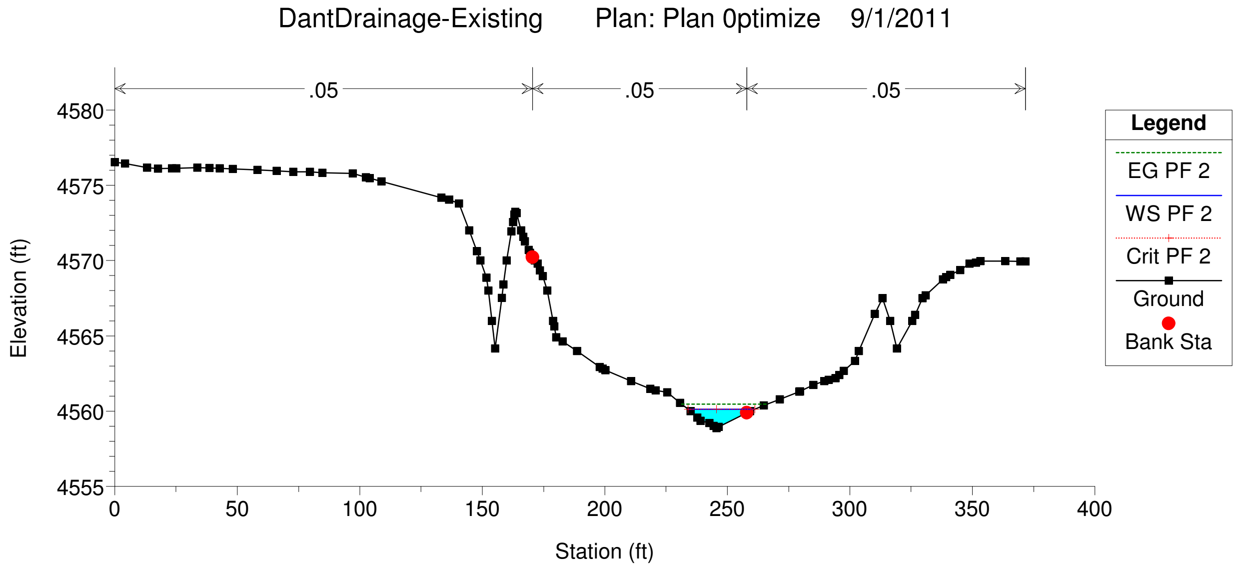
APPENDIX A

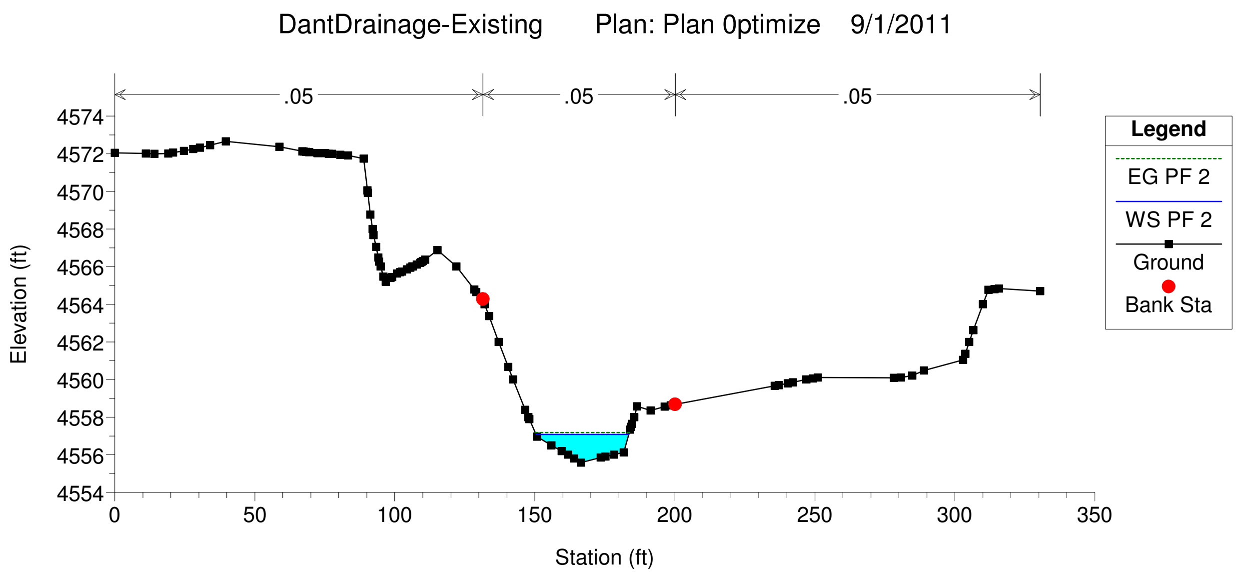
Existing Condition HEC-RAS Output

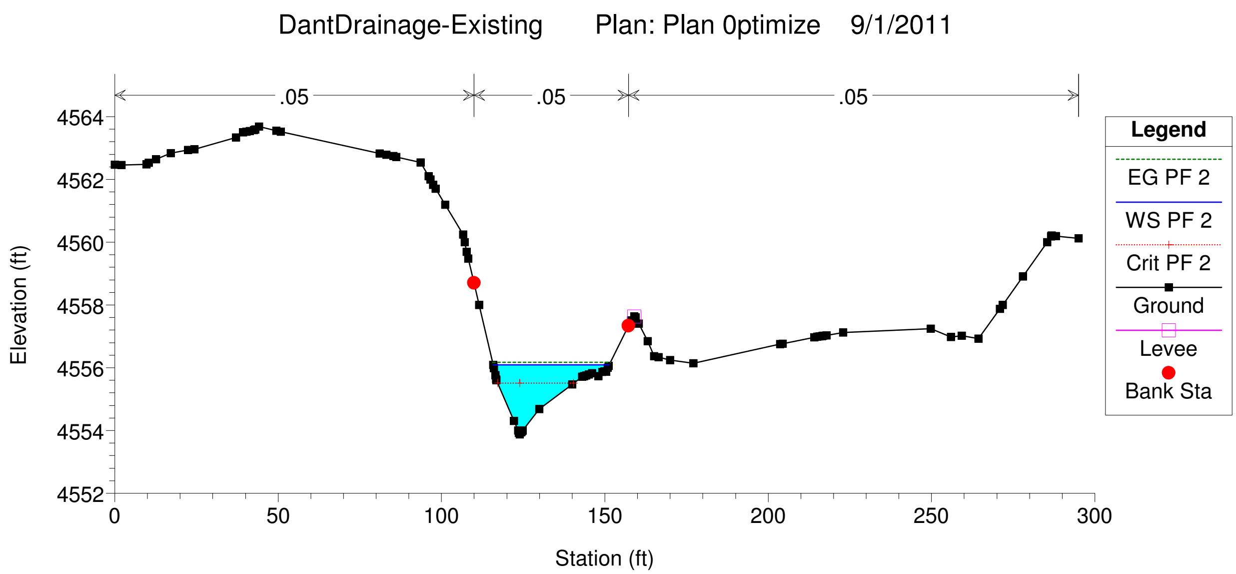
Existing Condition Model

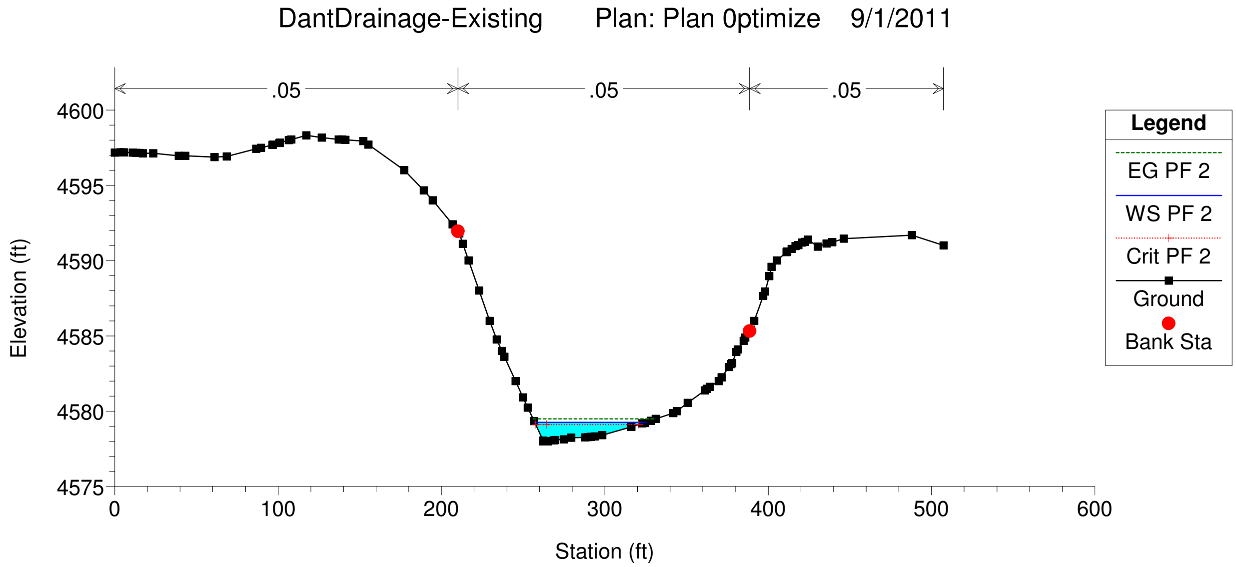


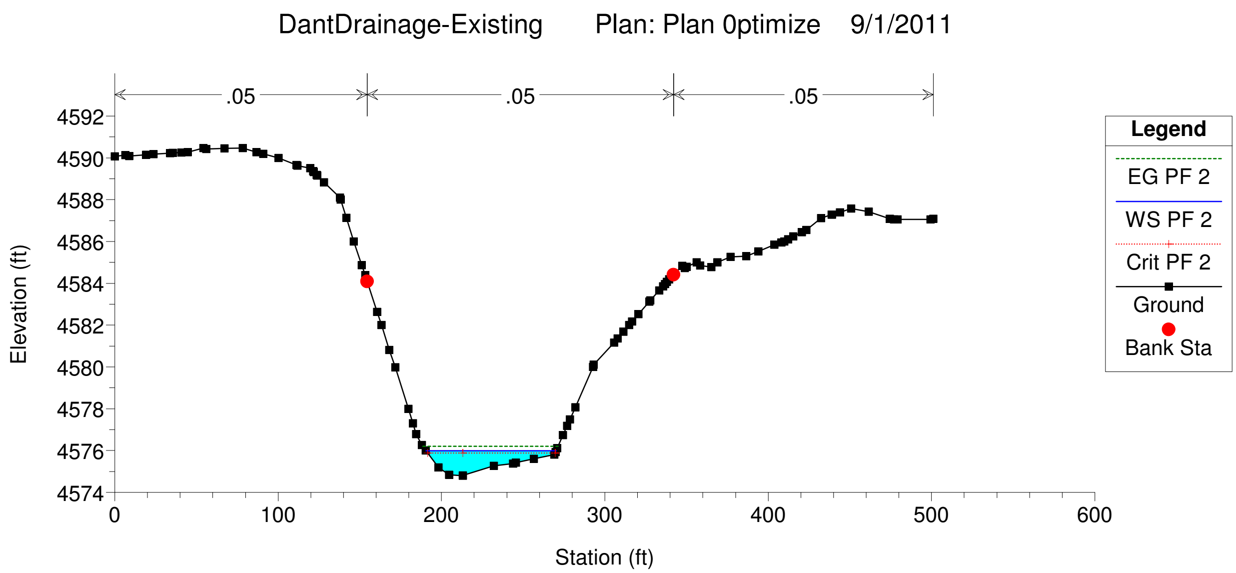
Cross Sections








DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
.05
.05
.05
Elevation (ft)
4575
4580
4585
4590
4595
4600
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta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.05
.05
.05
Elevation (ft)
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4576
4578
4580
4582
4584
4586
4588
4590
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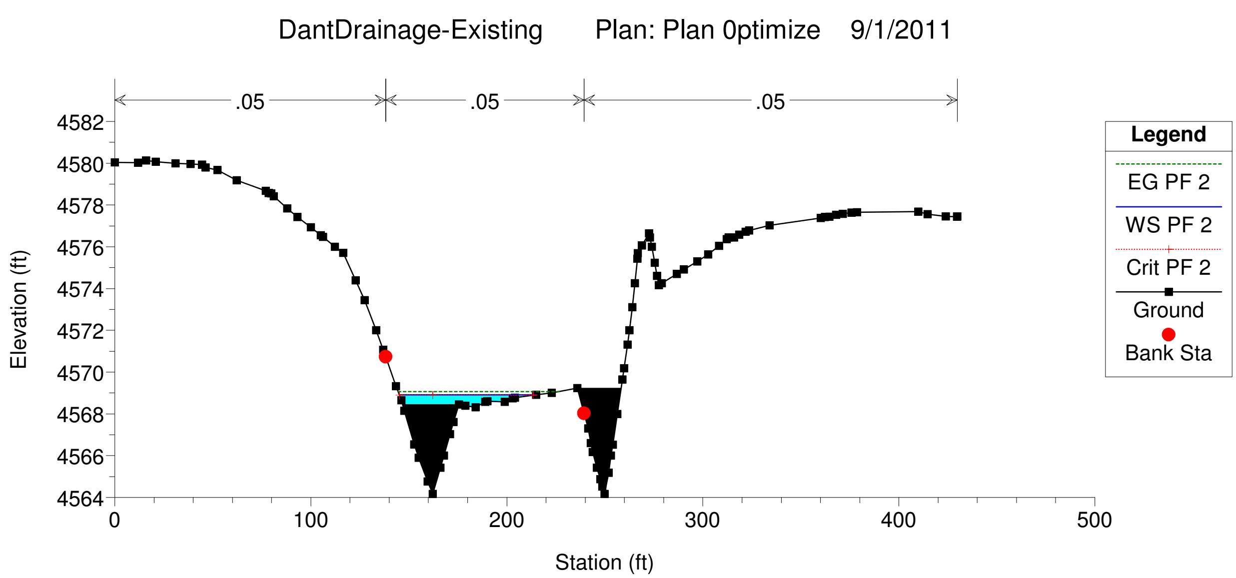
200
300
400
500
600
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta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.05
Elevation (ft)
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4566
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4574
4576
4578
4580
4582
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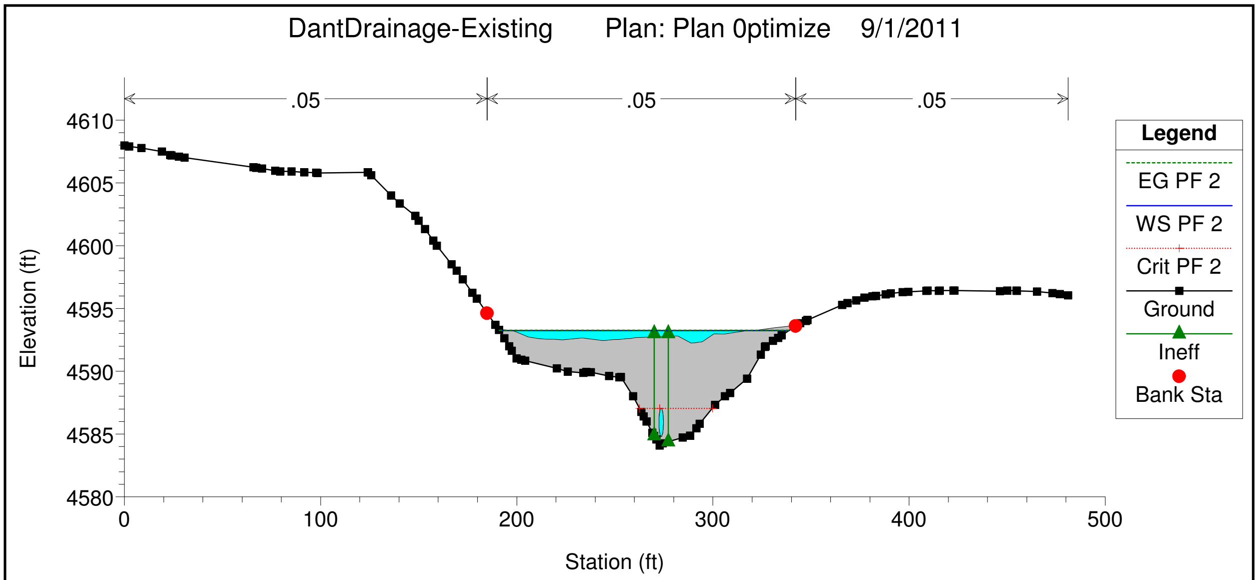
100
200
300
400
500
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
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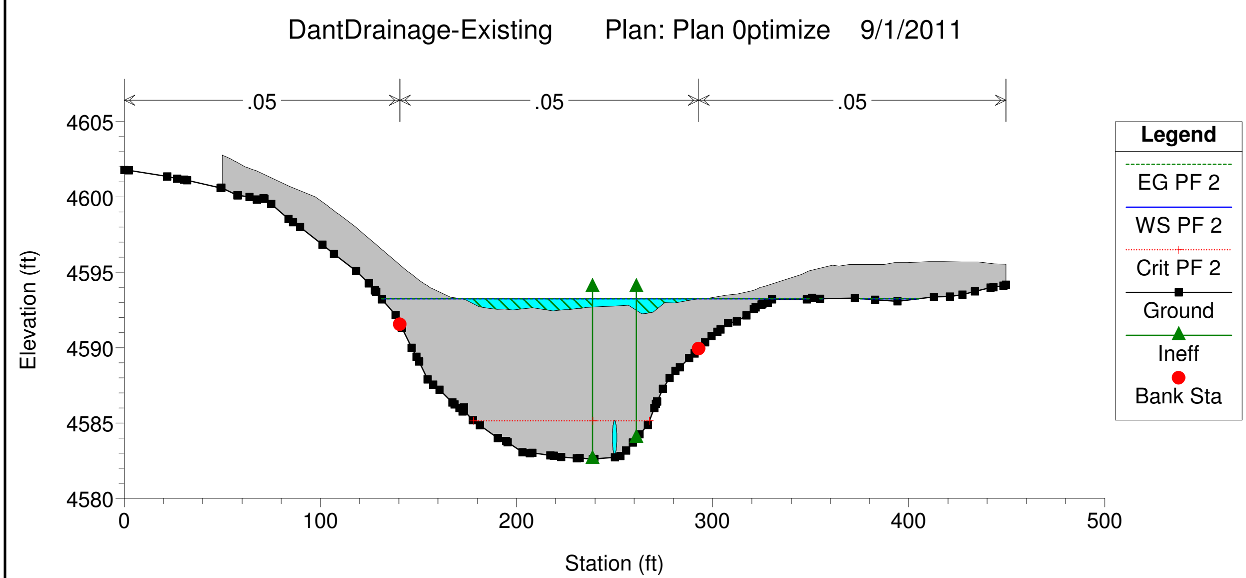
.05
.05
Elevation (ft)
4580
4585
4590
4595
4600
4605
4610
Station (ft)
0
100
200
300
400
500
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Ineff
Bank Sta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.05
.05
Elevation (ft)
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4585
4590
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4600
4605
Station (ft)
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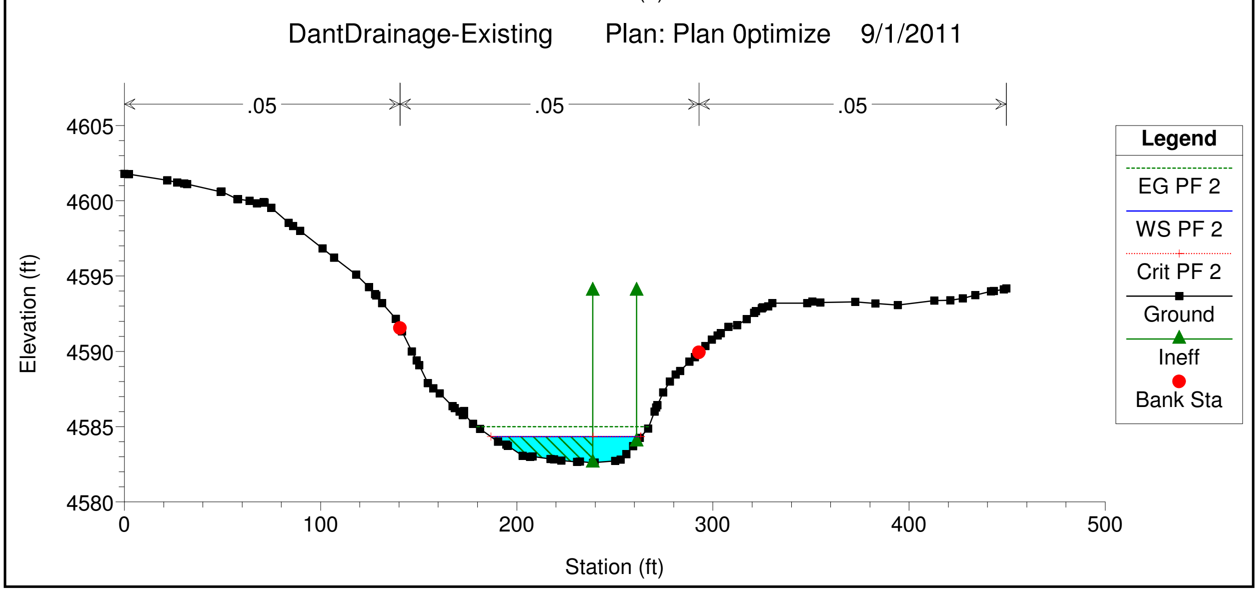
200
300
400
500
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Ineff
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
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.05
.05
Elevation (ft)
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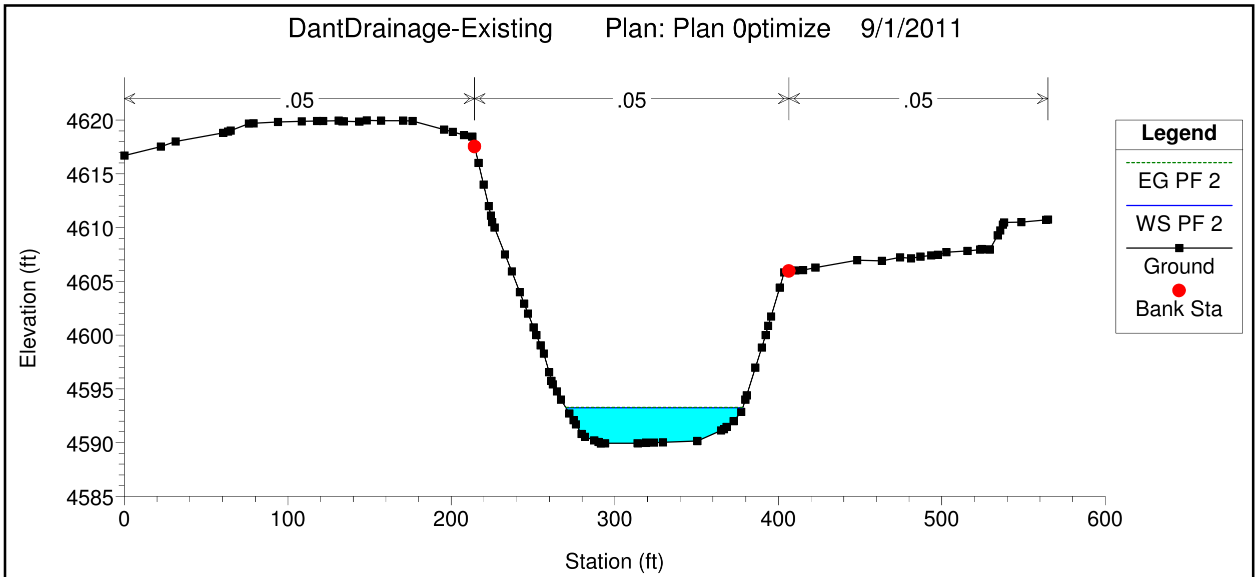
4585
4590
4595
4600
4605
Station (ft)
0
100
200
300
400
500
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Ineff
Bank Sta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.05
.05
Legend
EG PF 2
WS PF 2
Ground
Bank Sta
Elevation (ft)
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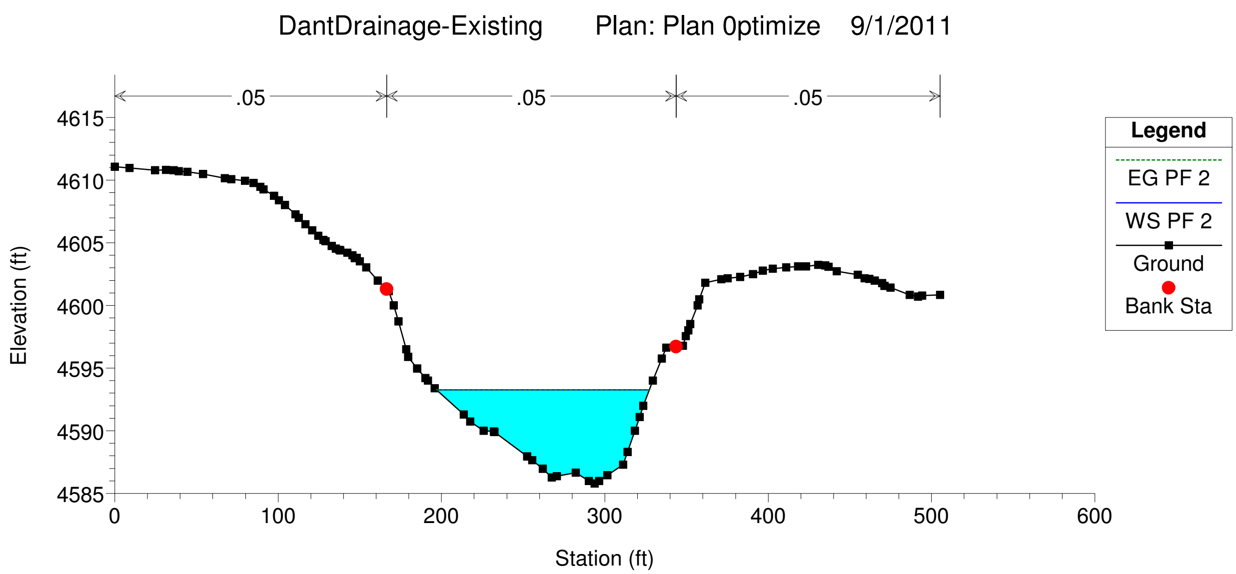
4595
4600
4605
4610
4615
4620
0
100
200
300
400
500
600
Station (ft)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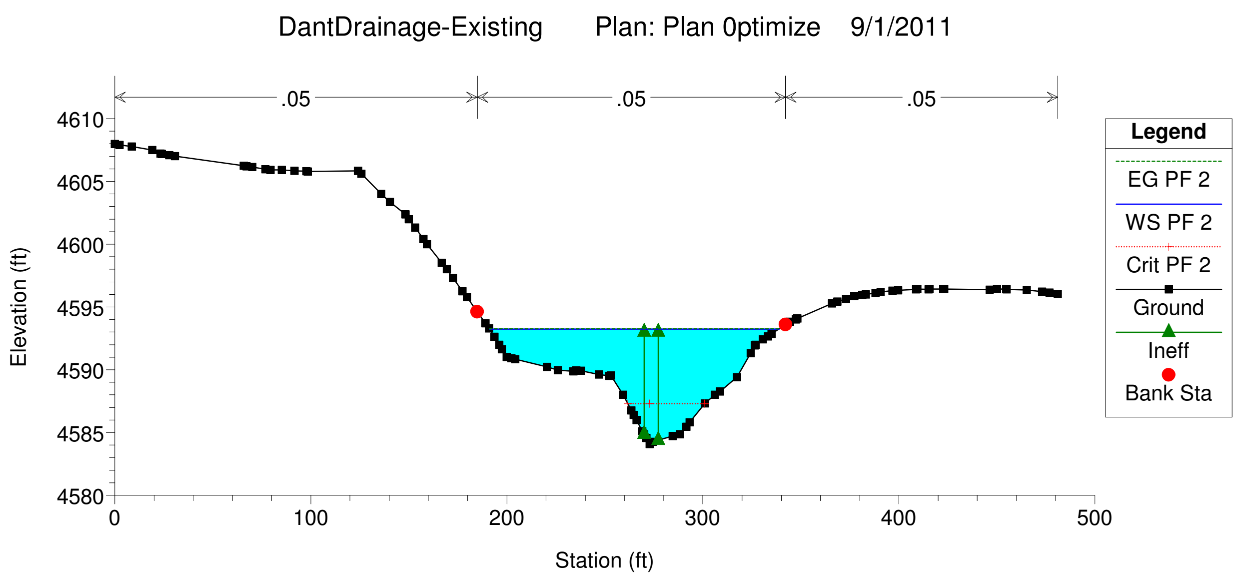
.05
.05
Legend
EG PF 2
WS PF 2
Ground
Bank Sta
Elevation (ft)
4585
4590
4595
4600
4605
4610
4615
0
100
200
300
400
500
600
Station (ft)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.05
.05
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Ineff
Bank Sta
Elevation (ft)
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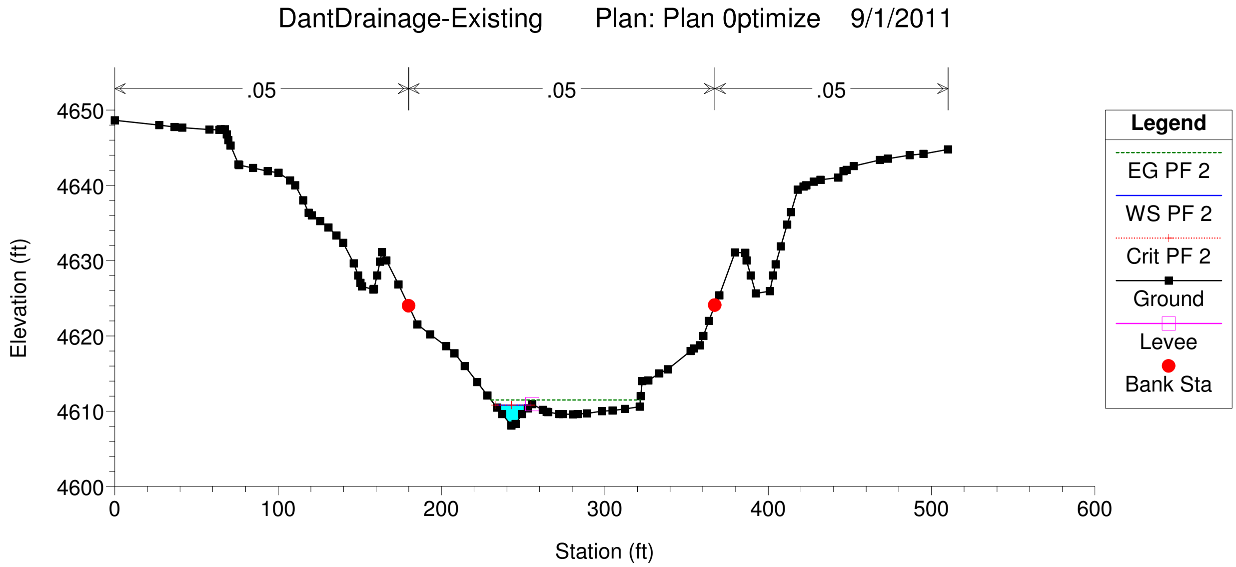
4585
4590
4595
4600
4605
4610
0
100
200
300
400
500
Station (ft)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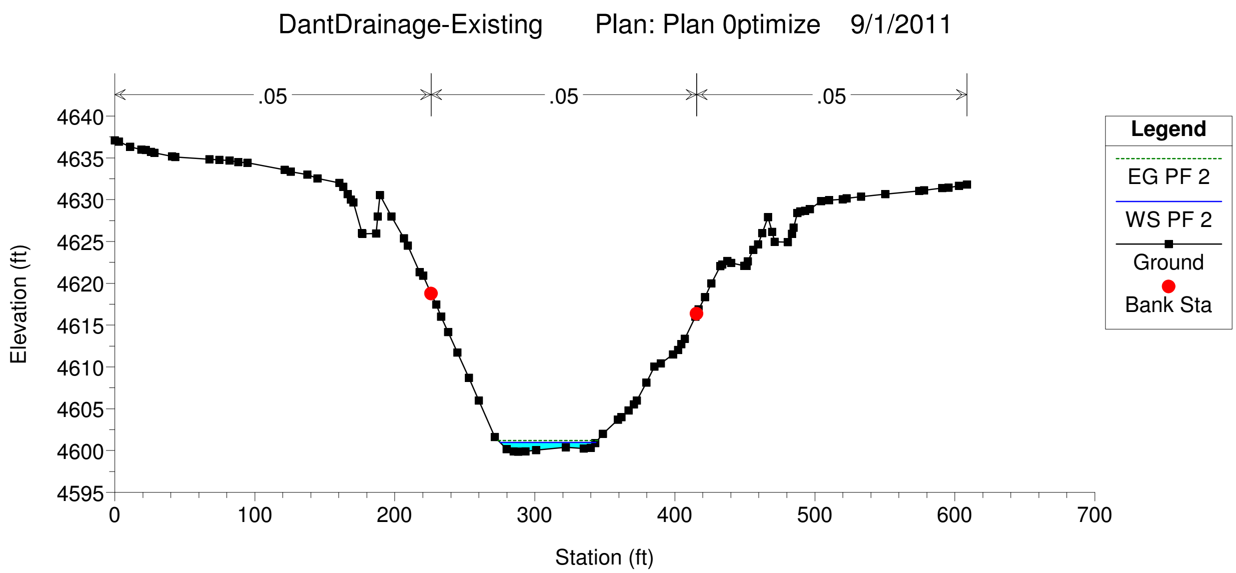
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Levee
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
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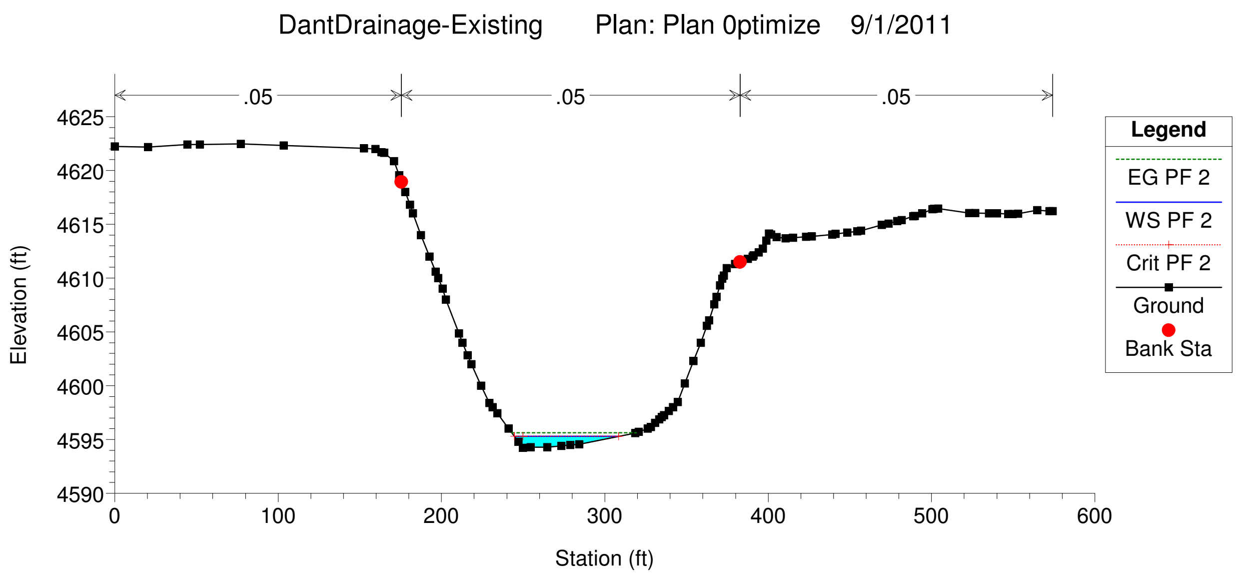
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Ground
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
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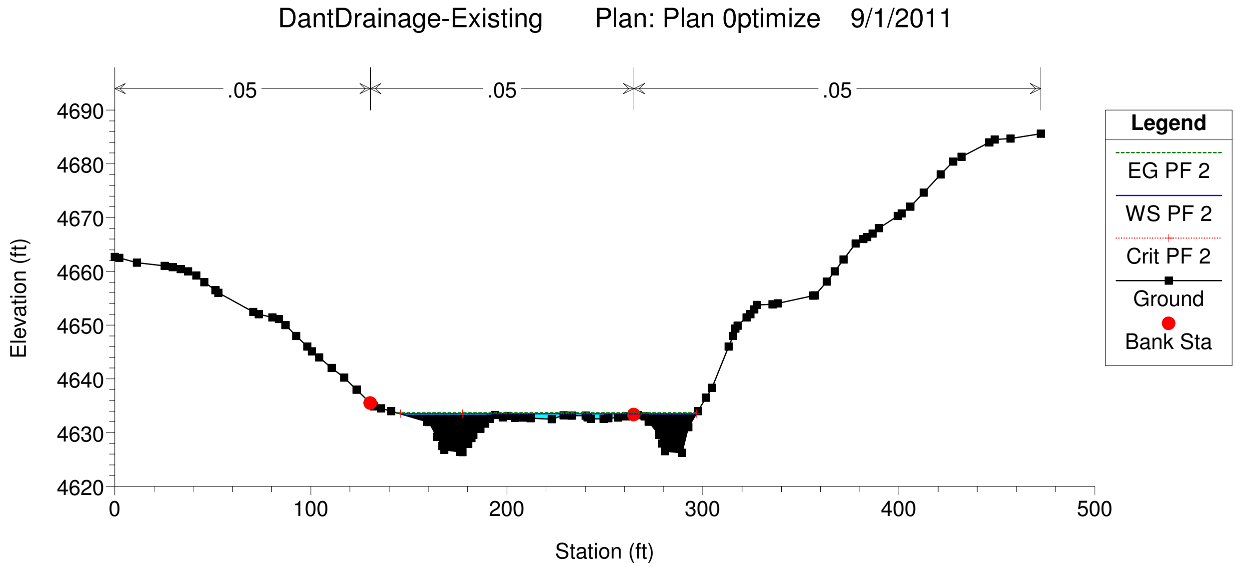
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta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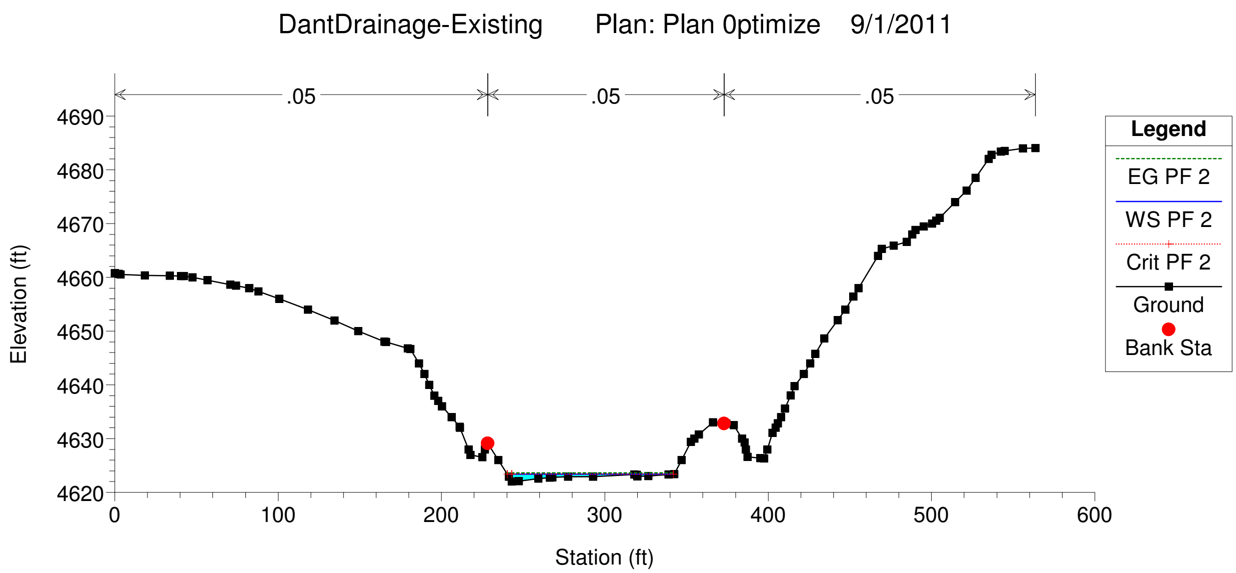
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
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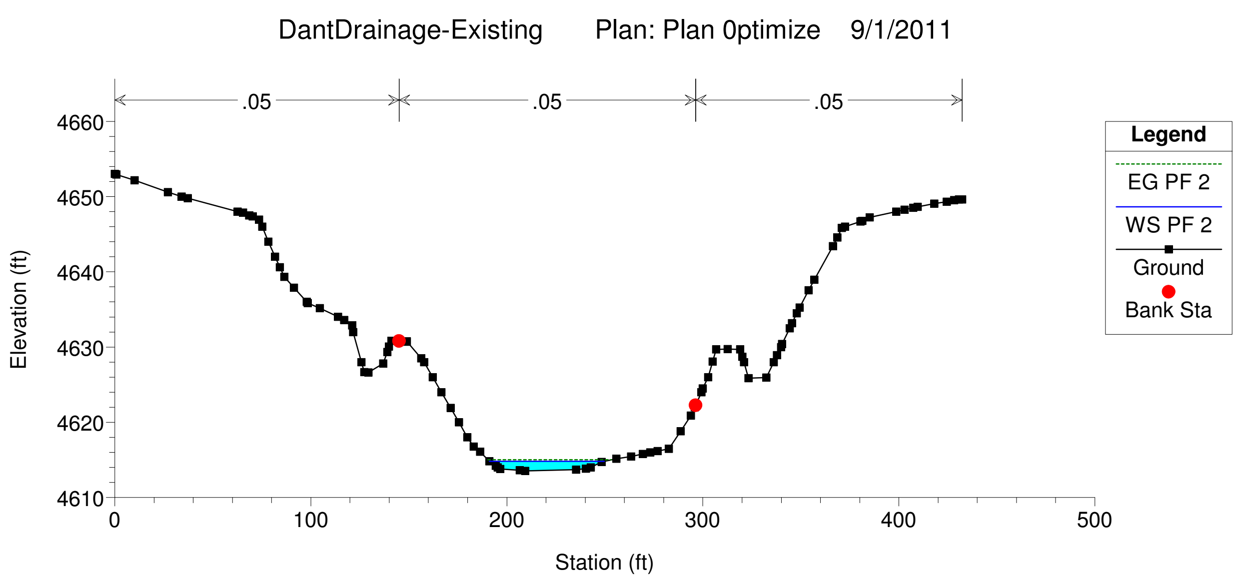
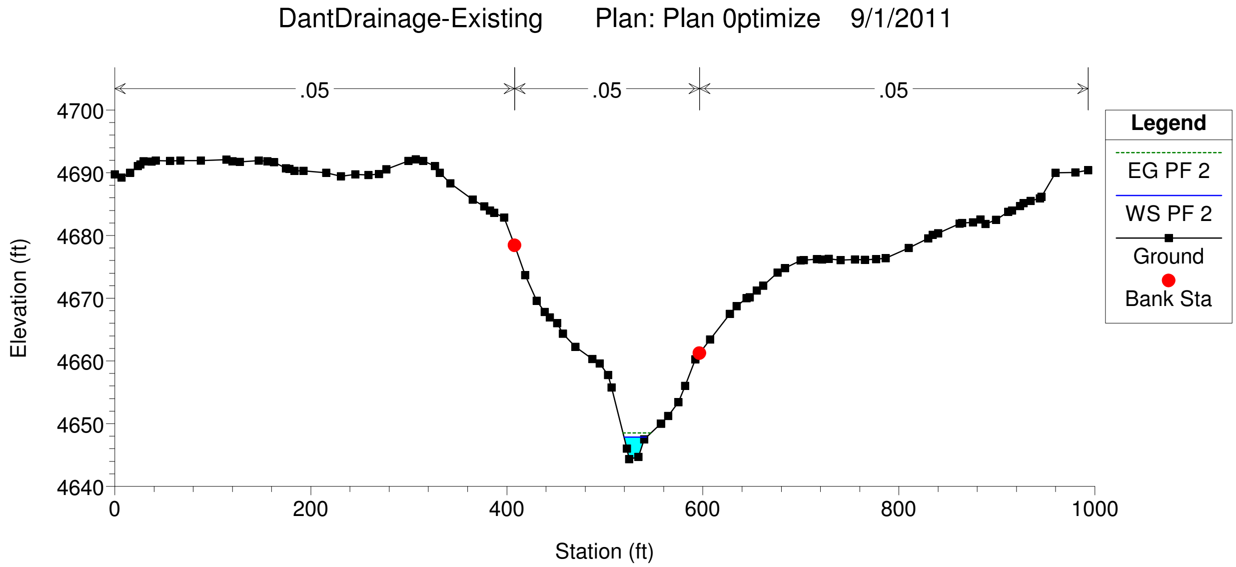
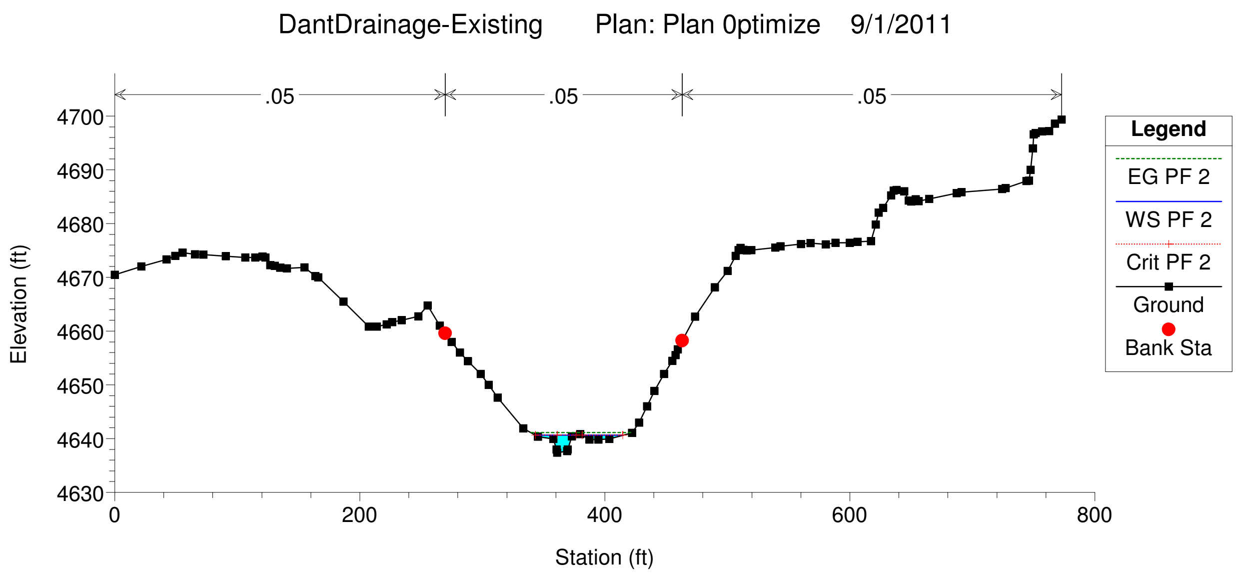
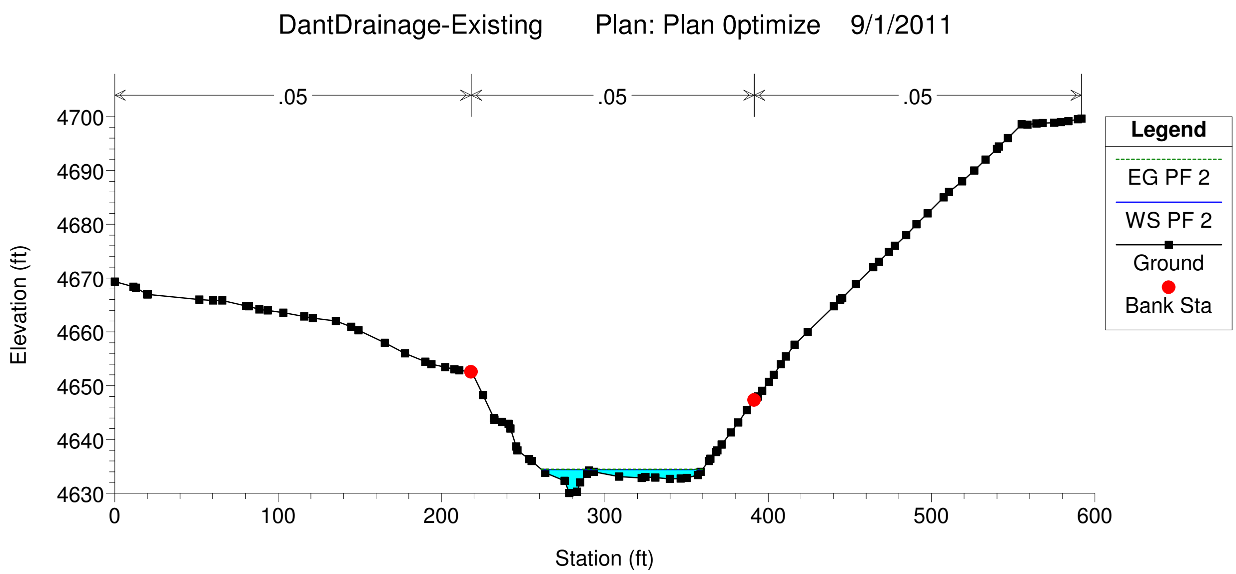
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta

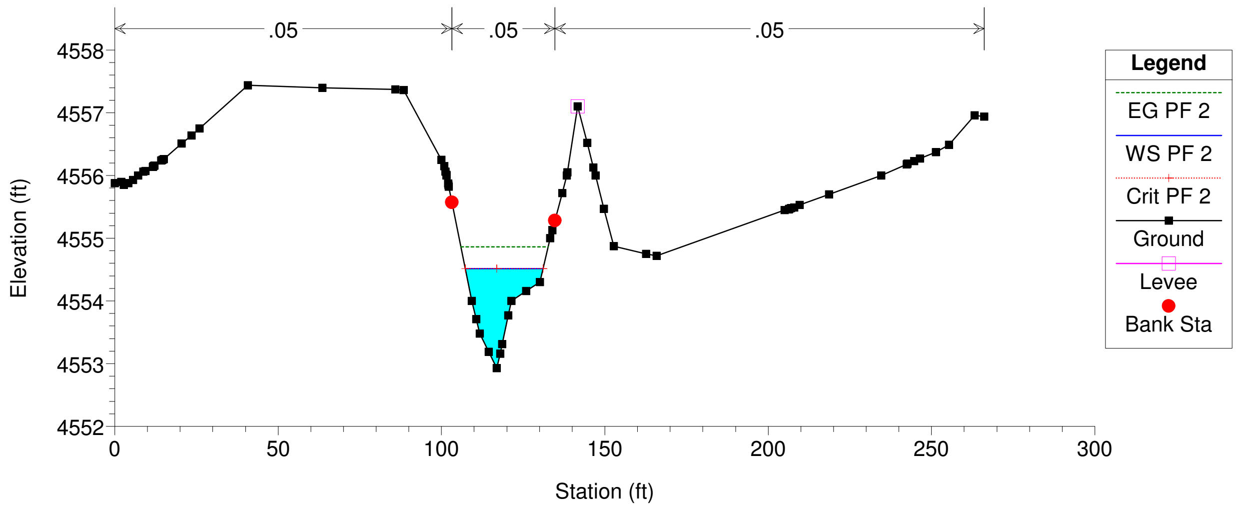

DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 2
WS PF 2
Ground
Bank Sta


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
.05
.05
.05
Legend
EG PF 2
WS PF 2
Ground
Bank Sta
Elevation (ft)
Station (ft)
4700
4690
4680
4670
4660
4650
4640
0
200
400
600
800
1000


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
.05
.05
.05
Legend
EG PF 2
WS PF 2
Crit PF 2
Ground
Bank Sta
Elevation (ft)
Station (ft)
4700
4690
4680
4670
4660
4650
4640
4630
0
200
400
600
800


DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011
.05
.05
.05
Legend
EG PF 2
WS PF 2
Ground
Bank Sta
Elevation (ft)
Station (ft)
4700
4690
4680
4670
4660
4650
4640
4630
0
100
200
300
400
500
600

DantDrainage-Existing Plan: Plan 0ptimize 9/1/2011



Plan: Plan Optimize   Dant Drainage   Main RS: 2781.717   Lat Struct   Profile: PF 2

E.G. US. (ft)	4635.62	Weir Sta US (ft)	123.54
W.S. US. (ft)	4635.47	Weir Sta DS (ft)	157.04
E.G. DS (ft)	4633.68	Min El Weir Flow (ft)	4626.31
W.S. DS (ft)	4633.49	Wr Top Wdth (ft)	33.10
Q US (cfs)	345.00	Weir Max Depth (ft)	7.38
Q Leaving Total (cfs)	139.22	Weir Avg Depth (ft)	3.89
Q DS (cfs)	205.70	Weir Flow Area (sq ft)	128.73
Perc Q Leaving	40.38	Weir Coef	0.460
Q Weir (cfs)	139.22	Weir Submerg	0.00
Q Gates (cfs)		Q Gate Group (cfs)	
Q Culv (cfs)	0.00	Gate Open Ht (ft)	
Q Lat RC (cfs)		Gate #Open	
		Gate Area (sq ft)	
Q Breach (cfs)		Gate Submerg	
Breach Avg Velocity (ft/s)		Gate Invert (ft)	
Breach Flow Area (sq ft)		Gate Weir Coef	

Last Chance Ditch Weir

Plan: Plan Optimize   Dant Drainage   Main RS: 883.2095   Lat Struct   Profile: PF 2

E.G. US. (ft)	4576.08	Weir Sta US (ft)	175.55
W.S. US. (ft)	4575.86	Weir Sta DS (ft)	236.60
E.G. DS (ft)	4569.08	Min El Weir Flow (ft)	4564.17
W.S. DS (ft)	4568.92	Wr Top Wdth (ft)	58.42
Q US (cfs)	205.70	Weir Max Depth (ft)	5.19
Q Leaving Total (cfs)	125.18	Weir Avg Depth (ft)	1.89
Q DS (cfs)	81.76	Weir Flow Area (sq ft)	110.31
Perc Q Leaving	60.25	Weir Coef	0.680
Q Weir (cfs)	125.18	Weir Submerg	0.00
Q Gates (cfs)		Q Gate Group (cfs)	
Q Culv (cfs)	0.00	Gate Open Ht (ft)	
Q Lat RC (cfs)		Gate #Open	
		Gate Area (sq ft)	
Q Breach (cfs)		Gate Submerg	
Breach Avg Velocity (ft/s)		Gate Invert (ft)	
Breach Flow Area (sq ft)		Gate Weir Coef	

Lake Ditch Weir

Plan: Plan Optimize   Dant Drainage   Main RS: 1161.709   Culv Group: Culvert #1   Profile: PF 2

Q Culv Group (cfs)	53.77	Culv Full Len (ft)	70.00
# Barrels	1	Culv Vel US (ft/s)	13.52
Q Barrel (cfs)	53.77	Culv Vel DS (ft/s)	13.52
E.G. US. (ft)	4593.25	Culv Inv El Up (ft)	4584.80
W.S. US. (ft)	4593.25	Culv Inv El Dn (ft)	4582.90
E.G. DS (ft)	4585.00	Culv Frctn Ls (ft)	3.84
W.S. DS (ft)	4584.33	Culv Exit Loss (ft)	2.99
Delta EG (ft)	8.25	Culv Entr Loss (ft)	1.42
Delta WS (ft)	8.93	Q Weir (cfs)	151.43
E.G. IC (ft)	4593.25	Weir Sta Lft (ft)	197.14
E.G. OC (ft)	4593.28	Weir Sta Rgt (ft)	318.08
Culvert Control	Inlet	Weir Submerg	0.00
Culv WS Inlet (ft)	4587.05	Weir Max Depth (ft)	1.00
Culv WS Outlet (ft)	4585.15	Weir Avg Depth (ft)	0.56
Culv Nml Depth (ft)	2.25	Weir Flow Area (sq ft)	67.88
Culv Crt Depth (ft)	2.25	Min El Weir Flow (ft)	4592.74

Pheasant Lane Culvert

Results - PF 1 = Capacity w/o Last Chance Ditch overtopping, PF 2 = 100-Yr, PF 3 = Moana Lane culvert capacity, PF 4 = Capacity w/o Lake Ditch overtopping

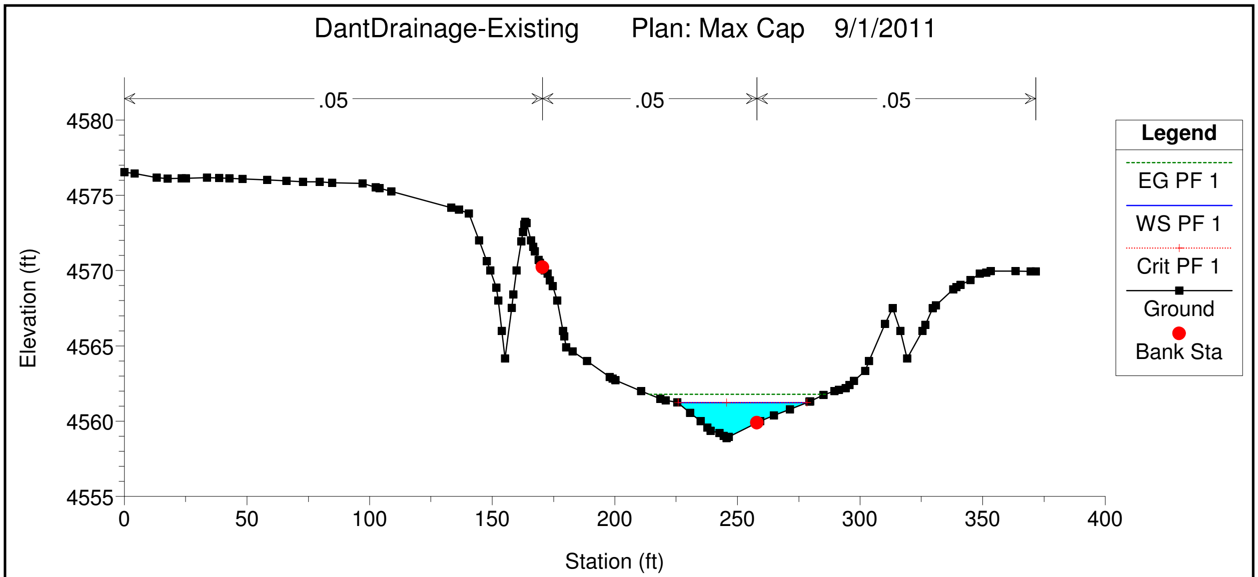
HEC-RAS Plan: Plan Optimize River: Dant Drainage Reach: Main

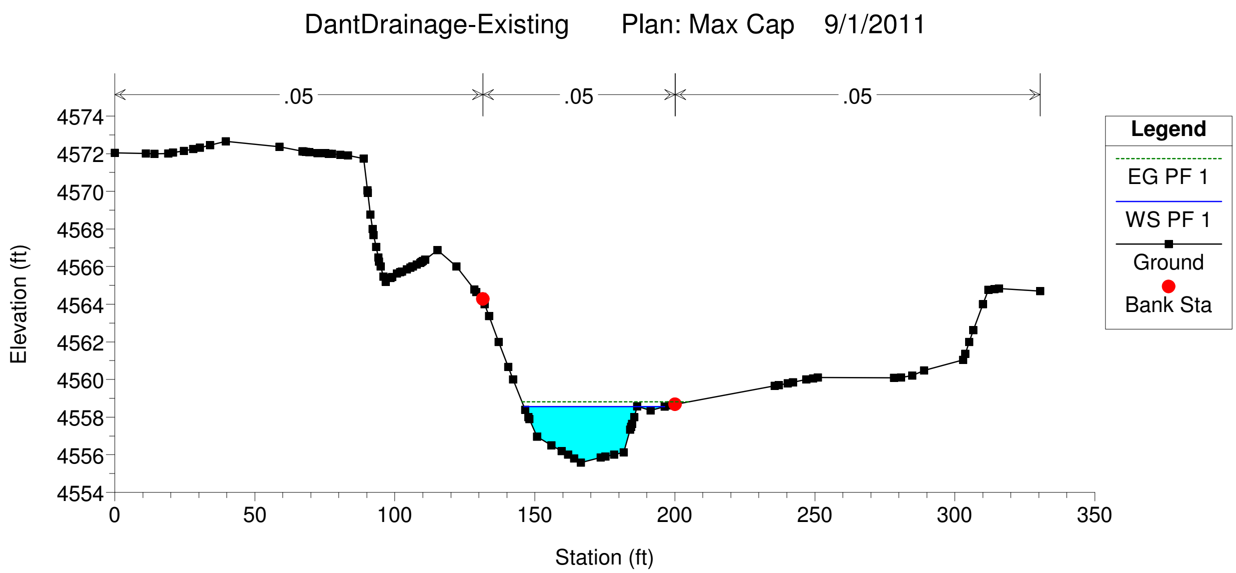
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	3321.402	PF 1	103.00	4644.32	4646.27		4646.61	0.017089	4.69	21.98	15.65	0.70
Main	3321.402	PF 2	345.00	4644.32	4647.85		4648.54	0.018921	6.68	51.68	23.03	0.79
Main	3321.402	PF 3	500.00	4644.32	4648.48	4648.11	4649.32	0.021118	7.39	67.64	28.25	0.84
Main	3321.402	PF 4	178.00	4644.32	4646.88		4647.35	0.017096	5.51	32.32	17.88	0.72
Main	3041.780	PF 1	103.00	4637.37	4639.09	4639.09	4639.75	0.037742	6.49	15.86	12.23	1.00
Main	3041.780	PF 2	345.00	4637.37	4640.63	4640.63	4641.10	0.039306	5.54	62.28	66.44	1.01
Main	3041.780	PF 3	500.00	4637.37	4640.92	4640.92	4641.47	0.038118	5.96	83.86	78.60	1.02
Main	3041.780	PF 4	178.00	4637.37	4639.68	4639.68	4640.57	0.036406	7.56	23.56	13.86	1.02
Main	2781.717		Lat Struct									
Main	2761.931	PF 1	103.00	4630.04	4633.31	4632.22	4633.37	0.007396	2.01	51.29	71.88	0.42
Main	2761.931	PF 2	345.00	4630.04	4634.38		4634.46	0.003958	2.38	144.70	98.22	0.35
Main	2761.931	PF 3	500.00	4630.04	4634.72		4634.84	0.004243	2.80	178.65	100.40	0.37
Main	2761.931	PF 4	178.00	4630.04	4633.82		4633.88	0.004031	1.92	92.50	87.83	0.33
Main	2653.730	PF 1	0.10	4632.49	4632.55	4632.55	4632.56	0.087062	0.82	0.13	4.34	0.86
Main	2653.730	PF 2	205.70	4632.49	4633.49	4633.49	4633.68	0.039830	3.55	60.43	150.92	0.92
Main	2653.730	PF 3	352.09	4632.49	4633.65	4633.65	4633.93	0.041303	4.37	84.30	152.62	0.98
Main	2653.730	PF 4	56.30	4632.49	4633.06	4633.06	4633.23	0.053518	3.28	17.19	52.12	1.01
Main	2542.598	PF 1	0.10	4622.02	4622.07	4622.07	4622.08	0.107326	0.86	0.12	4.54	0.93
Main	2542.598	PF 2	205.70	4622.02	4623.39	4623.39	4623.64	0.047519	4.06	50.68	101.69	1.01
Main	2542.598	PF 3	352.09	4622.02	4623.65	4623.61	4623.97	0.034653	4.55	77.40	103.18	0.93
Main	2542.598	PF 4	56.30	4622.02	4622.97	4622.97	4623.14	0.058750	3.31	17.01	54.40	1.04
Main	2300.189	PF 1	0.10	4613.51	4613.59		4613.60	0.002238	0.17	0.60	14.30	0.15
Main	2300.189	PF 2	205.70	4613.51	4614.81		4615.00	0.013889	3.50	58.75	58.61	0.62
Main	2300.189	PF 3	352.09	4613.51	4614.85	4614.85	4615.36	0.036286	5.75	61.20	59.57	1.00
Main	2300.189	PF 4	56.30	4613.51	4614.15		4614.24	0.017846	2.41	23.36	49.34	0.62
Main	2134.520	PF 1	0.10	4608.08	4608.18	4608.18	4608.21	0.102599	1.29	0.08	1.58	1.01
Main	2134.520	PF 2	205.70	4608.08	4610.79	4610.79	4611.49	0.034574	6.74	30.53	21.97	1.01
Main	2134.520	PF 3	352.09	4608.08	4610.95	4610.95	4611.15	0.013390	3.62	97.40	89.28	0.61
Main	2134.520	PF 4	56.30	4608.08	4609.64	4609.62	4610.05	0.037824	5.17	10.88	12.41	0.97
Main	1797.263	PF 1	0.10	4599.85	4599.93		4599.93	0.002264	0.19	0.54	10.79	0.15
Main	1797.263	PF 2	205.70	4599.85	4600.98		4601.22	0.024144	3.88	53.02	68.70	0.78
Main	1797.263	PF 3	352.09	4599.85	4601.27		4601.63	0.025251	4.79	73.53	71.83	0.83
Main	1797.263	PF 4	56.30	4599.85	4600.55	4600.45	4600.64	0.021083	2.29	24.63	63.81	0.65
Main	1618.228	PF 1	0.10	4594.22	4594.28	4594.28	4594.29	0.084604	0.79	0.13	4.67	0.84
Main	1618.228	PF 2	205.70	4594.22	4595.29	4595.29	4595.63	0.041572	4.71	43.70	63.71	1.00
Main	1618.228	PF 3	352.09	4594.22	4595.60	4595.60	4596.05	0.039381	5.36	65.63	75.49	1.01
Main	1618.228	PF 4	56.30	4594.22	4594.78	4594.78	4594.97	0.052378	3.46	16.26	44.69	1.01
Main	1465.997	PF 1	0.10	4589.92	4590.13		4590.13	0.000004	0.01	7.30	59.17	0.01
Main	1465.997	PF 2	205.70	4589.92	4593.26		4593.27	0.000148	0.70	293.71	108.19	0.07
Main	1465.997	PF 3	352.09	4589.92	4593.58		4593.60	0.000304	1.07	329.00	110.15	0.11
Main	1465.997	PF 4	56.30	4589.92	4593.00		4593.00	0.000015	0.21	265.39	106.60	0.02
Main	1308.650	PF 1	0.10	4585.80	4585.88	4585.88	4585.90	0.097293	1.07	0.10	2.47	0.95
Main	1308.650	PF 2	205.70	4585.80	4593.26		4593.26	0.000018	0.35	594.86	130.31	0.03
Main	1308.650	PF 3	352.09	4585.80	4593.58		4593.58	0.000044	0.55	637.15	133.60	0.04
Main	1308.650	PF 4	56.30	4585.80	4593.00		4593.00	0.000002	0.10	561.21	127.33	0.01
Main	1208.934	PF 1	0.10	4584.07	4584.91	4584.19	4584.91	0.000002	0.03	4.03	18.67	0.01
Main	1208.934	PF 2	205.70	4584.07	4593.26	4587.30	4593.26	0.000017	0.32	639.07	147.80	0.03
Main	1208.934	PF 3	352.09	4584.07	4593.58	4588.57	4593.58	0.000041	0.51	686.77	152.31	0.04
Main	1208.934	PF 4	56.30	4584.07	4592.98	4585.59	4593.00	0.000053	0.90	62.56	144.00	0.05
Main	1161.709		Culvert									
Main	1128.953	PF 1	0.10	4582.59	4582.65	4582.65	4582.66	0.106511	0.87	0.12	8.68	0.93
Main	1128.953	PF 2	205.70	4582.59	4584.33	4584.33	4585.00	0.031749	6.59	31.20	76.27	0.98
Main	1128.953	PF 3	352.09	4582.59	4584.93	4584.93	4585.89	0.028146	7.88	44.66	86.60	0.98
Main	1128.953	PF 4	56.30	4582.59	4583.45	4583.45	4583.77	0.040568	4.52	12.46	59.21	0.98
Main	1032.365	PF 1	0.10	4577.99	4578.03	4578.03	4578.04	0.063640	0.72	0.14	4.87	0.73
Main	1032.365	PF 2	205.70	4577.99	4579.24	4579.10	4579.48	0.024847	3.93	52.39	68.12	0.79
Main	1032.365	PF 3	352.09	4577.99	4579.53	4579.42	4579.89	0.027690	4.79	73.44	76.73	0.86
Main	1032.365	PF 4	56.30	4577.99	4578.73		4578.83	0.021106	2.52	22.32	49.88	0.66
Main	904.6746	PF 1	0.10	4574.80	4574.83	4574.83	4574.84	0.137839	0.73	0.14	8.38	0.99

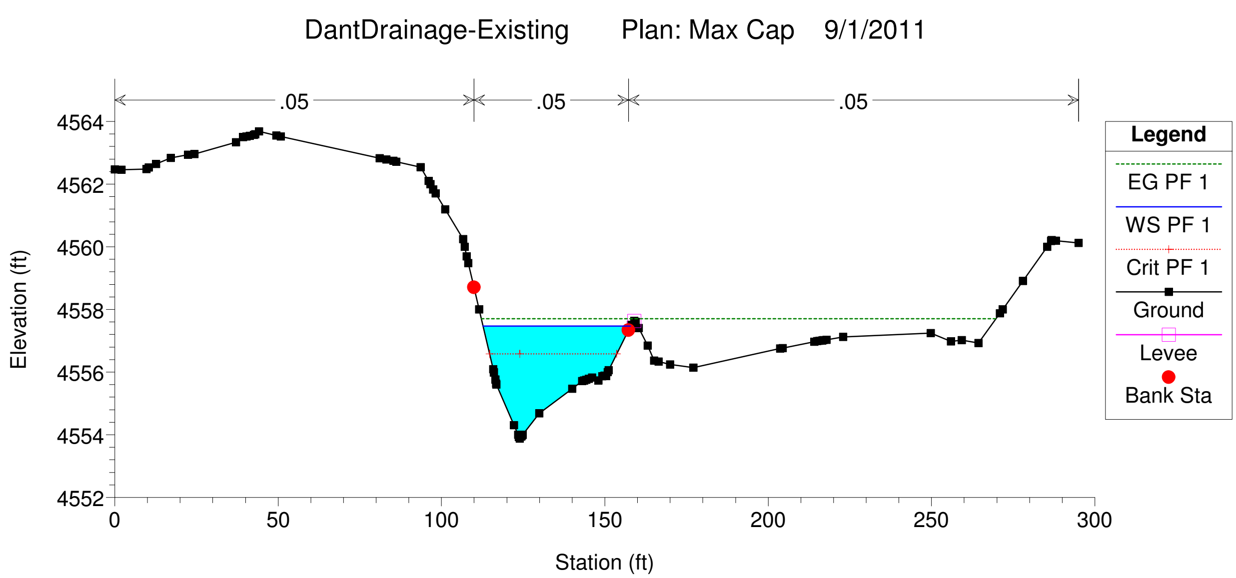
HEC-RAS Plan: Plan Optimize River: Dant Drainage Reach: Main (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	904.6746	PF 2	205.70	4574.80	4575.99	4575.88	4576.21	0.026373	3.75	54.78	79.76	0.80
Main	904.6746	PF 3	352.09	4574.80	4576.29		4576.59	0.023899	4.43	79.53	83.96	0.80
Main	904.6746	PF 4	56.30	4574.80	4575.51	4575.43	4575.62	0.030322	2.69	20.92	55.73	0.77
Main	883.2095		Lat Struct									
Main	668.2392	PF 1	0.10	4568.32	4568.37	4568.37	4568.38	0.129189	0.90	0.11	4.62	1.02
Main	668.2392	PF 2	81.67	4568.32	4568.91	4568.89	4569.07	0.043836	3.18	25.66	70.07	0.93
Main	668.2392	PF 3	205.60	4568.32	4569.19	4569.19	4569.48	0.048167	4.30	47.78	89.04	1.04
Main	668.2392	PF 4	0.18	4568.32	4568.38	4568.38	4568.40	0.113715	0.99	0.18	5.81	0.99
Main	460.7161	PF 1	0.10	4558.87	4558.96	4558.96	4558.99	0.129702	1.37	0.08	1.63	1.12
Main	460.7161	PF 2	81.67	4558.87	4560.13	4560.13	4560.47	0.039135	4.70	17.62	27.23	0.98
Main	460.7161	PF 3	205.60	4558.87	4560.74	4560.74	4561.22	0.030555	5.72	38.53	41.45	0.94
Main	460.7161	PF 4	0.18	4558.87	4559.06	4558.99	4559.07	0.008027	0.54	0.33	3.64	0.31
Main	289.6794	PF 1	0.10	4555.58	4555.65	4555.65	4555.67	0.151764	1.21	0.08	2.50	1.16
Main	289.6794	PF 2	81.67	4555.58	4557.08		4557.18	0.007619	2.53	32.27	33.17	0.45
Main	289.6794	PF 3	205.60	4555.58	4557.84		4558.03	0.007543	3.49	58.98	36.94	0.49
Main	289.6794	PF 4	0.18	4555.58	4555.67	4555.67	4555.69	0.104554	1.21	0.15	3.30	1.01
Main	146.5573	PF 1	0.10	4553.88	4554.09	4553.99	4554.09	0.003679	0.40	0.26	2.43	0.22
Main	146.5573	PF 2	81.67	4553.88	4556.09	4555.50	4556.18	0.006569	2.35	34.69	35.45	0.42
Main	146.5573	PF 3	205.60	4553.88	4556.85	4556.15	4557.01	0.006654	3.23	63.71	40.78	0.46
Main	146.5573	PF 4	0.18	4553.88	4554.14	4554.03	4554.14	0.003830	0.46	0.38	2.97	0.23
Main	49.08576	PF 1	0.10	4552.93	4553.03	4553.03	4553.06	0.111284	1.37	0.08	1.46	1.06
Main	49.08576	PF 2	81.67	4552.93	4554.52	4554.52	4554.86	0.039303	4.72	17.30	23.82	0.98
Main	49.08576	PF 3	205.60	4552.93	4555.15	4555.15	4555.72	0.034693	6.06	33.93	29.18	0.99
Main	49.08576	PF 4	0.18	4552.93	4553.06	4553.06	4553.10	0.105267	1.53	0.12	1.81	1.07

Max Capacity Run Cross Sections (350 cfs - dam to Last Chance Ditch, 5 cfs - Last Chance to Lake Ditch, 350 cfs - Lake Ditch to Moana







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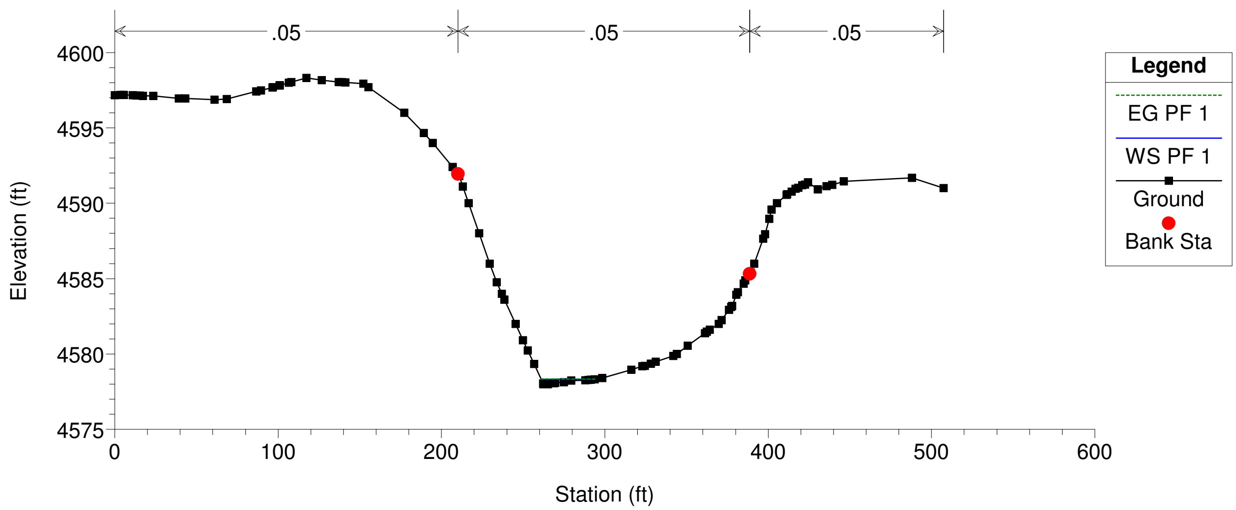

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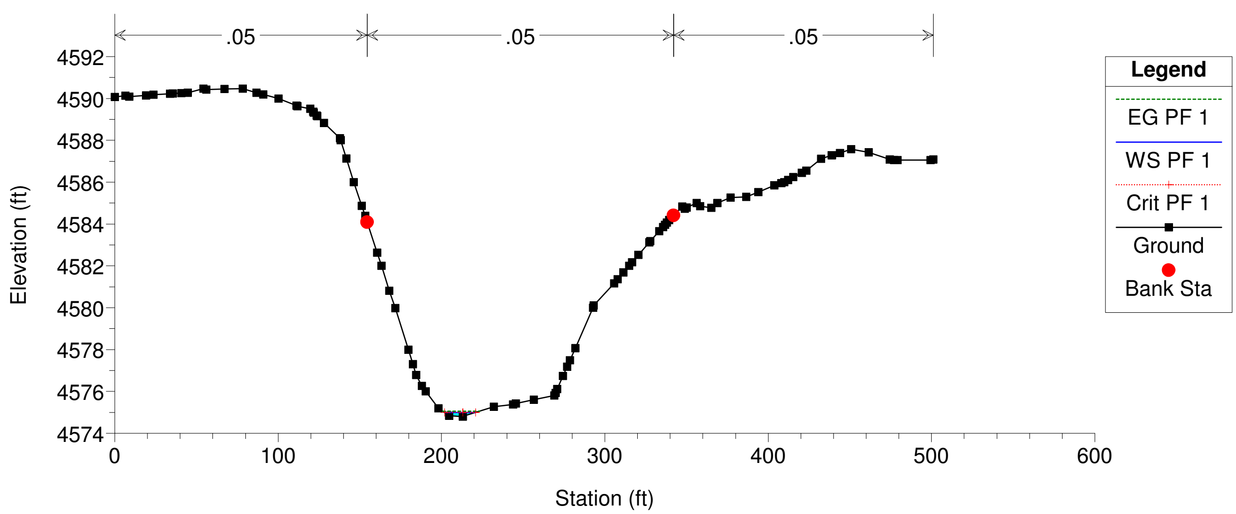

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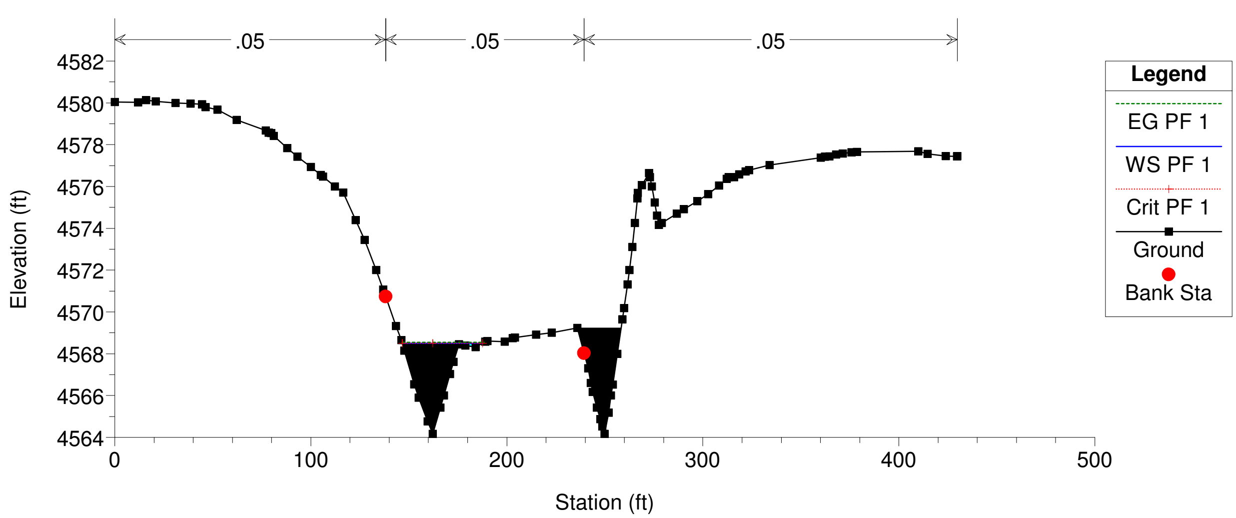

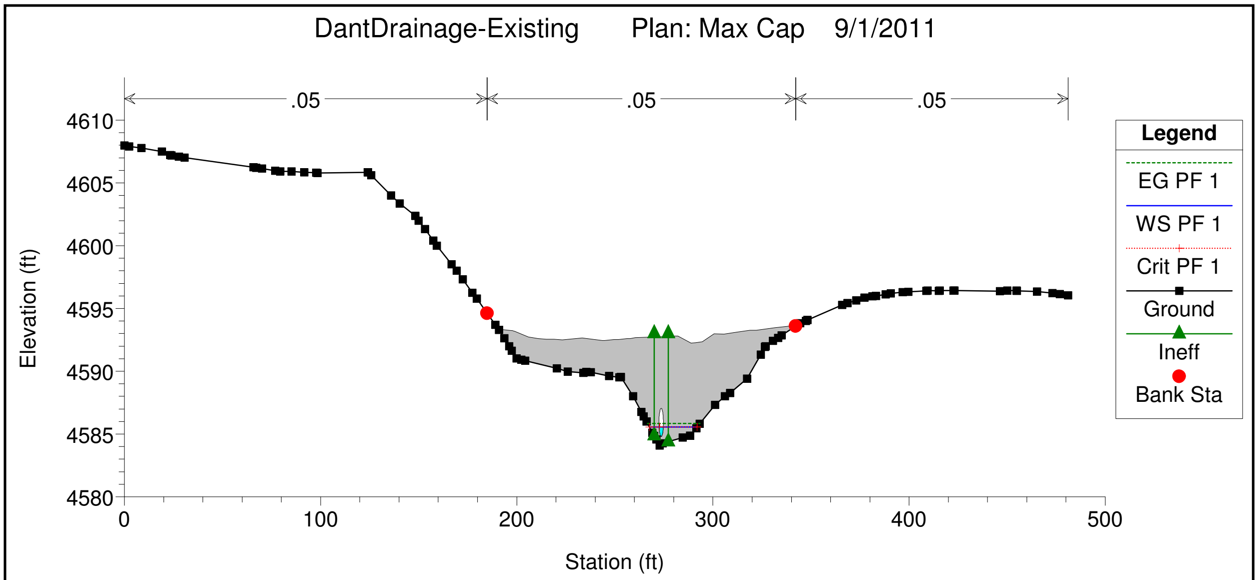
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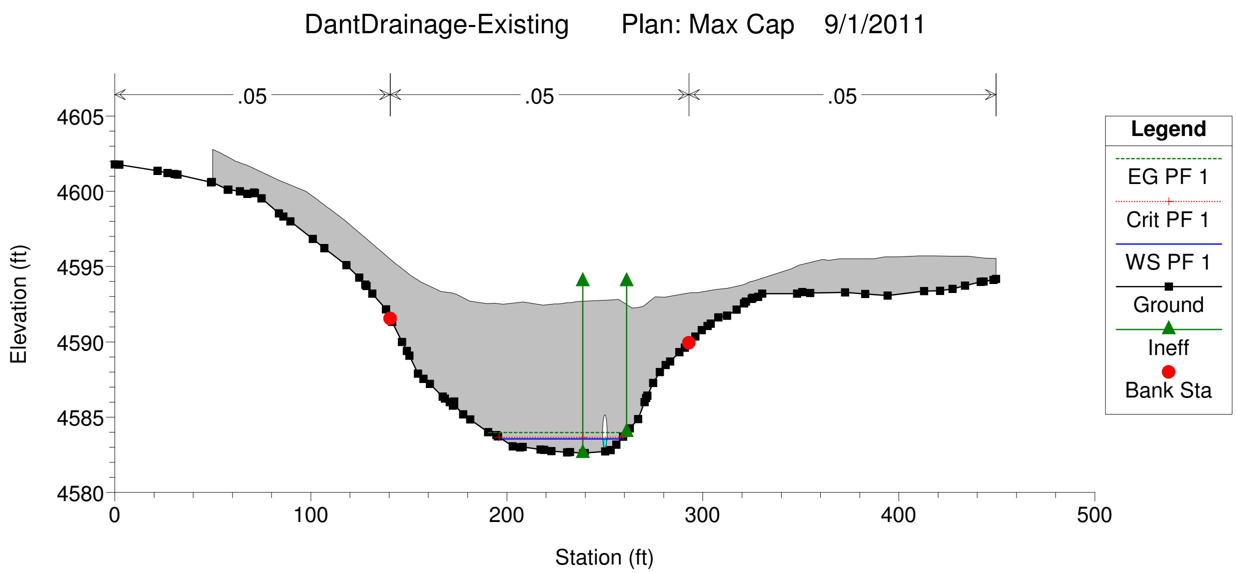
.05
.05
.05
Elevation (ft)
4610
4605
4600
4595
4590
4585
4580
0
100
200
300
400
500
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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.05
.05
Elevation (ft)
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4595
4590
4585
4580
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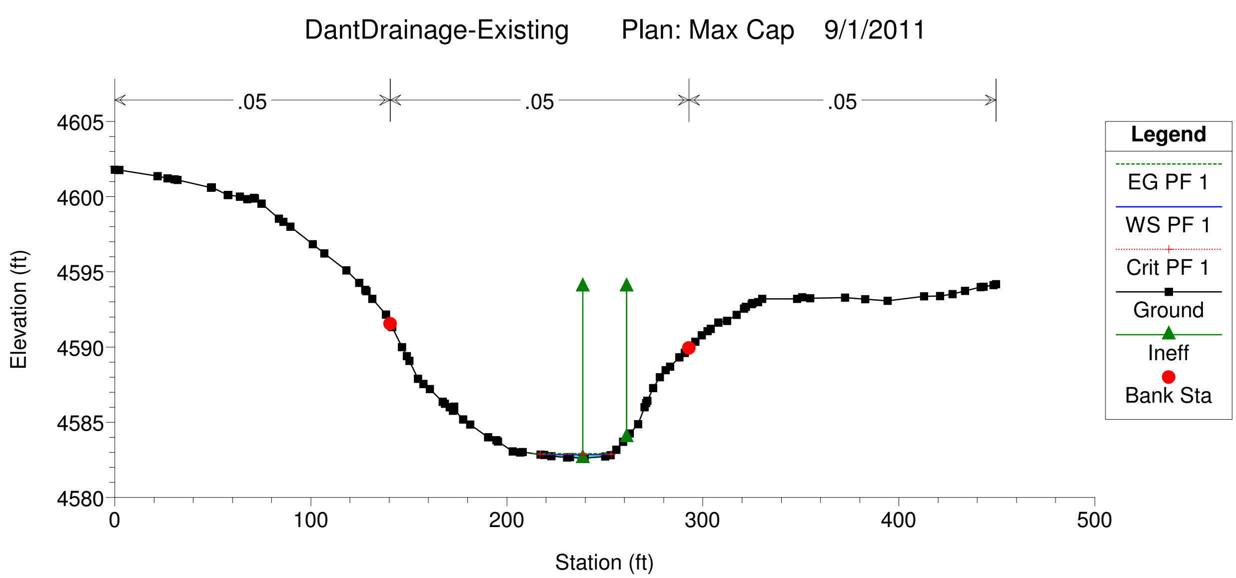
100
200
300
400
500
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Ineff
Bank Sta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.05
.05
Elevation (ft)
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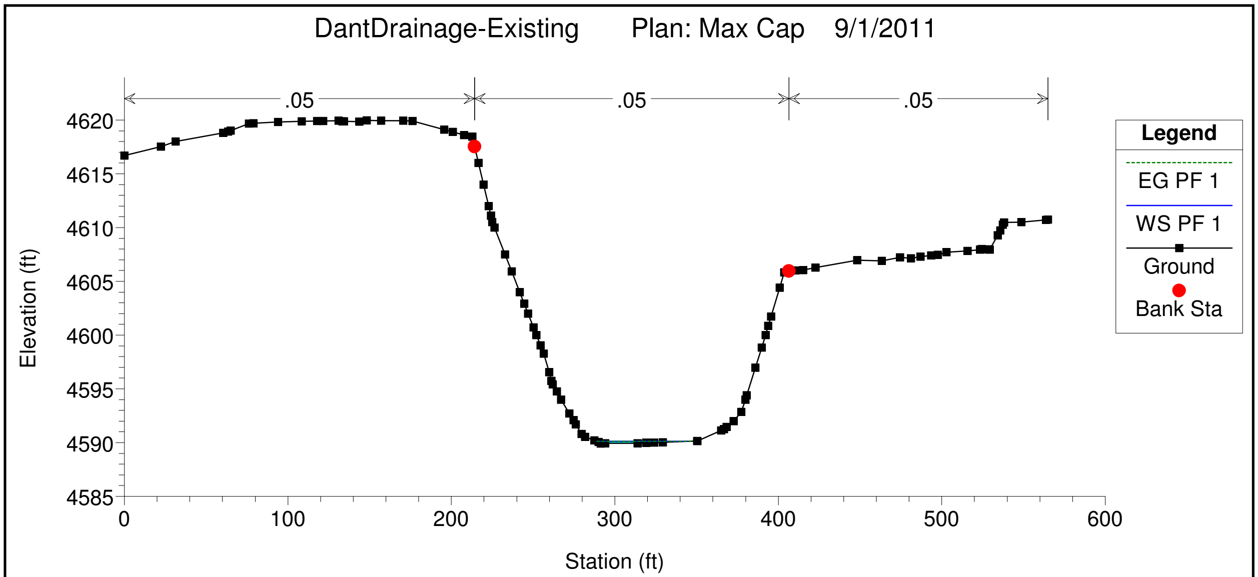
4590
4585
4580
0
100
200
300
400
500
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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Elevation (ft)
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4605
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Station (ft)
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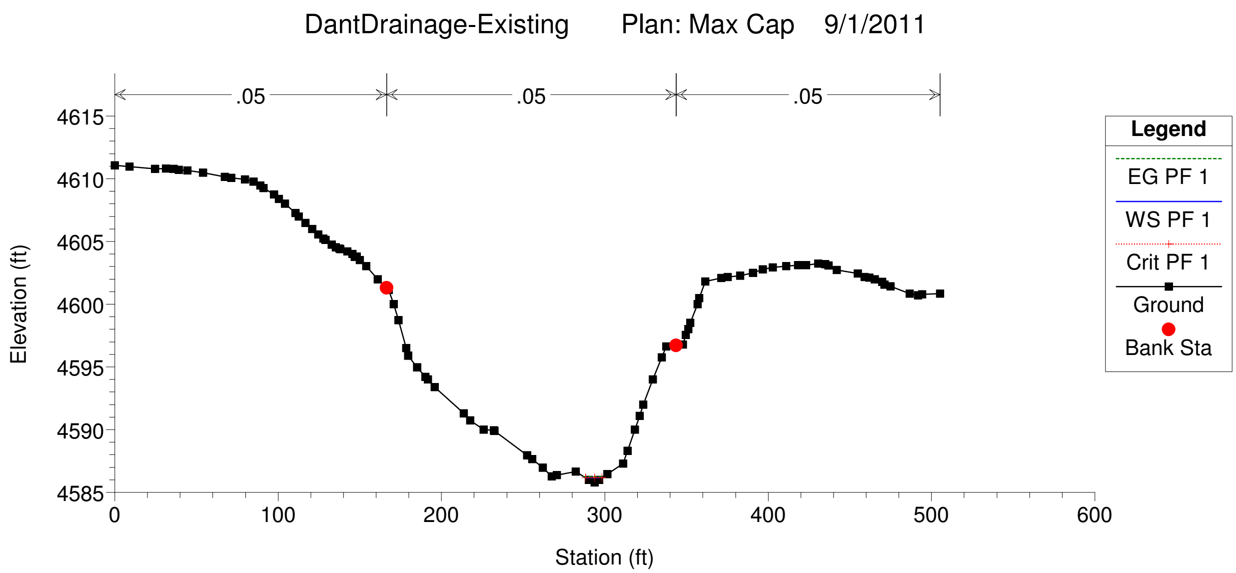
200
300
400
500
600
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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.05
.05
Elevation (ft)
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4605
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Station (ft)
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600
Legend
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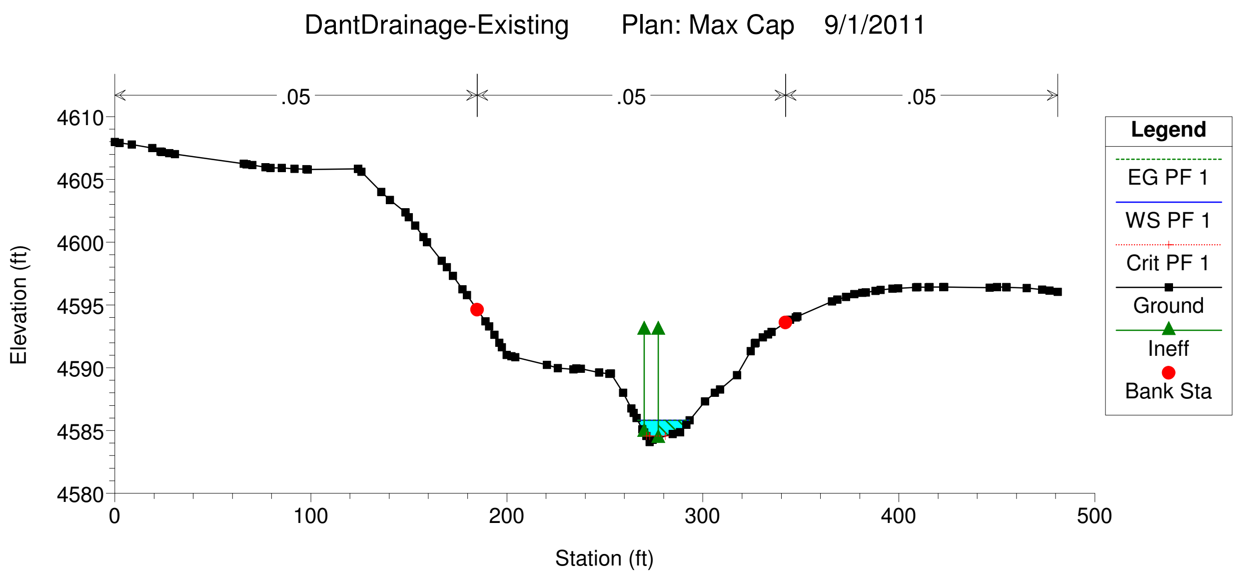
WS PF 1
Crit PF 1
Ground
Bank Sta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.05
.05
Elevation (ft)
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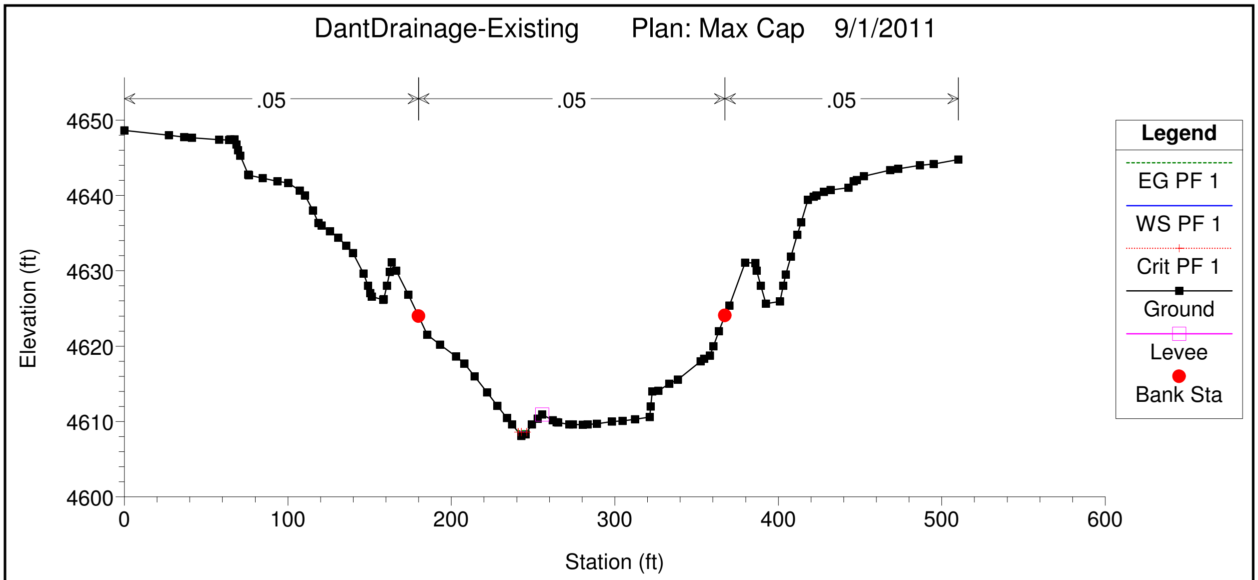
4585
4590
4595
4600
4605
4610
Station (ft)
0
100
200
300
400
500
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta



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.05
.05
Elevation (ft)
4600
4610
4620
4630
4640
4650
Station (ft)
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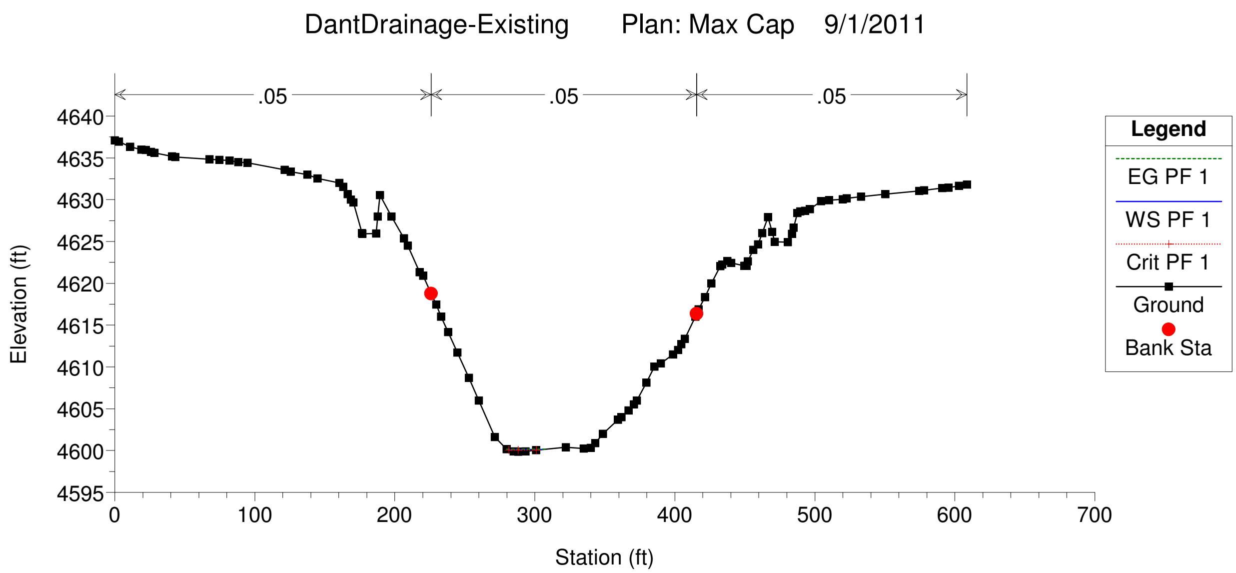
100
200
300
400
500
600
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta



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.05
.05
Elevation (ft)
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4600
4605
4610
4615
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4625
4630
4635
4640
Station (ft)
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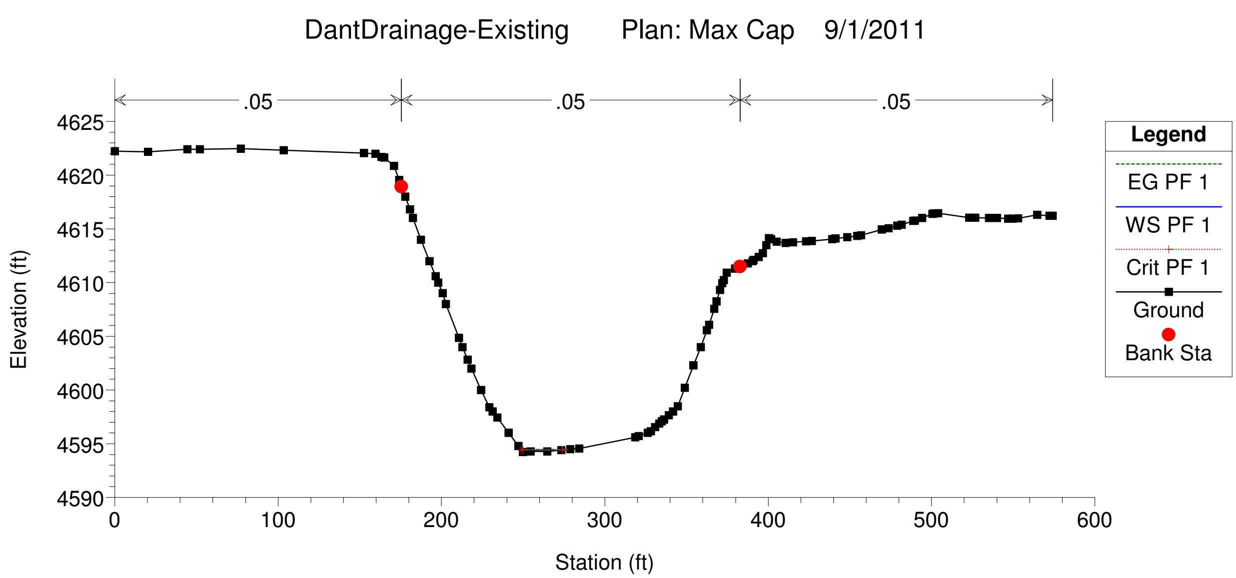
100
200
300
400
500
600
700
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta



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.05
.05
Elevation (ft)
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4600
4605
4610
4615
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Station (ft)
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Legend
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Crit PF 1
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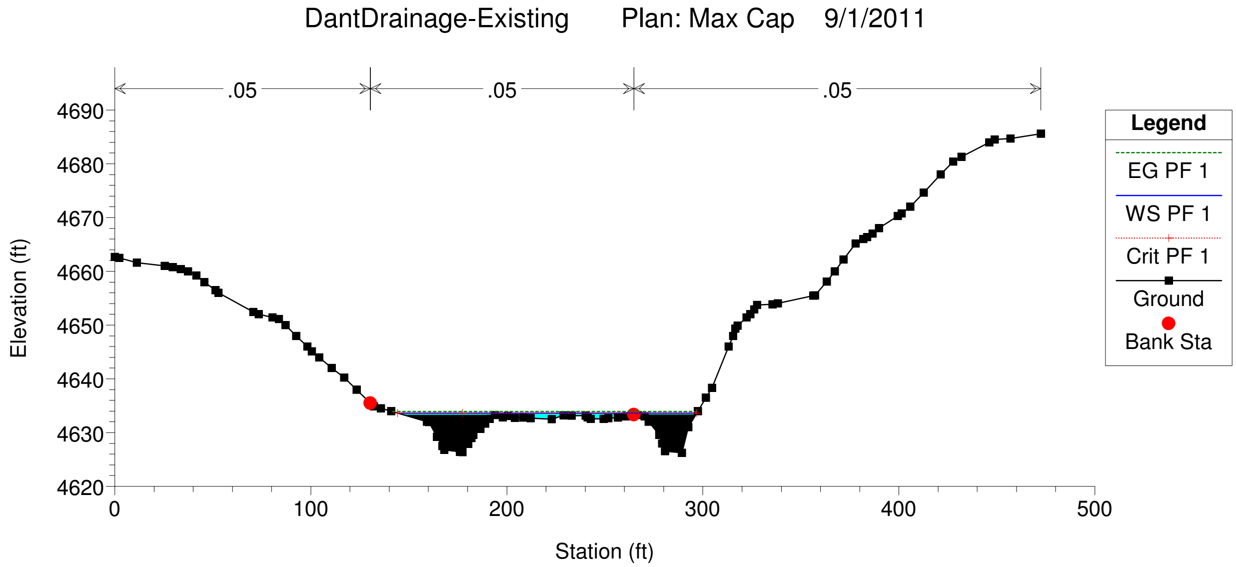
Bank Sta



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Station (ft)
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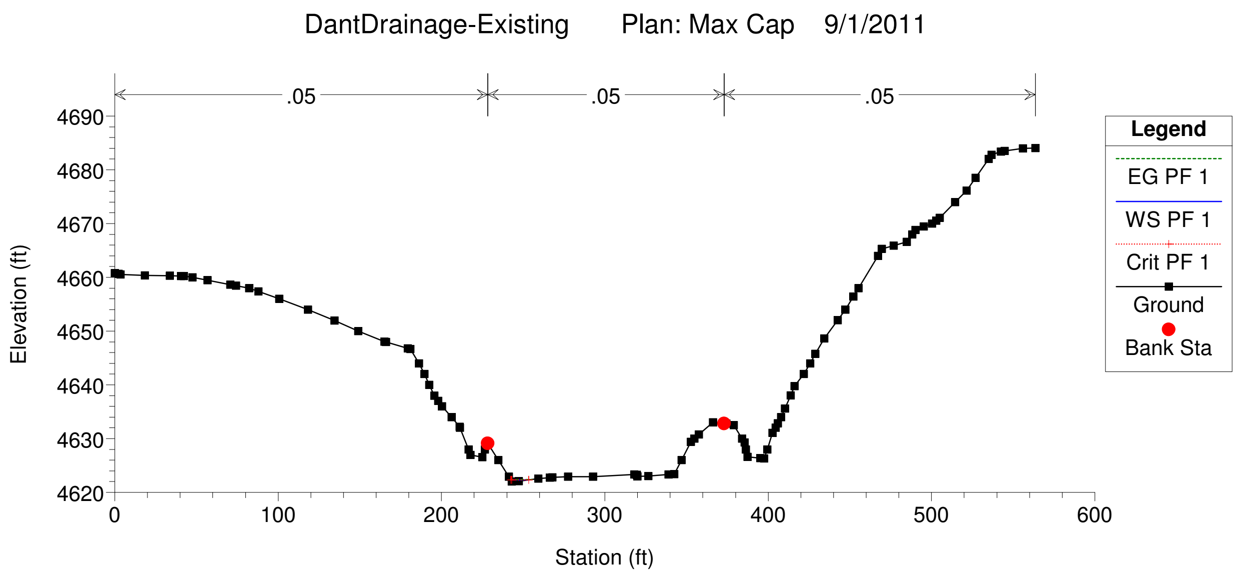
Crit PF 1
Ground
Bank Sta



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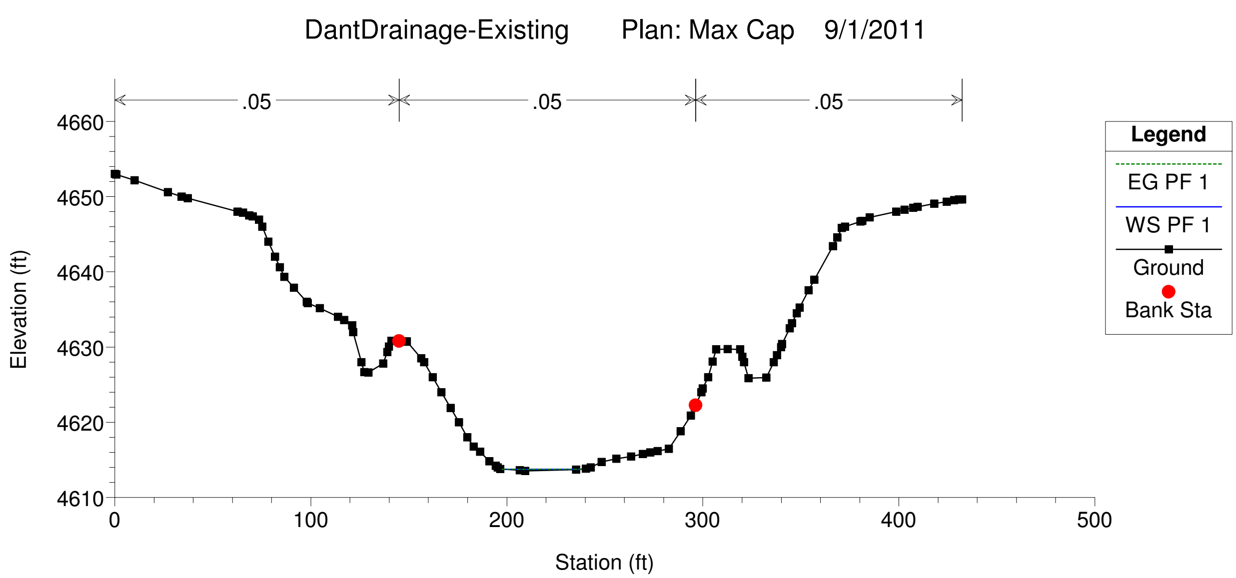
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta



DantDrainage-Existing Plan: Max Cap 9/1/2011
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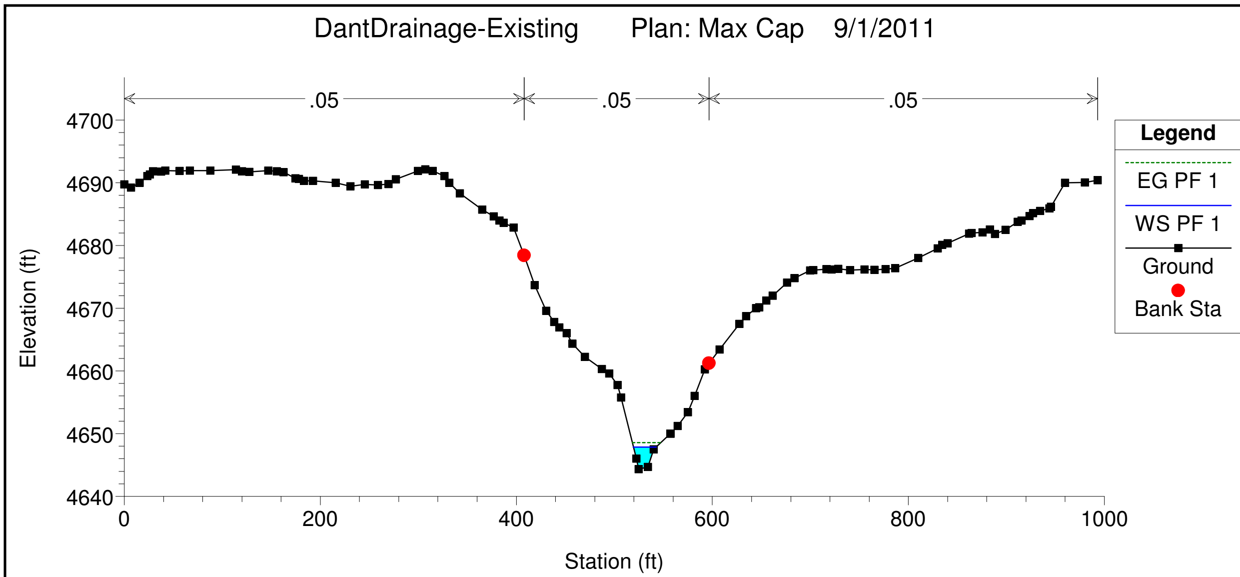
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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.05
.05
.05
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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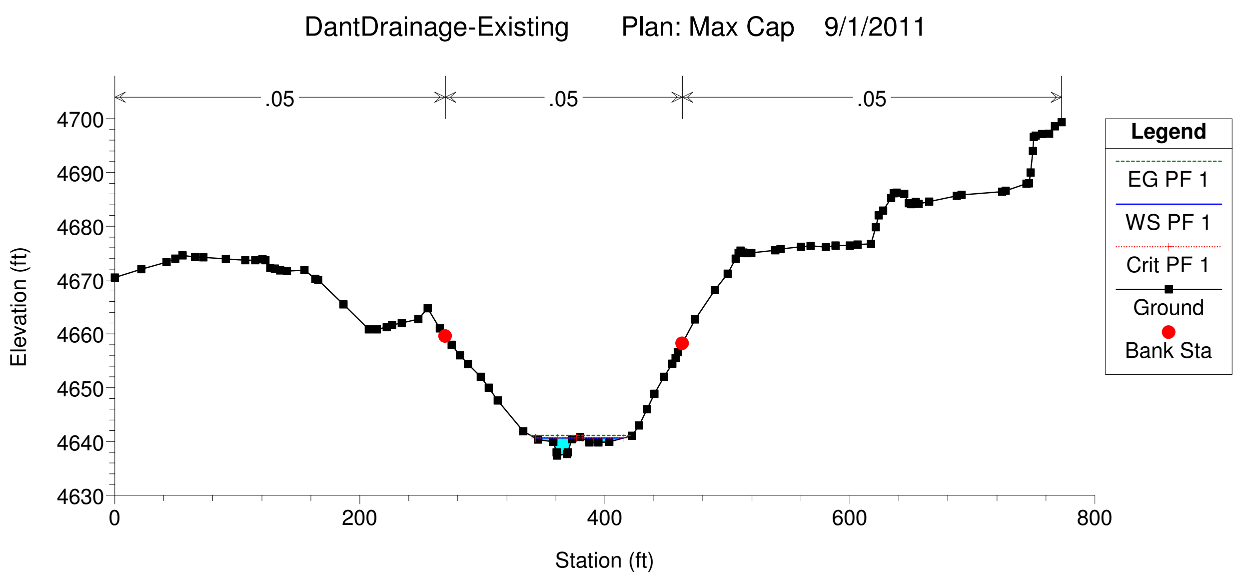
4650
4660
4670
4680
4690
4700
0
200
400
600
800
1000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Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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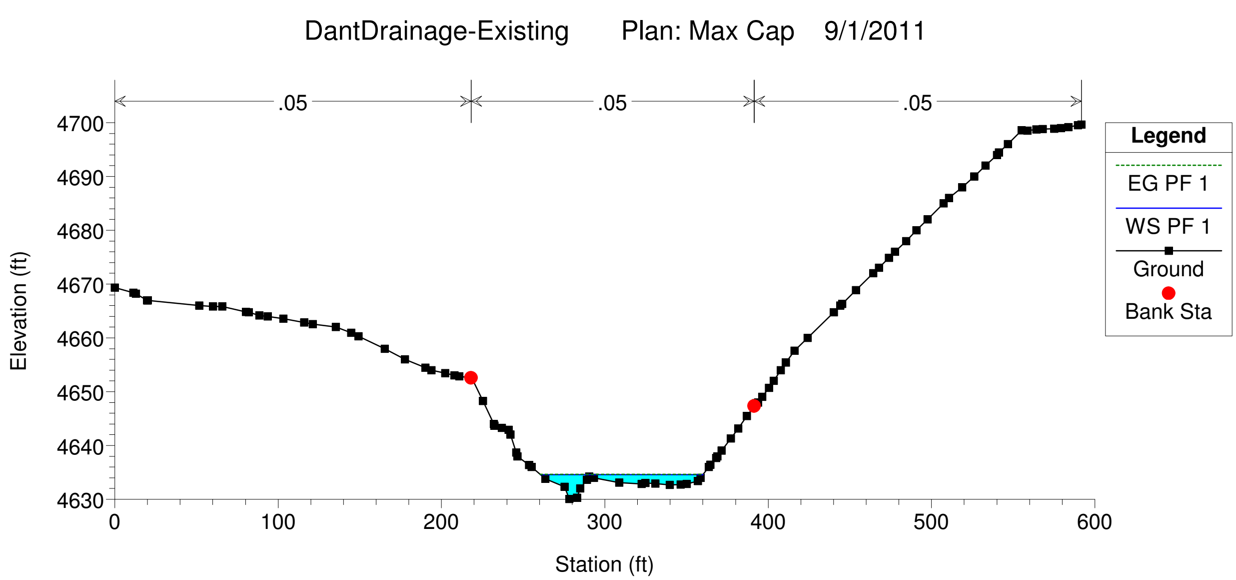
800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WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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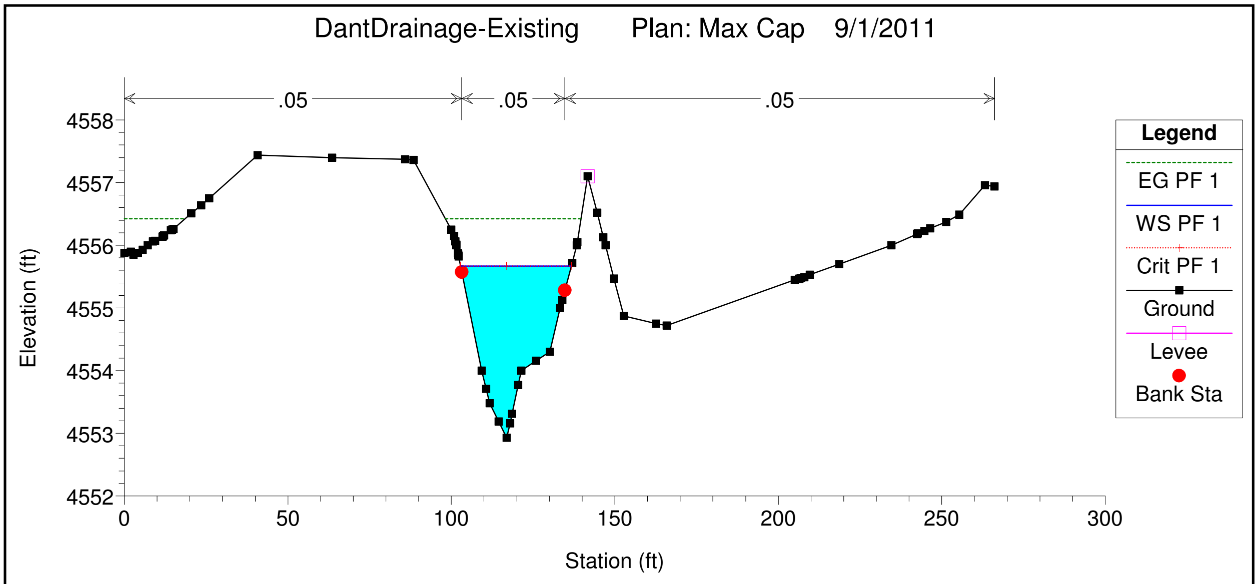


DantDrainage-Existing Plan: Max Cap 9/1/2011
.05
.05
.05
4558
4557
4556
4555
4554
4553
4552
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

Plan: Max Cap Dant Drainage Main RS: 1161.709 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	5.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	4.23
Q Barrel (cfs)	5.00	Culv Vel DS (ft/s)	5.28
E.G. US. (ft)	4585.82	Culv Inv El Up (ft)	4584.80
W.S. US. (ft)	4585.82	Culv Inv El Dn (ft)	4582.90
E.G. DS (ft)	4582.92	Culv Frctn Ls (ft)	1.86
W.S. DS (ft)	4582.84	Culv Exit Loss (ft)	1.06
Delta EG (ft)	2.90	Culv Entr Loss (ft)	0.00
Delta WS (ft)	2.97	Q Weir (cfs)	
E.G. IC (ft)	4585.82	Weir Sta Lft (ft)	
E.G. OC (ft)	4585.98	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4585.56	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4583.55	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	0.65	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	0.76	Min El Weir Flow (ft)	4592.74

Pheasant Lane Culvert

Max Capacity Run Output (350 cfs - dam to Last Chance Ditch, 5 cfs - Last Chance to Lake Ditch, 350 cfs - Lake Ditch to Moana

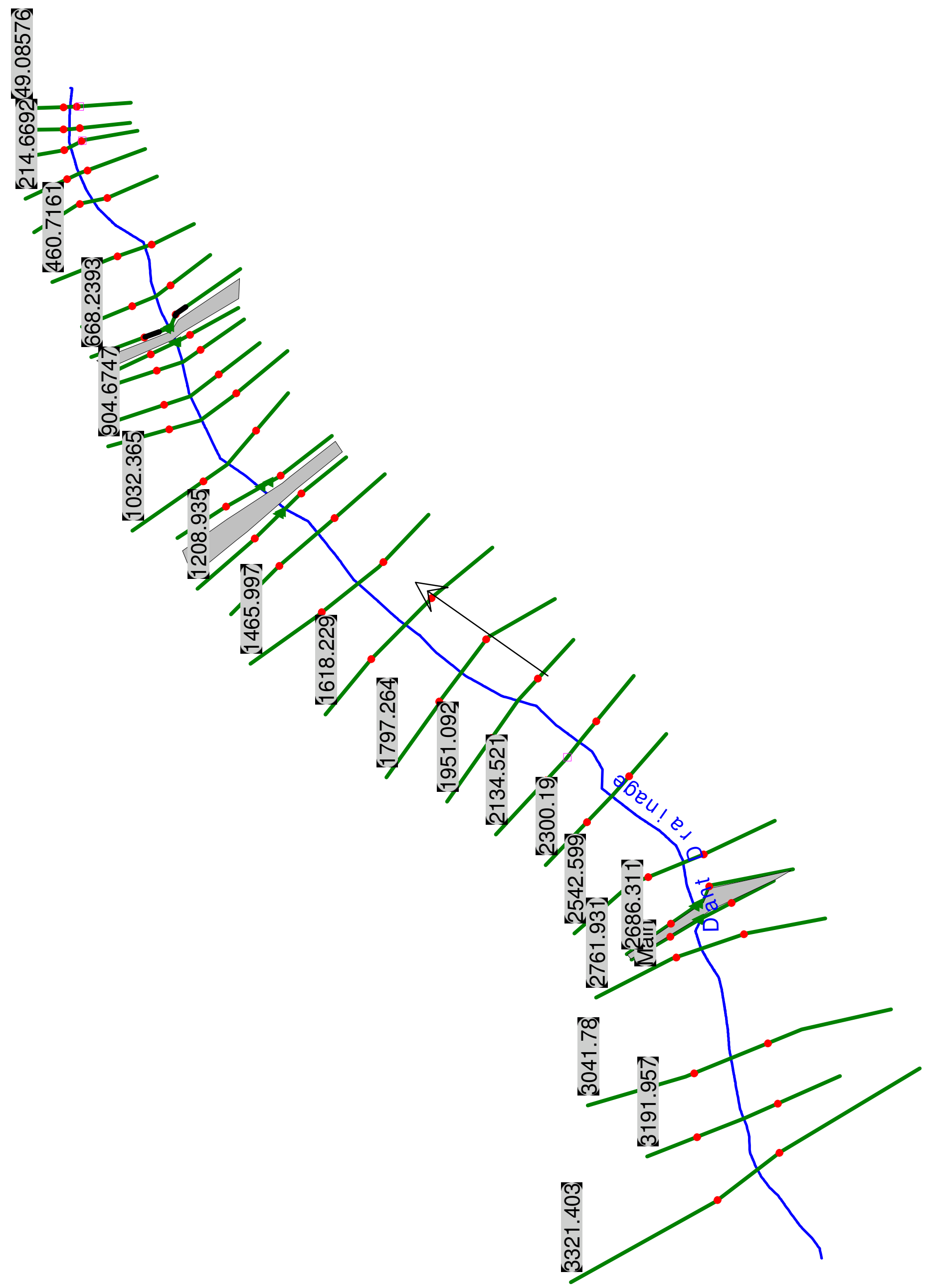
HEC-RAS Plan: Max Cap River: Dant Drainage Reach: Main Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	3321.402	PF 1	350.00	4644.32	4647.88		4648.57	0.019025	6.70	52.21	23.23	0.79
Main	3041.780	PF 1	350.00	4637.37	4640.64	4640.64	4641.12	0.039180	5.55	63.09	67.02	1.01
Main	2781.717		Lat Struct									
Main	2761.931	PF 1	350.00	4630.04	4634.60		4634.67	0.002576	2.10	167.02	99.66	0.29
Main	2653.730	PF 1	350.00	4632.49	4633.64	4633.64	4633.93	0.042333	4.39	83.33	152.55	0.99
Main	2542.598	PF 1	5.00	4622.02	4622.32	4622.32	4622.41	0.064013	2.44	2.05	10.95	1.00
Main	2300.189	PF 1	5.00	4613.51	4613.74		4613.76	0.023435	1.10	4.54	38.10	0.56
Main	2134.520	PF 1	5.00	4608.08	4608.62	4608.59	4608.74	0.040361	2.78	1.80	5.50	0.86
Main	1797.263	PF 1	5.00	4599.85	4600.14	4600.06	4600.16	0.017366	1.17	4.27	26.09	0.51
Main	1618.228	PF 1	5.00	4594.22	4594.41	4594.41	4594.46	0.075849	1.85	2.70	25.09	0.99
Main	1465.997	PF 1	5.00	4589.92	4590.11		4590.12	0.012629	0.79	6.35	55.40	0.41
Main	1308.650	PF 1	5.00	4585.80	4586.16	4586.16	4586.26	0.065922	2.55	1.96	10.08	1.02
Main	1208.934	PF 1	5.00	4584.07	4585.82	4584.56	4585.82	0.000155	0.47	10.60	26.50	0.07
Main	1161.709		Culvert									
Main	1128.953	PF 1	5.00	4582.59	4582.84	4582.84	4582.92	0.066882	2.22	2.25	36.13	0.99
Main	1032.365	PF 1	5.00	4577.99	4578.32		4578.34	0.012937	0.98	5.12	32.86	0.44
Main	904.6746	PF 1	5.00	4574.80	4575.00	4575.00	4575.06	0.073409	2.05	2.44	18.95	1.01
Main	883.2095		Lat Struct									
Main	668.2392	PF 1	5.00	4568.32	4568.51	4568.51	4568.55	0.098167	1.64	3.04	40.96	1.06
Main	460.7161	PF 1	350.00	4558.87	4561.22	4561.22	4561.78	0.026680	6.31	61.08	52.50	0.91
Main	289.6794	PF 1	350.00	4555.58	4558.56		4558.81	0.008750	3.99	87.69	50.04	0.53
Main	146.5573	PF 1	350.00	4553.88	4557.47	4556.59	4557.70	0.006805	3.88	90.29	45.13	0.48
Main	49.08576	PF 1	350.00	4552.93	4555.67	4555.67	4556.43	0.030643	7.00	50.33	33.82	0.98

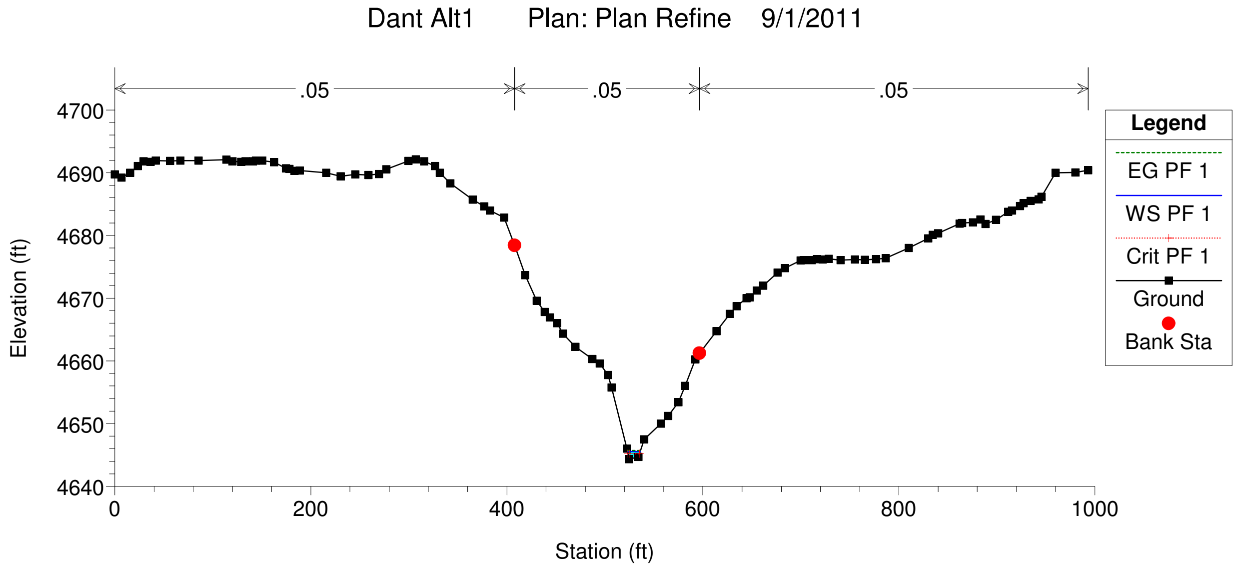
APPENDIX B

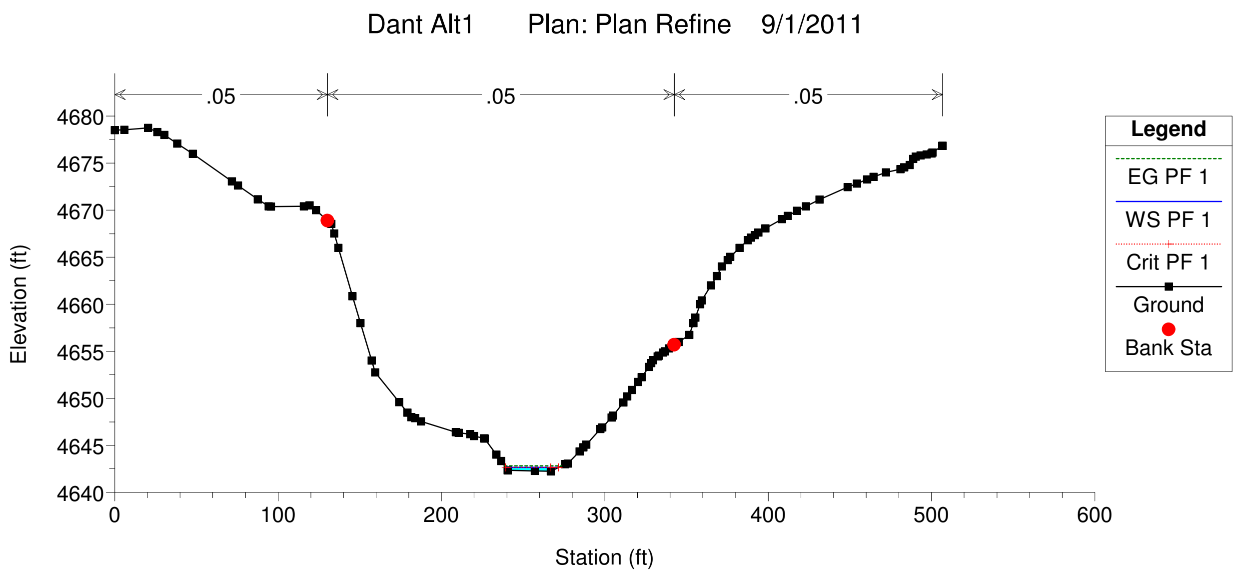
Proposed Alternatives HEC-RAS Output and Storm Drain Analyses

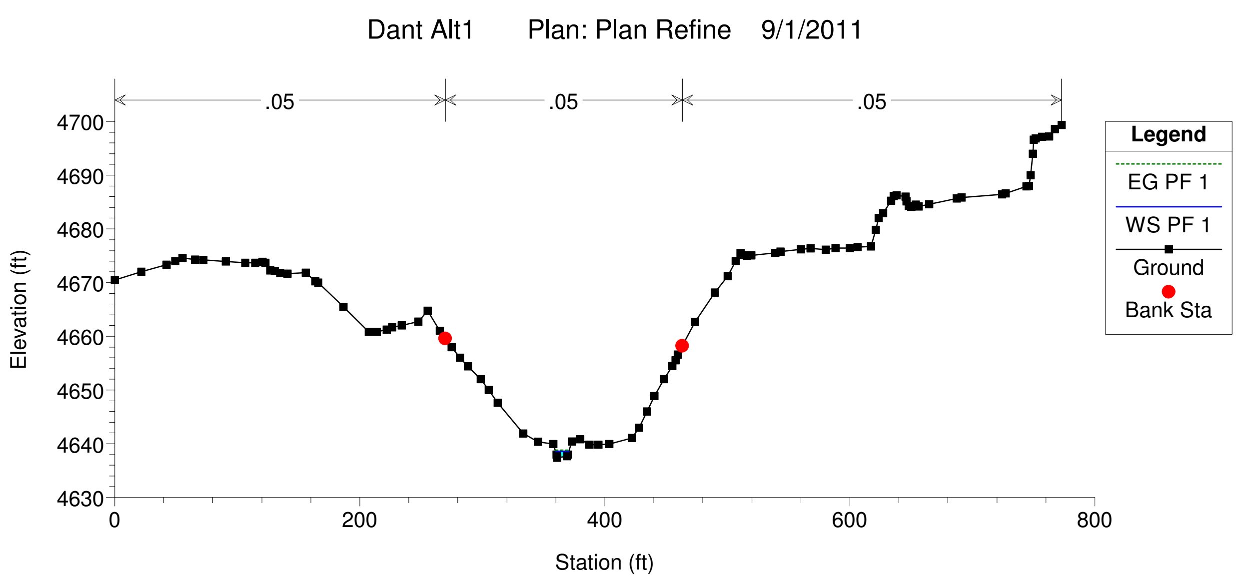
Alternative 1 Model

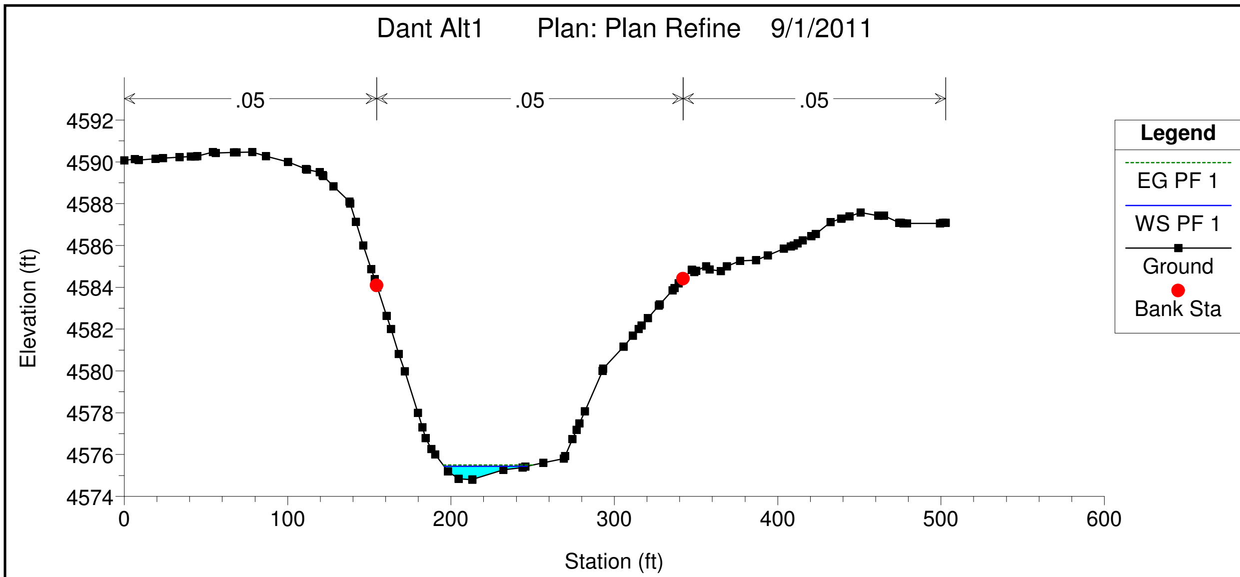


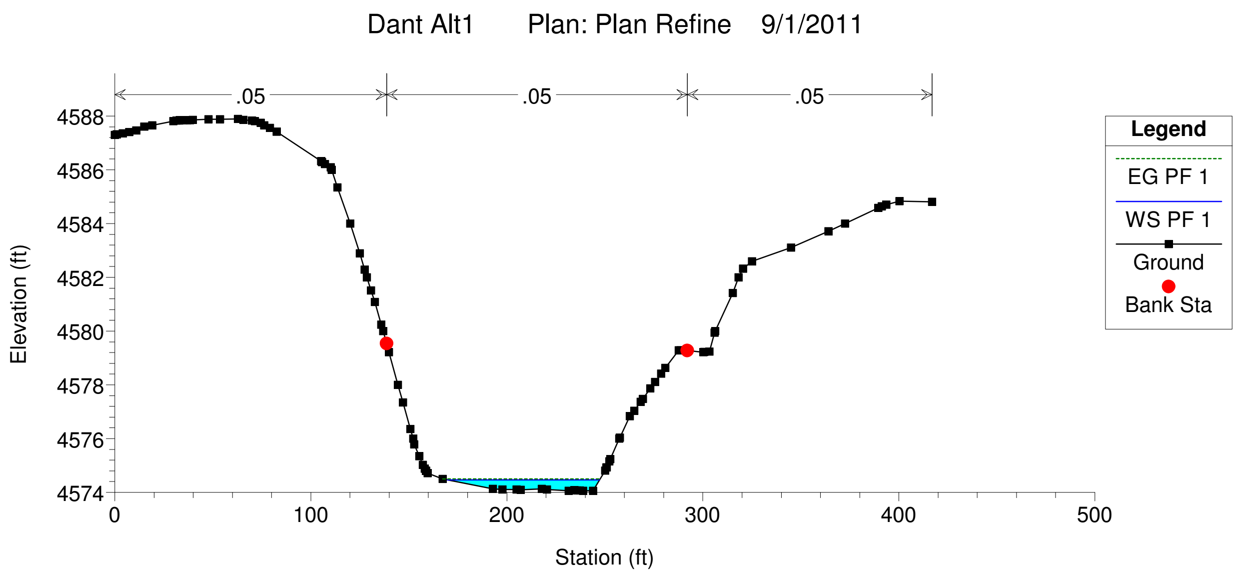
Cross Sections








Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4592
4590
4588
4586
4584
4582
4580
4578
4576
4574
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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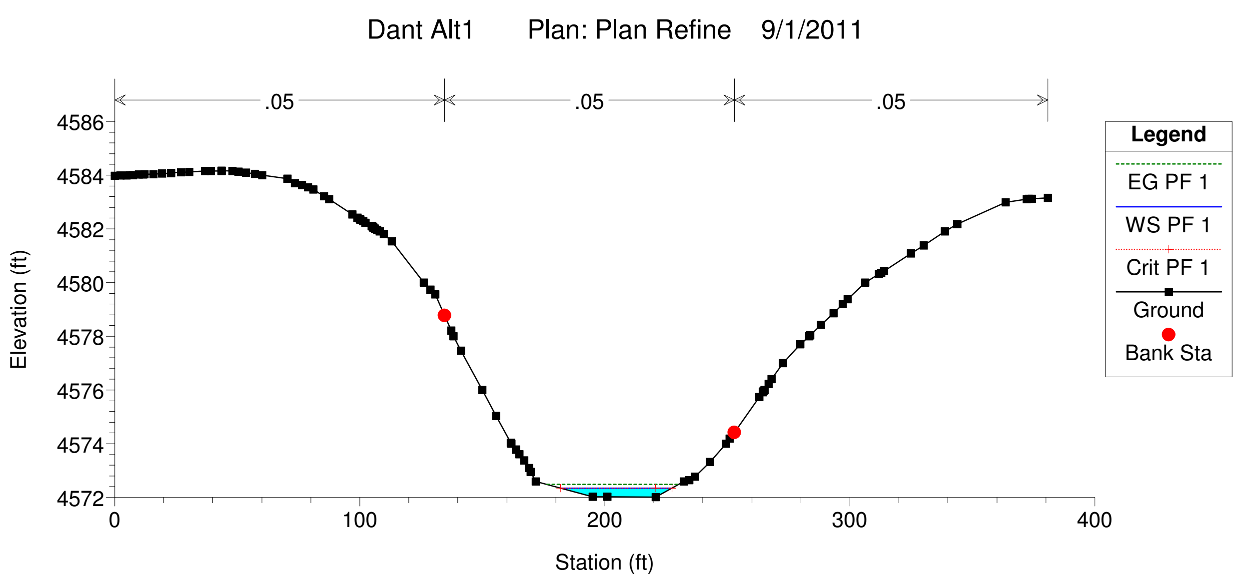
.05
.05
.05
Elevation (ft)
4588
4586
4584
4582
4580
4578
4576
4574
0
100
200
300
400
500
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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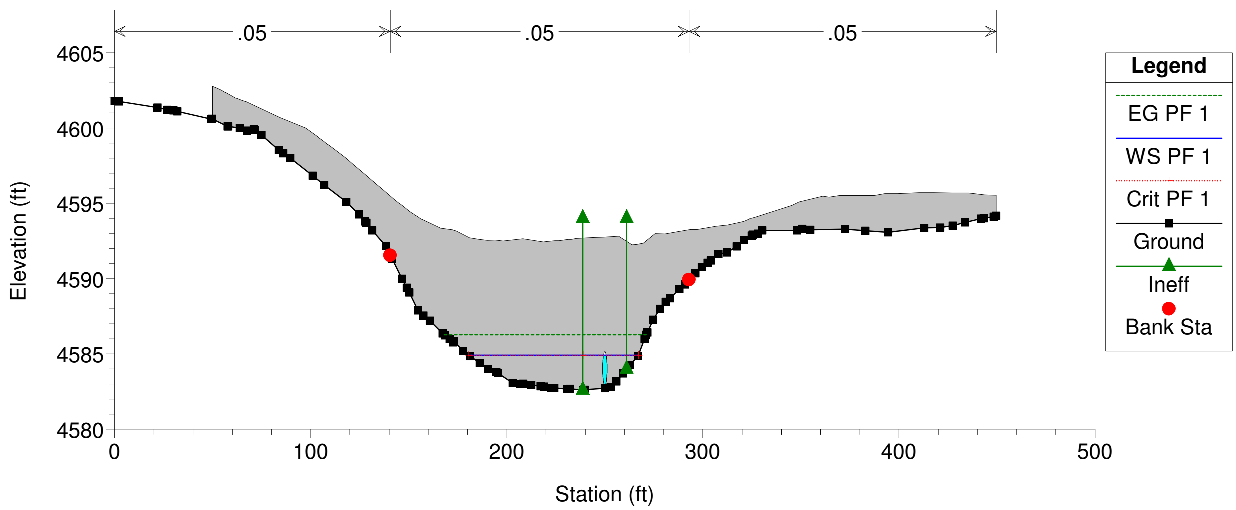
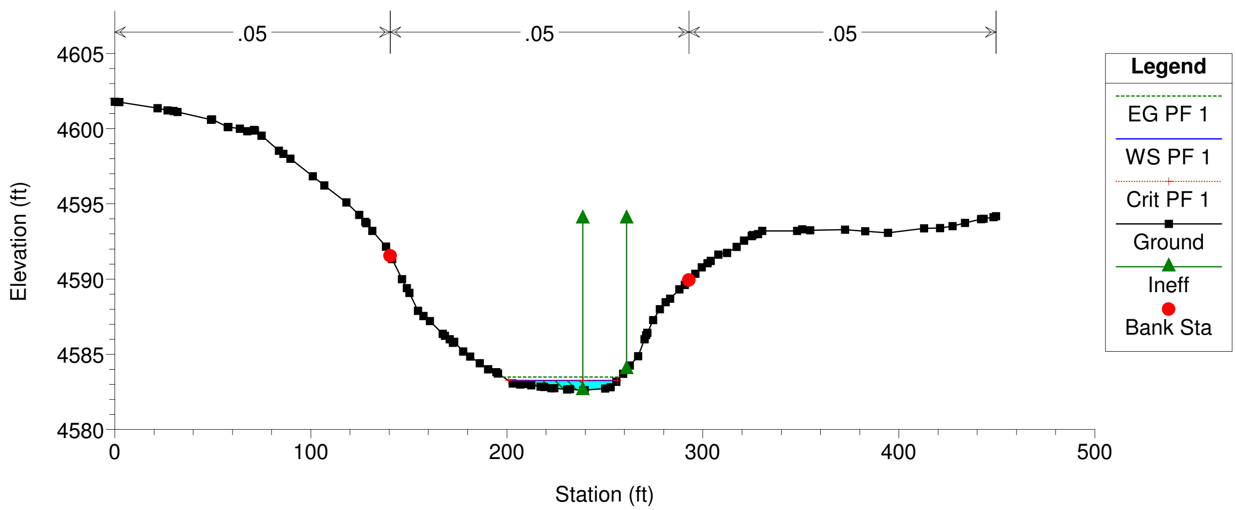
.05
.05
.05
Elevation (ft)
4586
4584
4582
4580
4578
4576
4574
4572
0
100
200
300
400
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

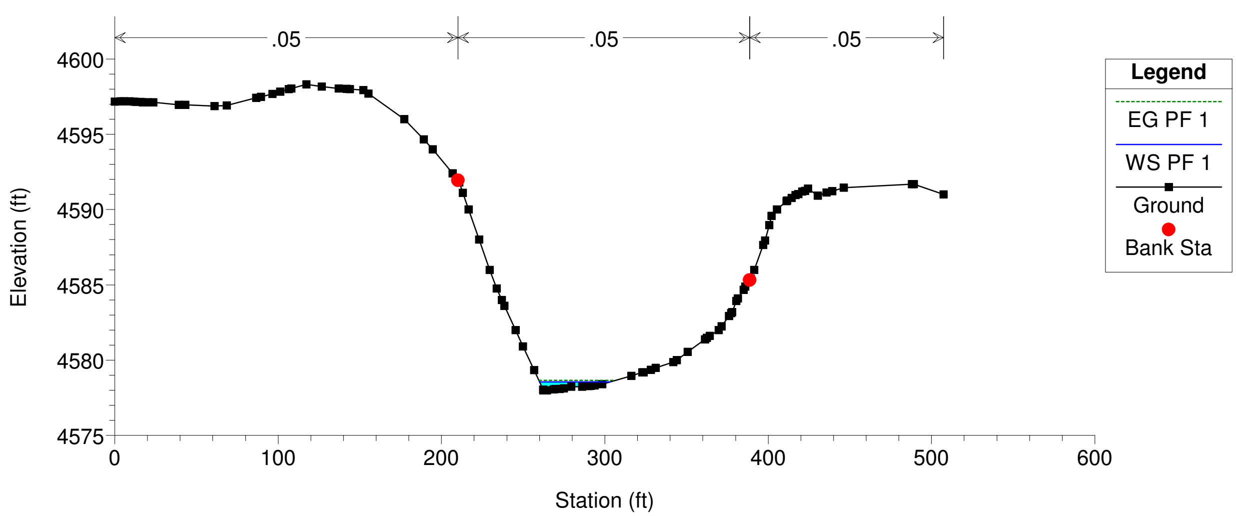
Dant Alt1 Plan: Plan Refine 9/1/2011



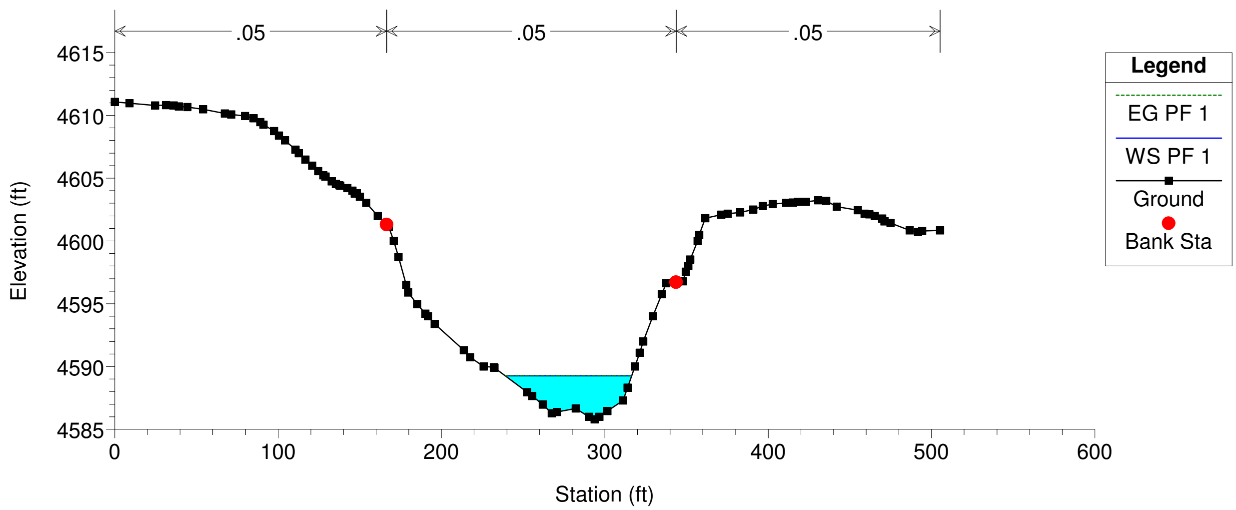
Dant Alt1 Plan: Plan Refine 9/1/2011



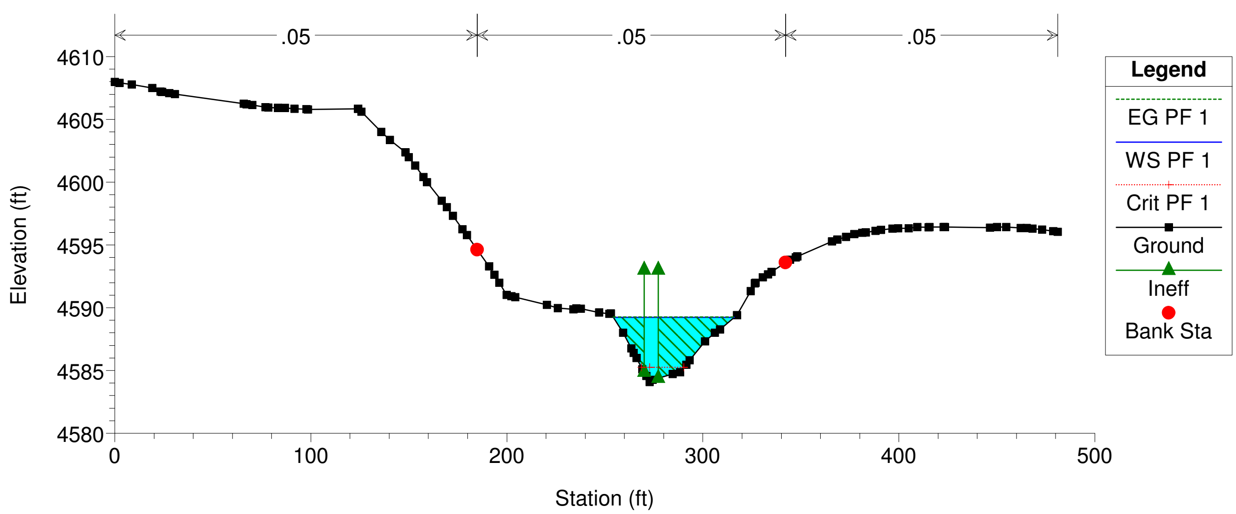
Dant Alt1 Plan: Plan Refine 9/1/2011



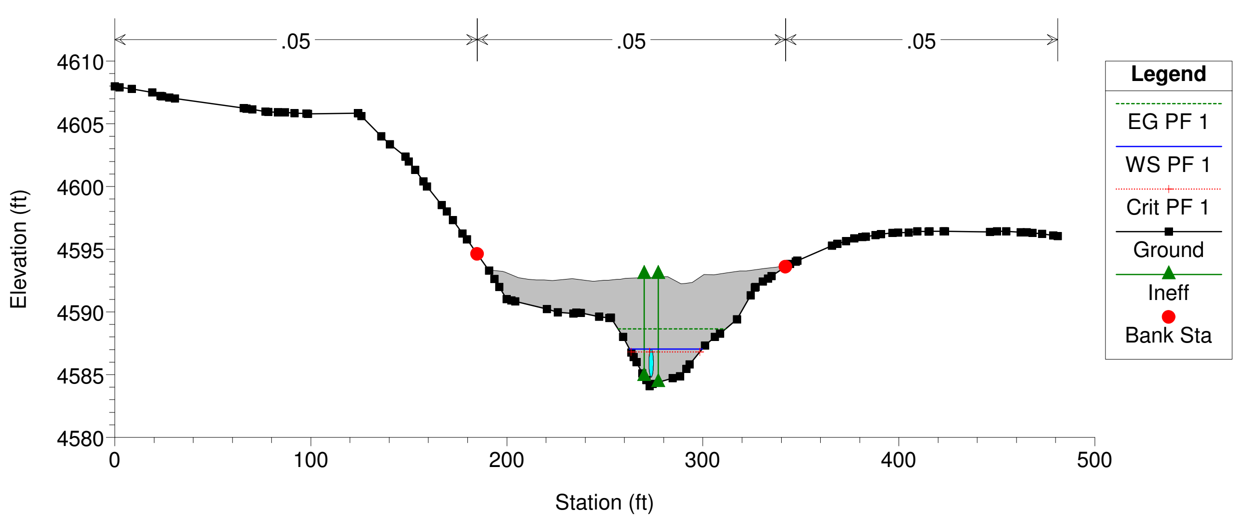
Dant Alt1 Plan: Plan Refine 9/1/2011



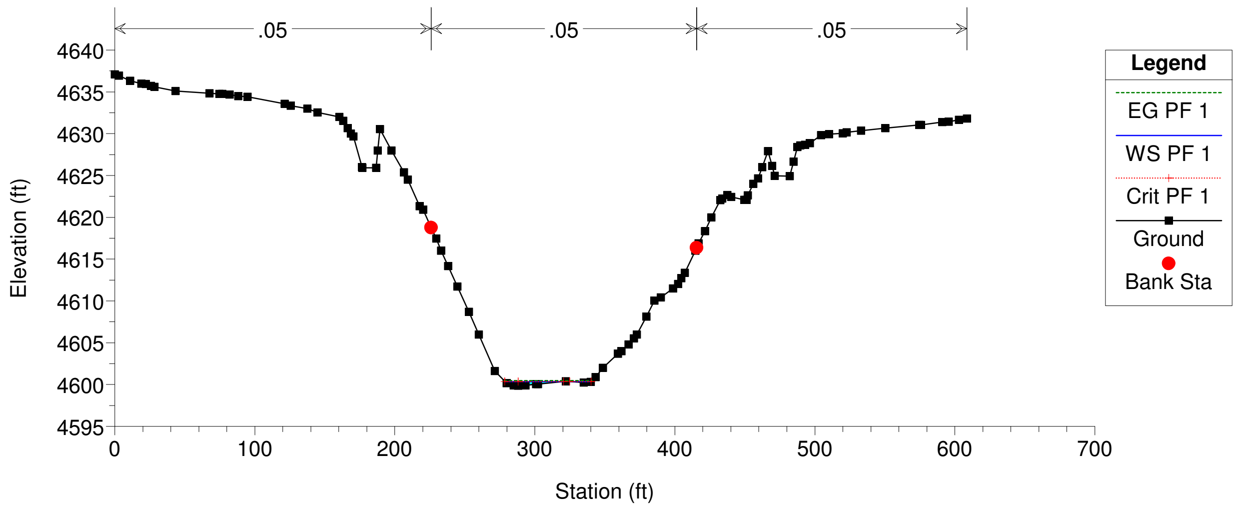
Dant Alt1 Plan: Plan Refine 9/1/2011



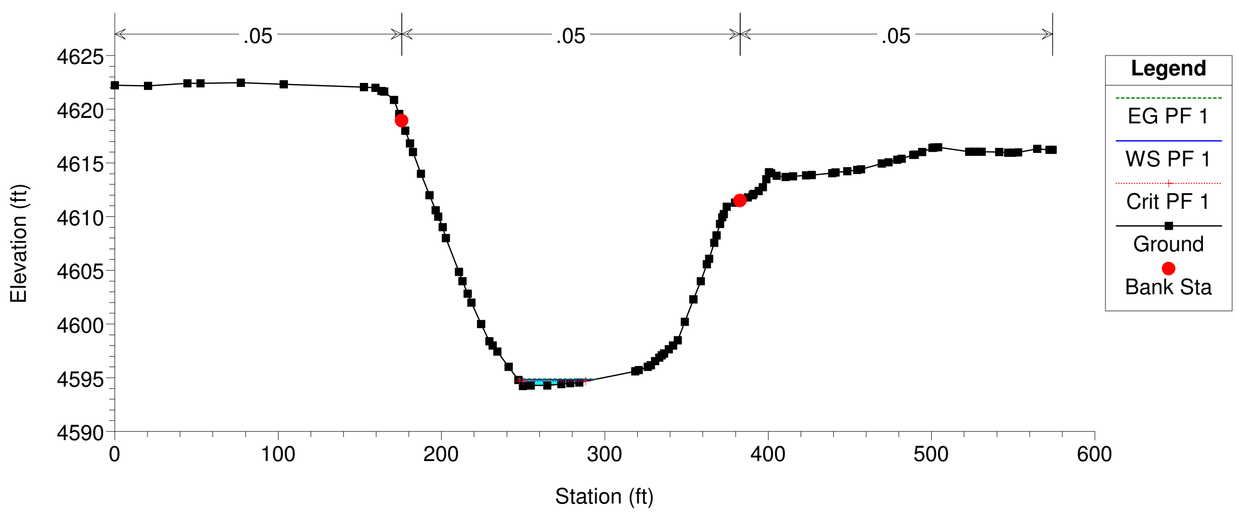
Dant Alt1 Plan: Plan Refine 9/1/2011



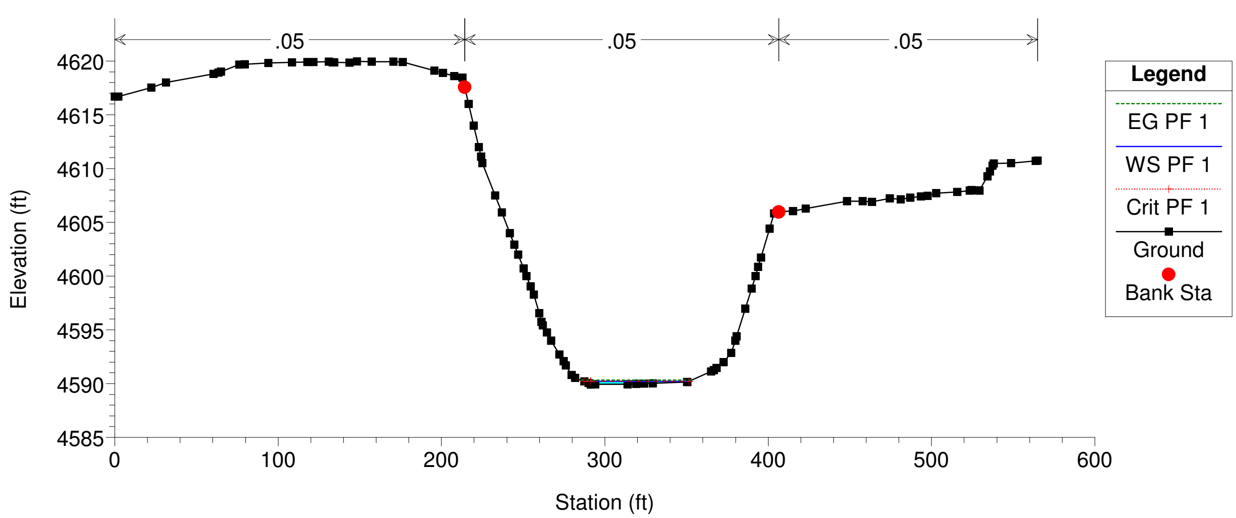
Dant Alt1 Plan: Plan Refine 9/1/2011

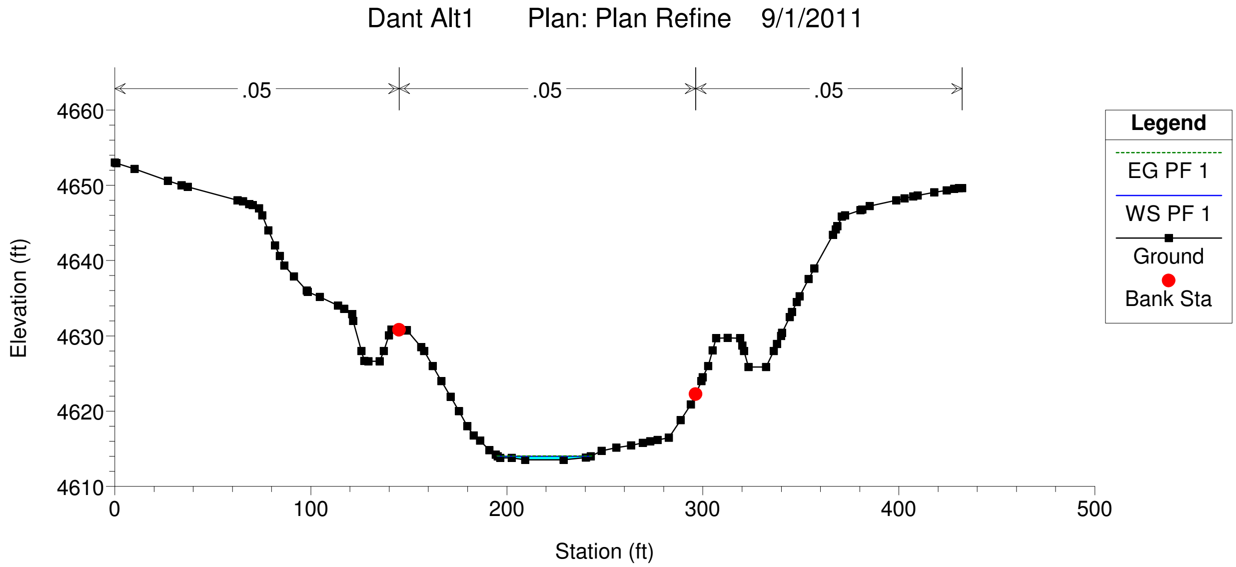


Dant Alt1 Plan: Plan Refine 9/1/2011



Dant Alt1 Plan: Plan Refine 9/1/2011

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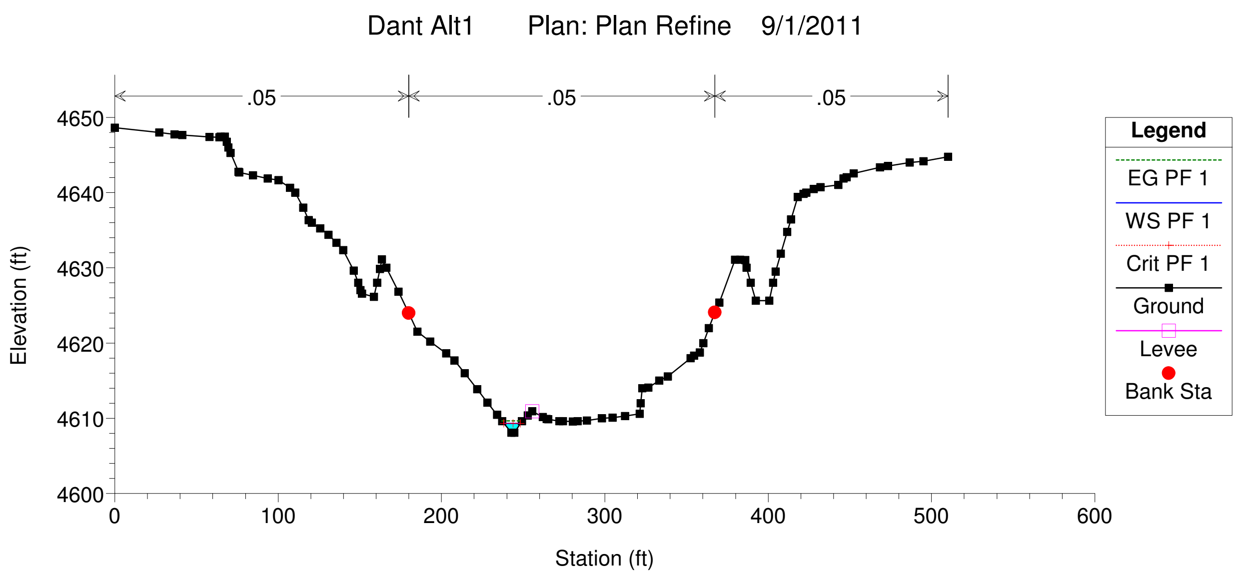
.05
.05
.05
Elevation (ft)
4660
4650
4640
4630
4620
4610
0
100
200
300
400
500
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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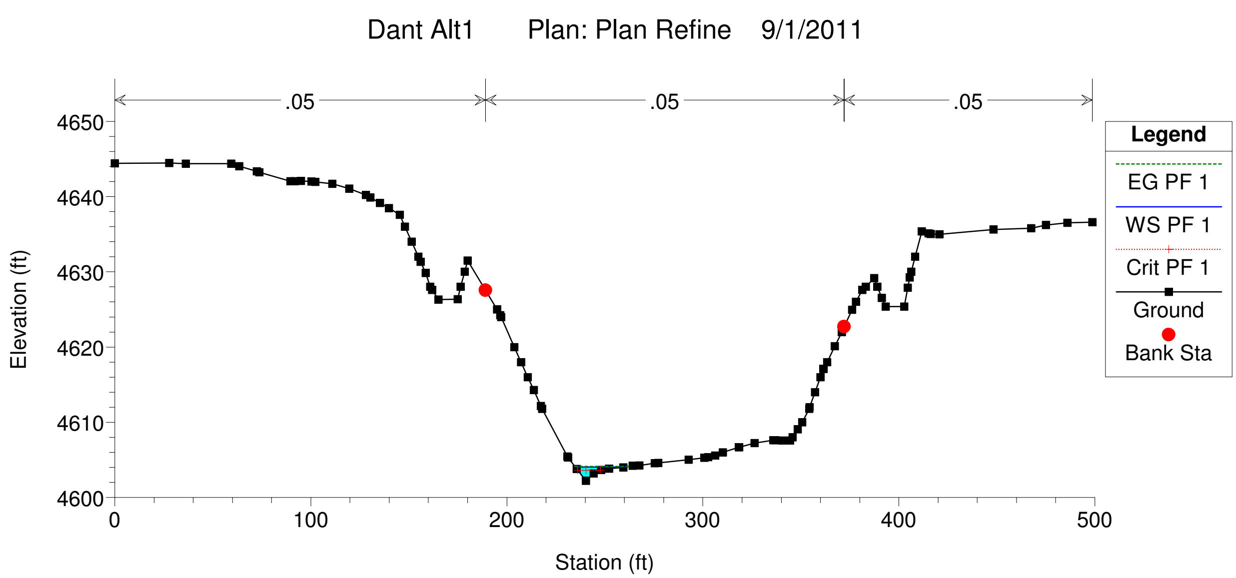
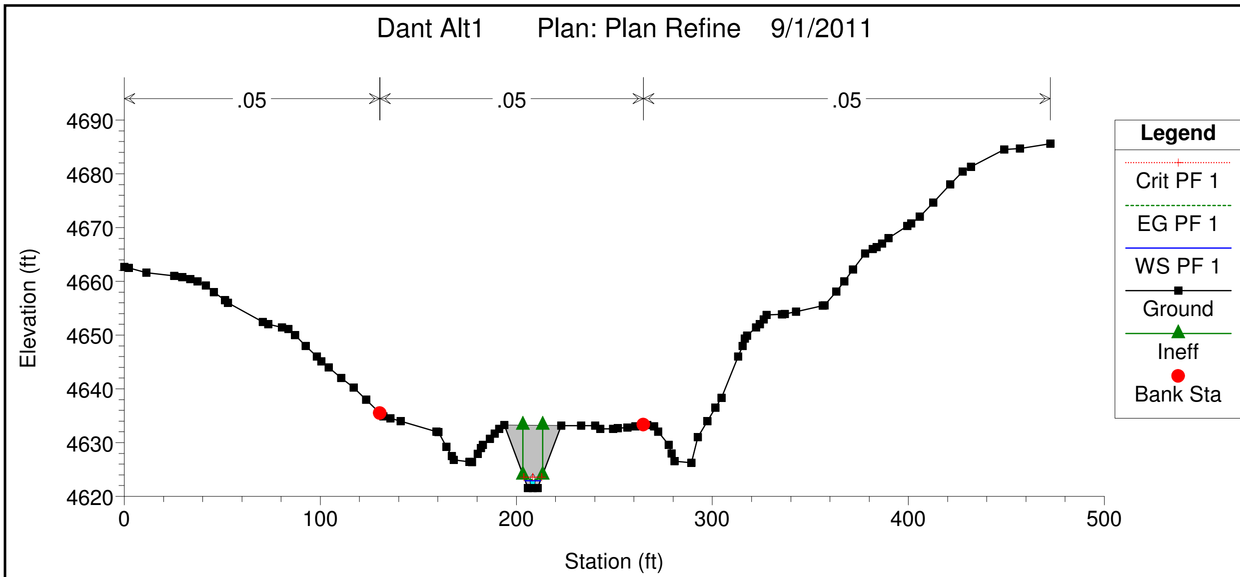
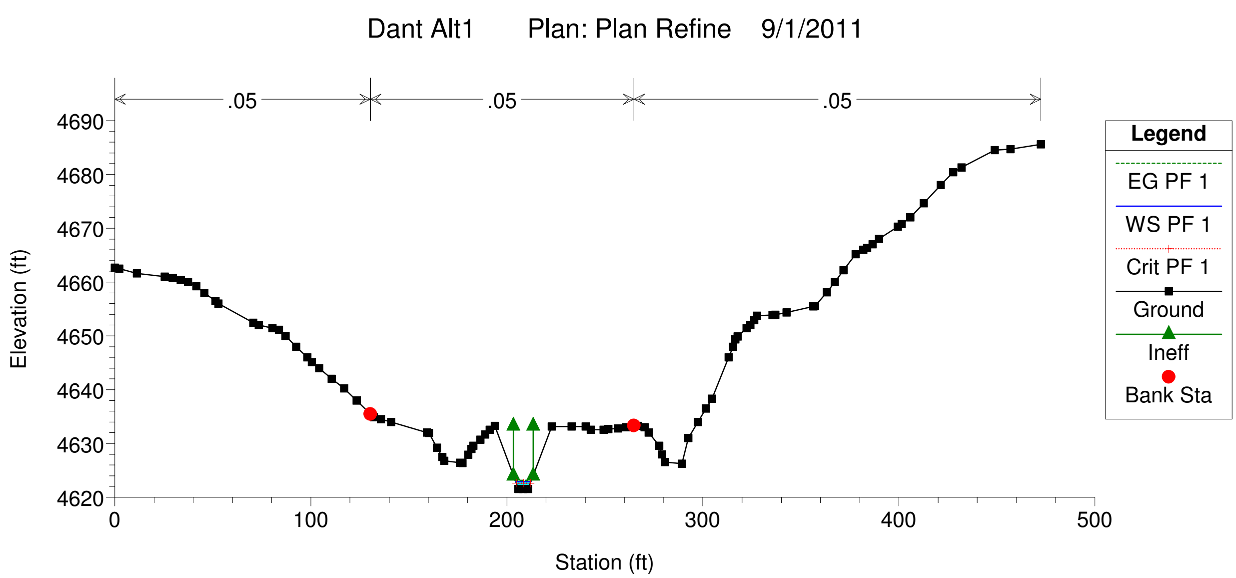
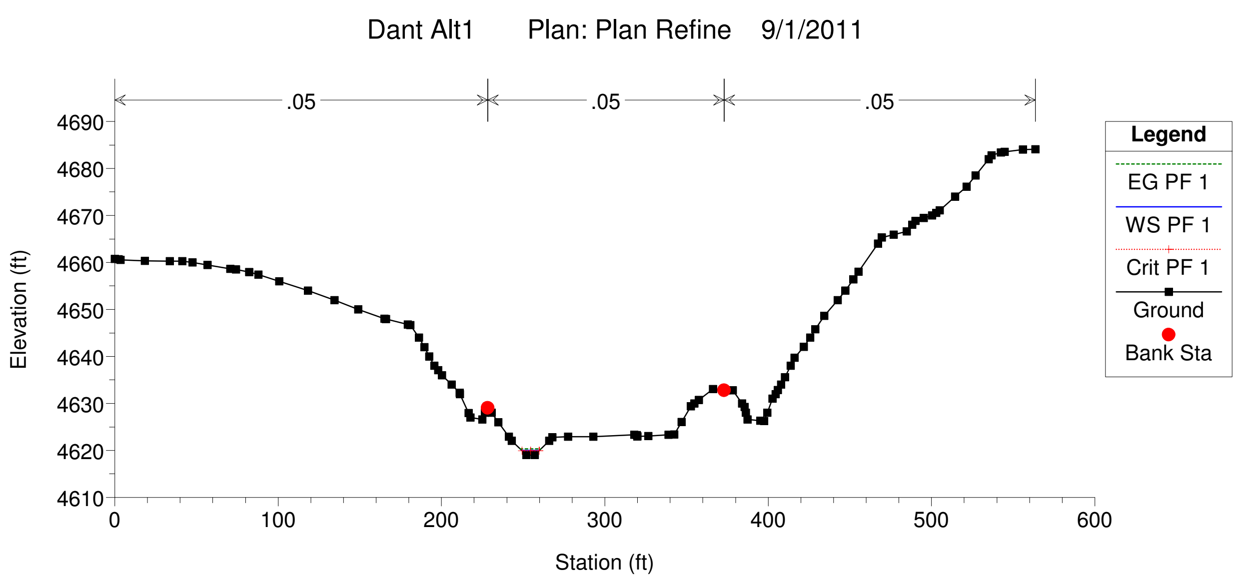
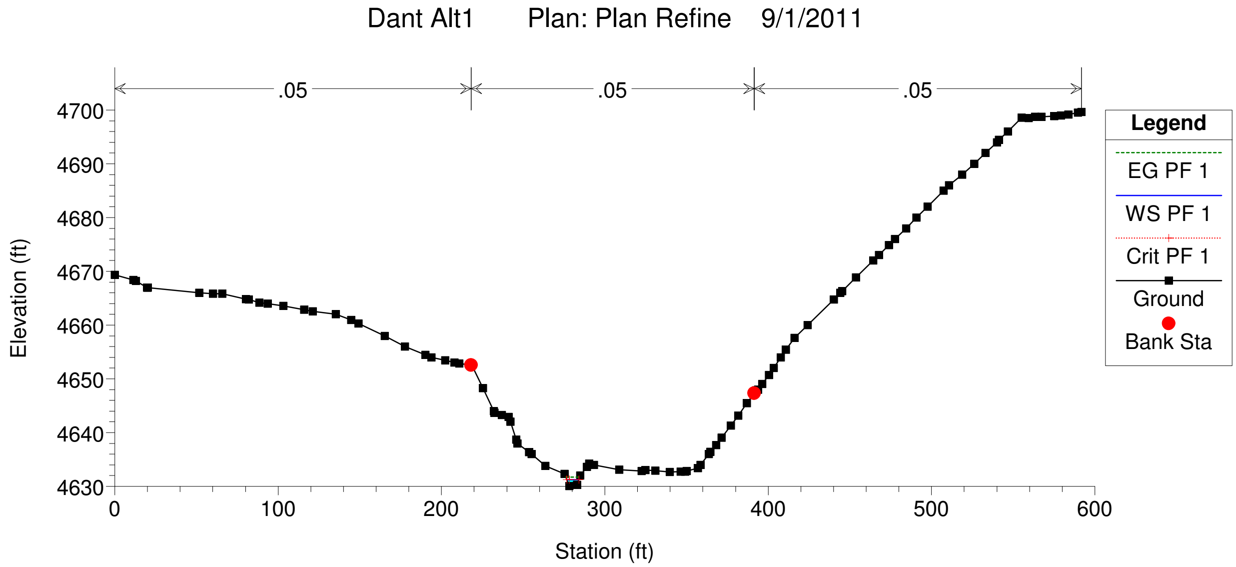
.05
.05
.05
Elevation (ft)
4650
4640
4630
4620
4610
4600
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4650
4640
4630
4620
4610
4600
0
100
200
300
400
500
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

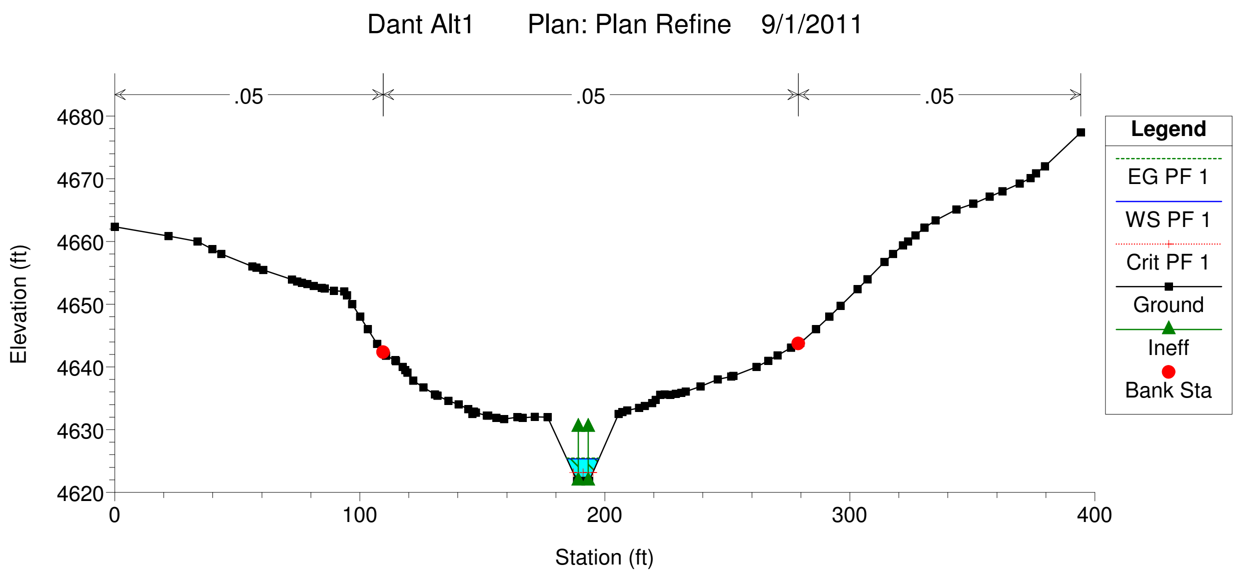

Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4620
4630
4640
4650
4660
4670
4680
4690
Station (ft)
0
100
200
300
400
500
Legend
Crit PF 1
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4620
4630
4640
4650
4660
4670
4680
4690
Station (ft)
0
100
200
300
400
500
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta

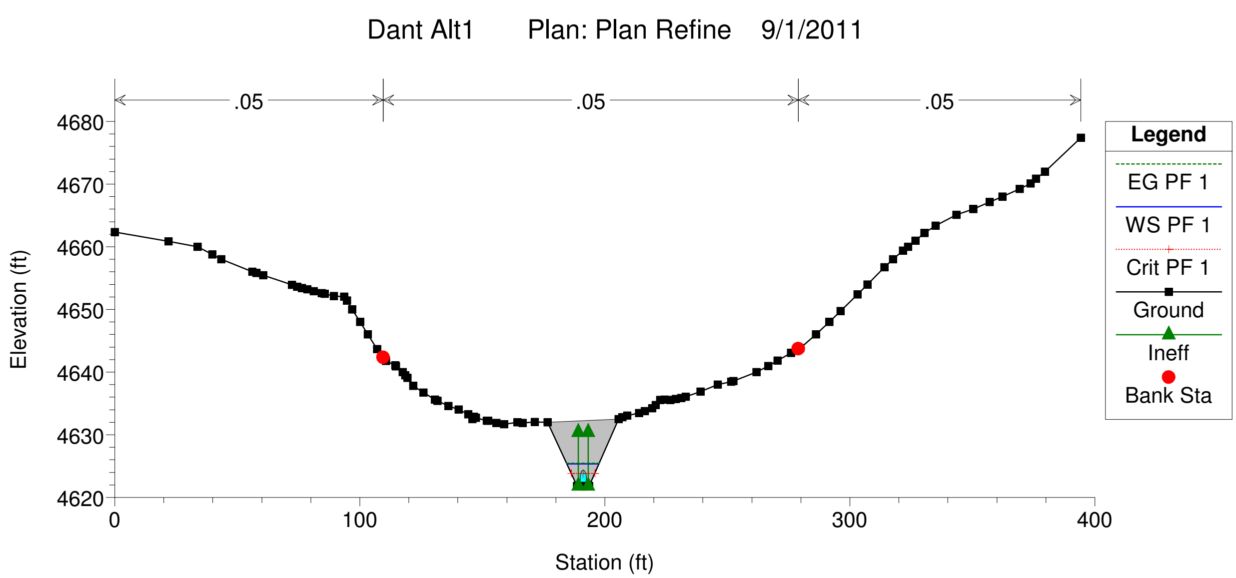

Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4610
4620
4630
4640
4650
4660
4670
4680
4690
Station (ft)
0
100
200
300
400
500
600
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta



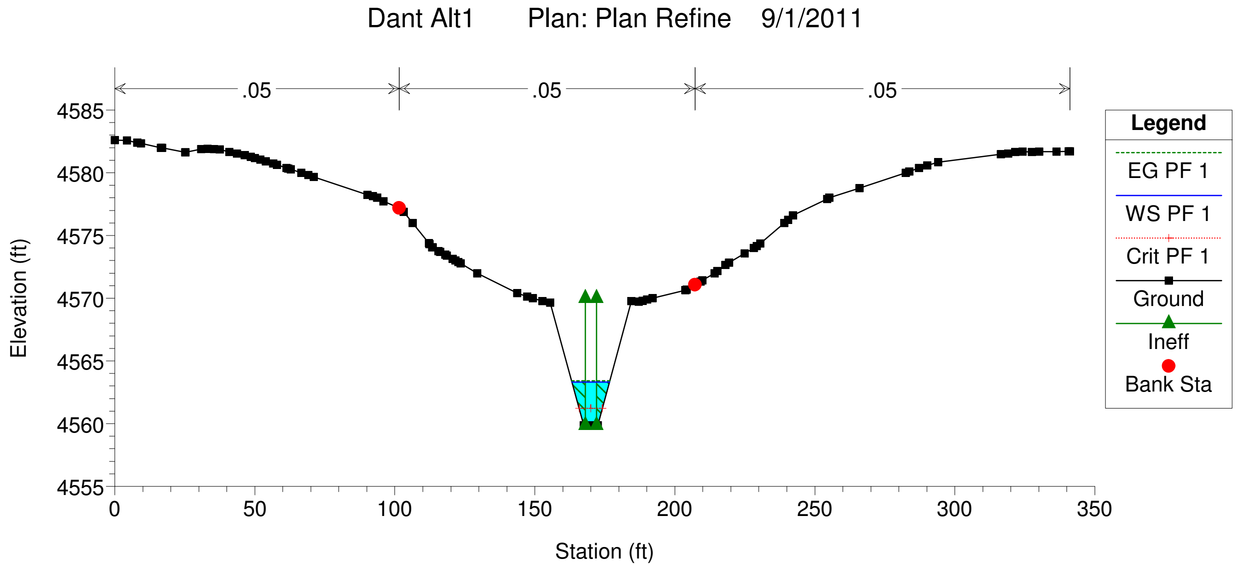
Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4700
4690
4680
4670
4660
4650
4640
4630
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

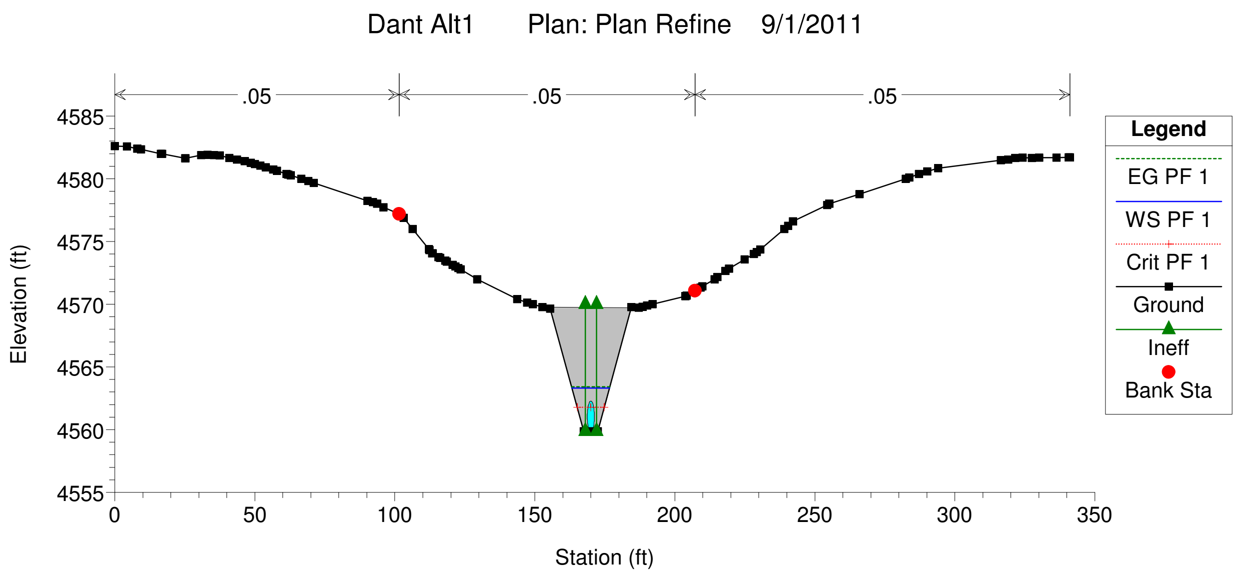


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4680
4670
4660
4650
4640
4630
4620
0
100
200
300
400
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta



Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4680
4670
4660
4650
4640
4630
4620
0
100
200
300
400
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4555
4560
4565
4570
4575
4580
4585
Station (ft)
0
50
100
150
200
250
300
350
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
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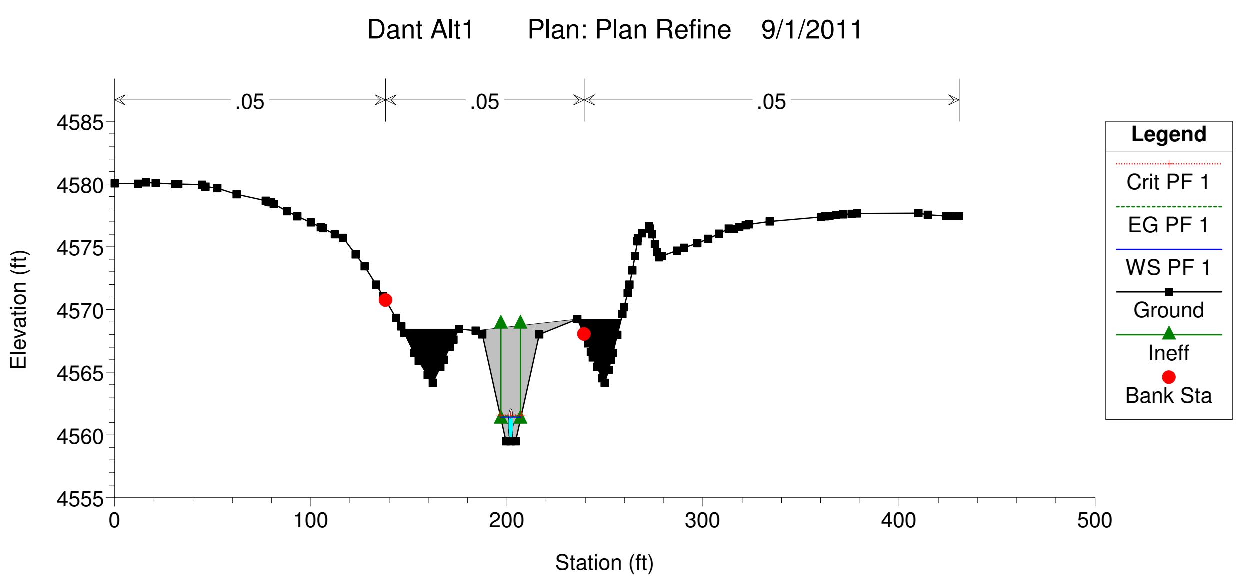
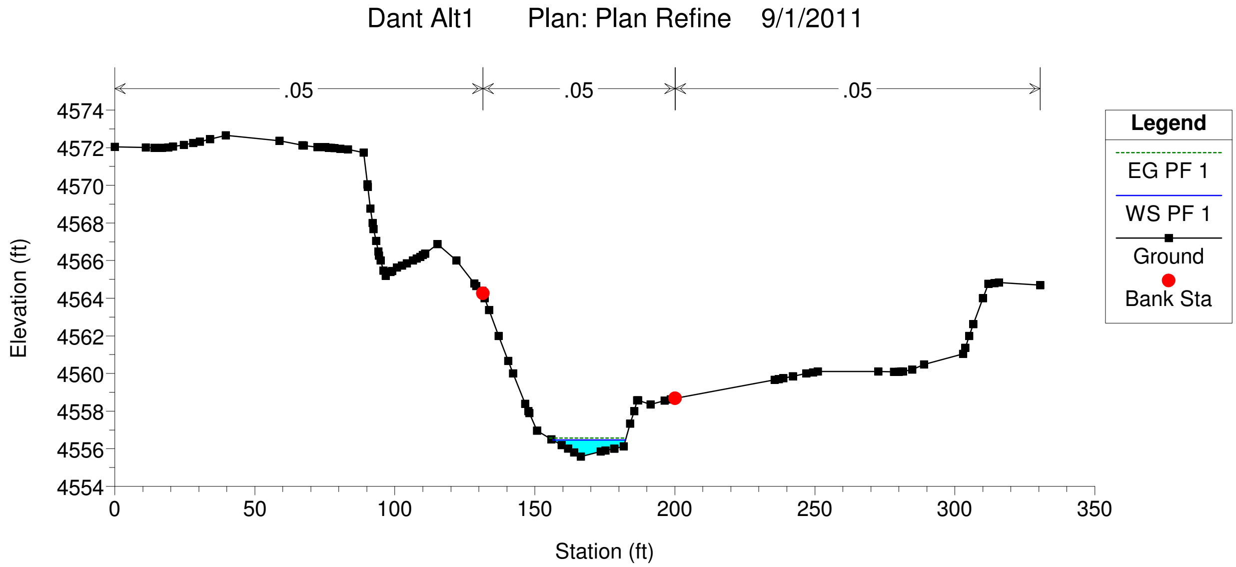
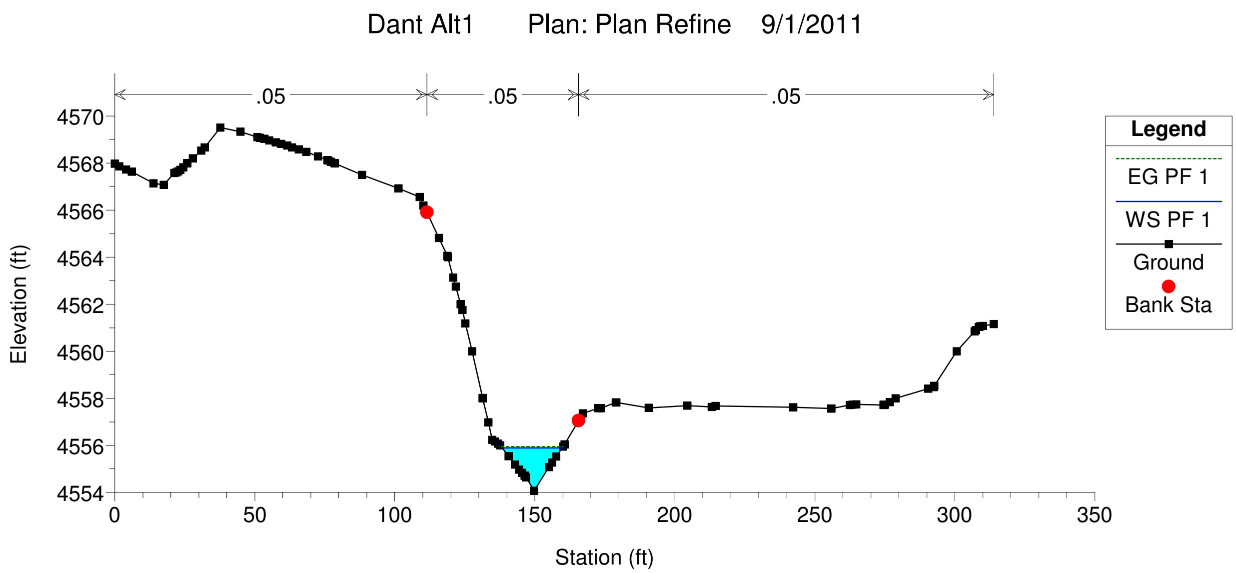
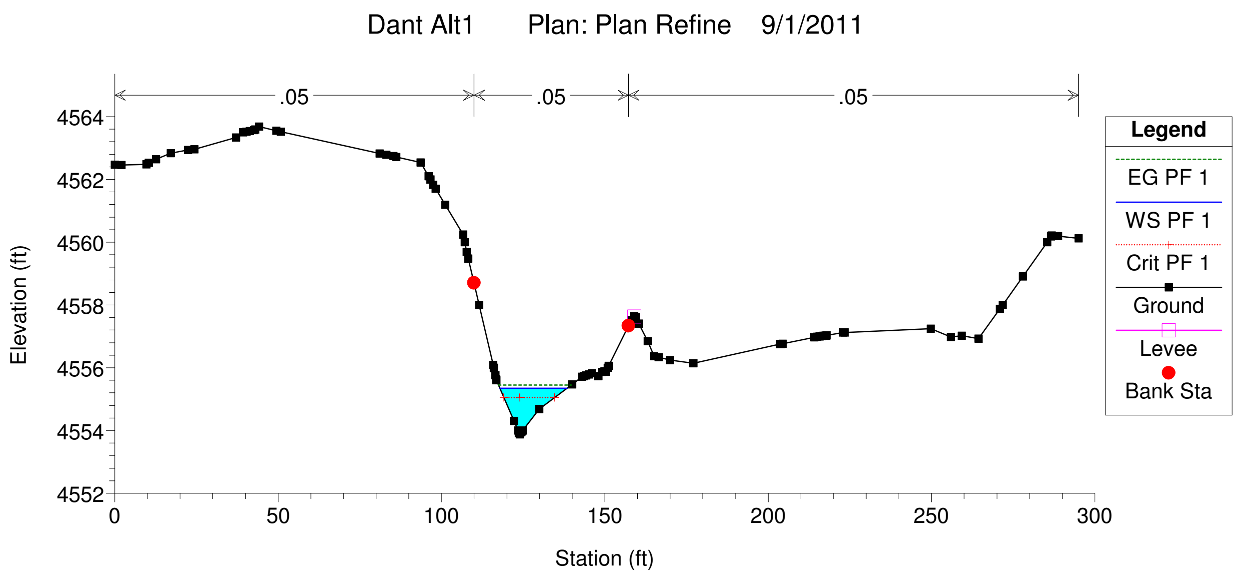
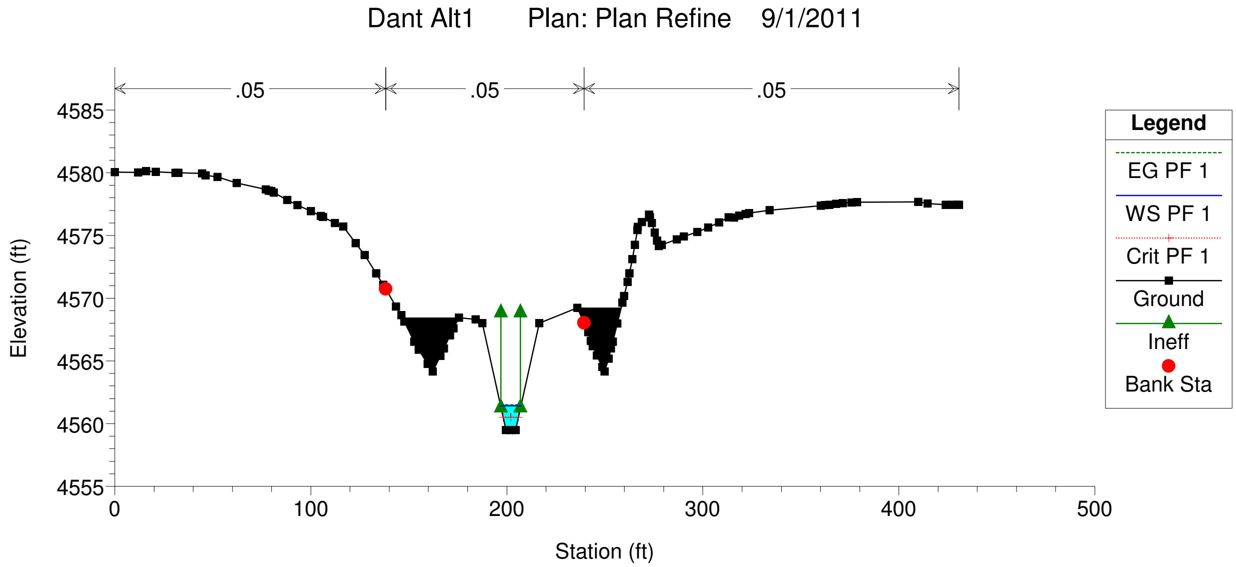
.05
.05
Elevation (ft)
4555
4560
4565
4570
4575
4580
4585
Station (ft)
0
50
100
150
200
250
300
350
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta

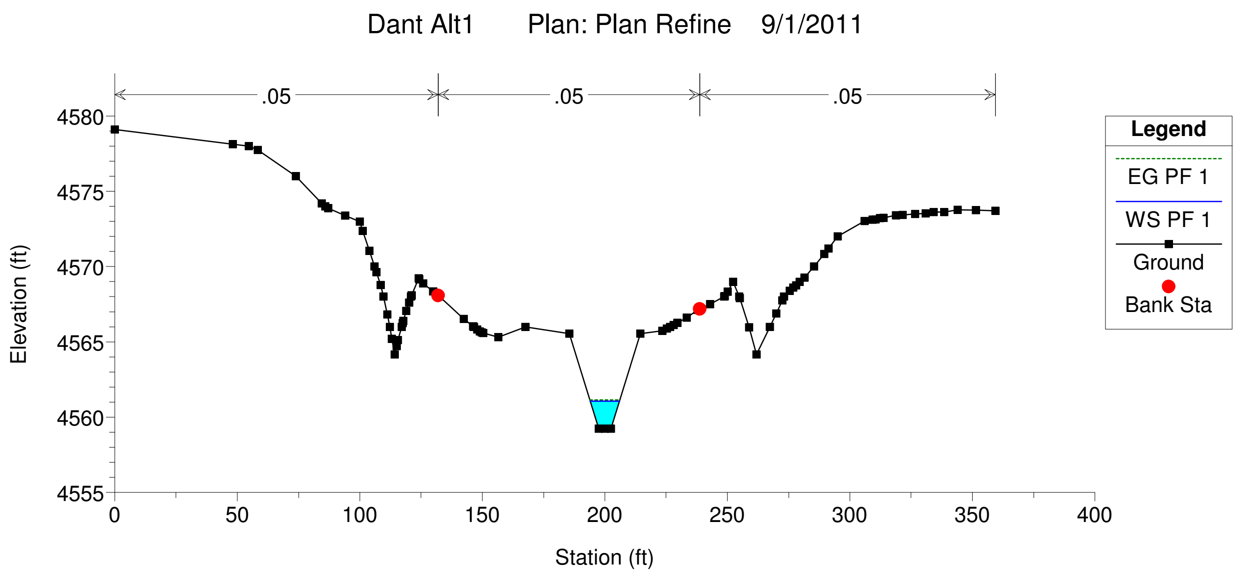

Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
4555
4560
4565
4570
4575
4580
4585
Station (ft)
0
100
200
300
400
500
Legend
Crit PF 1
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
4585
4580
4575
4570
4565
4560
4555
0
100
200
300
400
500
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
4580
4575
4570
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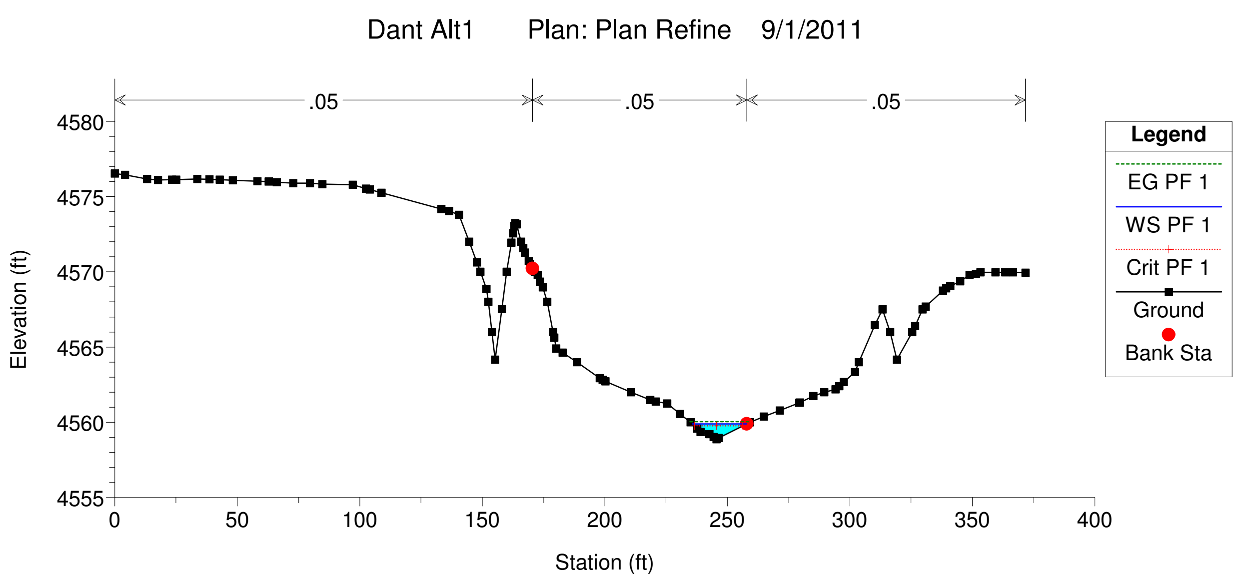
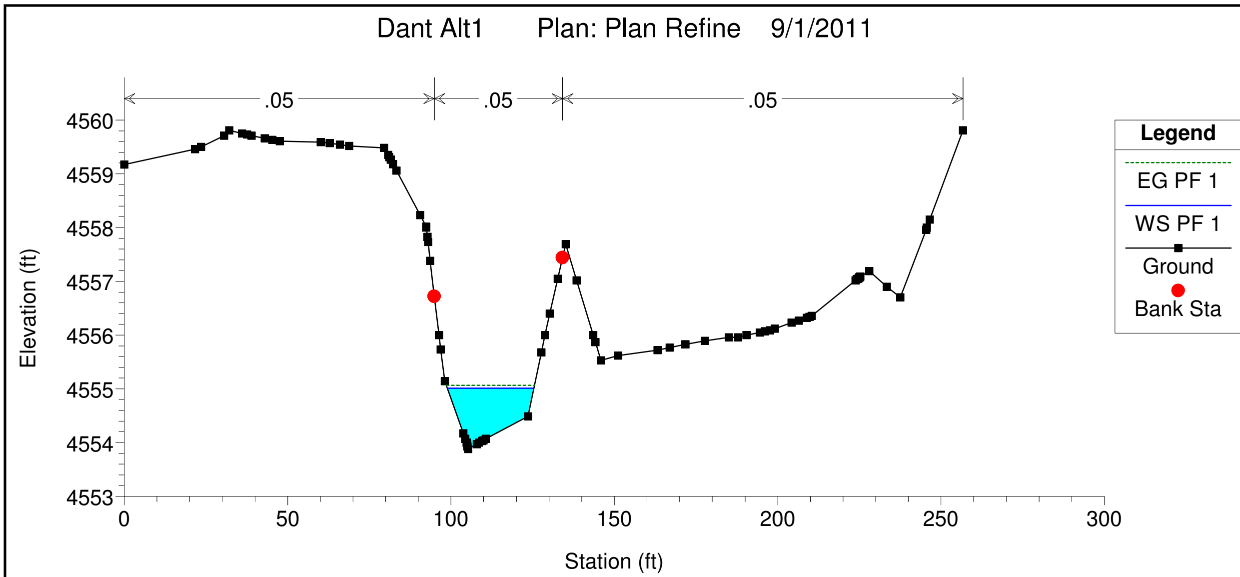
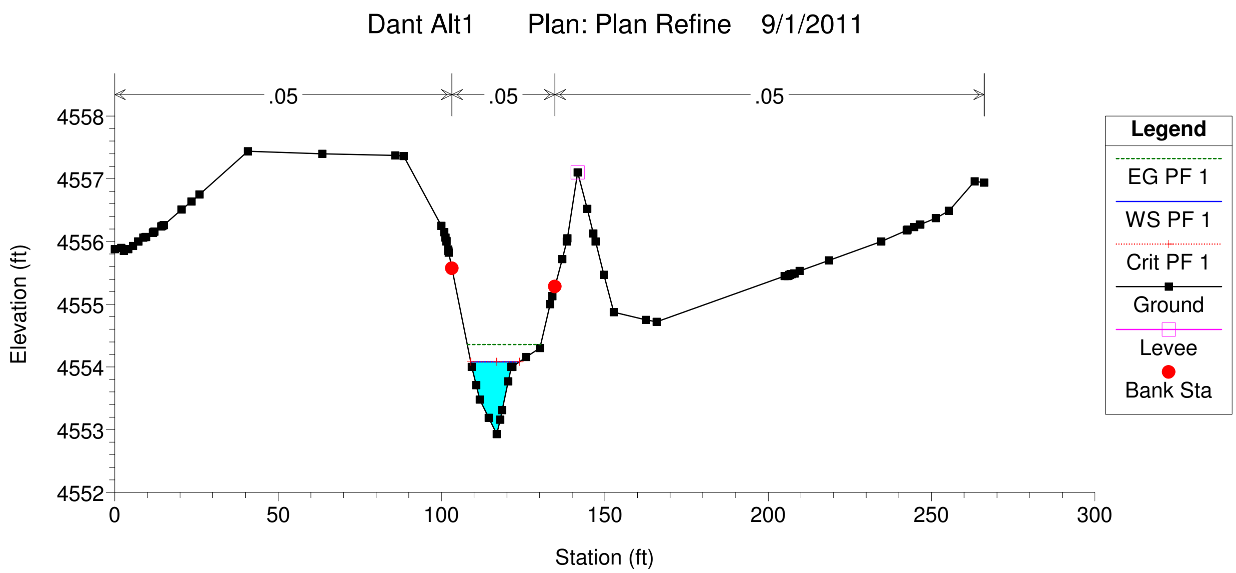
4560
4555
0
50
100
150
200
250
300
350
400
Legend
EG PF 1
WS PF 1
Ground
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
4580
4575
4570
4565
4560
4555
0
50
100
150
200
250
300
350
400
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta


Dant Alt1 Plan: Plan Refine 9/1/2011
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

Plan: Plan Refine   Dant Drainage   Main RS: 2671.256   Culv Group: Culvert #1   Profile: PF 1

Q Culv Group (cfs)	35.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	8.28
Q Barrel (cfs)	35.00	Culv Vel DS (ft/s)	9.02
E.G. US. (ft)	4625.47	Culv Inv El Up (ft)	4621.83
W.S. US. (ft)	4625.37	Culv Inv El Dn (ft)	4621.58
E.G. DS (ft)	4623.16	Culv Frctn Ls (ft)	0.22
W.S. DS (ft)	4622.91	Culv Exit Loss (ft)	1.53
Delta EG (ft)	2.31	Culv Entr Loss (ft)	0.57
Delta WS (ft)	2.46	Q Weir (cfs)	
E.G. IC (ft)	4625.47	Weir Sta Lft (ft)	
E.G. OC (ft)	4625.44	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4623.84	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4623.42	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.77	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.01	Min El Weir Flow (ft)	4633.22

Last Chance Ditch Culvert

Plan: Plan Refine   Dant Drainage   Main RS: 1161.71   Culv Group: Culvert #1   Profile: PF 1

Q Culv Group (cfs)	35.00	Culv Full Len (ft)	63.42
# Barrels	1	Culv Vel US (ft/s)	8.80
Q Barrel (cfs)	35.00	Culv Vel DS (ft/s)	9.33
E.G. US. (ft)	4589.26	Culv Inv El Up (ft)	4584.80
W.S. US. (ft)	4589.24	Culv Inv El Dn (ft)	4582.90
E.G. DS (ft)	4583.49	Culv Frctn Ls (ft)	2.39
W.S. DS (ft)	4583.25	Culv Exit Loss (ft)	2.77
Delta EG (ft)	5.76	Culv Entr Loss (ft)	0.60
Delta WS (ft)	6.00	Q Weir (cfs)	
E.G. IC (ft)	4589.26	Weir Sta Lft (ft)	
E.G. OC (ft)	4589.90	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4587.05	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4584.91	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	2.25	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.01	Min El Weir Flow (ft)	4592.74

Pheasant Lane Culvert

Plan: Plan Refine   Dant Drainage   Main RS: 687.2194   Culv Group: Culvert #1   Profile: PF 1

Q Culv Group (cfs)	35.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	8.28
Q Barrel (cfs)	35.00	Culv Vel DS (ft/s)	8.96
E.G. US. (ft)	4563.42	Culv Inv El Up (ft)	4559.78
W.S. US. (ft)	4563.32	Culv Inv El Dn (ft)	4559.58
E.G. DS (ft)	4561.51	Culv Frctn Ls (ft)	0.17
W.S. DS (ft)	4561.42	Culv Exit Loss (ft)	1.17
Delta EG (ft)	1.91	Culv Entr Loss (ft)	0.57
Delta WS (ft)	1.89	Q Weir (cfs)	
E.G. IC (ft)	4563.42	Weir Sta Lft (ft)	
E.G. OC (ft)	4563.39	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4561.79	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4561.44	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.77	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.01	Min El Weir Flow (ft)	4569.76

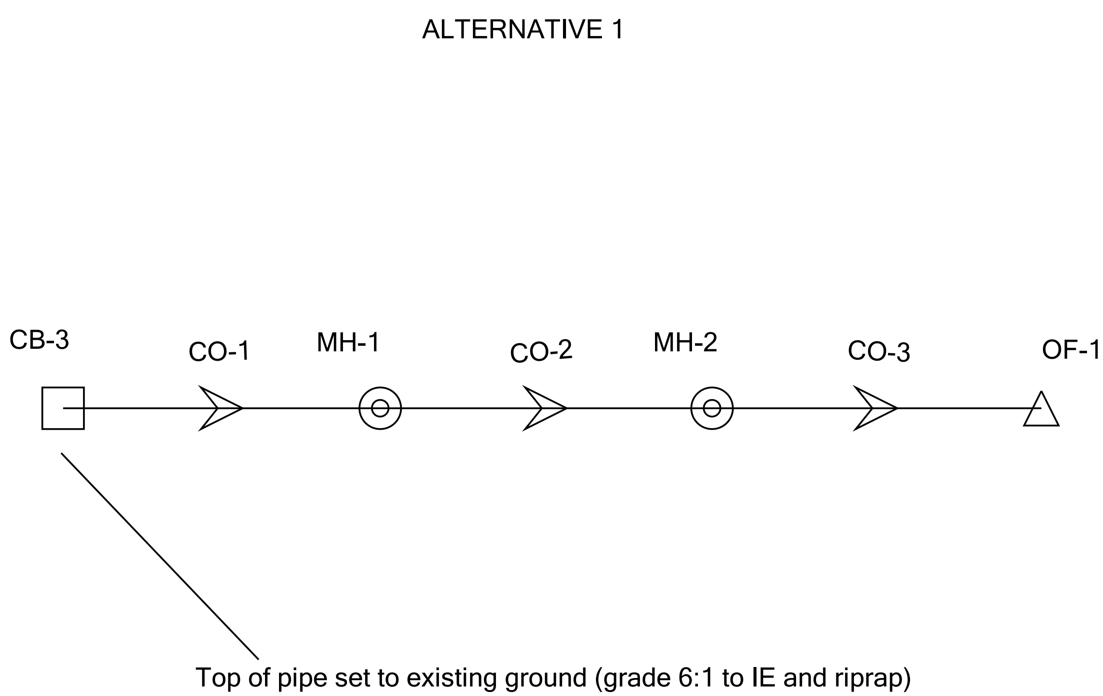
Lake Ditch Culvert

Results

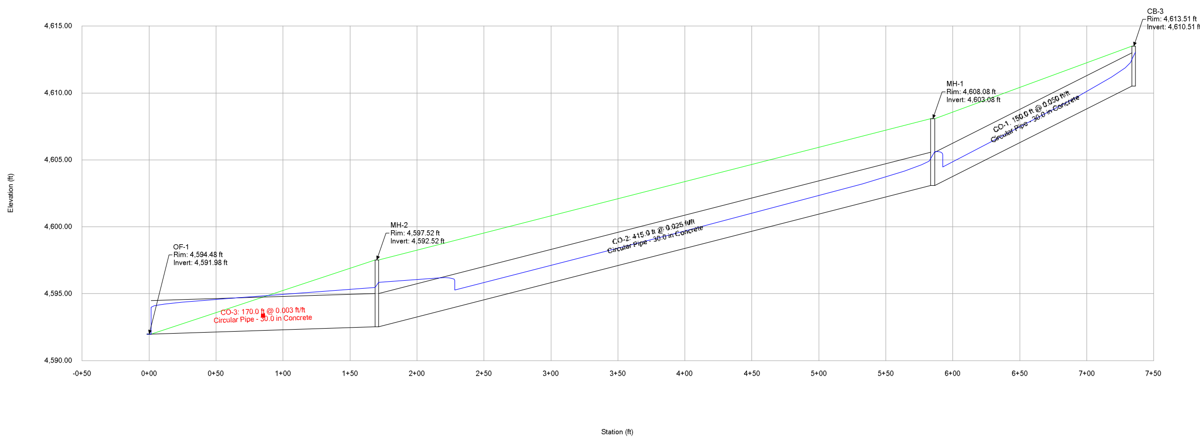
HEC-RAS Plan: Plan Refine River: Dant Drainage Reach: Main Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	3321.403	PF 1	35.00	4644.32	4645.56	4645.22	4645.69	0.012142	2.97	11.80	13.11	0.55
Main	3191.957	PF 1	35.00	4642.25	4642.66	4642.66	4642.82	0.052869	3.27	10.71	32.33	1.00
Main	3041.78	PF 1	35.00	4637.37	4638.60		4638.78	0.016266	3.46	10.11	10.85	0.63
Main	2761.931	PF 1	35.00	4630.04	4631.26	4631.26	4631.71	0.044021	5.38	6.51	7.35	1.01
Main	2686.311	PF 1	35.00	4621.86	4625.37	4623.18	4625.47	0.001318	2.49	14.04	13.12	0.23
Main	2671.256		Culvert									
Main	2653.73	PF 1	35.00	4621.54	4622.91	4622.62	4623.16	0.018379	3.98	8.78	7.82	0.66
Main	2542.599	PF 1	35.00	4619.02	4620.00	4619.96	4620.32	0.037365	4.51	7.76	10.84	0.94
Main	2300.19	PF 1	35.00	4613.51	4613.99		4614.06	0.018517	2.05	17.09	47.37	0.60
Main	2134.521	PF 1	35.00	4608.08	4609.31	4609.31	4609.66	0.040635	4.74	7.39	10.15	0.98
Main	1951.092	PF 1	35.00	4602.19	4604.04	4603.62	4604.13	0.012546	2.32	15.11	25.58	0.53
Main	1797.264	PF 1	35.00	4599.85	4600.36	4600.36	4600.48	0.060153	2.70	12.95	57.29	1.00
Main	1618.229	PF 1	35.00	4594.22	4594.81	4594.67	4594.87	0.016528	2.01	17.43	45.66	0.57
Main	1465.997	PF 1	35.00	4589.92	4590.22	4590.22	4590.33	0.068713	2.69	13.01	64.14	1.05
Main	1308.65	PF 1	35.00	4585.80	4589.26		4589.26	0.000017	0.21	169.43	77.39	0.02
Main	1208.935	PF 1	35.00	4584.07	4589.24	4585.25	4589.26	0.000138	0.99	35.24	61.73	0.08
Main	1161.71		Culvert									
Main	1128.953	PF 1	35.00	4582.59	4583.25	4583.25	4583.49	0.046473	4.00	8.74	55.54	1.00
Main	1032.365	PF 1	35.00	4577.99	4578.55		4578.65	0.030896	2.47	14.15	43.34	0.76
Main	904.6747	PF 1	35.00	4574.80	4575.44		4575.50	0.020079	2.04	17.13	50.63	0.62
Main	841.8653	PF 1	35.00	4574.06	4574.46		4574.50	0.012623	1.50	23.34	77.55	0.48
Main	757.0157	PF 1	35.00	4572.01	4572.35	4572.35	4572.48	0.059444	2.95	11.86	45.61	1.02
Main	706.665	PF 1	35.00	4559.87	4563.32	4561.21	4563.42	0.001401	2.54	13.79	13.41	0.24
Main	687.2194		Culvert									
Main	668.2393	PF 1	35.00	4559.49	4561.42	4560.52	4561.51	0.004231	2.35	14.90	10.45	0.34
Main	585.0293	PF 1	35.00	4559.24	4561.06		4561.14	0.004568	2.27	15.42	11.93	0.35
Main	460.7161	PF 1	35.00	4558.87	4559.89	4559.76	4560.03	0.024188	3.00	11.65	22.12	0.73
Main	289.6794	PF 1	35.00	4555.58	4556.47		4556.57	0.017113	2.54	13.79	26.03	0.61
Main	214.6692	PF 1	35.00	4554.07	4555.90		4555.95	0.004649	1.85	18.96	21.50	0.35
Main	146.5574	PF 1	35.00	4553.88	4555.35	4555.05	4555.45	0.012935	2.55	13.70	20.61	0.55
Main	103.0484	PF 1	35.00	4553.88	4555.01		4555.07	0.006014	1.84	19.03	26.50	0.38
Main	49.08576	PF 1	35.00	4552.93	4554.08	4554.08	4554.36	0.043589	4.18	8.37	14.91	0.98

Scenario: Base



Profile Report
Engineering Profile - Profile - 1 (StormPipe_VulnerableHouses.stc)



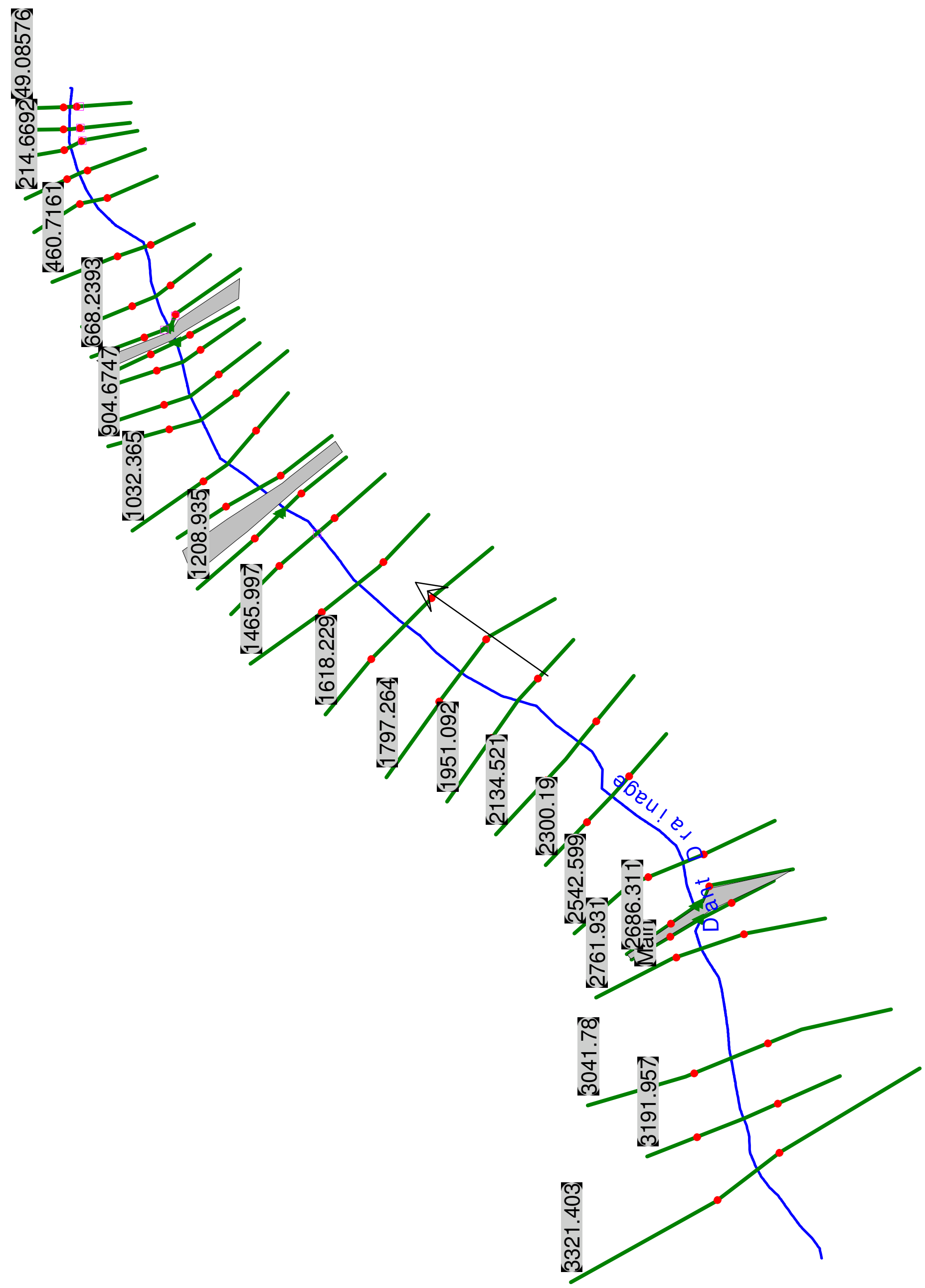
CONDUIT											
Label	Start Node	Stop Node	Length (ft)	Total Flow (ft³/s)	Rise (in)	Capacity (Full Flow) (ft³/s)	Velocity (Average) (ft/s)	Froude Number	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)
CO-1	CB-3	MH-1	150	35	30	91.28	17.36	3.392	4,610.51	4,603.08	0.05
CO-2	MH-1	MH-2	415	35	30	65.43	13.55	2.35	4,603.08	4,592.52	0.025
CO-3	MH-2	OF-1	170	35	30	23.12	7.13	0.795	4,592.52	4,591.98	0.003

INLET										
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Known) (ft³/s)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
CB-3	4,613.51	4,613.51	4,610.51	35	Standard	0.5	4,613.05	4,612.52	4,614.12	4,613.58

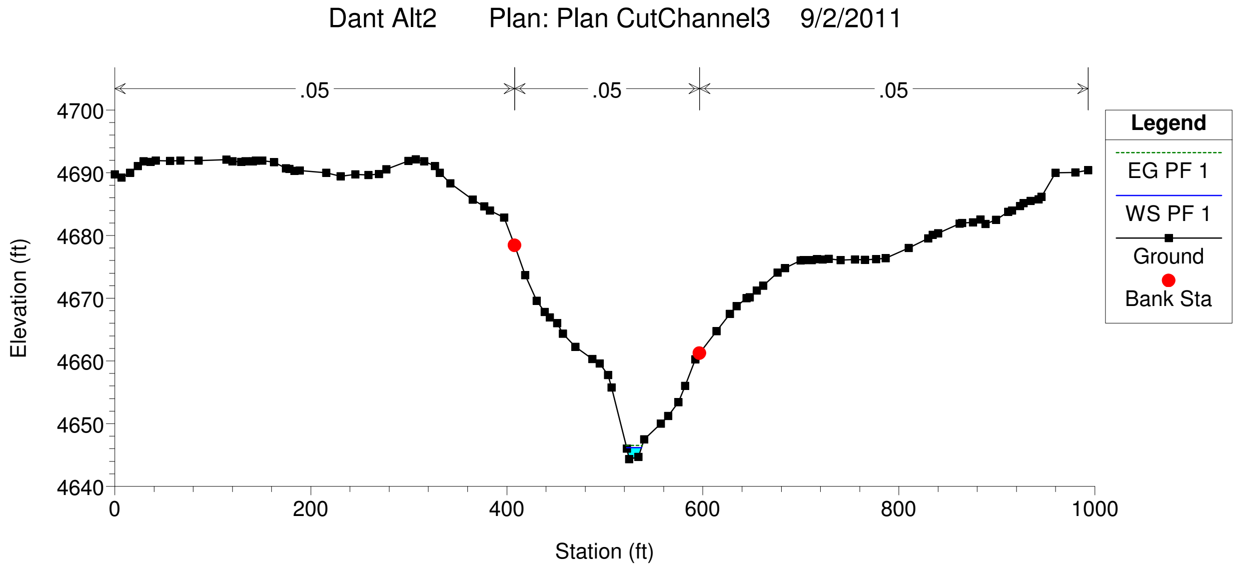
MANHOLES									
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
MH-1	4,608.08	4,608.08	4,603.08	Standard	0.6	4,605.73	4,605.09	4,606.52	4,606.15
MH-2	4,597.52	4,597.52	4,592.52	Standard	0.6	4,595.93	4,595.46	4,596.72	4,596.25

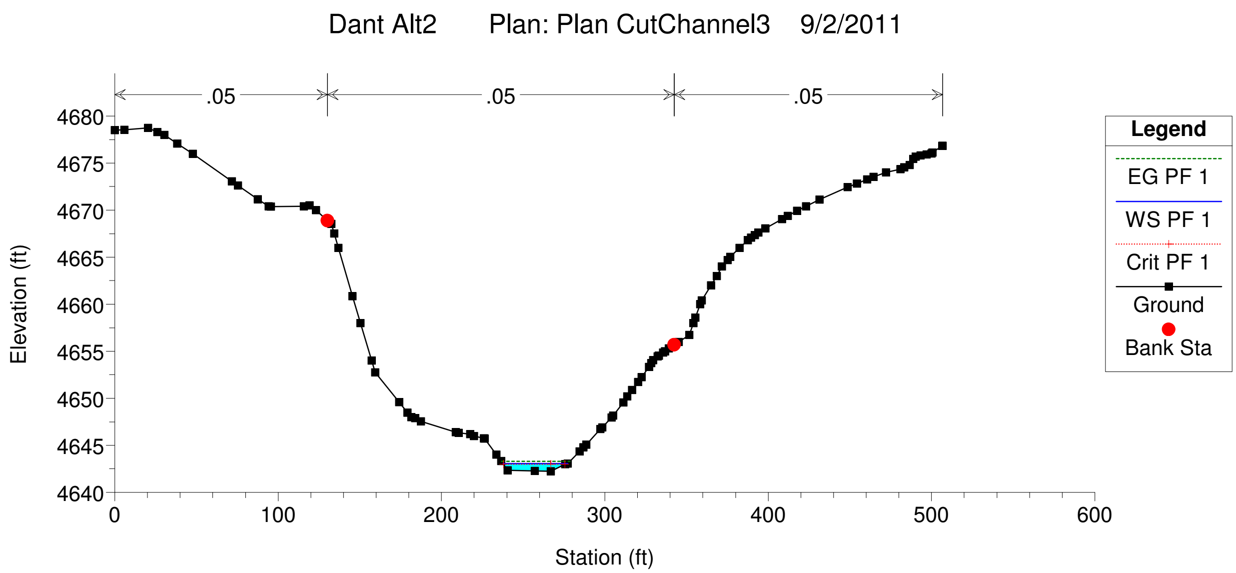
OUTLET				
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (Tailwater) (ft)
OF-1	4,591.98	4,591.98	Free Outfall	0

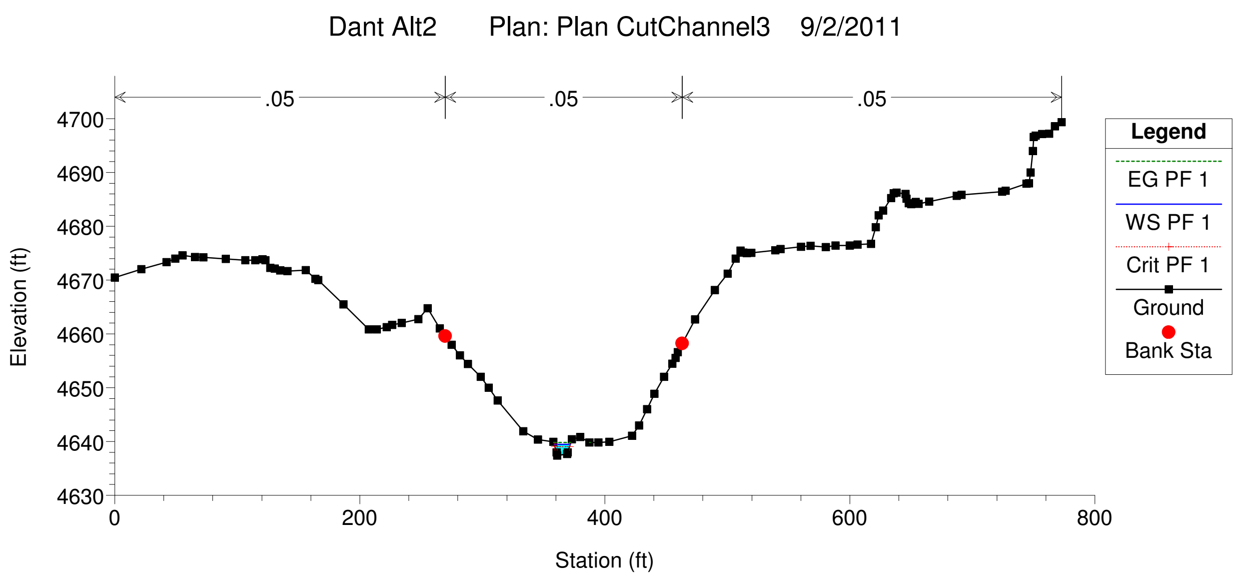
Alternative 2 Model

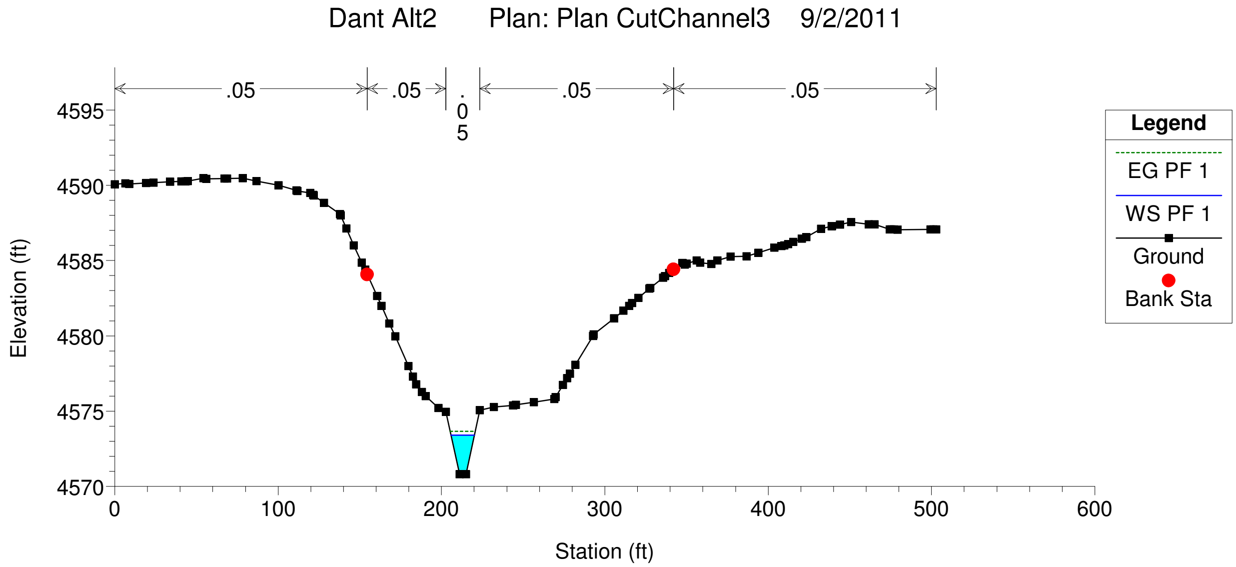


Cross Sections









Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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.05
.05
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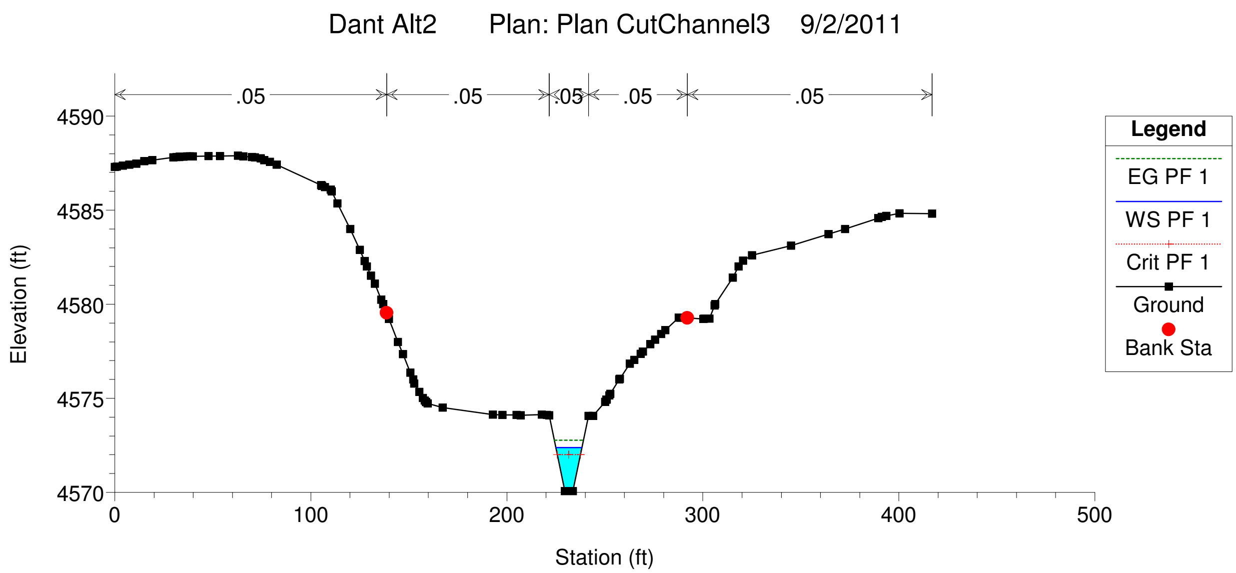
.05
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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Elevation (ft)
Station (ft)
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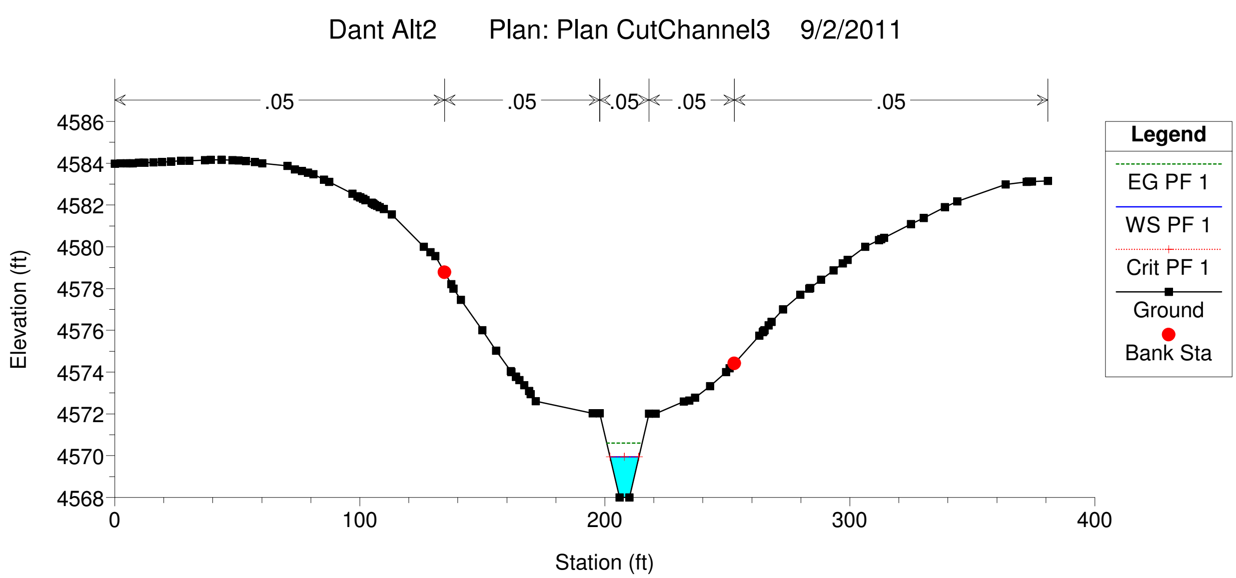
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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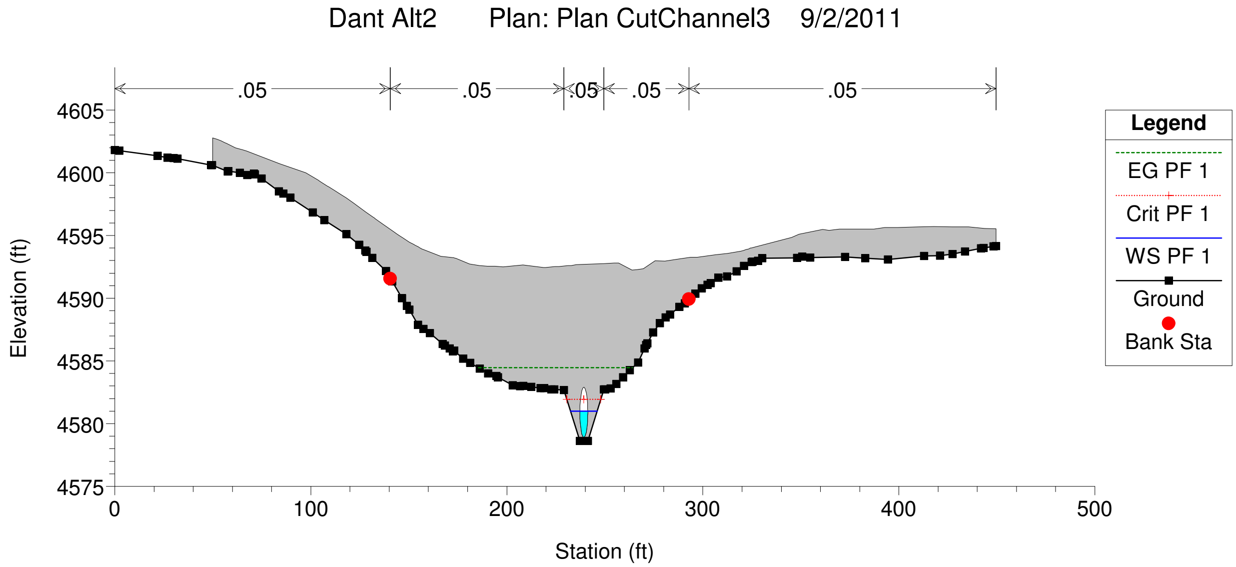
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta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.05
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Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
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4600
4595
4590
4585
4580
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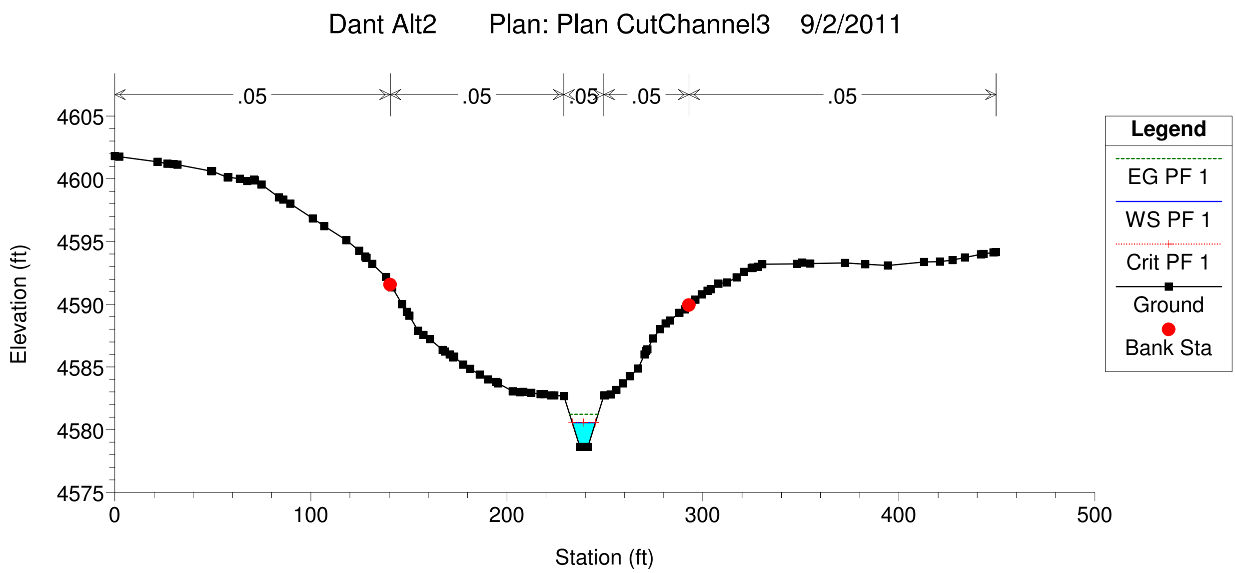
0
100
200
300
400
500
Station (ft)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.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
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4600
4595
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4585
4580
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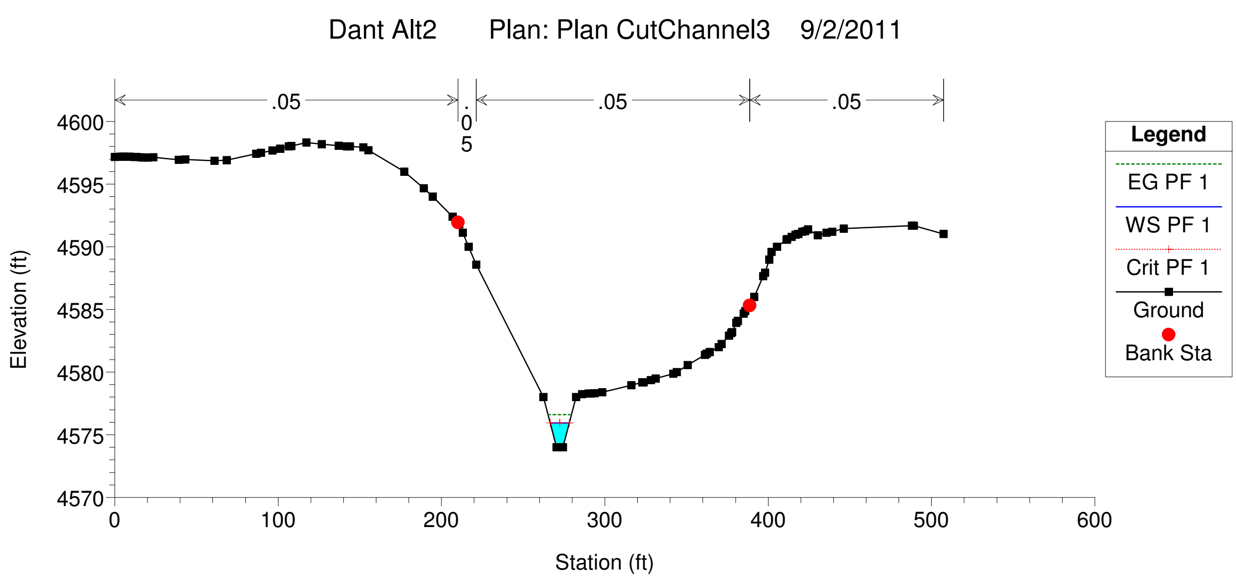
0
100
200
300
400
500
Station (ft)


Dant Alt2 Plan: Plan CutChannel3 9/2/2011
.05
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.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
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4585
4580
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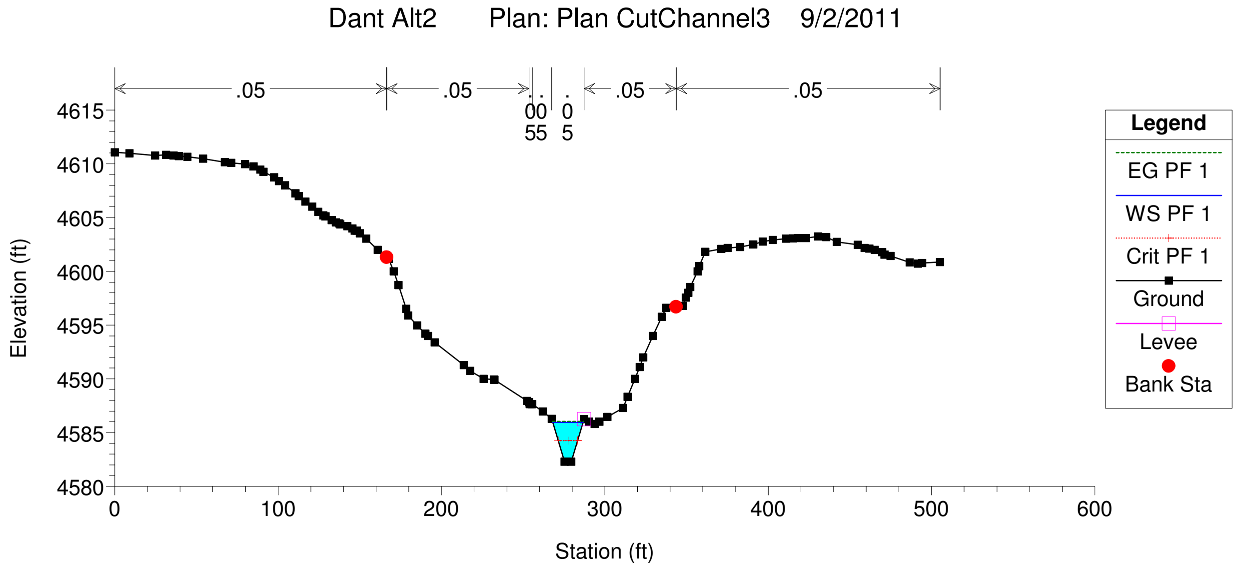
0
100
200
300
400
500
600
Station (ft)



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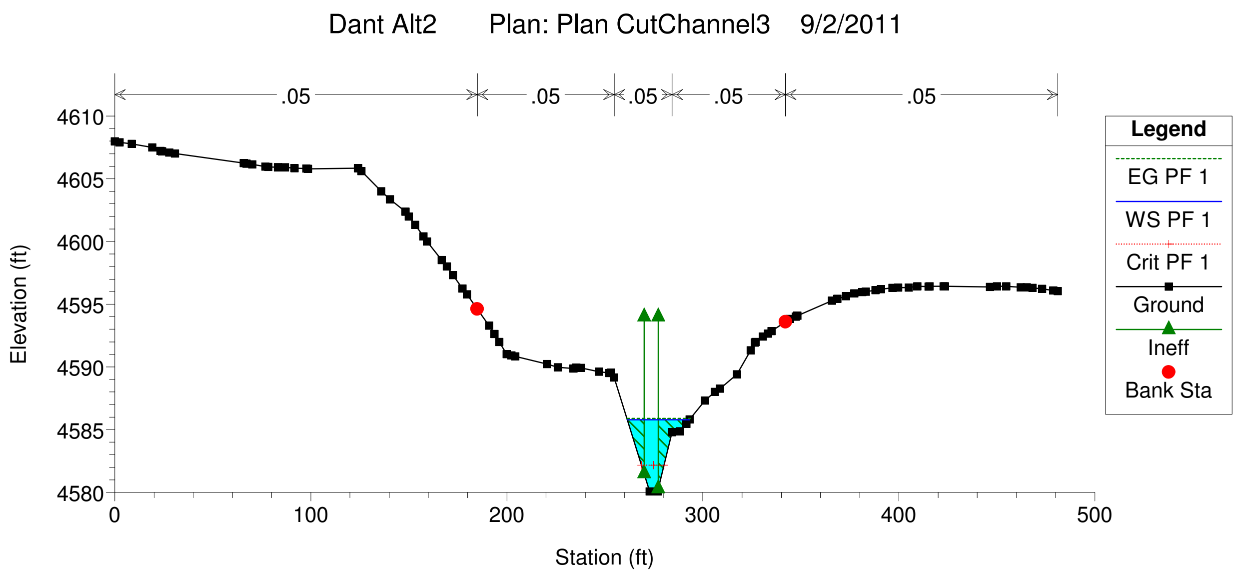
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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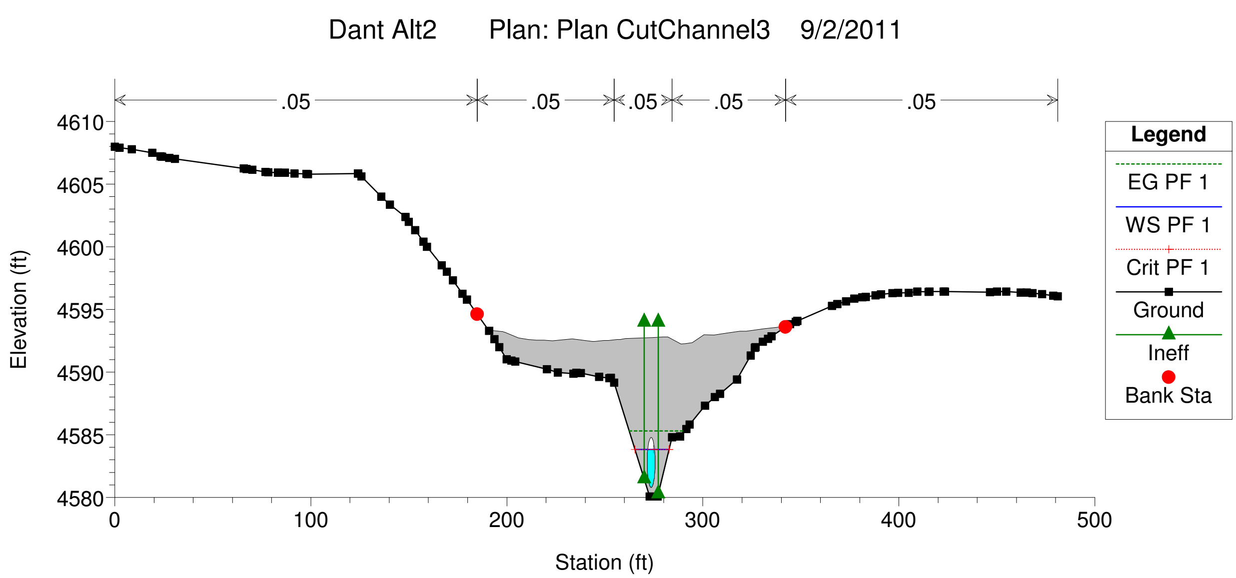
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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Elevation (ft)
Station (ft)
Legend
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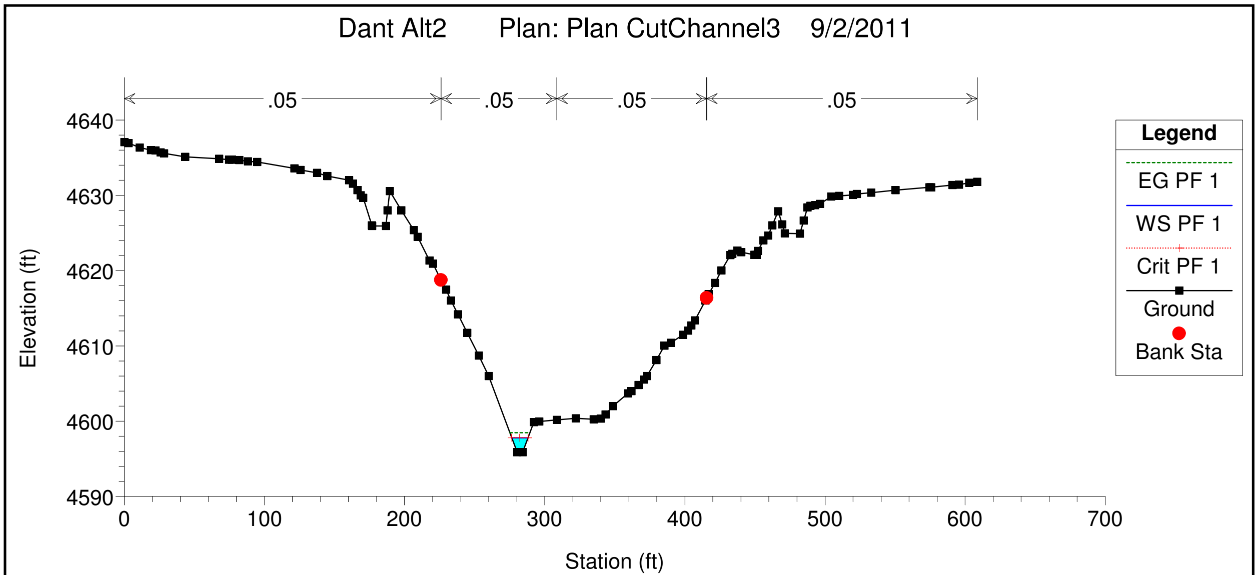
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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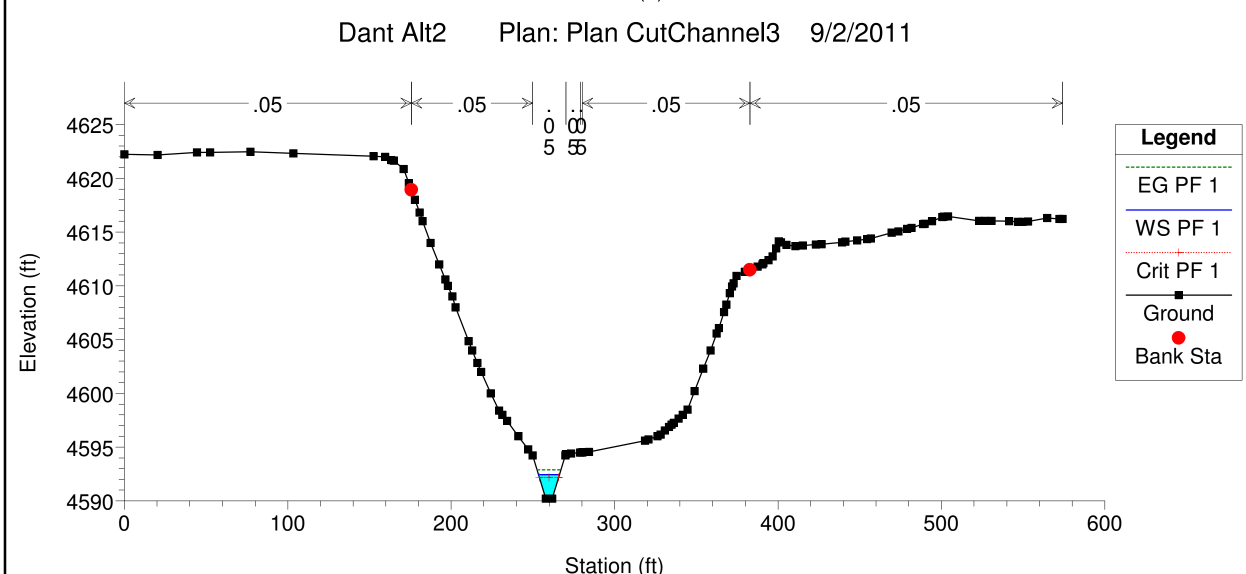
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
EG PF 1
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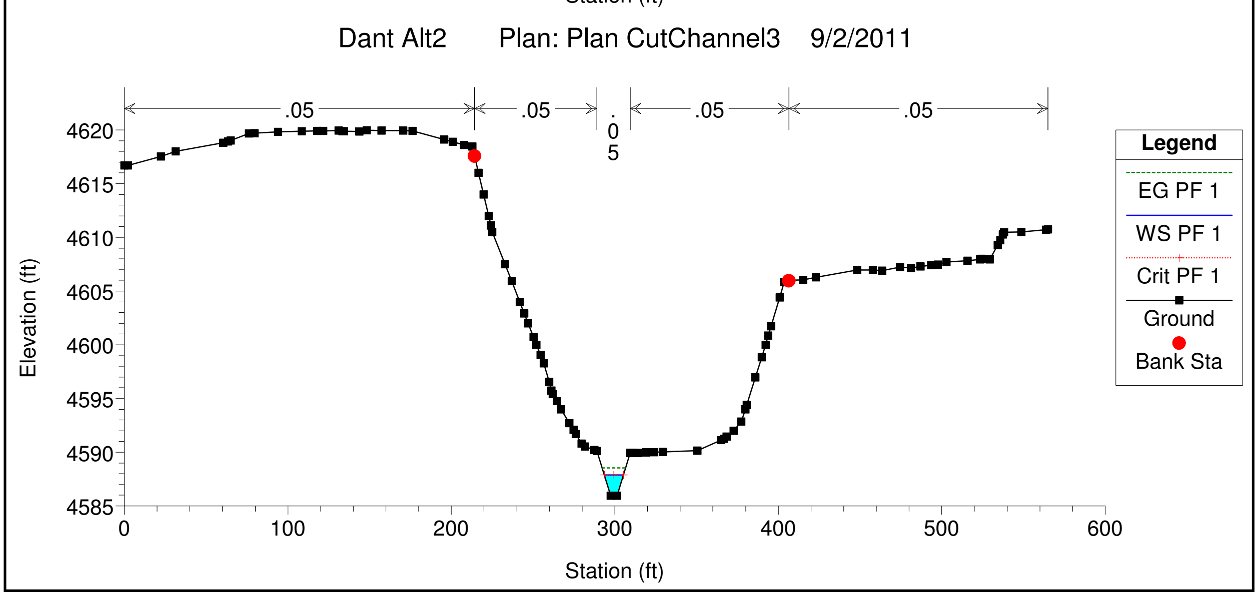
Crit PF 1
Ground
Bank Sta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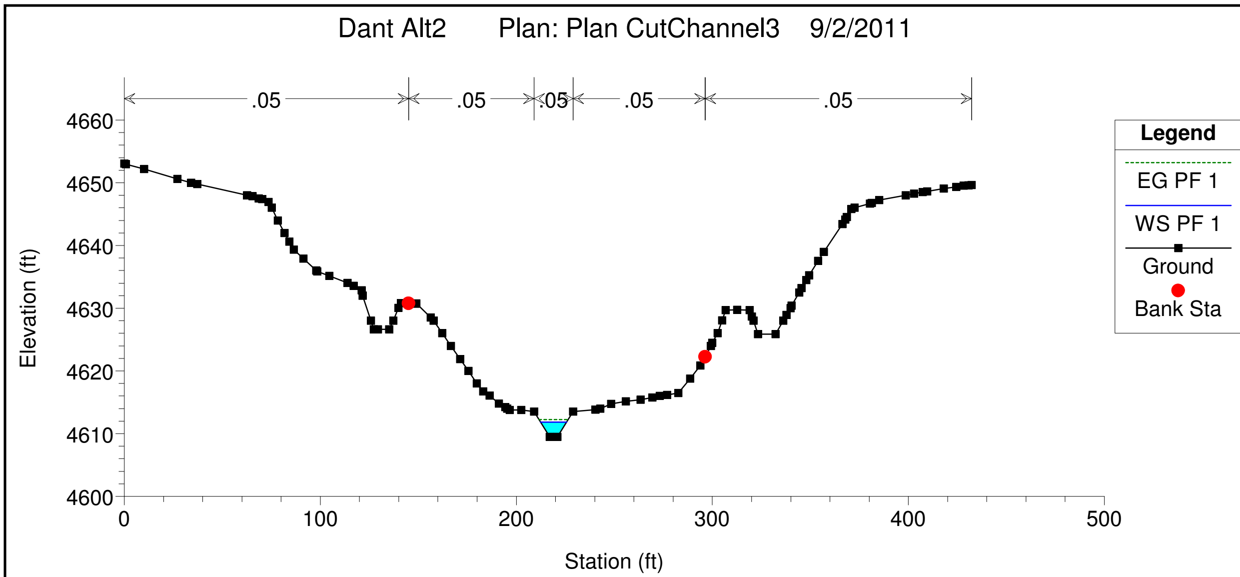
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta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Elevation (ft)
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4610
4620
4630
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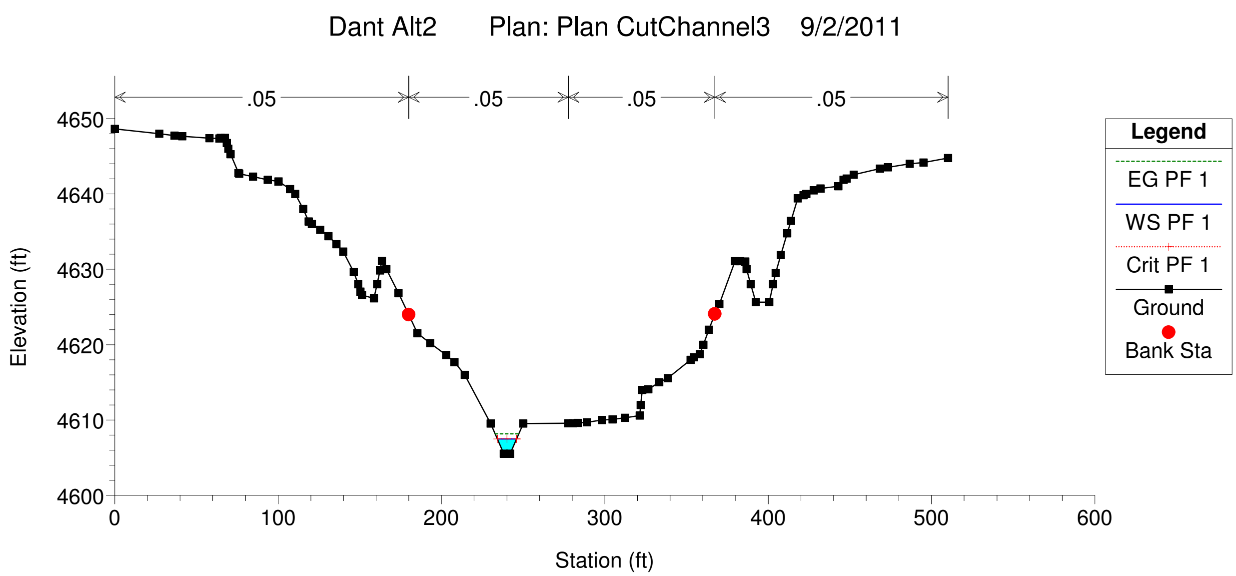
4650
4660
Station (ft)
0
100
200
300
400
500
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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Elevation (ft)
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4610
4620
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4650
Station (ft)
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100
200
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500
600
Legend
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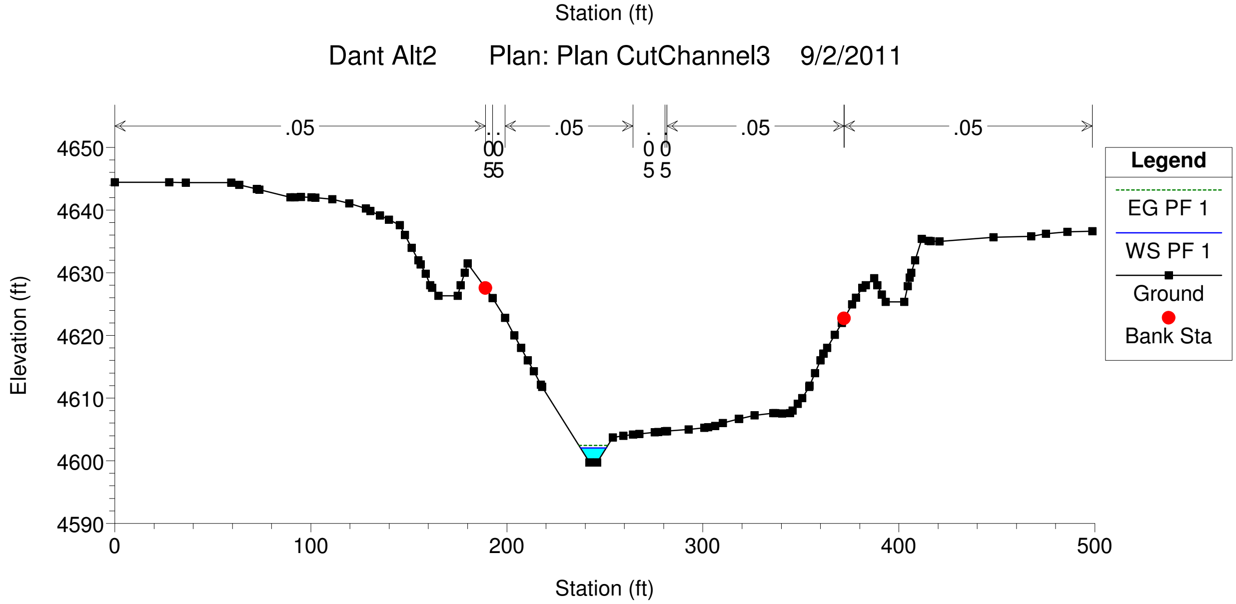
Crit PF 1
Ground
Bank Sta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Elevation (ft)
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Station (ft)
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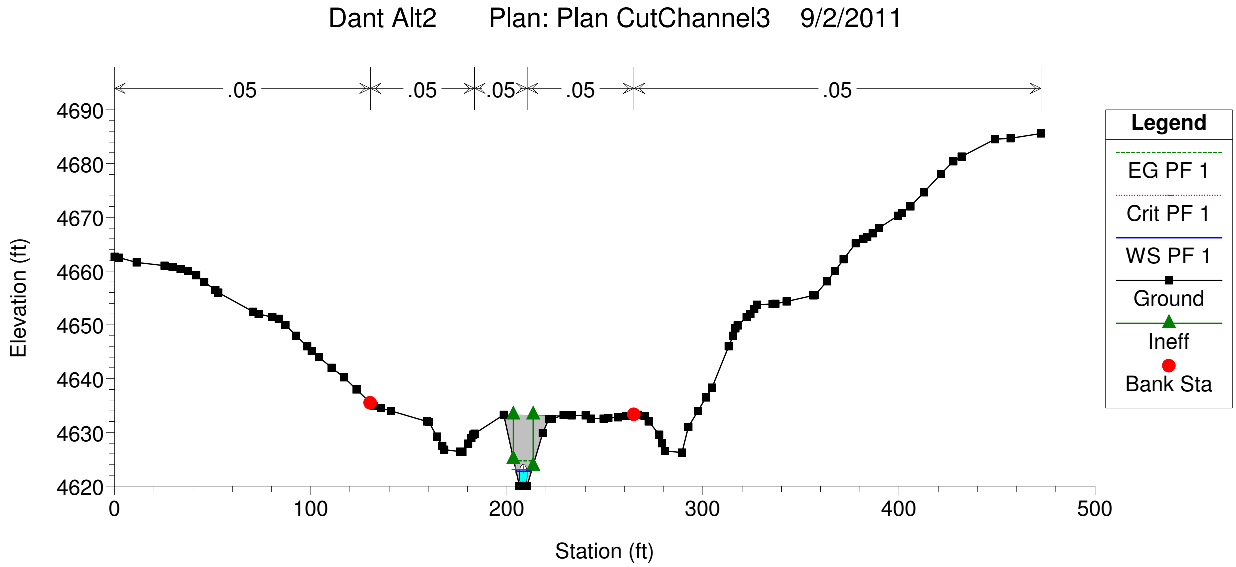
WS PF 1
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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Crit PF 1
WS PF 1
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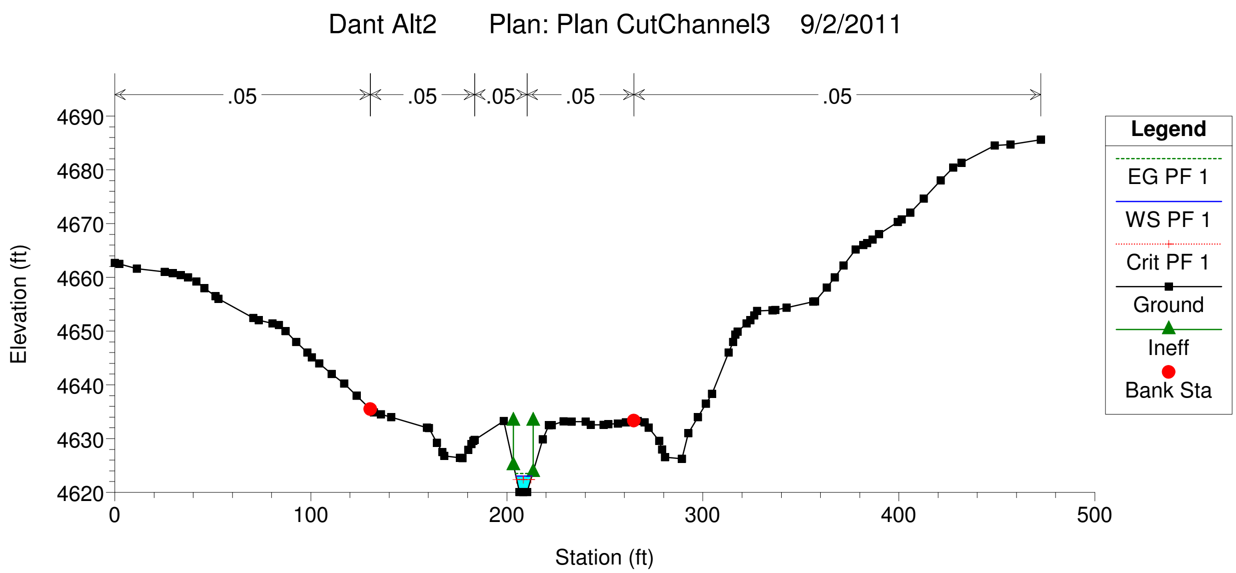
Ineff
Bank Sta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Elevation (ft)
Station (ft)
Legend
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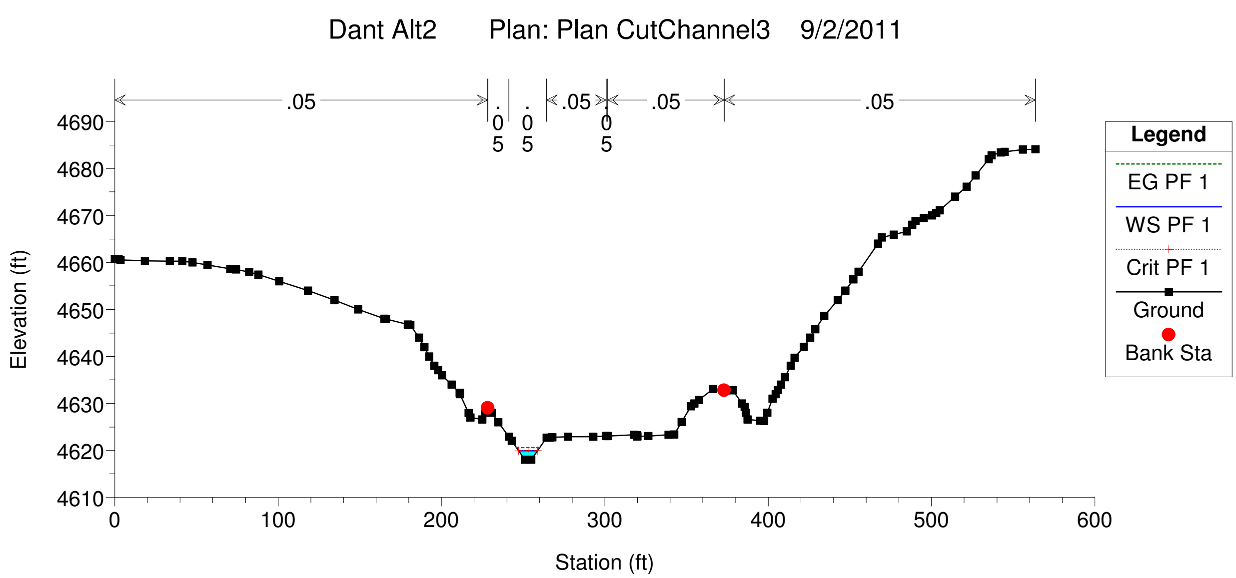
Bank Sta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Elevation (ft)
Station (ft)
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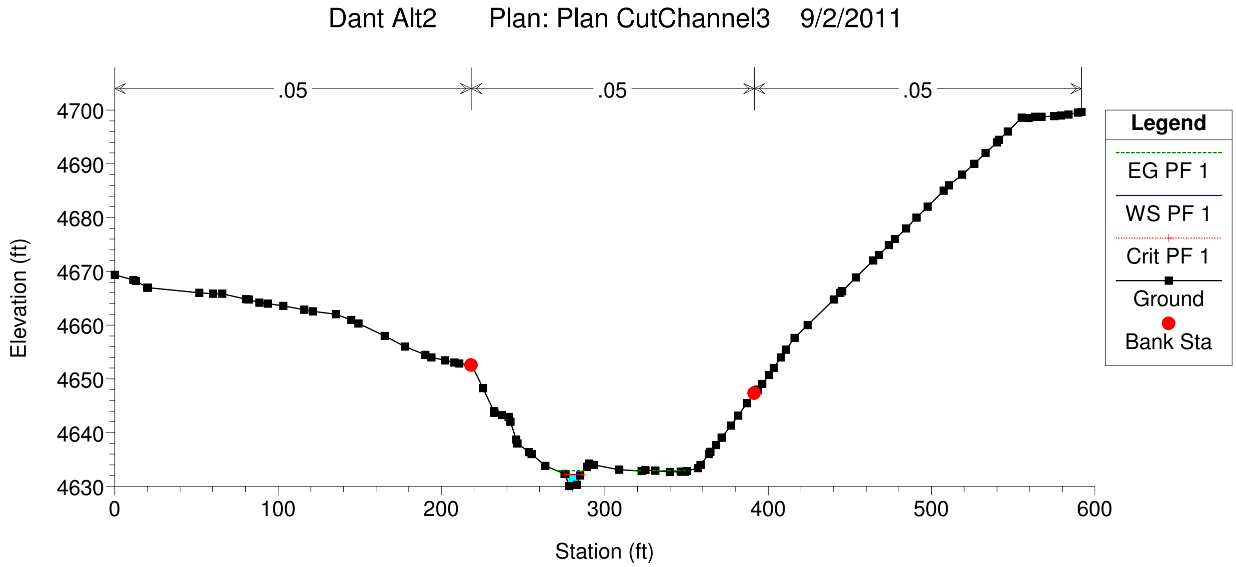
Crit PF 1
Ground
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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.05
.05
Elevation (ft)
4700
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4680
4670
4660
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200
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400
500
600
Station (ft)
Legend
EG PF 1
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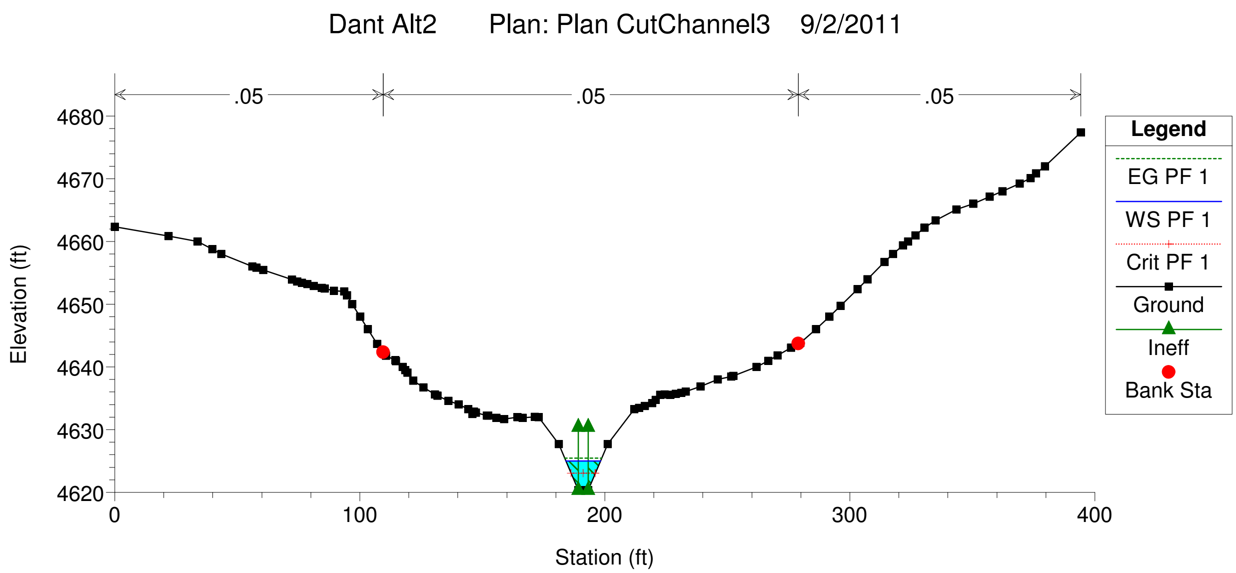
Crit PF 1
Ground
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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.05
Elevation (ft)
4680
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4660
4650
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400
Station (ft)
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Crit PF 1
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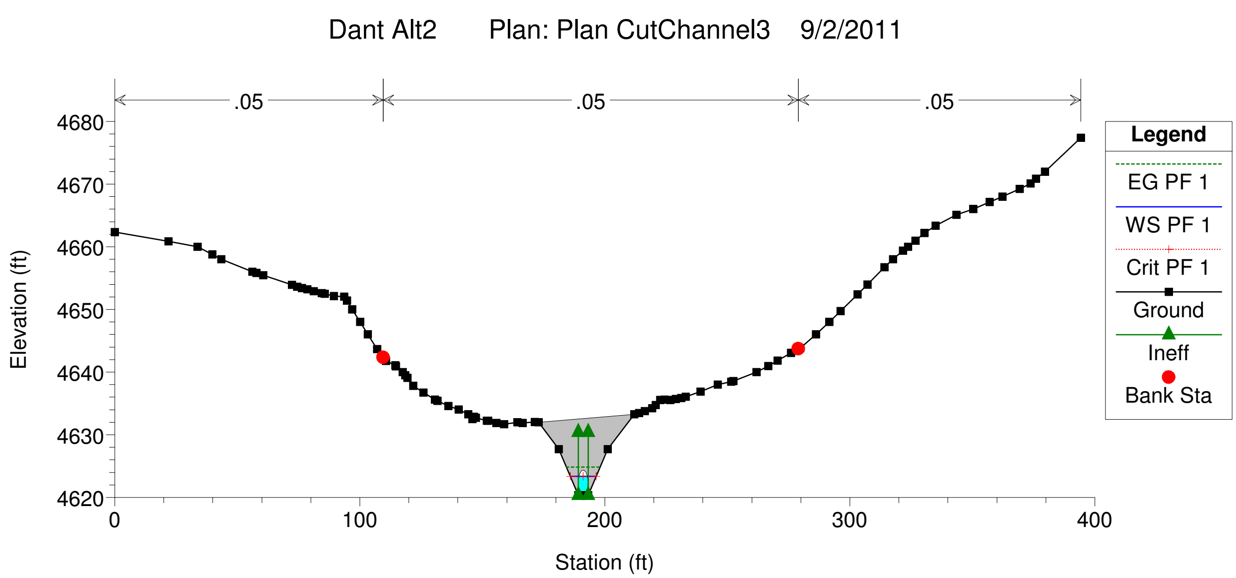
Ineff
Bank Sta



Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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.05
.05
Elevation (ft)
4680
4670
4660
4650
4640
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200
300
400
Station (ft)
Legend
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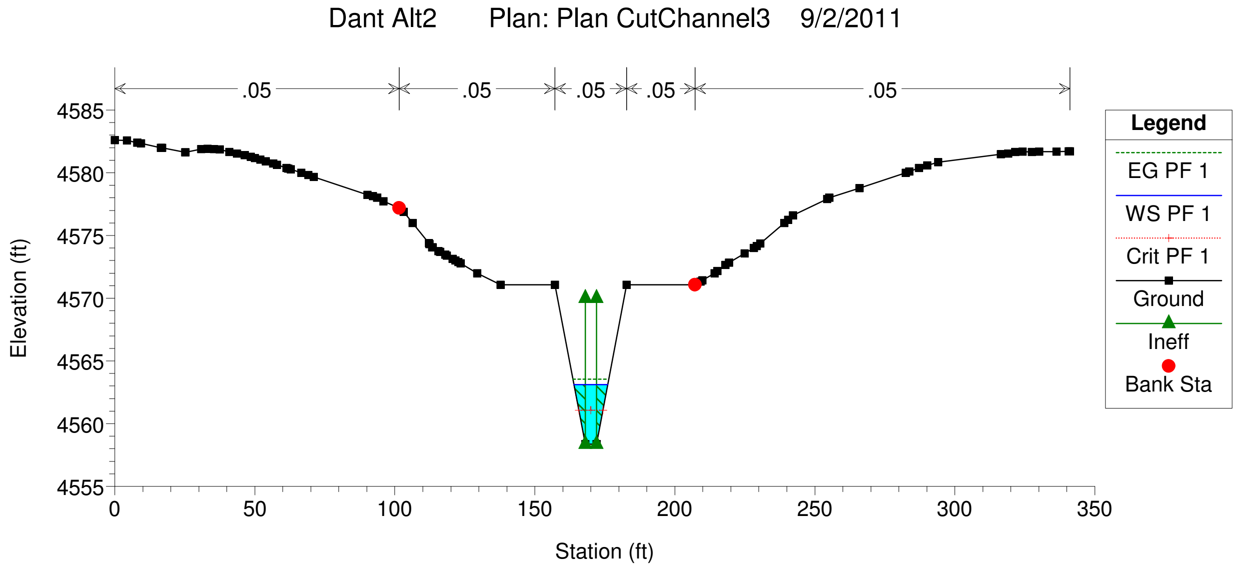
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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Elevation (ft)
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4575
4580
4585
Station (ft)
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150
200
250
300
350
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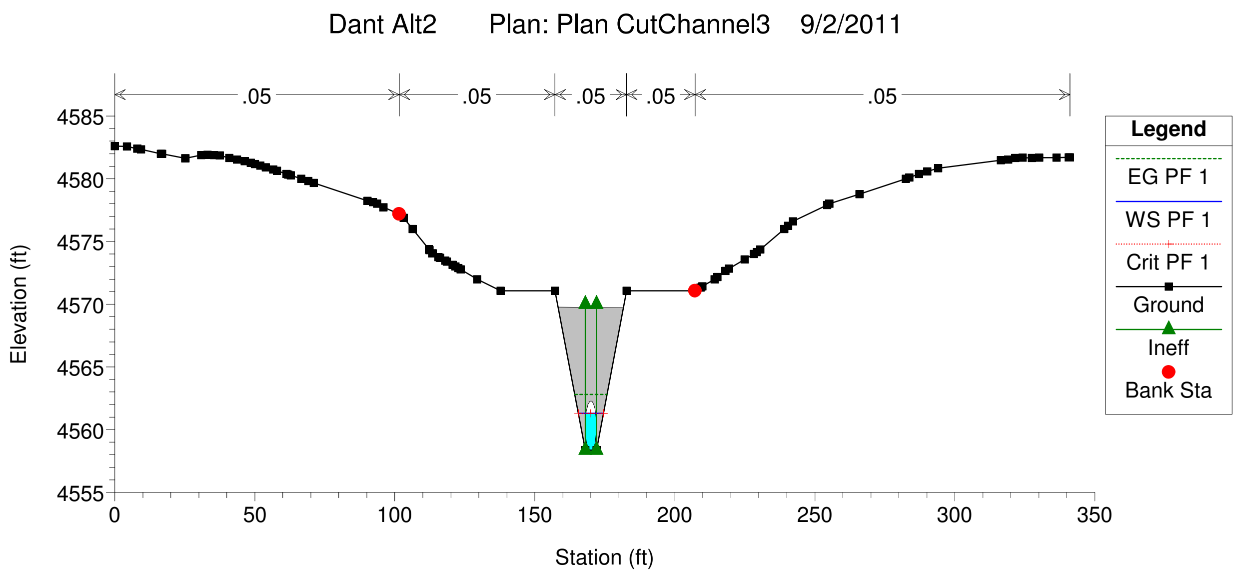
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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.05
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Elevation (ft)
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4560
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4575
4580
4585
Station (ft)
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Legend
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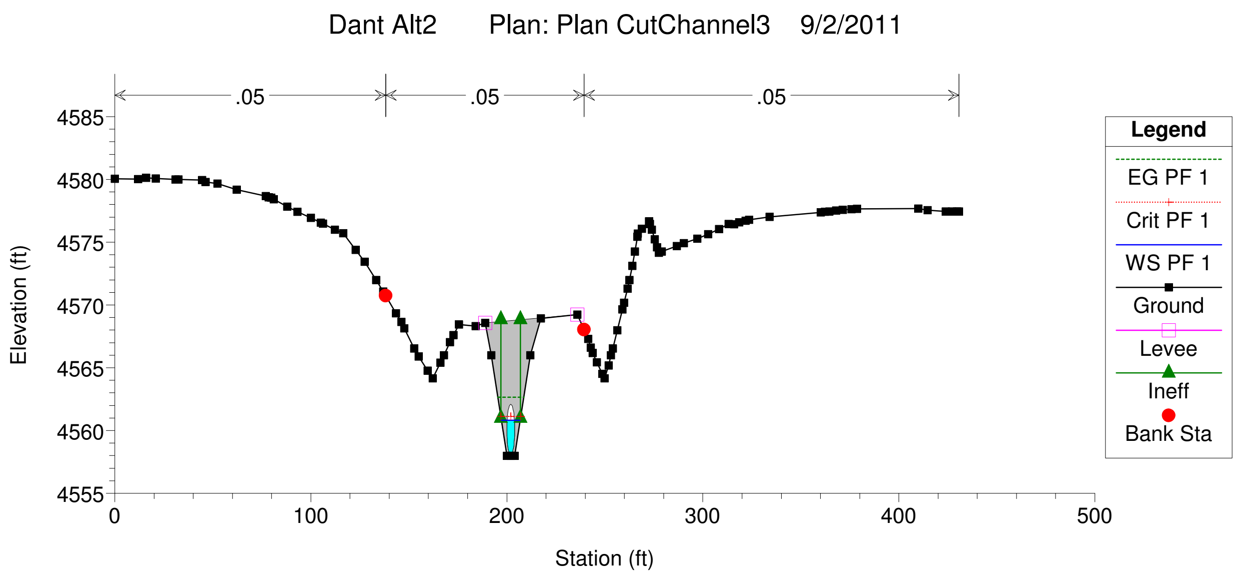
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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Elevation (ft)
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4580
4585
Station (ft)
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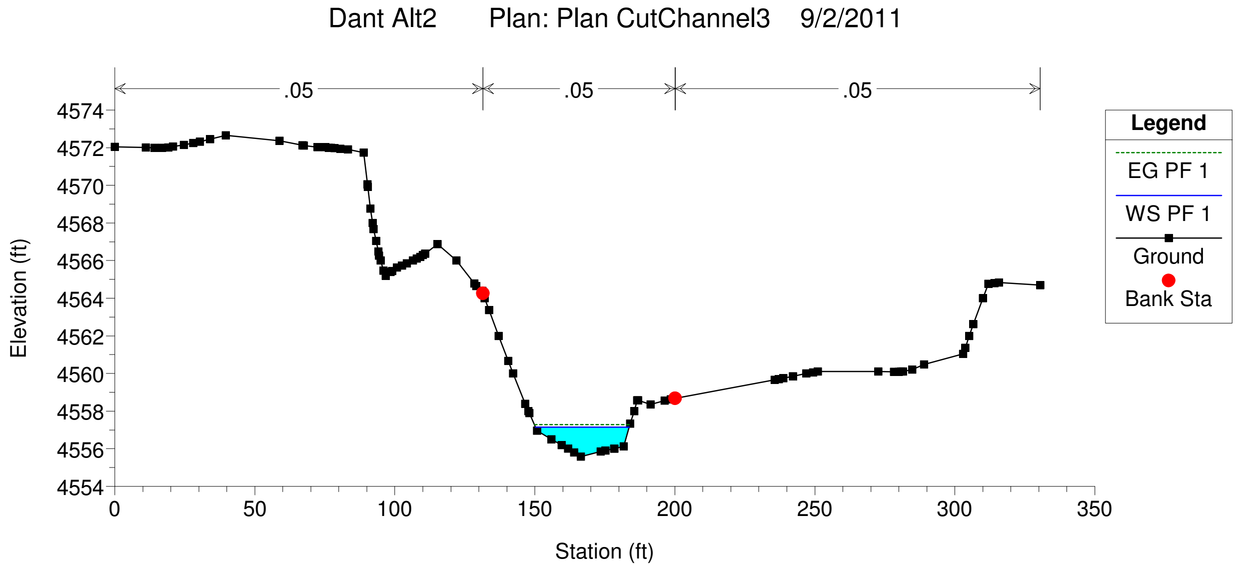
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Levee
Ineff
Bank Sta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Elevation (ft)
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4568
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4562
4560
4558
4556
4554
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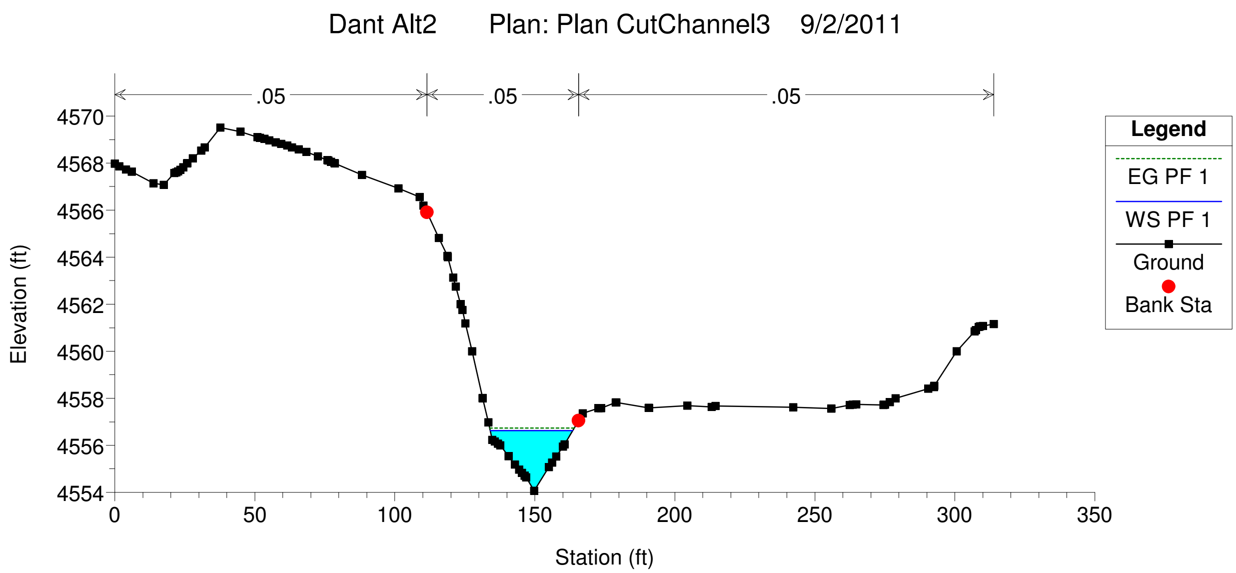
100
150
200
250
300
350
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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.05
.05
Elevation (ft)
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4558
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150
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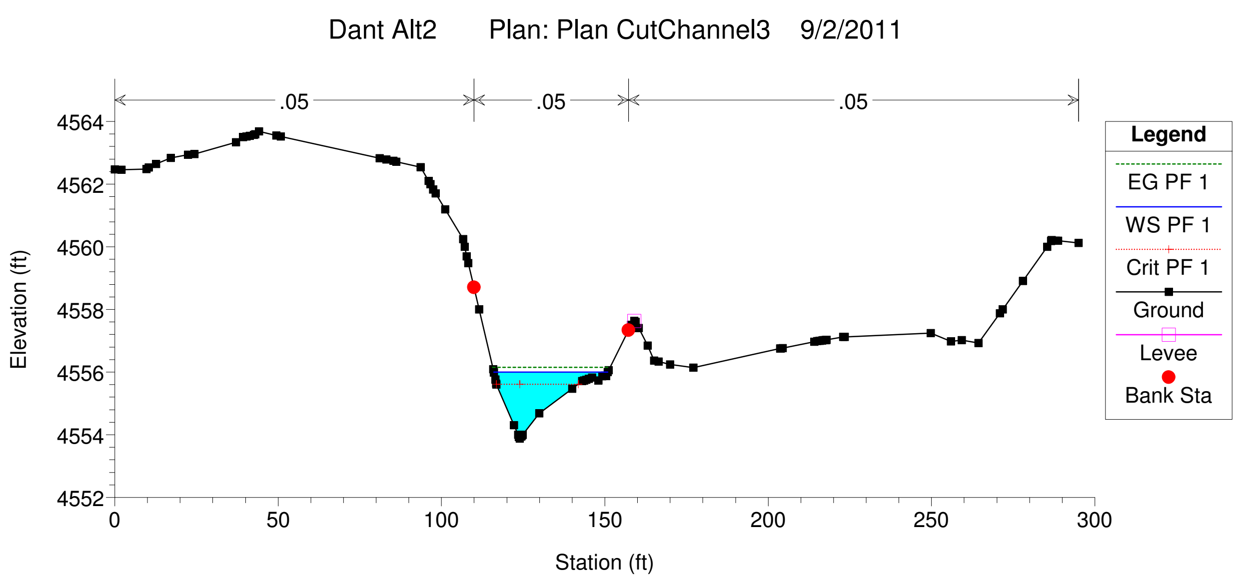
250
300
350
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta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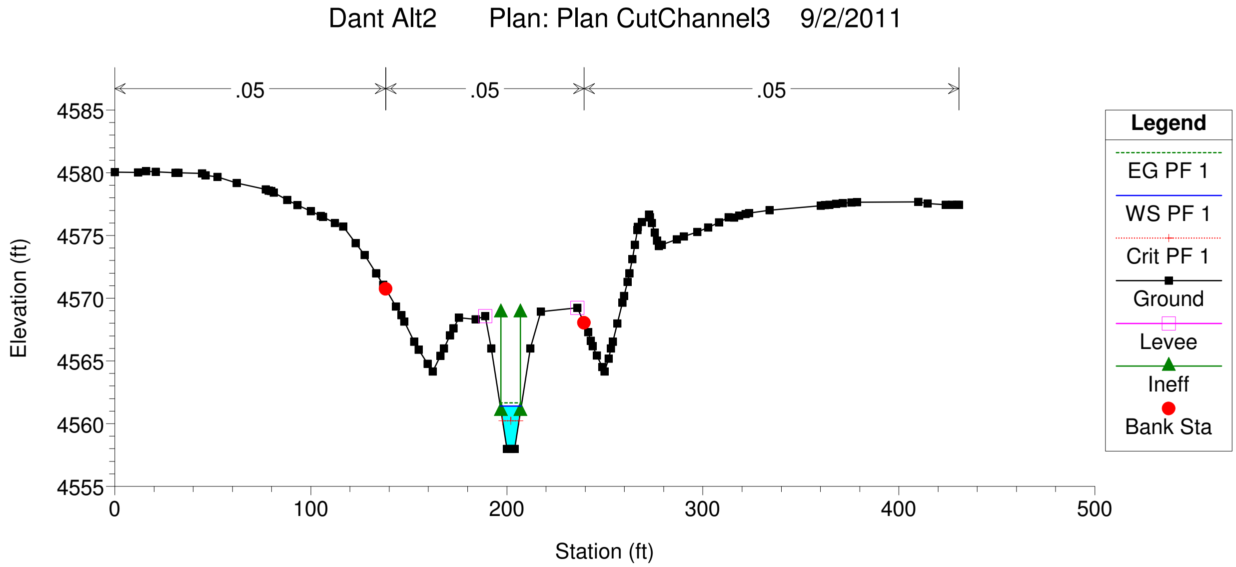
.05
.05
Elevation (ft)
4564
4562
4560
4558
4556
4554
4552
0
50
100
150
200
250
300
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
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4560
4565
4570
4575
4580
4585
Station (ft)
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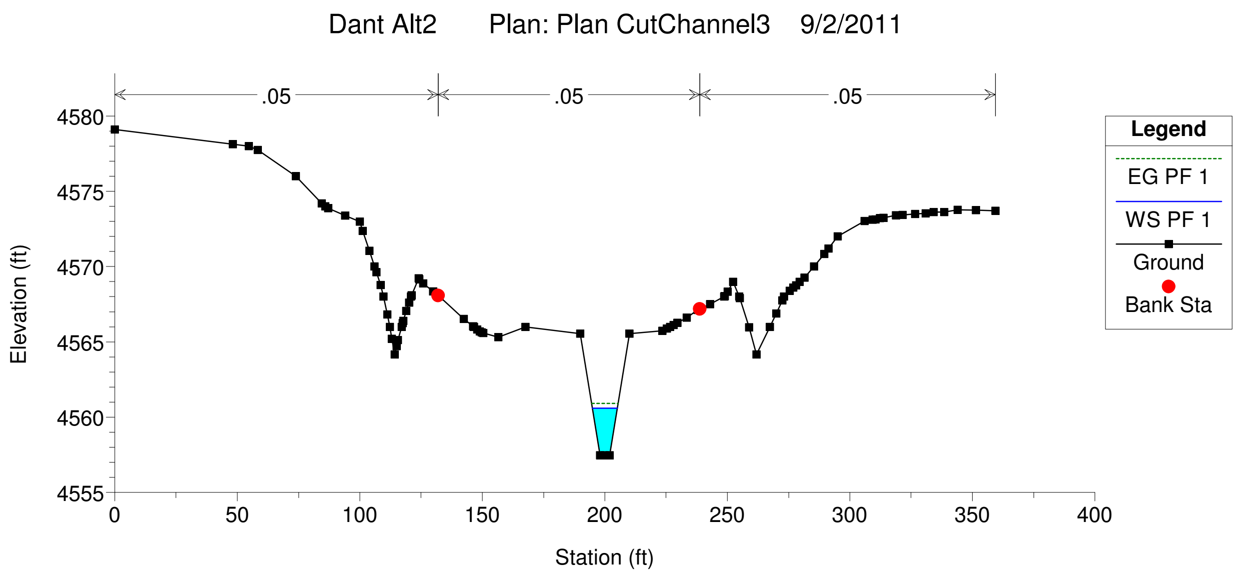
200
300
400
500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Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
4555
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Station (ft)
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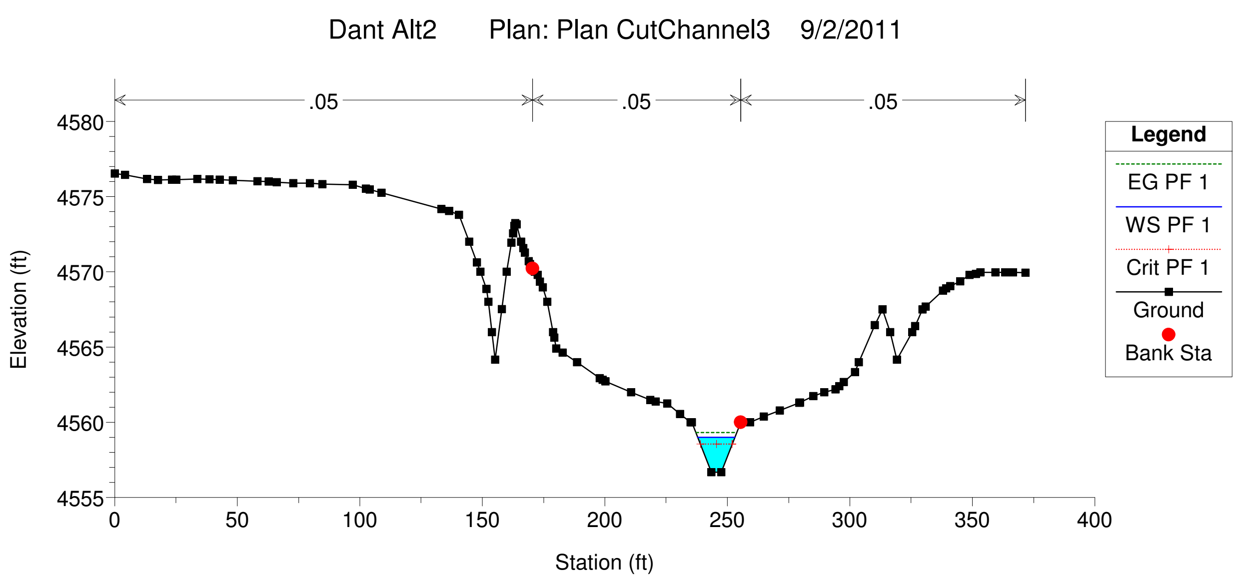
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Bank Sta
Elevation (ft)
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Station (ft)
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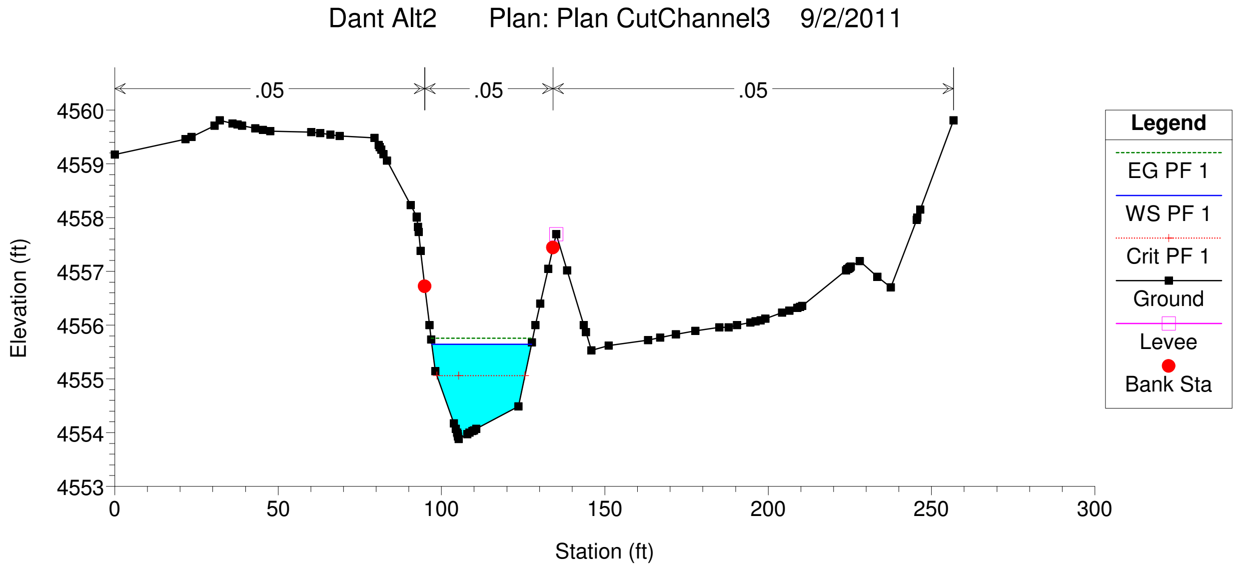
Dant Alt2 Plan: Plan CutChannel3 9/2/2011
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Elevation (ft)
Station (ft)
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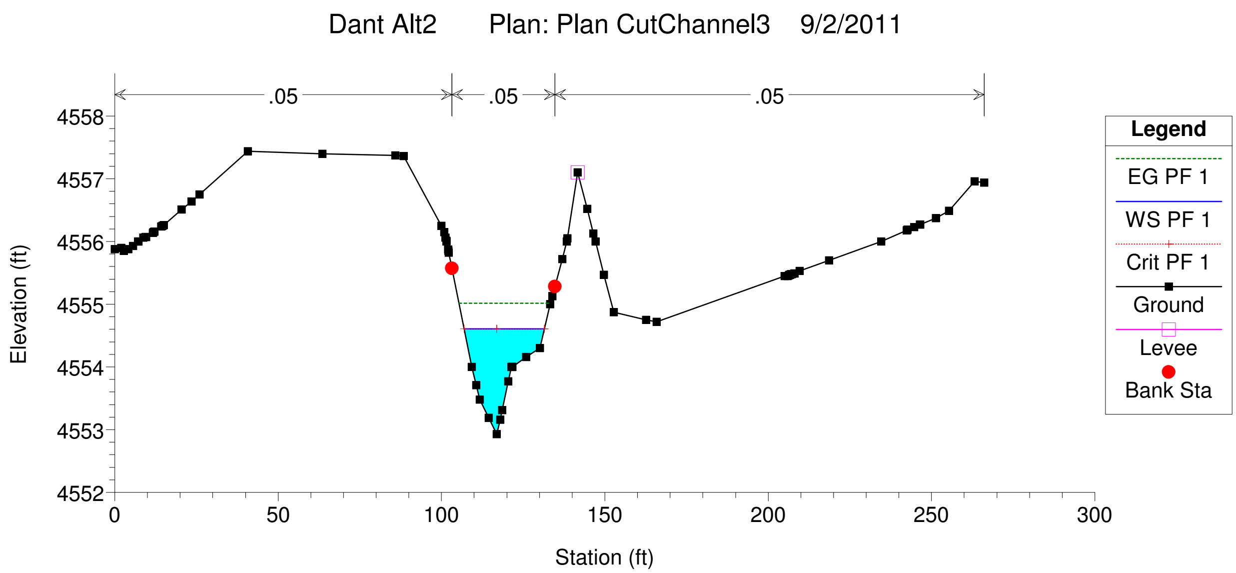
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


Dant Alt2 Plan: Plan CutChannel3 9/2/2011
.05
.05
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Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

Plan: Plan CutChannel3 Dant Drainage Main RS: 2670.943 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	100.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	9.79
Q Barrel (cfs)	100.00	Culv Vel DS (ft/s)	11.00
E.G. US. (ft)	4625.46	Culv Inv El Up (ft)	4620.33
W.S. US. (ft)	4625.02	Culv Inv El Dn (ft)	4620.08
E.G. DS (ft)	4623.49	Culv Frctn Ls (ft)	0.17
W.S. DS (ft)	4623.02	Culv Exit Loss (ft)	1.19
Delta EG (ft)	1.98	Culv Entr Loss (ft)	0.62
Delta WS (ft)	2.00	Q Weir (cfs)	
E.G. IC (ft)	4625.46	Weir Sta Lft (ft)	
E.G. OC (ft)	4625.59	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4623.36	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4622.80	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	2.46	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.03	Min El Weir Flow (ft)	4633.23

Last Chance Ditch Culvert

Plan: Plan CutChannel3 Dant Drainage Main RS: 1161.71 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	100.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	9.79
Q Barrel (cfs)	100.00	Culv Vel DS (ft/s)	14.91
E.G. US. (ft)	4585.90	Culv Inv El Up (ft)	4580.80
W.S. US. (ft)	4585.80	Culv Inv El Dn (ft)	4578.90
E.G. DS (ft)	4581.21	Culv Frctn Ls (ft)	0.86
W.S. DS (ft)	4580.56	Culv Exit Loss (ft)	3.25
Delta EG (ft)	4.69	Culv Entr Loss (ft)	0.58
Delta WS (ft)	5.24	Q Weir (cfs)	
E.G. IC (ft)	4585.90	Weir Sta Lft (ft)	
E.G. OC (ft)	4586.06	Weir Sta Rgt (ft)	
Culvert Control	Inlet	Weir Submerg	
Culv WS Inlet (ft)	4583.83	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4581.01	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.81	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.03	Min El Weir Flow (ft)	4592.74

Pheasant Lane Culvert

Plan: Plan CutChannel3 Dant Drainage Main RS: 687.6862 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	100.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	9.79
Q Barrel (cfs)	100.00	Culv Vel DS (ft/s)	10.88
E.G. US. (ft)	4563.54	Culv Inv El Up (ft)	4558.28
W.S. US. (ft)	4563.11	Culv Inv El Dn (ft)	4558.08
E.G. DS (ft)	4561.65	Culv Frctn Ls (ft)	0.14
W.S. DS (ft)	4561.40	Culv Exit Loss (ft)	1.01
Delta EG (ft)	1.89	Culv Entr Loss (ft)	0.74
Delta WS (ft)	1.71	Q Weir (cfs)	
E.G. IC (ft)	4563.41	Weir Sta Lft (ft)	
E.G. OC (ft)	4563.54	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	4561.31	Weir Max Depth (ft)	
Culv WS Outlet (ft)	4560.82	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	2.46	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.03	Min El Weir Flow (ft)	4569.76

Lake Ditch Culvert

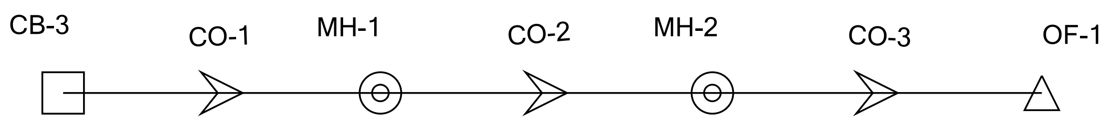
Alternative 2 Results

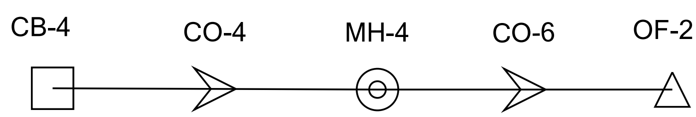
HEC-RAS Plan: Plan CutChannel3   River: Dant Drainage   Reach: Main   Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	3321.403	PF 1	100.00	4644.32	4646.18		4646.54	0.019111	4.83	20.71	15.35	0.73
Main	3191.957	PF 1	100.00	4642.25	4643.06	4643.00	4643.31	0.033343	3.99	25.06	39.61	0.88
Main	3041.78	PF 1	100.00	4637.37	4639.47	4639.06	4639.83	0.016818	4.86	20.60	13.26	0.69
Main	2761.931	PF 1	100.00	4630.04	4632.19	4632.19	4632.93	0.038922	6.90	14.48	9.95	1.01
Main	2686.311	PF 1	100.00	4620.36	4625.02	4623.07	4625.46	0.004198	5.37	18.63	14.18	0.44
Main	2670.943		Culvert									
Main	2653.73	PF 1	100.00	4620.04	4623.02	4622.38	4623.49	0.018159	5.50	18.19	8.21	0.65
Main	2542.599	PF 1	100.00	4618.02	4619.96	4619.96	4620.63	0.037574	6.53	15.31	11.77	1.01
Main	2300.19	PF 1	100.00	4609.51	4611.86		4612.23	0.017257	4.90	20.40	13.39	0.70
Main	2134.521	PF 1	100.00	4605.54	4607.49	4607.49	4608.15	0.037287	6.51	15.36	11.78	1.01
Main	1951.092	PF 1	100.00	4599.73	4602.03		4602.43	0.018776	5.06	19.77	13.20	0.73
Main	1797.264	PF 1	100.00	4595.85	4597.80	4597.80	4598.46	0.037211	6.51	15.37	11.79	1.00
Main	1618.229	PF 1	100.00	4590.22	4592.43	4592.17	4592.88	0.022149	5.38	18.60	12.84	0.79
Main	1465.997	PF 1	100.00	4585.94	4587.88	4587.88	4588.55	0.037576	6.53	15.31	11.76	1.01
Main	1308.65	PF 1	100.00	4582.28	4585.94	4584.25	4586.03	0.002554	2.41	41.46	18.64	0.28
Main	1208.935	PF 1	100.00	4580.07	4585.80	4582.17	4585.90	0.000819	2.54	39.44	31.74	0.19
Main	1161.71		Culvert									
Main	1128.953	PF 1	100.00	4578.61	4580.56	4580.56	4581.21	0.037213	6.51	15.37	11.79	1.00
Main	1032.365	PF 1	100.00	4574.00	4575.94	4575.94	4576.60	0.037555	6.53	15.32	11.77	1.01
Main	904.6747	PF 1	100.00	4570.80	4573.39		4573.67	0.011363	4.20	23.81	14.37	0.58
Main	841.8653	PF 1	100.00	4570.06	4572.38	4572.01	4572.77	0.018037	4.98	20.07	13.29	0.71
Main	757.0157	PF 1	100.00	4568.00	4569.94	4569.94	4570.60	0.037477	6.52	15.33	11.77	1.01
Main	706.665	PF 1	100.00	4558.37	4563.11	4561.08	4563.54	0.003954	5.27	18.96	12.06	0.43
Main	687.6862		Culvert									
Main	668.2393	PF 1	100.00	4557.99	4561.40	4560.22	4561.65	0.007069	3.98	25.12	10.82	0.44
Main	585.0293	PF 1	100.00	4557.46	4560.58		4560.90	0.011118	4.52	22.13	10.18	0.54
Main	460.7161	PF 1	100.00	4556.68	4559.00	4558.54	4559.32	0.014789	4.49	22.29	15.19	0.65
Main	289.6794	PF 1	100.00	4555.58	4557.15		4557.28	0.009334	2.90	34.43	33.48	0.50
Main	214.6692	PF 1	100.00	4554.07	4556.62		4556.73	0.005756	2.64	37.86	29.35	0.41
Main	146.5574	PF 1	100.00	4553.88	4556.00	4555.61	4556.16	0.013175	3.17	31.57	34.85	0.59
Main	103.0484	PF 1	100.00	4553.88	4555.64	4555.06	4555.76	0.006457	2.70	37.09	30.52	0.43
Main	49.08576	PF 1	100.00	4552.93	4554.61	4554.61	4555.02	0.040971	5.12	19.55	24.59	1.01

Scenario: Base

ALTERNATIVE 3





Profile Report
Engineering Profile - Profile - 1
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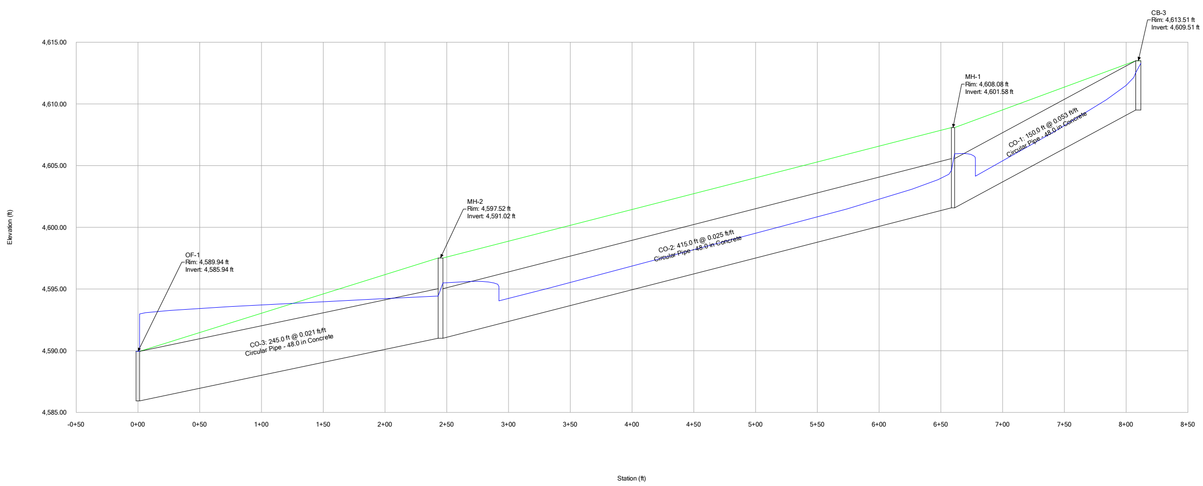

Profile Report
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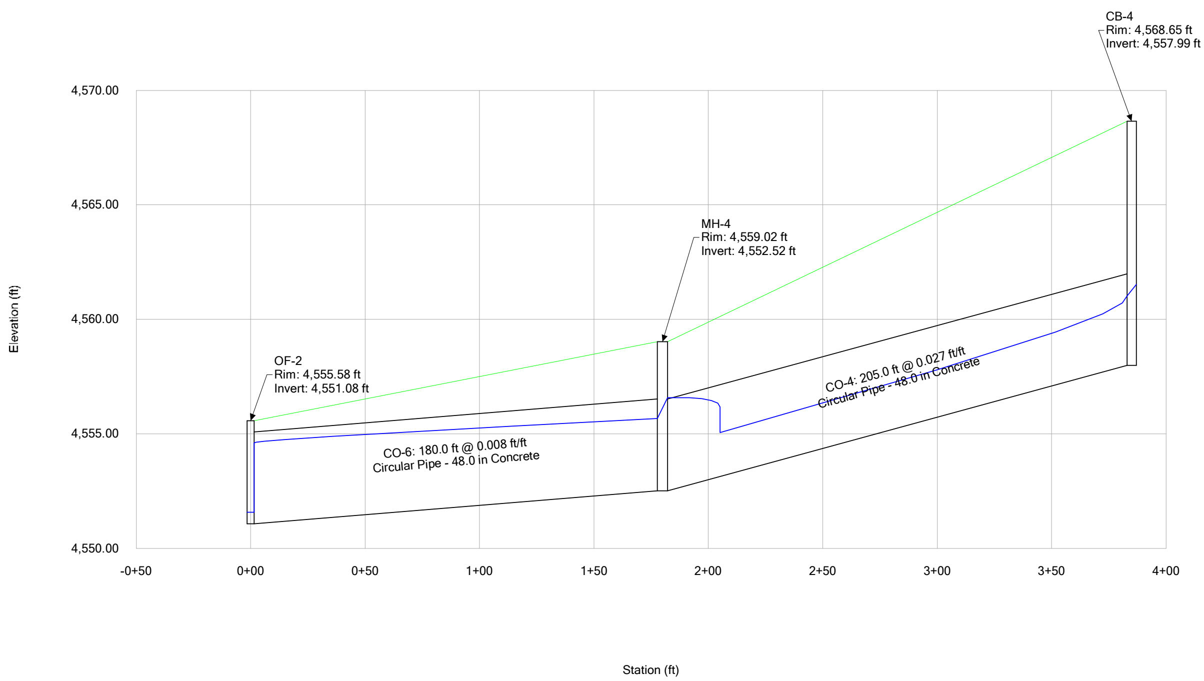


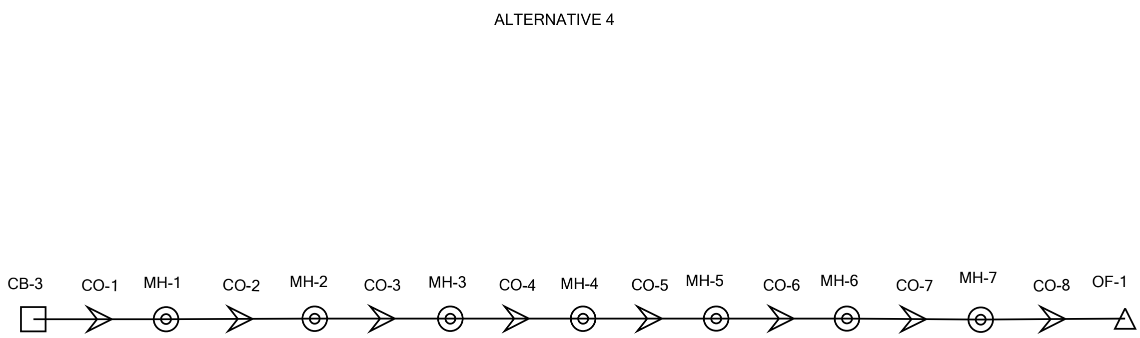
CONDUIT											
Label	Start Node	Stop Node	Length (ft)	Total Flow (ft³/s)	Rise (in)	Capacity (Full Flow) (ft³/s)	Velocity (Average) (ft/s)	Froude Number	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)
CO-1	CB-3	MH-1	150	100	48	330.26	23.03	3.836	4,609.51	4,601.58	0.053
CO-2	MH-1	MH-2	415	100	48	229.12	17.61	2.603	4,601.58	4,591.02	0.025
CO-3	MH-2	OF-1	245	100	48	206.83	16.32	2.325	4,591.02	4,585.94	0.021
CO-4	CB-4	MH-4	205	100	48	234.63	17.93	2.671	4,557.99	4,552.52	0.027
CO-6	MH-4	OF-2	180	100	48	128.47	11.3	1.302	4,552.52	4,551.08	0.008

INLET										
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Known) (ft³/s)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
CB-3	4,613.51	4,613.51	4,609.51	100	Standard	0.5	4,613.29	4,612.54	4,614.77	4,614.03
CB-4	4,568.65	4,568.65	4,557.99	100	Standard	0.5	4,561.77	4,561.02	4,563.25	4,562.51

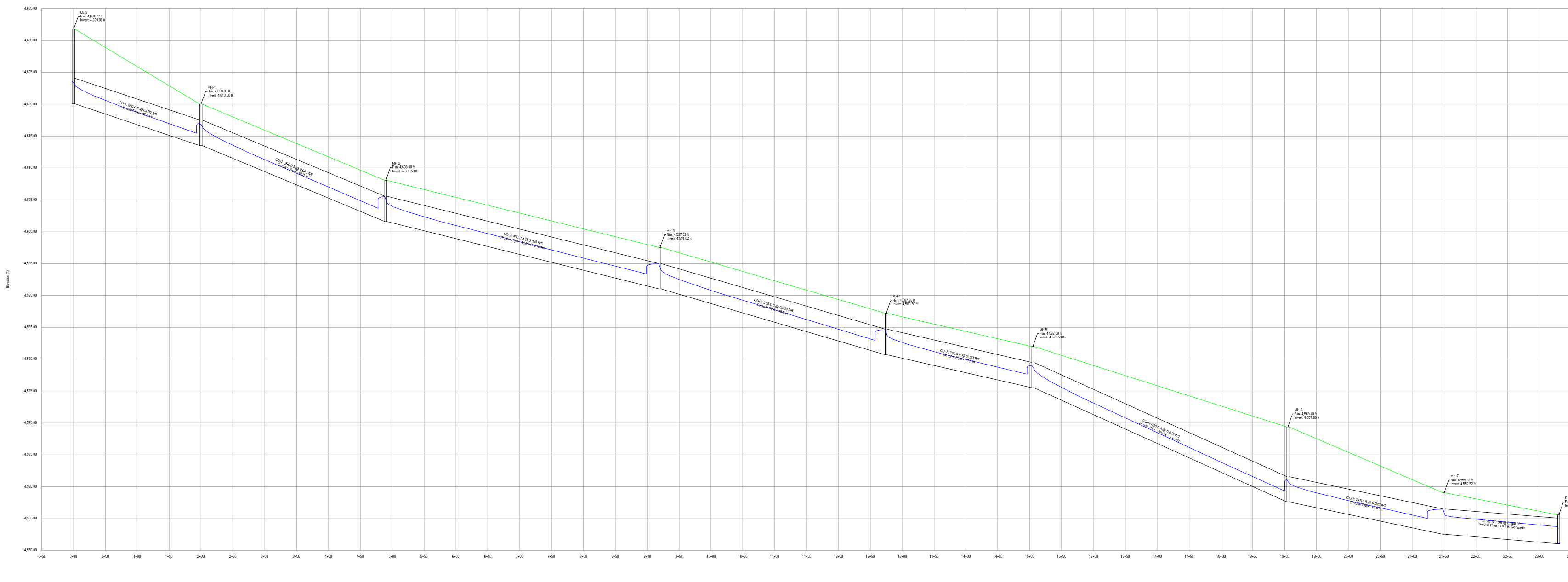
MANHOLES									
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
MH-1	4,608.08	4,608.08	4,601.58	Standard	0.6	4,605.50	4,604.61	4,606.50	4,606.10
MH-2	4,597.52	4,597.52	4,591.02	Standard	0.6	4,594.94	4,594.05	4,595.94	4,595.54
MH-4	4,559.02	4,559.02	4,552.52	Standard	0.6	4,556.44	4,555.55	4,557.44	4,557.04

OUTLET				
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (Tailwater) (ft)
OF-1	4,589.94	4,585.94	Free Outfall	0
OF-2	4,555.58	4,551.08	Free Outfall	0

Scenario: Base



Profile Report
Engineering Profile - Profile - 1 (Option4_check.stc)



CONDUIT											
Label	Start Node	Stop Node	Length (ft)	Total Flow (ft³/s)	Rise (in)	Capacity (Full Flow) (ft³/s)	Velocity (Average) (ft/s)	Froude Number	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)
CO-1	CB-3	MH-1	200	100	48	260.53	19.37	2.99	4,620.08	4,613.50	0.033
CO-2	MH-1	MH-2	290	100	48	291.21	21.01	3.365	4,613.50	4,601.58	0.041
CO-3	MH-2	MH-3	430	100	48	225.09	17.39	2.553	4,601.58	4,591.02	0.025
CO-4	MH-3	MH-4	355	100	48	244.9	18.5	2.798	4,591.02	4,580.70	0.029
CO-5	MH-4	MH-5	230	100	48	215.97	16.86	2.439	4,580.70	4,575.50	0.023
CO-6	MH-5	MH-6	400	100	48	303.85	21.68	3.518	4,575.50	4,557.60	0.045
CO-7	MH-6	MH-7	245	100	48	206.83	16.32	2.325	4,557.60	4,552.52	0.021
CO-8	MH-7	OF-1	180	100	48	128.47	11.3	1.302	4,552.52	4,551.08	0.008

INLET										
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Known) (ft³/s)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
CB-3	4,631.77	4,631.77	4,620.08	100	Standard	0.50	4,623.85	4,623.11	4,625.34	4,624.60

MANHOLES									
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Headloss Coefficient (Standard)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In Node) (ft)	Energy Grade Line (Out Node) (ft)
MH-1	4,620.00	4,620.00	4,613.50	Standard	0.6	4,617.42	4,616.53	4,618.42	4,618.02
MH-2	4,608.08	4,608.08	4,601.58	Standard	0.6	4,605.50	4,604.61	4,606.50	4,606.10
MH-3	4,597.52	4,597.52	4,591.02	Standard	0.6	4,594.94	4,594.05	4,595.94	4,595.54
MH-4	4,587.20	4,587.20	4,580.70	Standard	0.6	4,584.62	4,583.73	4,585.62	4,585.22
MH-5	4,582.00	4,582.00	4,575.50	Standard	0.6	4,579.42	4,578.53	4,580.42	4,580.02
MH-6	4,569.40	4,569.40	4,557.60	Standard	0.6	4,561.52	4,560.63	4,562.52	4,562.12
MH-7	4,559.02	4,559.02	4,552.52	Standard	0.6	4,556.44	4,555.55	4,557.44	4,557.04

OUTLET				
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (Tailwater) (ft)
OF-1	4,555.58	4,551.08	Free Outfall	0

APPENDIX C

Project Correspondence

ATKINS

Dant Drainage Existing Capacity

MEETING MINUTES
Thursday, July 21, 2011, 9:00 AM

City of Reno
8th Floor Conference Room

Attendees:

City of Reno: Glen Daily, Kerri Williams-Lanza, Joe Coudriet
Atkins: Brian Janes

Agenda/Minutes

1. **Review Existing Condition HEC-RAS Model Results** – *(Figures 1 and 2) two HEC-RAS models were run to estimate the existing condition floodplain for 345 cfs and 500 cfs, assuming that the Last Chance Ditch and Lake Ditch diverted flow out of the Dant Drainage area. Brian explained the results of these models*
   a. Dant Dam Outflow – *The outflow cited in the Kennedy Jenks report was 345 cfs. Figure 1 showed the preliminary limits of this flow for the existing condition and showed that 4 structures (4268 Whistlewood, 2055 and 2045 Meadowview, 2000 Pheasant) were potentially affected by this size flow between Dant Blvd and Pheasant Ln.*
   b. Moana Lane Culvert Design – *The design flow of the Moana Lane culverts was 500 cfs based on construction plans. Figure 2 showed the preliminary limits of this flow through the existing condition and showed that the same 4 structures (from Agenda Item 1a) were potentially affected by this flow between Dant Blvd and Pheasant Ln. Both of these analyses assumed that the Last Chance Ditch and Lake Ditch do not contribute flow to the Dant Drainage, but do intercept Dant Drainage stormwater flow and divert it out of the drainage, down the irrigation ditches. This reduces the downstream impacts of the stormwater runoff within the Dant Drainage.*
   c. Estimated Irrigation Ditch Capacities – *Both of these analyses assumed that the Last Chance Ditch and Lake Ditch intercept stormwater flow and divert it out of the Dant Drainage to the east. Glen brought up that a likely scenario would be that the ditches would be full of stormwater runoff from other, upstream areas of the City and that the Dant Drainage stormwater flow would sheet flow over the ditches and flow completely downstream (no diversion). This design premise was taken when the Dant Detention Dam and the downstream drainage improvements*

for the Moana Lane culvert crossing and Plumas Moana Storm Drain were originally designed and constructed. Figures 1 and 2 showed that the Last Chance and Lake Ditches could convey approximately 140-150 cfs and 100-120 cfs respectively if they were not filled with upstream stormwater runoff. These ditch conveyance estimates were taken in the Dant Drainage area. Downstream ditch capacities (to the east) were not known and outside the scope of this analysis, but could be incorporated.

2. **Review Maximum Capacity HEC-RAS Analysis** – *(Figure 3) a HEC-RAS model was run with 3 flow change locations to estimate the maximum capacity for the 3 reaches of the Dant Drainage. These model results were not dependent on whether the ditches diverted flow or not. The flow for each one of these reaches was increased until structures were impacted until a maximum flow was found that did not impact structures. Brian explained the results of this model.*

   a. Upstream of Last Chance Ditch – *The capacity for this reach was generally the full capacity of the analysis (345 cfs or 500 cfs). The only potentially affected structure is a sewer lift station or a geothermal station. These results suggested that the existing flows within the Dant Drainage could potentially be conveyed as-is within this section.*

   b. Between Last Chance and Lake Ditch – *The capacity for this reach was the most limiting of the three sections due to 2 residences located in the bottom of the drainage (2055 and 2045 Meadowview Lane). Additionally, a garage at 2000 Pheasant Lane limits this capacity, however Pheasant Lane garage could be avoided by increasing the capacity of the Pheasant Lane culvert. A maximum existing capacity of 35 cfs (+/-) was estimated from the modeling, however upon further investigation of this area and closer scrutiny of the TIN, the existing capacity estimate for this reach was reduced to 5 cfs.*

      i. *During the 2005 event, Geno Tortelli (City of Reno) reported that the garage of the 2000 Pheasant Lane residence was flooded and that Pheasant Lane was overtopped. This would suggest that approximately 45 cfs (or greater) was passing through the culvert if debris was not a consideration. Portions of the garage appear to be approximately 2 ft below the top of the road (from the contour information). The culvert can pass approximately 35 cfs without impacting the garage. Immediately downstream of the Pheasant Lane culvert there is a ranch style fence with a smaller metal fence attached to it. This fence has the potential to accumulated significant debris which would reduce the culvert capacity and increase flooding upstream of Pheasant Lane for even low flows.*

   c. Downstream of Lake Ditch – *The capacity for this reach was determined to be approximately 350 cfs. Within this reach, flow tends to spread out and collect at the headwall of the Moana Lane culverts.*

3. **Determine Next Steps**

   a. Planned Improvements

i. *It was discussed that, the improvements (as submitted to FEMA for feasibility) could potentially negatively impact the 2055 and 2045 Meadowview residences due to the low existing channel capacity.*

ii. *Assuming that the ditches do convey stormwater during smaller events, these two residences may not experience runoff through that reach of the Dant drainage during events potentially smaller than the Last Chance Ditch diversion(103 cfs) prior to flows continuing down Dant drainage). Therefore, conveyance of flow (up to 5 cfs) within that reach may not impact structures, but may be a condition that the homeowners do not currently experience.*

b. Alternatives

i. *Potential alternatives discussed by the group included:*

1. *Improvements to Dant drainage to bypass the irrigation Ditches for conveyance within the Dant drainage of up to 35 cfs.*

2. *Improvements to provide for conveyance of a larger flow downstream of Last Chance Ditch by constructing a storm drain or channel improvement through the 2045 and 2055 Meadowview lots.*

3. *Atkins will explore what improvements would be required to convey approximately 35 cfs downstream, and what improvements would be required to convey a larger flow downstream (~100 cfs depending on size of channel improvements necessary). The intent would be to present the cost of these improvements to FEMA and discuss the constraints of the alternatives to determine the future direction of the project and whether additional funding would be required. It was discussed that not considering the project constraints and budget, a better approach would be to improve the drainage to convey the Dant Dam outflow (345 cfs) to the Moana Culverts. The optimum project would also allow all flows already in the Last Chance Ditch (from upstream along the irrigation ditch) at the Dant Wash to be directed to the Dant Wash, (thereby increasing the 345 cfs). It was also discussed that since the drainage is located substantially within private property, a significant project which could substantially change the rural character of the drainage may not be acceptable from an aesthetic consideration and impacts to private properties.*

c. Feasibility

i. *Based on these findings, the feasibility of the project as originally proposed to FEMA is in question, however whether to pursue improvements relies heavily on whether the Last Chance and Lake Ditches convey stormwater flow during storm events or whether they are full and do not convey stormwater flow.*

ii. *Assuming that the ditches DO convey stormwater flow from the Dant Drainage results in an existing condition where residents downstream of the ditches are assumed to see less stormwater runoff. The following bullets support why this assumption was made for this project to date.*

- *Assuming that the ditches divert flow attempts to ensure that a proposed project does not inadvertently convey more flow downstream (in the Dant Drainage) than what is currently experienced in the existing condition. When comparing a proposed project to this existing condition, the proposed project will be required to meet stricter constraints due to a lower existing condition flow.*
- *The Dant Dam and Moana Lane culvert projects assumed that the irrigation ditches did not divert stormwater flow. This was appropriate for their analysis because it assumed that all flow makes it to Moana Lane and that the culverts are designed for the worst case 100-year event.*
- *It is possible that a 100-year event could be localized to the Dant Drainage watershed as well exceed the Dant Drainage watershed and that the ditches could either divert flow or not divert flow depending on the aerial size of a given storm.*
- *Residents downstream of the ditches where the flow breaks out of the ditch east of the Dant Drainage are assumed to get flooded by Dant Drainage stormwater contributions to the irrigation ditches in the existing condition.*
- *Atkins recommends that the analysis assume that the two ditches divert flow from the Dant Drainage based on the 103 cfs and 56 cfs (regardless of Dant Drainage flow) that has been identified in Action Item 1a.*

iii. *Assuming that the ditches DO NOT convey stormwater flow from the Dant Drainage results in an existing condition where residents downstream of the ditches are assumed to see more stormwater runoff.*

- *Assuming that the ditches do not divert flow could inadvertently result in a proposed project that conveys more flow downstream (in the Dant Drainage) than what is currently experienced in the existing condition. When comparing a proposed project to this existing condition, the proposed project will be required to meet much lower constraints due to a higher existing condition flow.*
- *Making this assumption would indicate that the residents downstream of the ditches (east of the Dant Drainage) were flooded in 2005 because of upstream ditch capacity and not because of Dant Drainage stormwater contributions to the irrigation ditches.*

iv. *It was determined that the City Legal department would be consulted and apprised of the challenges of this project. Additionally, the ditch companies and two homeowners would be contacted to attempt to better understand the existing condition during storm events.*

Action Items:

1. Brian will forward the ditch flows from the two models not presented in the meeting to the City.
    a. *Because of how HEC-RAS models lateral weirs and cross section orientation, the models are continuing to divert more and more flow down the irrigation ditches even after the water surface elevation exceeds the top of bank elevations. This is shown on Figures 1 and 2. Figure 1 shows 140 cfs diverted (Last Chance) when 345 cfs is the total drainage flow and 148 cfs diverted when 500 cfs is the total drainage flow. HEC-RAS is assuming that as water surface increases, additional flow will go down both the Dant Drainage and the irrigation ditch. Given the configuration of the ditches, it is more likely that the ditches will divert 100% of the flow up to the top of ditch bank, and then no additional flow above that. This scenario results in 103 cfs diverted down the Last Chance Ditch and 56 cfs diverted down the Lake Ditch regardless of the flow in the Dant Drainage.*
2. Brian will forward site pictures to the City.
3. Glen will forward Brian the contact information for the 2 ditch companies
    a. Brian will schedule a field meeting with each ditch company to discuss planned improvements, challenges, and maintenance history.
4. Brian will attempt to estimate preliminary housing costs for 2055 and 2045 Meadowview Lane to compare against improvement costs.
5. Glen will research to determine if the City has any drainage easements.
6. Kerri, Joe and Glen will discuss the project with the City Legal department, John Flansberg, and Terri Svetich.
    a. If approved, Joe and Glen will talk to the 2055 and 2045 Meadowview homeowners to determine if they might be interested in a drainage project to improve conveyance and what recent history of flooding they have seen.

ATKINS

September 1, 2011

Glen Daily, P.E.
Associate Civil Engineer
Sanitary Engineering
Public Works
City of Reno
1 East First Street
Reno, NV 89505

RE: Field Meetings with Last Chance Ditch and Lake Ditch for Dant Drainage

Summary

On 8/10 and 8/11, field meetings were held with Last Chance Ditch and Lake Ditch personnel respectively. Our contacts for Last Chance Ditch were Norm Dianda (President, 786-2677) and Tony Groux (Ditch Rider, 843-8308). Our contact for the Lake Ditch was Marty Richard (Ditch Manager, 815-7883). Brian Janes and Kamal Qaiser attended from Atkins, and Glen Daily and Joe Coudriet attended from the City of Reno.

At the meeting with the Last Chance Ditch, Norm and Tony stated that every time there is a significant flow down the Dant Drainage, the Last Chance Ditch gets a large influx of sediment and stormwater which backs up the flow in the ditch both upstream and downstream. These events cause maintenance problems for the ditch and did happen in the 2005 event. We discussed possible scenarios that would convey stormwater under the ditch downstream during lower flows in an attempt to reduce impacts to the ditch. Norm and Tony were supportive of any attempts to convey stormwater under the ditch and mentioned that it would also be useful if a ditch spillway or gate was installed so that ditch water could be diverted down the Dant Drainage when needed. Norm and Tony said that currently approximately 200 customers are served by the Last Chance Ditch, and that flows in the ditch run from April to October. Generally, Norm and Tony seemed to be open to working with the City to accommodate a future project and acknowledged the benefit that it would have to the Last Chance Ditch.

At the meeting with the Lake Ditch, Marty said that the ditch does intercept stormwater sometimes but that it does not cause serious maintenance issues. He stated that they have a crew of three people that do year round maintenance and that it is mostly limited to willow and moss control to maintain the ditch capacity. He did mention that some of the ditch banks were reinforced with concrete, however it did not appear to be caused by storm water influx. During our discussions of significant events and the 2005 event, it was mentioned that some residents were building sand bags, however it is unclear which ones. When discussing the 2005 event, Marty said that the ditch did convey water out and did not recall any overtopping in the Dant Drainage area, however there could have been some where the Lake Ditch makes a 90 ^{o} turn near Greenfield Drive. At that location, a cinderblock wall was constructed near the 2005 time frame. Marty did say that downstream in the Manzanita Lane area, the Lake Ditch did have some overtopping issues and potential property damage. His only knowledge of Lake ditch problems were in the vicinity of Lakeridge where rosewood crosses the ditch. At that point, it sounded like the Lake ditch has similar problems as the Dant Drainage causes for Last Chance Ditch. Marty seemed to be open to storm water improvements in the Dant area and also requested that a overflow weir or gate be installed to divert ditch water if needed.

During the Lake Ditch meeting, Marty introduced the group to John Luchetti who owns the property at 1755 Greenfield Drive, just downstream of the Lake Ditch on the Dant Drainage. Significant events were discussed and John said that in the last 15 or so years he hasn't seen flow overtop the Lake Ditch and come through his property. The only thing he mentioned was that the Lake ditch used to leak near Greenfield Drive where the ditch makes a 90° turn. Somewhere near the 2005 time frame, this portion of the ditch had a cinderblock wall built on the outside of the turn which protrudes above ground level and has stopped the leakage. It is not known whether the wall was built prior to or after the 2005 event. Joe asked if John would be open to storm drainage improvements that would potentially run through his property, explaining that his property would be restored to his satisfaction. John responded that he would be open to considering that.

<u>Existing Condition Capacity Analysis</u>
On 8/10, after the meeting with the Last Chance Ditch, Atkins brought to the City's attention that the original existing condition capacity (see 7/21 meeting minutes) needed to be revised. At that meeting, Atkins presented that the existing condition capacity of the Dant Drainage was approximately 35 cfs before residents within the drainage would be impacted. Based on further review of the TIN for the 2 foot contours and refinement of the existing condition HEC-RAS model, it has since been determined that only about 5 cfs could be passed down the Dant Drainage without impacting residents at 2045 and 2055 Meadowview Lanes. Both of these residences were essentially built at the bottom of the Dant Drainage with little or no storm water conveyance ability. Nearly any flow would be extremely close to structures and could drain through drive ways and yards.

<u>Alternatives</u>
Considering the revised existing condition results and the information received from the ditch companies, it appears that the Dant Drainage may not have seen a 100-year event (345 cfs) as defined in the *Supplemental Engineering Report for Plumas/Moana Storm Drain Project* in recent years or the ditches convey more flow out of the drainage than what was estimated. Assuming that the existing condition HEC-RAS model is accurate would indicate that the 2005 event on the Dant Drainage was slightly less than a 100-year event due to the following:

- Storm water from the Dant Dam, drained to the Last Chance Ditch, which filled and conveyed storm water out of the drainage. The ditch likely overtopped and conveyed storm water down the drainage. Additionally, significant amounts of sediment were deposited in the ditch. Areas upstream of the ditch (within the Dant Drainage) were inundated and experienced erosion.
- Stormwater arrived at the Lake Ditch and was conveyed out of the drainage without significant impact to the ditch. Mention was made of residents sand bagging, but it was unclear where this was done. At this time it is unknown whether the 2045 and 2055 Meadowview Lane residents were impacted.
- Per John Luchetti (1755 Greenfield Drive), very little if any flow was seen between the Lake Ditch and Moana Lane. There were minor issues with the Lake Ditch where it makes a 90° turn near Greenfield Drive, however that appeared to be related to seepage rather than overtopping.

The City and Atkins discussed which alternatives to include (with cost estimates) in the project report with the following results.

1. The original project which consisted on structures under both ditches and the upsizing of the Pheasant Lane culvert would not be included as an alternative due to the conveyance constraints within the 2045 and 2055 Meadowview Drive areas. Instead the limitations would be defined to explain why the initial project description has been modified.
2. An alternative (and cost estimate) would be presented to convey 35 cfs under both ditches in culverts and past the 2045 and 2055 Meadowview Lane residences in a storm drain and possibly by the 1755 Greenfield Drive residence in an open channel or storm drain.
3. An alternative (and cost estimate) would be presented to convey as much flow as possible (100 cfs +/-) to the Moana Lane culverts. This alternative would include:
    a. A structure under Last Chance Ditch.
    b. An open channel from the Last Chance Ditch to Lake Ditch.
    c. An upsized structure under Pheasant Lane.
    d. A structure under Lake Ditch.
4. An alternative (and cost estimate) would be presented similar to the open channel alternative above, however a storm drain would be used to convey the 100 cfs +/- from upstream of the Last Chance Ditch to downstream of the Lake Ditch.
5. An alternative (and cost estimate) would be presented as a combination of alternatives 3 and 4 that would use open channel conveyance where space permitted and storm drain conveyance where space was constrained.
6. A qualitative description of a 100-year option would be discussed that would define likely needs for a project of that scope to include possible purchase of the 2045 and 2055 Meadowview Lane residences.

<u>The Way Forward</u>

Atkins will proceed to finalize the above alternatives, approximate preliminary cost estimates, and qualitative descriptions for inclusion in a draft project report to be submitted to the City on August 26th. The City will review the draft, and provide comments for inclusion and submission of a final report to be submitted to the City 3 days after receipt of the draft comments.

I believe this will provide you with a very good summary of the work done during this phase of the project and provide you with a summary document to use to discuss project funding with FEMA. Please let me know if you have any questions.

Sincerely,

Brian Janes, P.E., CFM
Project Manager / Water Resources

APPENDIX C

Project Photographs

Upstream Headwall of Pheasant Lane 27” CMP culvert.

Looking upstream from Pheasant Lane culvert.

Ranch fence 2-3 ft downstream of Pheasant Lane culvert.

Looking downstream from the Pheasant Lane culvert.

West Moana Lane culverts.

Looking downstream in the Dant Drainage, just upstream of the Last Chance Ditch crossing.

Dant Drainage connection to the Last Chance Ditch.