CITY OF SONOMA
STORM DRAIN MASTER PLAN

MAY, 2011

Prepared for:

City of Sonoma
Public Works
Sonoma, CA

Prepared by:

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STORM DRAIN MASTER PLAN
CITY OF SONOMA

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Note: * Full Size copies of these figures are provided under separate attachments

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EXECUTIVE SUMMARY

Winzler & Kelly was retained by the City to provide a Storm Drain Master Plan (SDMP) that would identify and incorporate proposed storm drain system improvement projects into the City's 2010 Capital Improvement Program (CIP). Because the City's storm drain network is linked dynamically to Sonoma Creek, Fryer Creek, Nathanson Creek and Schell Creek, the SDMP also attempts to analyze the effect of specific improvements to open channel drainages. In some cases, flooding in a particular area may be reduced by incorporating storm drain system improvements or by making improvements to the open channels.

The goal of this SDMP is to identify projects necessary to decrease/alleviate flooding in regions of the City where current modeling efforts have demonstrated that flooding potential exists. The extent of the SDMP scope was specifically limited to storm drain system (pipe) improvements. However, since the storm drain system is dynamically linked to open channel systems, additional modeling (beyond scope) was conducted to include channel improvement projects.

The 2010 CIP SDMP projects were established by modeling specific improvements utilizing software (MIKE) capable of coupling dynamic one-dimensional channel/storm drain hydraulic modeling with dynamic two-dimensional floodplain/street flooding hydraulic modeling. Watershed boundaries were delineated, respective flows estimated within each watershed, and flows routed into the existing storm drain networks and associated open channels. Three separate design storm conditions were modeled: 10-year, 25-year, and 100-year.

ES-1 Existing Network Summary

The City's storm drain pipe network comprises approximately 46 miles of pipeline. The total combined watershed drainage area is approximately 4,800 acres and contributes flow to Sonoma, Fryer, Nathanson and Schell Creeks, with the majority of flows routed to Nathanson Creek via contributing watersheds (2,800 acres). Additionally, water is conveyed in road-side ditch drainages and cross culverts totaling 7,200 lineal feet. Pipe material type varies throughout the storm drain system.

ES-2 Modeling

Aerial mapping, ground survey, and field investigations formed the basis of topographic information required for incorporation into hydrologic and hydraulic modeling systems. Boundary conditions for the models were generally established by using information contained in Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) reports. Table ES-2 lists the various software programs used and their intended purpose.

TABLE ES-2 Software Utilized

Software Program	Purpose
GIS	Hydrology preprocessing – calculate lag times and Curve Numbers based on Land Use/Soil Type
MIKE URBAN	Storm drain system modeling
MIKE 11	One-dimensional channel modeling
MIKE 21	Two-dimensional modeling to combine floodplain and street flooding
MIKE FLOOD	Coupling MIKE 11 and MIKE 21 together

ES-3 Capital Improvement Program

A summary of the storm drain system capital improvement projects (CIP) that are recommended to address capacity deficiencies based on multiple storm intensities are listed in Table ES-3.

TABLE ES-3 CIP Cost Summary

Project ID No.	CIP Year(s)	Project Description	Estimated Construction Cost	Estimated CIP Cost
1	FY 11-13	Fryer Creek culvert at West MacArthur St.	$899,200	$1,240,897
2	FY 12-15	Nathanson Creek – Patten St. Bridge	$849,344	$1,172,094
3	FY 14-17	Nathanson Creek Floodwalls	$3,027,518	$4,056,874
4	FY 10-11	Line F-12 – Increase Pipe Size	$400,569	$552,786
5	FY 17-20	Bypass – Connect Line F-12 to Line SON-5	$2,194,845	$2,941,092
6	FY 13-14	Line F-1 – Increase Pipe Size	$229,570	$316,807
7	FY 14-15	Line N-3 – Increase Pipe Size	$175,527	$242,228
8	FY 19-20	Line N-5 – Increase Pipe Size	$509,461	$703,056
9	FY 13-15	Line S-1 – Increase Pipe Size – Pipe 70 and 62-66	$1,024,277	$1,372,531
10	FY 11-12	Line S-1 – Increase Pipe Size upstream of Junction with Line S-1-6	$663,449	$915,559
		TOTALS	$9,973,760	$13,513,924

ES-4 Additional Recommendations

In addition to recommended CIP projects, the following points provide recommendations for projects that will enable the City to better understand their overall storm drain network, including both piping systems and open channel conveyance.

- Stream Gages – Since stream gages do not currently exist on Fryer Creek nor Nathanson Creek, model calibration is not possible. Model accuracies can be verified if known data points including flow and water surface elevations are available. The City might consider sharing costs of implementing installation/maintenance of such devices with the Sonoma County Water Agency (SCWA).
- Although preliminary modeling of implementation of open channel creek projects was performed, the scope of this SDMP was to identify potential storm drain (pipe) improvements. Additional detailed modeling of open channel systems should be considered prior to construction of related open channel projects in order to accurately quantify project limits and associated costs.
- Costs to construct open channel improvements on private property may be affected substantially by the existence / or lack of easements and rights-of-way held by the City, SCWA and possibly the Corp of Engineers. Prior to designing/constructing projects of this type, the City should gather the necessary information to fully understand all associated legal requirements pertaining to work occurring in or adjacent to Nathanson, Fryer, Sonoma and Schell Creeks.

1.0 INTRODUCTION

The City of Sonoma (City) is currently in the process of developing a capital improvement program for its storm drain system. The City has requested its City Engineering Consultant, Winzler & Kelly to provide engineering services to develop a storm drain system model within the Zone 3A watershed boundaries ("Study"), and to develop a SDMP. The Study area consists of four watersheds: Nathanson Creek, Fryer Creek, Schell Creek and Sonoma Creek. Channel modeling includes Nathanson Creek and Fryer Creek only. Previous FEMA modeling of the Sonoma Creek and Schell Creek channels are also utilized for this Study. Pipe network modeling includes storm drainage infrastructure within all four subbasins.

The City's storm drain network is dynamically coupled to Nathanson Creek and Fryer Creek, and the storm drain infrastructure is also dynamically coupled to a two-dimensional surface model for all watersheds with the exception of Sonoma Creek. This model configuration was selected to provide insight into storm drain system interactions with the Nathanson Creek and Fryer Creek channels, their floodplains, and flooding in City streets. Two-dimensional coupling of the City's storm drain system with Schell Creek was included due to the size of the City's storm drain system draining to Schell Creek, and again this allowed for modeling interactions between the storm drain system and street flooding within the Schell Creek watershed. There is comparatively very little storm drain infrastructure discharging to Sonoma Creek.

The City's storm drain pipe network comprises almost 46 miles of pipeline. The total combined watershed drainage area is approximately 4,800 acres and contributes flow to Sonoma, Fryer, Nathanson and Schell Creeks, with the majority of flows routed to Nathanson Creek via contributing watersheds (2,800 acres). Additionally, water is conveyed in road-side ditch drainages and cross culverts totaling 7,200 lineal feet. Pipe material type varies throughout the storm drain system.

The City maintains the storm drain pipe system along with road-side ditches and associated cross-culverts. SCWA maintains easements (mainly for channel maintenance only) for Nathanson Creek, while most of Fryer Creek (within City limits) is owned and maintained by SCWA (a small portion of East Fork of Fryer is maintained through an easement). SCWA also establishes the design criteria from which this SDMP assesses the City's storm drain system and creek hydraulics through SCWA's Flood Control Design Criteria (FCDC). The FCDC provides the basis from which storm drain and channel hydraulics are assessed and deficiencies identified for inclusion in the SDMP.

1.1 Purpose

The purpose of this Master Plan is to establish a Capital Improvement Program (CIP) for the City's storm drain system infrastructure in order to reduce flooding in flood-prone regions of the City. This is accomplished by delineating watershed boundaries, estimating respective flows within each watershed, and routing flows into the existing storm drain network and associated open channels. Using a combination of one-dimensional channel hydraulics and storm drain hydraulic modeling and a two-dimensional floodplain and street flooding hydraulic model, hydraulic analyses of these systems dynamically coupled together provides a mechanism to assess deficiencies within the City's storm drain system and creeks, and predicts where localized flooding may occur. Recommended improvements have been developed to alleviate operational deficiencies with respect to the FCDC. Specifically, the SDMP identifies the following existing infrastructure and surface features:

- Existing storm drain pipe network
- Open ditch (with cross culvert) drainages
- Open channel creek drainages
- Watershed delineations
- Two-dimensional surface model of the City

This document also includes:

- Capacity analysis of existing pipe network
- Capacity analysis of open channel drainages
- Capital improvement program

This SDMP has been prepared to provide a detailed analysis of the adequacy of the major storm drainage facilities serving the City. This SDMP provides the following review:

- Detailed delineation of contributing watershed and sub-watershed boundaries
- Comprehensive descriptions and mapping of the City's storm drain system
- Creation of a City Storm Drain Map that shows locations of public storm drains and facilities, and size of pipelines
- An assessment of the capacity of the existing creeks, open drainage channels, culverts, and closed conduits having diameters 24 inches and larger
- Identification of system deficiencies
- Development of a storm drain CIP to address system deficiencies
- Associated CIP cost estimates

1.2 Objectives and Scope

The primary objective of the work is to locate and identify storm drain and channel deficiencies with respect to the FCDC and local areas prone to flooding, and to develop storm drain system improvements required to reduce the risk of flooding during specific storm events as defined by SCWA design standards (10-yr, 25-yr, 100-yr). A technical memorandum summarizing data review and design criteria/methodology was prepared and submitted for City review during the initial phase of preparation of the SDMP. This memorandum is included as Appendix C.

Data was collected from a variety of sources including the following:

- Anecdotal information provided by City and SCWA staff
- FEMA background data and HEC-2 models
- Field survey data used to generate creek (Nathanson and Fryer) profiles
- Field visits to obtain storm drain invert elevations (at select locations)
- Hydrologic maps and calculations
- Hydraulic studies (SCWA)
- Aerial topographic mapping (by Others under separate contract with the City)

The SDMP identifies certain open channel projects that if implemented, will reduce flooding severity in localized areas. However, the main intent of developing the CIP is specifically focused on identifying storm drain system (pipe and structures) improvements. Open channel improvements were included since they may be more cost-effective than related storm drain system improvements in dealing with localized street flooding originating from Nathanson and Fryer Creeks.

2.0 SUMMARY OF EXISTING STORM DRAIN SYSTEM

2.1 Existing Pipe Network

Both hard copy mapping and GIS mapping of existing storm drainage facilities were obtained from the City. The storm drainage facilities generally consist of a closed conduit network and open road-side ditches draining to one of four creeks flowing through the City: Sonoma Creek, Fryer Creek, Nathanson Creek and Schell Creek. Existing pipe sizes are detailed in Table 2-1.

TABLE 2-1 Storm Drain Pipe Size

Pipe Diameter (in)	Length (ft)
Unknown	112,575
4	1,096
6	2,714
8	6,180
10	3,244
12	5,029
15	13,363
16	824
18	31,407
21	5,028
24	12,819
27	1,400
30	10,626
33	280
36	10,080
42	4,053
48	4,652
54	7,257
60	3,787
66	3,476
72	496
84	529
Total	**240,916**

Note: It is assumed the unknown pipe diameters are less than 24-inches.

Pipe elevations were established by field dipping manholes at select locations and using interpolation between manholes (assuming straight line grades). The storm drain network is shown on Figure 2-1.

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Modeled Storm Drain Pipes & Run ID
Storm Drain Pipes (not modeled)
Storm Drain Manholes & ID
Storm Drain Outlets & ID

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits; Winzler and Kelly GIS: Creeks, Storm Drain System.

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Cartography	Date	Project #
AF	5/13/2011	0241809039

Figure 2-1
Existing Storm Drain System

Storm Drain Master Plan

City of Sonoma

Collectively, the City's storm drain network consists of 45.6 miles of pipe. While a majority of the pipe material in the existing system is unidentified, the prevalent materials in the identified sections are shown in Table 2-2.

TABLE 2-2 Storm Drain Pipe Materials

Pipe Material	Length (ft)
Unknown	201,248
ADS	578
CI	84
CIP	768
CMP	88
CSP	92
CSPA	48
HDPE	1,373
PVC	5,682
RCP	30,901
SDR	54
Total	**240,916**

2.2 Fryer Creek

Fryer Creek is a channelized creek which flows generally south through the City from the northern foothills. For portions of its reach it has been contained in a closed conduit system. The channel is heavily confined by development on both sides of the creek. There are two branches to the creek: a western branch entering into the main channel just north of West Macarthur Street and an eastern branch entering the main channel just north of Newcomb Street. Its watershed is approximately 1,379 acres at the southern city limits.

The creek has flooded its bank on numerous occasions, and is a tributary to Nathanson Creek (ultimately draining to Sonoma Creek). The creek's gradient is modest along the entire reach within the City of Sonoma with an average slope of 0.3%. Sediment deposition is increasing in the downstream reach (according to SCWA). The FEMA flood map is shown in Appendix A-1.

2.3 Nathanson Creek

Nathanson Creek begins in the foothills north of town and flows generally south through the eastern portion of the City just east of Broadway, and terminates at the confluence with Sonoma Creek (south of the City limits). The watershed is approximately 2,425 acres at the northerly City limits and 2,854 acres at the southerly limits. The creek has been encroached upon by urban development and has previously flooded its banks causing significant damage. The creek gradient is modest along the entire reach within the City of Sonoma with an average slope of 0.5%. See Appendix A-2 for FEMA mapping in this area.

The Nathanson Creek bypass channel (owned by the City) is located in Nathanson Creek Park. This channel provides stormwater diversion when flood water elevations (in the main channel) become high enough to enter the bypass. The bypass channel can be described as wide and shallow, with a relatively flat gradient and trapezoidal shape. Downstream and slightly north of the confluence with the main Nathanson Creek channel, the bypass narrows and becomes steeper.

2.4 Sonoma Creek

Sonoma Creek is the principal waterway draining the Sonoma Valley, terminating at San Pablo Bay. The creek flows south, and skirts the western portion of the City. A relatively small amount of flow generated within contributing watersheds is routed directly to Sonoma Creek via the City's storm drain system. However, Nathanson Creek (including Fryer Creek flows) ultimately drain to Sonoma Creek south of the City boundary (See Appendix A-3).

2.5 Additional Surface Drainage

There are a series of open road-side ditches interconnected with the closed conduit system. The ditches are generally trapezoidal in shape and range from 6 to 20 feet wide by 2 to 8 feet deep. Several locations exist where road-side ditches convey moderate flow including:

- Broadway - Napa Road to East McArthur
- 1st St. West - W. Spain Street to Mountain Cemetery
- 2nd St. West - Andrieux Street to south side of Bettencourt Street

3.0 DATA COLLECTION

Technical data relating to the Study for the City was collected and reviewed. Detailed lists of key documents and other materials collected to date are provided in the appendices. Data collection efforts included requesting data from FEMA, the City, SCWA and County Permit and Resource Management Department (PRMD). The list of data collected is summarized in Appendix B.

3.1 Aerial Survey

Aerial Mapping (provided by Others) was utilized to provide a base map for the project. Delta Geomatics Corporation provided aerial mapping at a mapping scale of 1"= 40', with 1-foot contour intervals. Winzler & Kelly provided ground control for the project which required 28 aerial panels, controlled with Leica System 1200 Real Time Kinematic GPS. The basis of bearings and coordinate values were based on the California Coordinate System, Zone 2 (NAD '83). The vertical datum was NAVD '88 holding the value for NGS monument, Designation HPGN D CA 04 LF, PID JT9620 using the elevation published by the Central Coast Height Modernization Project 2007 of 36.533 meters (119.86 feet). Aerial topography is depicted in Figure 3-1.

3.2 Field Visits

Additional information obtained in the field was required to augment the aerial survey data. Conventional topographical survey at select creek locations was collected. Also, select manhole locations were dipped and site visits conducted with City staff to collect detailed information.

3.2.1 Manhole Dipping

Winzler & Kelly, with assistance from City maintenance staff, opened three hundred forty-four (344) storm drain structures to obtain invert elevations and confirm pipe sizes. Measurements were taken from the rim or grate of structures to the inverts of pipes. These measurements were used to calculate the invert elevations of pipes based on the rim or grate elevation obtained from the aerial mapping.

3.2.2 Survey

A control network was established using GPS and conventional (total station) survey methods for use in collecting creek cross sections at required locations. Twenty-six (26) cross sections were collected on Nathanson Creek and seventeen (17) cross sections were collected on Fryer Creek. Locations for cross sections specifically selected to provide accurate data for modeling of the open channel drainage systems. Cross sections for the West Fork and East Fork of Fryer Creek were developed from topography rather than being surveyed in the field. A total of twenty (20) cross sections were developed for the West Fork of Fryer Creek, while ten (10) cross sections were developed for the East Fork of Fryer Creek. Refer to Figure 3-1 for cross section locations.

3.2.3 Site Reconnaissance

Engineers provided assistance field verifying locations identified through mapping review and discussions with City staff where necessary modeling information was lacking. Pipes and open ditches were traced following a downstream progression.

3.3 City Provided Data

Hard copy plans of City drainage structures as well as the City GIS mapping were provided by the City to identify many drainage features. After reviewing this data, certain areas were identified that required field verification as described in paragraph 3.2.3

3.4 FEMA Data

Hard copies of FEMA input and output hydraulic model runs and County of Sonoma Flood Insurance Study (FIS) including creek profiles were reviewed. FEMA cross sections were included in the current hydraulic model to augment surveyed cross sections for specific areas. Bridge structure cross sections were confirmed by field surveys and site reconnaissance.

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Modeled Storm Drain Pipes
Field Surveyed Cross-Section Location and Station
Aerial Topography Cross-Section Location and Station
Cross-Section Data from HEC Models
Major Contour, 5 foot
Minor Contour, 1 foot
Storm Drain Outlets
Storm Drain Manholes

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits; Winzler and Kelly GIS: Creeks, Storm Drain System.

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Cartography	Date	Project #
AF	5/13/2011	0241809039

Figure 3-1
Aerial Topography with Surveyed Cross-Section Locations

Storm Drain Master Plan

City of Sonoma

4.0 HYDROLOGY

4.1 Design Criteria and Assumptions

SCWA developed design criteria and methodology for hydrologic and hydraulic design in the *FCDC*, revised August 1983. These criteria were used in development of the SDMP's hydrology model to accurately simulate rainfall runoff processes within the City's contributing watersheds and for subsequent routing to the City's drainage facilities.

The design criteria used in the hydrologic analysis is based on SCWA's FCDC Standards. These criteria include:

- For watersheds of four square miles or more (major waterways), the design storm is a 100-year event.
- For watersheds of one to four square miles (secondary waterways), the design storm is a 25-year event.
- For watersheds less than one square mile (minor waterways), the design storm is a 10-year event.

The hydrology model was developed in MIKE URBAN (MU) for subsequent coupling with the MIKE FLOOD (MF) model (one-dimensional channel hydraulics and two-dimensional floodplain and street flooding hydraulics). MU simulates precipitation-runoff and routing processes and allows for the coupling of subbasin hydrographs to a storm drain system for subsequent routing and ultimate discharge to a creek. MU was selected because of its use of standard TR-55 hydrological methods, its compatibility with the MF model and the ability to dynamically couple the City's storm drain system with MF models of Fryer and Nathanson Creeks to better simulate the complex interactions between the storm drain system, channels, floodplain, and street hydraulics.

4.2 Watershed Delineation

Major watersheds were divided (Sonoma Creek, Fryer Creek, Nathanson Creek, and Schell Creek) into sub-drainages, referred hereinafter as *sub-basins*. A sub-basin element represents a complete watershed that is separated into three distinct processes: *loss rate, transform, and base flow*. The quantity of rainfall that falls and infiltrates is represented by a loss rate method. The excess rainfall which does not infiltrate and becomes runoff is represented by a transform method. Groundwater contributions to channel flow rate are represented with a base flow method.

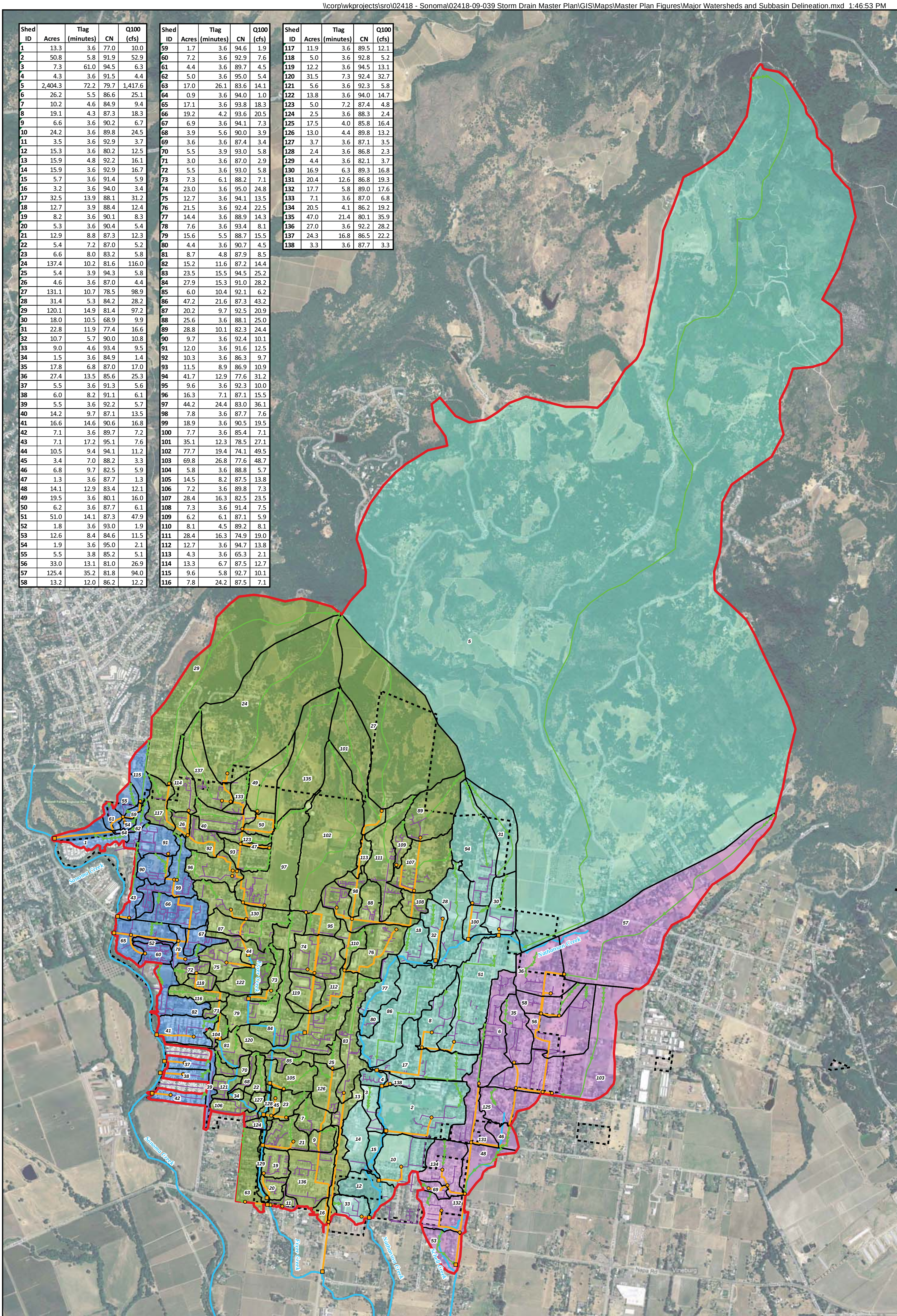
Figures showing delineated subbasins, as well as complementary figures detailing Land Use and Hydrologic Soil Groups are included as Figure 4-1.1, 4-1.2 and 4-1.3. Full size foldups (22x34) of these Figures are included as a separate attachment.

\\corp\wkprojects\sro\02418 - Sonoma\02418-09-039 Storm Drain Master Plan\GIS\Maps\Master Plan Figures\Major Watersheds and Subbasin Delineation.mxd 1:46:53 PM

Shed ID	Acres	Tlag (minutes)	CN	Q100 (cfs)
1	13.3	3.6	77.0	10.0
2	50.8	5.8	91.9	52.9
3	7.3	61.0	94.5	6.3
4	4.3	3.6	91.5	4.4
5	2,404.3	72.2	79.7	1,417.6
6	26.2	5.5	86.6	25.1
7	10.2	4.6	84.9	9.4
8	19.1	4.3	87.3	18.3
9	6.6	3.6	90.2	6.7
10	24.2	3.6	89.8	24.5
11	3.5	3.6	92.9	3.7
12	15.3	3.6	80.2	12.5
13	15.9	4.8	92.2	16.1
14	15.9	3.6	92.9	16.7
15	5.7	3.6	91.4	5.9
16	3.2	3.6	94.0	3.4
17	32.5	13.9	88.1	31.2
18	12.7	3.9	88.4	12.4
19	8.2	3.6	90.1	8.3
20	5.3	3.6	90.4	5.4
21	12.9	8.8	87.3	12.3
22	5.4	7.2	87.0	5.2
23	6.6	8.0	83.2	5.8
24	137.4	10.2	81.6	116.0
25	5.4	3.9	94.3	5.8
26	4.6	3.6	87.0	4.4
27	131.1	10.7	78.5	98.9
28	31.4	5.3	84.2	28.2
29	120.1	14.9	81.4	97.2
30	18.0	10.5	68.9	9.9
31	22.8	11.9	77.4	16.6
32	10.7	5.7	90.0	10.8
33	9.0	4.6	93.4	9.5
34	1.5	3.6	84.9	1.4
35	17.8	6.8	87.0	17.0
36	27.4	13.5	85.6	25.3
37	5.5	3.6	91.3	5.6
38	6.0	8.2	91.1	6.1
39	5.5	3.6	92.2	5.7
40	14.2	9.7	87.1	13.5
41	16.6	14.6	90.6	16.8
42	7.1	3.6	89.7	7.2
43	7.1	17.2	95.1	7.6
44	10.5	9.4	94.1	11.2
45	3.4	7.0	88.2	3.3
46	6.8	9.7	82.5	5.9
47	1.3	3.6	87.7	1.3
48	14.1	12.9	83.4	12.1
49	19.5	3.6	80.1	16.0
50	6.2	3.6	87.7	6.1
51	51.0	14.1	87.3	47.9
52	1.8	3.6	93.0	1.9
53	12.6	8.4	84.6	11.5
54	1.9	3.6	95.0	2.1
55	5.5	3.8	85.2	5.1
56	33.0	13.1	81.0	26.9
57	125.4	35.2	81.8	94.0
58	13.2	12.0	86.2	12.2

Shed ID	Acres	Tlag (minutes)	CN	Q100 (cfs)
59	1.7	3.6	94.6	1.9
60	7.2	3.6	92.9	7.6
61	4.4	3.6	89.7	4.5
62	5.0	3.6	95.0	5.4
63	17.0	26.1	83.6	14.1
64	0.9	3.6	94.0	1.0
65	17.1	3.6	93.8	18.3
66	19.2	4.2	93.6	20.5
67	6.9	3.6	94.1	7.3
68	3.9	5.6	90.0	3.9
69	3.6	3.6	87.4	3.4
70	5.5	3.9	93.0	5.8
71	3.0	3.6	87.0	2.9
72	5.5	3.6	93.0	5.8
73	7.3	6.1	88.2	7.1
74	23.0	3.6	95.0	24.8
75	12.7	3.6	94.1	13.5
76	21.5	3.6	92.4	22.5
77	14.4	3.6	88.9	14.3
78	7.6	3.6	93.4	8.1
79	15.6	5.5	88.7	15.5
80	4.4	3.6	90.7	4.5
81	8.7	4.8	87.9	8.5
82	15.2	11.6	87.2	14.4
83	23.5	15.5	94.5	25.2
84	27.9	15.3	91.0	28.2
85	6.0	10.4	92.1	6.2
86	47.2	21.6	87.3	43.2
87	20.2	9.7	92.5	20.9
88	25.6	3.6	88.1	25.0
89	28.8	10.1	82.3	24.4
90	9.7	3.6	92.4	10.1
91	12.0	3.6	91.6	12.5
92	10.3	3.6	86.3	9.7
93	11.5	8.9	86.9	10.9
94	41.7	12.9	77.6	31.2
95	9.6	3.6	92.3	10.0
96	16.3	7.1	87.1	15.5
97	44.2	24.4	83.0	36.1
98	7.8	3.6	87.7	7.6
99	18.9	3.6	90.5	19.5
100	7.7	3.6	85.4	7.1
101	35.1	12.3	78.5	27.1
102	77.7	19.4	74.1	49.5
103	69.8	26.8	77.6	48.7
104	5.8	3.6	88.8	5.7
105	14.5	8.2	87.5	13.8
106	7.2	3.6	89.8	7.3
107	28.4	16.3	82.5	23.5
108	7.3	3.6	91.4	7.5
109	6.2	6.1	87.1	5.9
110	8.1	4.5	89.2	8.1
111	28.4	16.3	74.9	19.0
112	12.7	3.6	94.7	13.8
113	4.3	3.6	65.3	2.1
114	13.3	6.7	87.5	12.7
115	9.6	5.8	92.7	10.1
116	7.8	24.2	87.5	7.1

Shed ID	Acres	Tlag (minutes)	CN	Q100 (cfs)
117	11.9	3.6	89.5	12.1
118	5.0	3.6	92.8	5.2
119	12.2	3.6	94.5	13.1
120	31.5	7.3	92.4	32.7
121	5.6	3.6	92.3	5.8
122	13.8	3.6	94.0	14.7
123	5.0	7.2	87.4	4.8
124	2.5	3.6	88.3	2.4
125	17.5	4.0	85.8	16.4
126	13.0	4.4	89.8	13.2
127	3.7	3.6	87.1	3.5
128	2.4	3.6	86.8	2.3
129	4.4	3.6	82.1	3.7
130	16.9	6.3	89.3	16.8
131	20.4	12.6	86.8	19.3
132	17.7	5.8	89.0	17.6
133	7.1	3.6	87.0	6.8
134	20.5	4.1	86.2	19.2
135	47.0	21.4	80.1	35.9
136	27.0	3.6	92.2	28.2
137	24.3	16.8	86.5	22.2
138	3.3	3.6	87.7	3.3



City Limits
Watershed Boundary
Major Watersheds
Sonoma Creek
Fryer Creek
Nathanson Creek
Schell Creek
ID Minor Watersheds & ID

Creeks
Bypass Channel
Modeled Storm Drain Pipes
Storm Drain Pipes (not modeled)
Flow Path
Modeled Storm Drain Manholes
Modeled Storm Drain Outlets

0 1,000 2,000 ft

1 inch = 1,000 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits; Winzler and Kelly GIS: Creeks, Storm Drain System, Sheds.

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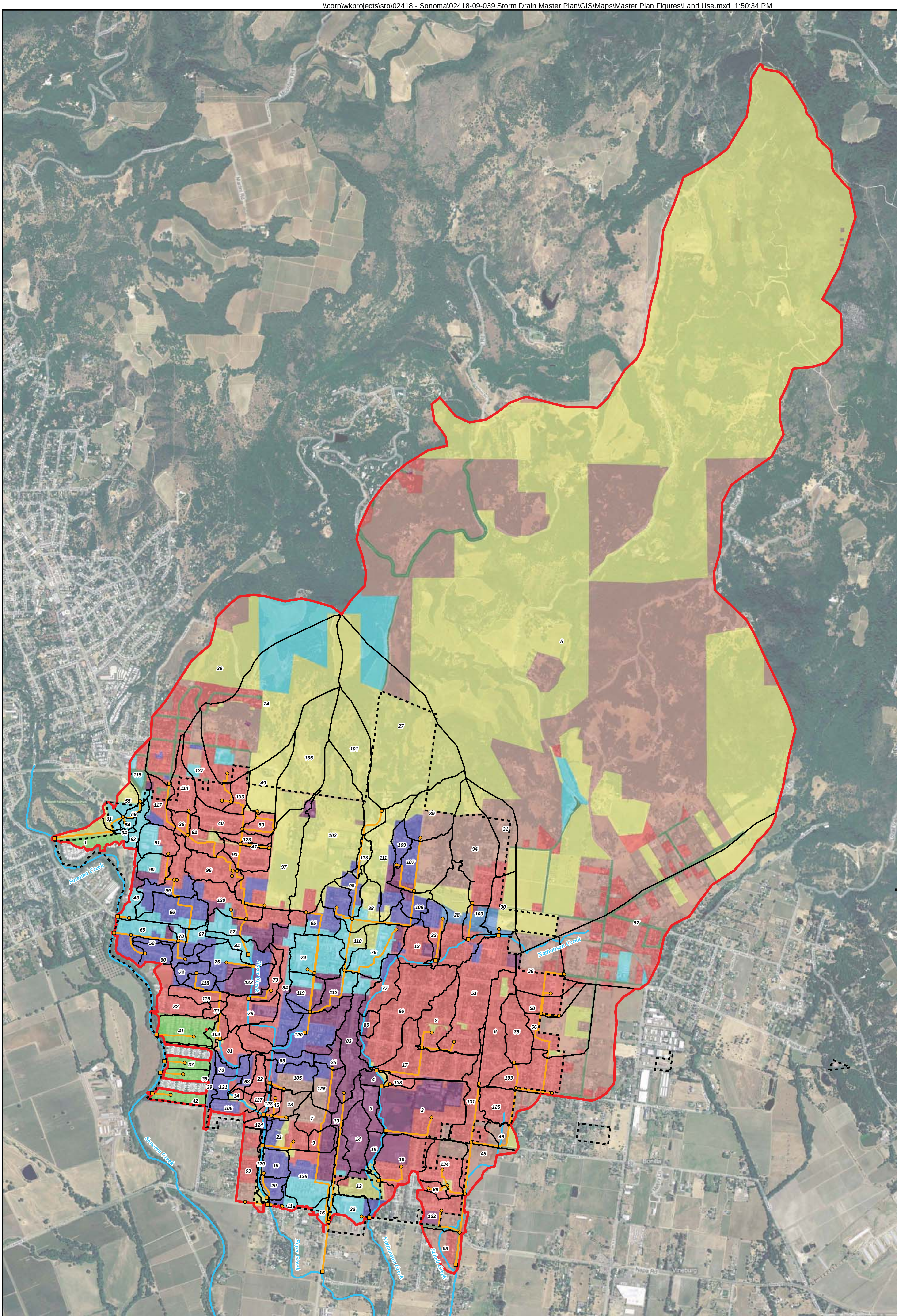
Cartography	Date	Project #
AF	5/12/2011	0241809039

Figure 4-1.1
Major Watersheds and Subbasin Delineations

Storm Drain Master Plan

City of Sonoma



City Limits
Watershed Boundary
Minor Watersheds & ID
Creeks
Bypass Channel
Modeled Storm Drain Pipes
Modeled Storm Drain Manholes
Modeled Storm Drain Outlets

Land Use
Very Low Density Residential
Low Density Residential
Medium Density Residential
Mobile Home Park
Commercial
Public, Mixed Use, and High Density Residential
Wine Production
Parks and Agriculture
Roads

0 1,000 2,000 ft
1 inch = 1,000 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits and Land Use; City of Sonoma: Zoning; Winzler and Kelly GIS: Creeks, Storm Drain System, Sheds.

WINZLER & KELLY
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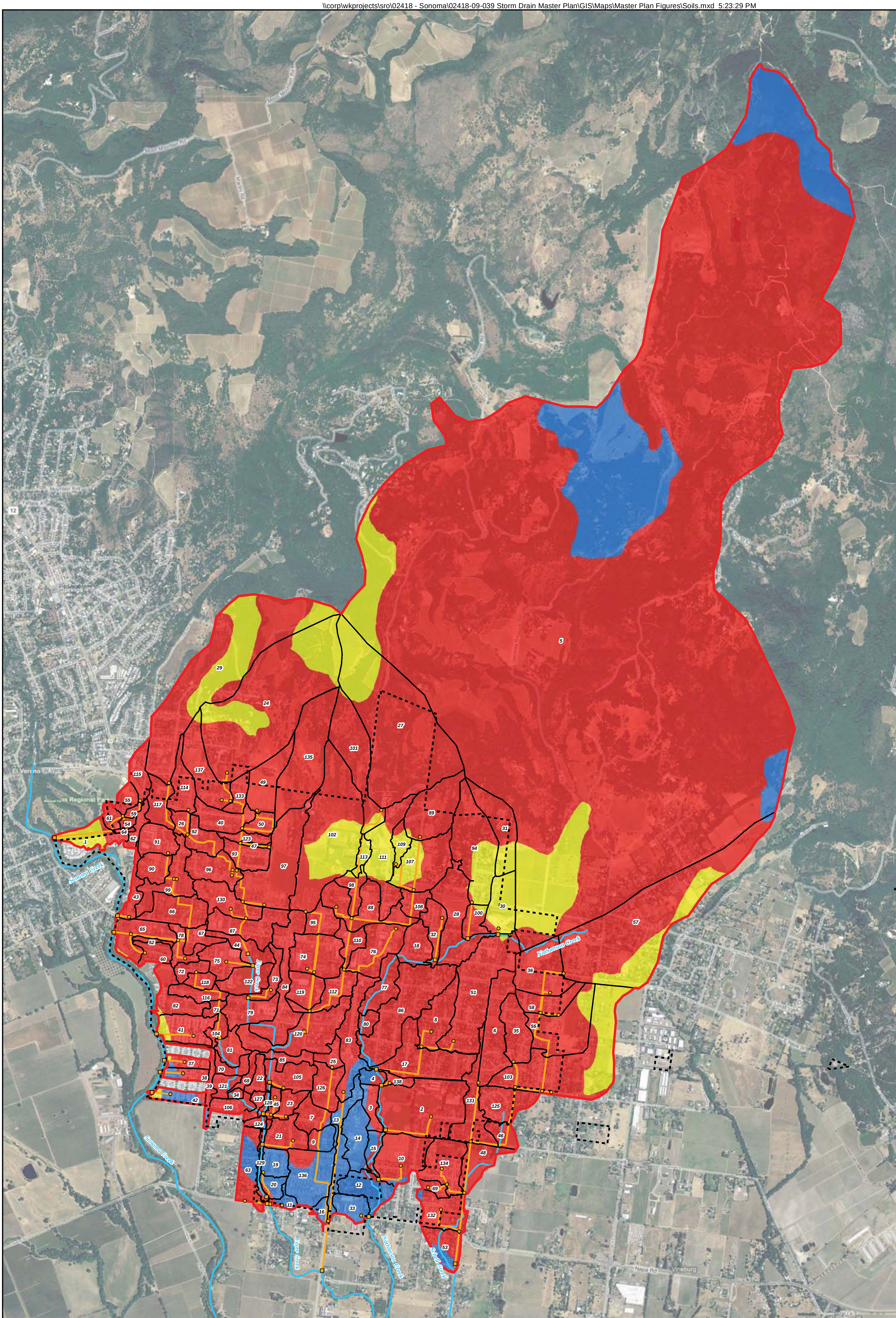
Cartography	Date	Project #
AF	5/12/2011	0241809039

Figure 4-1.2
Watershed Subbasins by Land Use

Storm Drain Master Plan

City of Sonoma

\\corp\wkprojects\sro\02418 - Sonoma\02418-09-039 Storm Drain Master Plan\GIS\Maps\Master Plan Figures\Soils.mxd 5:23:29 PM



City Limits
Watershed Boundary
ID Minor Watersheds & ID
Creeks
Bypass Channel
Modeled Storm Drain Pipes
Modeled Storm Drain Manholes
Modeled Storm Drain Outlets

Hydrologic Soil Group

A - Sandy, Well Drained
B - Sandy Loam
C - Clay Loam
D - Poorly Drained

0 1,000 2,000 ft

1 inch = 1,000 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits; SSURGO: Digital Soil Survey; Winzler and Kelly GIS: Creeks, Storm Drain System, Sheds.

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Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 4-1.3
Watershed Subbasins by Hydrologic Soil Group

Storm Drain Master Plan

City of Sonoma

4.3 TR-55/SCS Model

The hydrologic runoff procedures outlined in the USDA-NRCS (formally Soil Conservation Service) Technical Release No. 55 (TR-55) were followed and implemented for developing and simulating hydrology within MU. TR-55 is widely used as a hydrological basis for flood studies and is accepted in the industry.

4.3.1 Loss Rate Method

Following TR-55 principles, the empirical curve number method was utilized in MU to estimate total excess precipitation. The curve number (CN) represents the soil cover, land cover and antecedent moisture conditions of a watershed and its sub-basins. The CN method determines runoff using the amount of precipitation and the infiltration parameters associated with soil type, soil moisture, preceding rainfall, and surface retention. The amount of rainfall is converted to runoff using the CN. The CN ranges from 0 to 100, where a value of 100 represents zero losses or a completely impermeable surface (USDA, 1986). Impermeable pavements typically are assigned a CN of 98.

Surface soils are classified into four hydrologic soil groups (HSG) A, B, C, and D according to their minimum infiltration rate. Antecedent moisture conditions are classified as either low (AMC I), average (AMC II), or high (AMC III). For the purpose of this report, it is assumed that AMC II curve numbers be applied. AMC II assumes that 0.5-inches to 1.1-inches of rain had fallen in the watershed of interest over the course of 5-days prior to the initiation of the design storm. Curve numbers developed for AMC II are the most widely used in hydrologic analysis when utilizing the SCS method. The hydrologic soil classification of the project area is derived from “Soil Survey of Sonoma County, California”.

The diverse land coverage within the watersheds were identified from City and County of Sonoma zoning/land use GIS layer data assuming full build-out conditions. Because most sub-basins consist of multiple HSGs and multiple land uses, an area weighted composite CN was calculated for each sub-basin. Table 4-1 summarizes curve numbers that were utilized in this study.

TABLE 4-1 Land use and curve numbers (CN) based on hydrological soild group (HSG) and AMC II

LAND USE	Curve Number (CN)			
	Hydrologic Soil Group (HSG)			
	A	B	C	D
City				
Agricultural	39	61	74	80
Commercial (15 d.u./acre, max)	89	92	94	95
Commercial-Gateway (15 d.u./acre, max)	89	92	94	95
Mixed Use (12 d.u./acre, max)	80	88	93	95
Public Facility	80	88	93	95
Park	39	61	74	80
High Density (11-15 d.u./acre)	80	88	93	95

LAND USE	**Curve Number (CN)**			
	Hydrologic Soil Group (HSG)			
	A	**B**	**C**	**D**
Hillside Residential (1 d.u./10 acres, max)	46	65	77	82
Low Density Residential (2-5 d.u./acre)	61	75	83	87
Medium Density Residential (7-11 d.u./acre)	78	86	91	93
Housing Opportunity (15-20 d.u./acre)	89	92	94	95
Mobile Home Park (7 d.u./acre, max)	77	85	90	92
Rural Residential (2 d.u./acre, maximum)	46	65	77	82
Sonoma Residential (3-8 d.u./acre)	62	76	84	88
Wine Production	65	75	82	86
County				
Diverse Agriculture	39	61	74	80
General Commercial	89	92	94	95
General Industrial	81	88	91	93
Land Extensive Agriculture	49	69	79	84
Land Intensive Agriculture	63	75	83	87
Limited Commercial	80	88	93	95
Limited Industrial	78	86	91	93
Public/Quasi-Public (buildout)	80	88	93	95
Recreation/Visitor Serving Commercial	89	92	94	95
Resources/Rural Development	61	75	83	87
Rural Residential (< 2 units/acre)	54	70	80	85
Urban Residential (2-4 units/acre)	61	75	83	87

NOTE: Curve numbers (CN) reported is for antecedent moisture condition II (AMC II)

4.3.2 Transform Method

Following TR-55 principles, the SCS Unit Hydrograph (UH) model was used in MU as the direct-runoff transform method. The model is based upon averages of UH derived from gauged rainfall and runoff for a large number of small agricultural watersheds throughout the United States. The SCS UH model uses a dimensionless, single-peaked unit hydrograph. Utilizing the UH method in MU requires the lag time for each sub-basin. For watersheds with no gauge information, the lag time is related to time of concentration as:

$$T_{lag} = 0.6\ T_c$$

Travel time (Tt) or time of concentration (Tc) is the time required for surface runoff from the most remote part of the drainage area to reach the design point. Tc is the sum of the sheet flow time, shallow concentrated flow time and the open channel/pipe flow time.

$$T_c = T_{t(sheet)} + T_{t(shallow\ concentrated)} + T_{t(channel)}$$

Sheet flow is flow over the plain surfaces. Typical recommendations include that this segment of flow be less than 300 feet. However, sheet flow length is limited to 300 feet in TR-55 model. Manning's kinematic equation is used to compute T_t :

$$T_t = \frac{0.007\left(n\,L\right)^{0.8}}{(P_2)^{0.5}\,S^{0.4}}$$

Where

T_t = travel time (hr)
n = Manning roughness coefficient (for sheet flow)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft)

After the initial sheet flow, an equation describing shallow concentrated flow is used until the flow path can be represented as open channel flow:

$$T_t = \frac{L}{3600\ V}$$

Finally, once the flow path reaches a channel, curb and gutter, or other hydraulic condition travel time is estimated using open channel flow equation:

$$T_t = \frac{L}{3600\ V} \qquad V = \frac{1.49}{n} R^{2/3} S^{0.5} \text{ (Manning Equation)}$$

The primary flow path for each sub-basin was obtained through digitization using the aerial 1-foot contour topographic data recently completed for the City. For sub-basins outside the city limits, United States Geologic Survey (USGS) quadrangle maps were used. The flow paths were digitized in GIS and elevations required to determine sub-basin slopes were also obtained from the topographic data. Principles outlined in TR-55 were utilized to calculate the time of concentration and lag time conversions based on sheet, shallow concentrated, and channel/pipe flow through each sub-basin. The hydraulic routing time used in this study assumes full pipe and full channel flow velocities along the sub-basin flow path. Manning's Equation was utilized for full channel capacity calculations using 'n' values tabulated below in Table 4-2. Utilizing the information discussed above, the lag times for each sub-basin were calculated and input into the MU hydrology model.

TABLE 4-2 Manning's 'N' Values Used In Full Channel Flow Calculation

Type of Channel and Description	n
RCP	0.014
Concrete Trench Drain	0.014
Concrete Swale	0.015
Earth: Short grass, few weeds	0.035
Earth: Light brush on banks	0.05
Earth: Dense weeds	0.08
Natural Channel	0.07

4.3.3 Base Flow Method

Base flow accounts for the quantity of flow contributed from groundwater, and not direct precipitation-runoff. For modeling design storms, each sub-basin requires an initial base flow. Because most flow paths within the study area are only occupied with flow during precipitation events, the base flow for each sub-basin is assumed to be zero.

4.3.4 Precipitation Events

MU offers various methods for assigning and modeling precipitation events. For the purpose of simulating design precipitation events, the 24-hour SCS Hypothetical Storm method was utilized. This method requires the 24-hour rainfall amount associated with a specific frequency. The method also requires the determination of a rainfall distribution. The SCS has defined four distributions within the United States based on storm intensity. Sonoma County is considered to have a Type IA distribution (NRCS, 1986). For the purpose of this study, 24-hour rainfall depths were obtained from the NOAA Atlas 2.

Table 4-3 provides 24-hour rainfall depths were used in development of the storm drain master plan. Flows for each catchment incorporating the 10-year, 25-year and 100-year events are provide in Appendix D.

TABLE 4-3 Design Rainfall Events Used in the SDMP

Rainfall Event	Rainfall Depth (in)
10 year, 24 hour	4.5
25 year, 24 hour	5.5
100 year, 24 hour	7.0

5.0 HYDRAULICS

5.1 Design Criteria and Assumptions

The design criteria used in the hydrologic/hydraulic analysis is based on the SCWA FCDC Standards. These criteria include:

- For watersheds of one to four square miles (secondary waterways), the design storm is a 25-year event.
- For watersheds less than one square mile (minor waterways), the design storm is a 10-year event.
- Secondary or minor waterways outletting into major or secondary downstream waterways shall be designed to operate against a 25-year or 10-year flow respectively in the major or secondary downstream waterway, provided that the ground elevation along the secondary or minor system shall be above the 100-year water surface elevation in the major or secondary downstream waterway.
- Secondary or minor waterways in closed conduits shall have surface routes to carry the incremental 100-year flows with no inundation of structures, or be sized for the full 100-year flows.
- Closed conduits shall be designed with maximum surcharging to within one foot of top of rim or grade for purposes of determining hydraulic capacity.
- Minimum pipe diameter is 12-inches with a minimum velocity of 2.5 feet per second (fps) when flowing full.
- Downstream boundary conditions are based on existing water surface elevations taken from FEMA models for creeks and hydraulic models for pipes when available
- Detention basins will generally be sized for 100-year, 24-hour storm events assuming no increase in runoff from existing conditions

5.2 MIKE URBAN

MU is a hydrodynamic model capable of routing runoff from sub-basins through closed conduit and open channel reaches referred to in the model as *links.* Links were digitized in the model based on the City of Sonoma GIS data provided by the City and subsequent modifications were made based on further information provided by the City, survey information, and field visits with City staff. Only storm drain pipes greater than 24 inches in diameter were included in the MU storm drain network. Link data such as invert in elevations, invert out elevations, diameter, material, and length were input into the MU model. Nodes (storm drain inlets/outlets or manholes) were digitized in the model to represent the majority of storm drain manholes and catch basins within the City's storm drain network. Node information such as diameter, bottom invert elevations, and ground elevation were also input into the MU model.

Figure 2-1 shows the digitized storm drain network utilized in the MU model. A full size fold-up of this figure is also included as a separate attachment.

The City of Sonoma storm drain network includes a total of 16 storm drain outlets that discharge to Nathanson Creek, Fryer Creek, Sonoma Creek, or Schell Creek. The outlets are summarized in Table 5-1 along with unique identifiers used in the MU model, its discharge location and station, and the storm drain system designation associated with the discharge. The unique identifiers associated with each outlet and its associated storm drain network are included in Figure 2-1. These MU storm drain outlets provide the active linkage between MU storm drain hydraulics and the MIKE 11 channel hydraulics to be discussed in the following section.

TABLE 5-1 Description of MIKE URBAN Storm Drain System Outlets

MIKE URBAN ID (MUID)	Discharge Reach	Outlet Chainage (ft)	Storm Drain System Designation
Node_1091	Fryer Creek	13.6	Line F-12
Node_928	Fryer Creek	3+13.6	Line F-11
Node_657	Fryer Creek	10+13.6	Line F-10
Node_939	Fryer Creek	34+13.6	Line F-7
Node_669	Fryer Creek	41+63.6	Line F-6
Node_679	Fryer Creek	48+13.6	Line F-5
Node_685	Fryer Creek	60+45.1	Line F-4
Node_688	Fryer Creek	61+93.5	Line F-2
Node_689	Fryer Creek	61+93.5	Line F-3
Node_732	Fryer Creek	[1]	Line F1
Node_1097	East Fork of Fryer Creek	0.0	Line F-9
Node_1062	West Fork of Fryer Creek	0.0	Line F-8
Node_1034	Nathanson Creek	132+60.4	Line N-8
Node_791	Nathanson Creek	139+60.5	Line N-7
Node_1072	Nathanson Creek	149+10.5	Line N-6
Node_854	Nathanson Creek	189+10.9	Line N-5
Node_861	Nathanson Creek	193+61.0	Line N-4
Node_911	Nathanson Creek	204+61.1	Line N-3
Node_1036	Nathanson Creek	227+03.4	Line N-1
Node_919	Nathanson Creek	[1]	Line N-2 (discharges to High Flow Channel of Nathanson Creek)
Node_986	Sonoma Creek	[1]	Line SON-7
Node_1030	Sonoma Creek	[1]	Line SON-6
Node_1057	Sonoma Creek	[1]	Line SON-5
Node_963	Sonoma Creek	[1]	Line SON-4
Node_970	Sonoma Creek	[1]	Line SON-3
Node_1156	Sonoma Creek	[1]	Line SON-2
Node_972	Sonoma Creek	[1]	Line SON-1
Node_1031	Schell Creek	[1]	Line S-1

[1] The stationing associated with this Creek location was outside the MIKE 11 active channel domain.

The storm drain outlets discharging to Nathanson Creek, Fryer Creek, or either of the forks of Fryer Creek were dynamically linked to the MIKE 11 unsteady flow, channel hydraulic models created for these creeks. Therefore, the hydraulic grade line of the creek at any given time represents the tail water condition at each respective storm drain outlet. The storm drain outlets discharging to Sonoma Creek and Schell Creek were assigned tailwater boundary conditions based on 100-year FEMA flood mapping for these creeks.

5.3 MIKE 11

MIKE 11 (M11) is an implicit finite difference model developed by DHI Water and Environment used for modeling networks of one-dimensional channels with respect to both hydrodynamics and water quality transport. It is an unsteady flow model based on the St. Venant equations and thus capable of monitoring one-dimensional channel flows over time and space. M11 has the ability to be dynamically coupled with MU to dynamically simulate interactions between the one-dimensional channels and the City's storm drain network, and can also be coupled with MIKE 21 (M21) to dynamically simulate interactions between the one-dimensional channels and a two-dimensional floodplain. For this storm drain master plan, M11 was coupled to both MU and M21, which is described further in the following section. M11 when coupled with M21 is also known as MIKE FLOOD (MF).

The basic hydrodynamic (HD) model within M11 was utilized for simulating both Nathanson Creek and Fryer Creek channel hydraulics. Sonoma Creek and Schell creek were not included in the M11 model. The HD model allows for calculation of water level, velocity, and discharge throughout the model domain over the simulation period. Simulation periods of 24 hours were utilized to match the 24 hour storms simulated for the 10-year, 25-year, and 100-year return period precipitation events.

The Nathanson Creek model domain included the portion of the creek within city limits and extends from the upstream reaches of the creek near the intersection of 7th St East and Lovall Valley Road to Napa Road to the south. The Fryer Creek model domain extends from the Safeway parking lot near the intersection of 5th Street West and W Napa Street (where open channel conditions commence) to Leveroni Road to the south. Both forks of Fryer Creek were also included in the M11 model. The East Fork of Fryer Creek model domain extends from 2nd Street West to the confluence with Fryer Creek, while the West Fork of Fryer Creek model domain extends from just north of West MacArthur St to the confluence of Fryer Creek.

Input data used in constructing the M11 models for Nathanson Creek, Fryer Creek, and the West and East Forks of Fryer Creek included:

- Network data defining the spatial alignment of the channels
- Topographical data and FEMA HEC-2 data to define structural elements within the channels including bridges and culverts
- Topographical data to define channel cross sections derived from both field survey information and FEMA HEC-2 cross sections
- Hydrodynamic parameters such as Manning's "n" values

- Initial conditions including water level at the downstream boundary of the model domain and base flow at the upstream boundary of the model
- Boundary conditions including water level at the downstream boundary of the model representing the 10-year, 25-year, or 100-year water surface elevation reported in FEMA FIRM mapping

The spatial alignment of the channels was derived from thalweg survey data collected at cross sections with the exception of the West and East Forks of Fryer Creek. The spatial alignments of these forks were digitized based on aerial topographic mapping provided by the City. As mentioned above, structural bridge and culvert input data was obtained from FEMA HEC-2 models for Fryer and Nathanson, while structural data for the West and East Forks of Fryer Creek were obtained from field observation and data collection. Cross sectional data for Nathanson Creek and Fryer Creek was a combination of field survey data and FEMA HEC-2 cross sectional data, while cross sectional data for the West and East Forks of Fryer Creek was obtained from aerial topographic mapping. Manning’s “n” values used in the model were also obtained from the FEMA HEC-2 models.

It is important to note that contrary to the FEMA HEC-2 models, M11 cross sections extend only from left top of bank to right top of bank rather than including the floodplain within the cross sections. Therefore, MIKE 11 models only the active channel, while M21 simulates floodplain hydraulics two dimensionally for a better representation of floodplain and street flooding.

M21 is discussed in the following section.

5.4 MIKE 21

M21 is a 2-dimensional, unsteady hydrodynamic model capable of simulating complex floodplain and street flooding. The M11 model described above, simulates only the active channel portion of Fryer and Nathanson Creeks, while the M21 model routes flow 2-dimensionally once flows from the M11 model exceed the active channel carrying capacity. The M21 model domain also routes street flow 2-dimensionally from flow escaping the storm drain system through manholes and drain inlets.

The M21 model domain covers the extents of the City of Sonoma’s storm drain system including all storm drain infrastructure discharging to Fryer and Nathanson Creeks in addition to a significant storm drain system on the east side of the City of Sonoma which discharges to Schell Creek. The MIKE 21model domain extents are shown in Figure 5-1.

The 1.0-foot resolution Digital Elevation Model (DEM) described in Section 3.1 was used for developing the M21 model surface. The original DEM was aggregated to a resolution of 10.0-feet for use in the M21 model. This resolution provides sufficient detail to accurately represent floodplain and street flooding and two-dimensional hydraulic routing without overwhelming the M21 model engine in terms of computational points. It is generally recommended that M21 models should not exceed 1,000,000 computational grid cells. The 10-foot resolution used in the City of Sonoma M21 model results in 936,804 computational grid cells.

The M21 model was dynamically coupled to both the M1 model simulating one dimensional active channel hydraulics for both Fryer and Nathanson Creeks and the MU model simulating the catchment hydrology and storm drain system hydraulics. The coupling of these models is described in Section 5.5 below.

5.5 MIKE FLOOD and Coupling with MIKE URBAN

MIKE FLOOD (MF) represents the model developed by dynamically coupling the M11 one-dimensional channel hydraulics models for Fryer and Nathanson Creeks and the M21 two-dimensional floodplain hydraulics. For the purposes of storm drain master planning, the MF was coupled with the MU model to better simulate and offer new insight into complex and dynamic interactions between Fryer and Nathanson Creeks, the City's storm drain network, and overland flooding within the floodplain and road network. The ability to accurately simulate these dynamics ultimately allows for accurate prediction of flood reduction impacts of varying alternatives.

Coupling of the new MU model simulating hydrology and storm drain system hydraulics and the newly developed MF model simulating channel and overland flow hydraulics represents a significant advancement in hydraulic modeling within the City of Sonoma.

5.6 Boundary Conditions

The following boundary conditions were used in the Storm Drain Master Plan:

- Downstream water level boundary condition on Nathanson Creek station 25500.7 of 38.0 ft. This location is sufficiently downstream of Napa Road, the limit of our detailed study, and results in a 100 year flood elevation of approximately 52 ft at Napa Road.
- Downstream water level boundary condition of 49.8 feet on Fryer Creek station 7911.5. This location is sufficiently downstream of Leveroni Road, the limit of our detailed study, and results in a 100 year flood elevation of 58 ft at Leveroni Road.
- Upstream flow boundary conditions of 5 cfs at the upstream most extent of both Fryer and Nathanson Creeks, and the upstream most extent of West and East Forks of Fryer Creek. These are intended to represent base flows and increase stability of the MIKE 11 model.
- Downstream water level boundary conditions on storm drain outlets to Sonoma Creek were set based on FEMA FIRM flood profiles for Sonoma Creek.
- Downstream water level boundary condition on the Schell Creek storm drain outlet was also set based on FEMA FIRM flood profile for Schell Creek.

5.7 Calibration

No model calibration was done as part of this SDMP. There are no known gages on either Fryer or Nathanson Creek available for model calibration. We recommend the City consider installing gages on these creeks to provide the necessary data from which to calibrate the MU/MF model. Model results were compared with previous FEMA water surface profiles for Fryer Creek and Nathanson Creek. Although the model results are quite similar, it is possible that the FEMA model may be un-calibrated due to the lack of available stream gage data.

6.0 MODEL RESULTS

6.1 Baseline Conditions

Baseline model runs for the 10-year, 25-year, and 100-year 24-hour storms were completed to identify storm drain and channel hydraulics not meeting the SCWA design criteria set forth in the FCDC, revised August 1983. The following design criteria have been used in assessing baseline conditions and identifying storm drain or channel hydraulics not meeting the design criteria:

- All storm drain networks within the City of Sonoma drain watersheds of less than one square mile; therefore, all storm drain networks are minor waterways with a design storm equal to a 10-year event. All closed conduit storm drains shall be assessed on whether they meet the design criteria limiting surcharging to within one foot of top of rim or grade.
- All storm drains in closed conduits not designed to handle 100-year flows shall have surface routes to carry the incremental 100-year flows with no inundation of structures.
- Fryer Creek drains a watershed of approximately 2 square miles; therefore, Fryer Creek is a secondary waterway with a design storm equal to a 25-year event. The 25-year event shall be maintained with 1.5 feet of freeboard, with the 100-year event kept within the channel banks.
- Nathanson Creek drains a watershed of over 4 square miles; therefore, Nathanson Creek is a major waterway with a design storm equal to a 100-year event. The 100-year event shall be kept within the channel banks.

Baseline results for hydrology, Fryer and Nathanson Creeks, and the City's storm drain system are summarized in the following sections.

6.1.1 Baseline TR-55 Hydrology Results

The rainfall events described in Section 4.3.4 for the 10-year, 25-year, and 100-year 24-hour storms were simulated to develop runoff hydrographs within MU. Rainfall runoff transformation was done within MU using standard TR-55 hydrology methods described in Section 4.3. The resulting runoff hydrograph peak flows for each subbasin are summarized in Appendix D. Results are included for the 10-year, 25-year, and 100-year 24-hour storms.

6.1.2 MIKE Model Results

MU/MF model simulation runs were performed for the 10-year, 25-year, and 100-year 24-hour storms to assess the storm drain system and Fryer and Nathanson Creeks for compliance with the design criteria. Results include:

- Storm drain pipe hydraulics.
- Channel hydraulics including water surface profiles and summary tables of peak flows at critical locations for both Fryer and Nathanson Creeks.
- Overland flow results showing maximum flood depths within the floodplains and City.

Overland flow results are included in Figures 6-1, 6-2, and 6-3 respectively for the 10-year, 25-year, and 100-year 24-hour storms. Full size maps of these figures are included under separate attachment.

Channel hydraulic and storm drain hydraulic results are summarized individually in the following sections.

6.1.2.1. Fryer Creek Hydraulic Results

Fryer Creek receives drainage from a significant portion of the City of Sonoma as depicted in Figure 4-1.1. Fryer Creek channel hydraulics were simulated within MIKE 11, and flows in Fryer Creek were input to the MIKE 11 model through a dynamic coupling with MU in which all storm drain runoff hydrographs are input at their respective outfall locations within Fryer Creek. Fryer Creek was also dynamically coupled to the MIKE 21 2-dimenisonal surface overland flow model to predict floodplain and street overland flow as a result of Fryer Creek overtopping its banks.

The MIKE 11 model results for maximum water surface elevations under the 10-year, 25-year, and 100-year, 24-hour storms are shown graphically in Figure 6-4 at the end of Section 6. The governing design criteria for Fryer Creek, given it is a secondary waterway, is maintaining 1.5-feet of freeboard during the 25-year, 24 hour storm, while having sufficient channel capacity to pass the 100-year event within its channel banks. Figure 6-5 specifically shows the 25-year storm water surface profile for Fryer Creek in addition to the left and right channel bank elevations.

The water surface profile on Figure 6-5 indicates that flows in Fryer Creek during the 25-year design storm exceed the 1.5-foot freeboard requirement throughout the channel's reach within the City, and also exceeds the full bank channel capacity throughout the majority of its reach within the City. The 25-year water surface profile exceeds the channel banks through much of the upper Fryer Creek watershed north of West MacArthur Street including the vicinity of the confluence of the East Fork, Arroyo Way, and the Bettencourt Street and Andrieux Street areas. The 551-ft long Bettencourt culvert flows under both flooded inlet and outlet conditions, while the West MacArthur culvert is flooded at its inlet during the 25-year storm. The Arroyo Way bridge is fully submerged, while the Leveroni Road bridge is flooded above its soffit elevation.

Large hydraulic losses at the West MacArthur Street culvert are depicted in the water surface profiles in Figure 6-4. During the 25-year storm, these losses total approximately four feet across the length culvert. The profile figure shows the culvert bottom at West MacArthur Street is perched approximately two feet on the upstream side and four feet on the downstream side of the culvert. This culvert orientation and its limited cross sectional area (5.5 ft x 12.5 ft) cause significant backwatering effects seen in the water surface profile upstream of the culvert.

Replacement of this culvert with a bridge could be a feasible project for the City and was investigated as part of the CIP planning and project development. Results are described in Section 7.

Figure 6-2 shows the 25-year overland flooding results within the Fryer Creek watershed caused by both flooding of Fryer Creek and storm drain system related flooding. Overland flooding is concentrated in the following areas:

- The open channel portion of Fryer Creek located flowing from 4th Street West to 3rd Street West between Bettencourt Street to the north and Arroyo Way to the south.
- The area north of West MacArthur Street and mainly west of Fryer Creek in the vicinity of the confluence of the East Fork of Fryer Creek.
- Some localized flooding at the upstream end of Fryer Creek (where open channel conditions begin) just east of the Safeway parking lot located at the corner of Fifth Street West and West Napa Street.
- Some localized flooding at the downstream end of Fryer Creek near Leveroni Road.

These localized flooding areas result from Fryer Creek being unable to contain the 25-year, 24-hour event within its banks. Figure 6-3 shows more extensive flooding in the Fryer Creek watershed during the 100-year, 24-hour event.

Table 6-1 summarizes 25-year and 100-year baseline peak flows and peak hydraulic grade lines (HGLs) within the Fryer Creek channel at key locations. Note that these peak flows represent flows contained within MIKE 11, and do not include flows within the MIKE 21 floodplain and/or street flooding. Also, MIKE 11 has different stationing associated with computational points related to peak flow and peak HGL. The former are called Q-points within MIKE 11; the latter are called H-points within MIKE 11. This variation between Q-point and H-point stationing makes reporting both peak flows and peak HGLs for a specific location difficult. However, complete MIKE 11 output summarizing peak flows and peak HGLs at all the Q-points and H-points are included in Appendix F.

TABLE 6-1 Summary Table of Peak Flows and Peak HGLs in Fryer Creek.

Fryer Creek Location	Creek Station (Model Q point Station/H point Station)	Peak Q25 (cfs) 1	Peak Q100 (cfs) 1	Peak Q25 HGL (ft)	Peak Q100 HGL (ft)
Beginning of Open Channel	0+13 (0+35/0+13)	310	357	77.4	77.7
At Andrieux St culvert entrance	10+57 (10+49/10+57)	315	3359	70.6	71.5
At confluence of East Fork Fryer Creek	26+60 (27+13/26+60)	544	594	68.5	68.9
At confluence of West Fork Fryer Creek	41+45 (41+49/41+45)	603	799	61.6	62.4
At Leveroni Road	61+68 (61+68/ 61+68[2])	587	722	57.4	58.0

[1] Peak Q25 and Q100 flows shown are taken directly from the Model Station (Q-point) shown since actual stations do not exist as flow computational points within the MIKE 11 model.

[2] The HGLs for this station were interpolated between adjacent computational points.

The Table 6-1 shows a 14% - 32.5% increase in flow from the 25-year event to the 100-year event depending on location along Fryer Creek. The lower end of the spectrum (14% increase) occurs at the beginning of the open channel and at Andrieux Street where channel flows approach 25-year flood capacity, and significant overbank flows are occurring. Note that the peak flows shown above are limited to the channel flows and do not incorporate flows that have escaped the banks onto City streets or the floodplain. The largest increase in peak flows (32.5%) occurs at the confluence of West Fork Fryer Creek where Fryer Creek has the most freeboard along its reach and no flow is lost to overland flow. The slight decrease in peak flows when comparing flows at the confluence of West Fork Fryer Creek and at Leveroni Road can be attributed to attenuation of peak flows behind the Leveroni Road bridge structure.

CIP projects aimed at reducing flooding within the Fryer Creek watershed are discussed in Section 7.

6.1.2.2. West Fork of Fryer Creek Hydraulic Results

The West Fork of Fryer Creek is located within the southwestern portion of the Fryer Creek watershed. The West Fork channel hydraulics were simulated within MIKE 11, and flows were input to the MIKE 11 model through a dynamic coupling with MU in which the single storm drain outfall to the West Fork was modeled. Runoff hydrographs from the other subbasins within the West Fork watershed that do not contain storm drain system were input as overland flow to the MIKE 11 model. The West Fork was also dynamically coupled to the MIKE

21 2-dimenisonal surface overland flow model to predict floodplain and street overland flow as a result of HGL exceeding creek bank elevations.

The MIKE 11 model results for maximum water surface elevations under the 10-year and 100-year, 24-hour storms are shown graphically in Figure 6-6 at the end of Section 6. The 25-year, 24-hour storm is not shown on this figure due to the proximity of the maximum water surface profile to the 10-year, and 100-year storms. The governing design criteria for the West Fork of Fryer Creek, given it is a minor waterway, is maintaining 1.5-feet of freeboard during the 10-year, 24 hour storm, while having sufficient channel capacity to pass the 100-year event within its channel banks. Figure 6-7 specifically shows the 10-year storm water surface profile for the West Fork of Fryer Creek in addition to the left and right channel bank elevations.

The water surface profile on Figure 6-7 indicates that flows in the West Fork of Fryer Creek during the 10-year design storm exceed the 1.5-foot freeboard requirement throughout the channel's reach within the City, and also exceed the full bank channel capacity throughout the majority of its reach within the City.

6.1.2.3. East Fork of Fryer Creek Hydraulic Results

The East Fork of Fryer Creek is located within the eastern portion of the Fryer Creek watershed. The East Fork channel hydraulics were simulated within MIKE 11, and flows were input to the MIKE 11 model through a dynamic coupling with MU in which the single storm drain outfall to the East Fork was modeled. Runoff hydrographs from the other subbasins within the East Fork watershed that do not contain storm drain systems were input as overland flow to the MIKE 11 model. The East Fork was also dynamically coupled to the MIKE 21 2-dimenisonal surface overland flow model to predict floodplain and street overland flow as a result of the creek flooding its banks.

The MIKE 11 model results for maximum water surface elevations under the 10-year and 100-year, 24-hour storms are shown graphically in Figure 6-8 at the end of Section 6. The 25-year, 24-hour storm is not shown on this figure due to the proximity of the maximum water surface profile to the 10-year, and 100-year storms. The governing design criteria for the East Fork of Fryer Creek, given it is a secondary waterway, is maintaining 1.5-feet of freeboard during the 25-year, 24 hour storm, while having sufficient channel capacity to pass the 100-year event within its channel banks. Figure 6-9 specifically shows the 25-year storm water surface profile for the East Fork of Fryer Creek in addition to the left and right channel bank elevations.

The water surface profile on Figure 6-9 indicates that flows in the East Fork of Fryer Creek during the 25-year design storm exceed the 1.5-foot freeboard requirement throughout the channel's reach within the City, and also exceeds full bank channel capacity throughout the majority of its reach within the City.

6.1.2.4. Nathanson Creek Hydraulic Results

The Nathanson Creek watershed comprises the eastern majority of the City of Sonoma as depicted in Figure 4-1.1. This watershed is larger than Fryer Creek watershed, and is defined as a major waterway per the SCWA FCDC. Nathanson Creek channel hydraulics were simulated within MIKE 11 in conjunction with Fryer Creek; therefore, flows enter Nathanson Creek via a dynamic coupling with MU in which all storm drain runoff hydrographs are input at their respective outfall locations within Nathanson Creek. Nathanson Creek was also dynamically coupled to the MIKE 21 2-dimenisonal surface overland flow model to predict floodplain and street overland flow as a result of HGL exceeding bank elevations.

The MIKE 11 model results for maximum water surface elevations under the 10-year, and 100-year, 24-hour storms are shown graphically in Figure 6-10. The 25-year, 24-hour storm is not shown on this figure due to the close proximity of the maximum water surface profile for the 10-year, and 100-year storms. The governing design criteria for Nathanson Creek, designated as a major waterway, is maintaining 1.5-feet of freeboard during the 100-year, 24 hour storm. Figure 6-11 specifically shows the 100-year storm, water surface profile for Nathanson Creek in addition to the left and right channel bank elevations.

The water surface profile on Figure 6-11 indicates 100-year, 24-hour storm flows are nearly exceeding capacity of the channel along the majority of its reach indicated by the close proximity of the water surface profile with the left and right channel bank elevations. There is little to no freeboard throughout the reach, and several locations exist where 100-year water surface profile elevations exceed the channel bank elevations causing flooding (shown in Figure 6-3). The most notable flooding locations occur at the following locations:

- Between E MacArthur Street and Chase Street (heavy)
- Just upstream of France Street (heavy)
- Upstream of Patten Street (heavy)
- Between 2nd Street East and 3rd St East (heavy)
- Just upstream of East Napa Street (moderate)
- Upstream of 4th Street East (moderate)

The upstream soffit of most bridges on Nathanson Creek is submerged during the 100-year event. The upstream hydraulic grade line at the Patten Street bridge is approximately equal to the bridge's top of deck elevation.

Figure 6-3 shows the 100-year overland flooding results within the Nathanson Creek watershed caused by both flooding of Nathanson Creek, overland flow causing street and structure flooding, and storm drain system related flooding. Overland flooding caused by Nathanson Creek is focused in the following areas:

- A minor overbank breach on the southern bank of Nathanson Creek near the vicinity of the extended intersection of 5th St East and East Spain Street.
- A larger overbank breach on the southern bank of Nathanson Creek in the vicinity of 4th St East, and another overbank breach of the southern bank just upstream of 3rd St East. These flows combine to flow south down 4th St East.
- A larger overbank breach on the southern bank of Nathanson Creek in the vicinity of 2nd St East.
- Several breach locations of both west and east banks of Nathanson Creek from Patten Street to Austin Street.
- Some localized flooding at the southern extent of Nathanson Creek in the vicinity of Sonoma Valley High School and Train Town.

Table 6-2 summarizes 100-year baseline peak flows within the Nathanson Creek channel at key locations. Peak flows described here represent flows contained within MIKE 11, and do not include flows within the MIKE 21 floodplain and/or street flooding.

TABLE 6-2 Summary Table of Peak Flows and Peak HGLs in Nathanson Creek.

Nathanson Creek Location	Creek Station	Peak Q100 (cfs)[1]	Peak Q100 HGL (ft)[2]
At 4th St East	139+70	836	95.0
At 2nd St East	156+15	1,097	85.2
At Patten St	165+01	979	81.3
At Austin St	188+16	940	70.3
At Napa Rd	227+03	1,012	52.2

[1] Peak Q25 and Q100 flows shown are taken directly from the Model Station (Q-point) shown, as the actual stations do not exist as flow computational points within the MIKE 11 model.
[2] The HGLs for these stations were interpolated between adjacent computational points.

Table 6-2 shows some significant variation of 100-year peak flows at the locations shown along Nathanson Creek. The large decrease between 2nd St East and Patten Street is mostly due to large breaches occurring upstream of Patten Street, and results in significant floodplain and street flooding. The Patten Street bridge is also responsible for some attenuation as can be seen in the hydraulic profile of the creek in Figure 6-7.

CIP projects aimed at reducing flooding within the Nathanson Creek watershed are discussed in Section 7.

6.1.2.5. Storm Drain System Hydraulics

The storm drain systems discharging to Sonoma, Fryer, Nathanson, and Schell Creeks within the City of Sonoma all drain areas of less than one square mile;

therefore, all storm drain systems are considered minor waterways with a 10-year design storm. As previously described, SCWA FCDC states that all minor waterways within closed conduits must be able to contain the 10-year design storm. Surcharging is allowed; however, the storm drain system must maintain a minimum one foot of freeboard. Furthermore, the criteria also address 100-year flooding and states that the storm drain system must be able to pass the 100-year flood without causing overland flooding of structures.

Figure 6-1 showing the 10-year flood map for the City of Sonoma also includes a graphical display of freeboard at manholes within the system. The following symbolization was used in this figure:

- Manholes meeting the 1-foot freeboard criteria are shown in green.
- Manholes not meeting the 1-foot freeboard criteria but not exceeding the manhole rim elevation are shown in yellow.
- Manholes with a 10-year hydraulic grade line exceeding the rim elevation are shown in red.

The following pipe segment list outlines storm drain system components not meeting the 1-foot freeboard requirement during the 10-year, 24-hour design storm. In addition to Figure 6-1, refer to Figure 2-1 for storm drain system designations. Appendix E includes longitudinal profiles showing the 10-year hydraulic grade line with respect to ground level for each storm drain line discussed below.

1) Line S-1 – there are a number of storm drain inlets/manholes not meeting the 1-foot freeboard requirement north of Newcomb Street. These include the two most upstream inlets/manholes along East Napa Street, several inlets/manholes between Avenue Del Oro and East Napa Street, and one inlet/manhole along East MacArthur Street. These limitations are due to excessive headloss through the existing 36-inch storm drain pipe located from the intersection of Avenue Del Oro and Appleton Way extending south to East MacArthur Street. An improvement project is proposed to resolve hydraulic constraints within Line S-1, and will be discussed further in Section 7.

2) Line S-1-3 – the most upstream storm drain inlet/manhole located at the intersection of East MacArthur Street and 5th Street East does not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event. However, the pipe appears to be adequately sized, and is not surcharged during the 10-year event. There is little to no cover on the most upstream portion of Line S-1-3. This limitation is not due to hydraulic constraints within the existing storm drain piping but may be due to cover constraints. No improvement project is proposed for this line at this time.

3) Line N-3 – the four most upstream storm drain inlets/manholes on Line N-3 along Eastin Drive do not meet the 1-foot freeboard requirement during the

10-year, 24-hour design event. The most upstream inlet/manhole is also flooding during the 10-year, 24-hour event. These limitations are due to excessive headloss through the existing 24-inch storm drain pipe. An improvement project is proposed to resolve hydraulic constraints within Line N-3, and will be discussed further in Section 7.

4) Line N-5 – several storm drain inlets/manholes along Line N-5 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event, and there are four inlets/manholes with hydraulic grade lines exceeding their rim elevations thereby causing street flooding. There are cover limitations along this line, with some portions of the pipeline having less than one foot of cover. However, there does appear to be excessive headloss through the existing 30-inch storm drain piping causing backwatering of the upstream portion of the alignment. An improvement project is proposed to resolve hydraulic constraints within Line N-5, and will be discussed further in Section 7.

5) Line N-8 – The two storm drain inlets/manholes on Line N-8 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event. This is mainly due to backwater effect from the 10-year water surface elevation within Nathanson Creek. The most upstream inlet/manhole has a rim elevation approximately equal to the water surface elevation within Nathanson, while the intermediary inlet/manhole has a rim elevation approximately 6-inches above the water surface elevation within Nathanson Creek. This limitation is not due to hydraulic constraints within the existing storm drain piping but due to Nathanson Creek backwater effects. No improvement project is proposed for this line at this time.

6) Line F-1 – Several storm drain inlets/outlets located along the roadside ditch on the eastern side of Broadway/Highway 12 are not meeting the 1-foot freeboard requirement. However, this line is not surcharged during the 10-year, 24-hour event, and this limitation appears to be related to minimal cover over the existing storm drain pipe. All of the storm drain inlets/outlets along the roadside ditch have ½-foot freeboard or greater. There are no hydraulic constraints within Line F-1. No improvement project is proposed for this line at this time.

7) Line F-2 - The two storm drain inlets/manholes on Line F-2 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event due to backwater effect from the 10-year water surface elevation within Fryer Creek. Neither inlet/manhole is flooding. This limitation is not due to hydraulic constraints within the existing storm drain piping but due to Fryer Creek backwater effects. No improvement project is proposed for this line at this time.

8) Line F-3 - The three storm drain inlets/manholes on Line F-3 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event due to backwater effect from the 10-year water surface elevation within Fryer Creek. Two of the inlets/manholes are flooding. This limitation is not due to hydraulic constraints within the existing storm drain piping but due to Fryer Creek backwater effects. No improvement project is proposed for this line at this time.

9) Line F-4 – The storm drain inlets/manholes on Line F-3 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event (with the exception of the most upstream inlet/manhole) due to backwater effect from the 10-year water surface elevation within Fryer Creek. None of the inlets/manholes are flooding. This limitation is not due to hydraulic constraints within the existing storm drain piping but due to Fryer Creek backwater effects. No improvement project is proposed for this line at this time.

10) Line F-6 – The most upstream storm drain inlet on Line F-6 does not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event due to backwater effect from the 10-year water surface elevation within Fryer Creek. None of the inlets/manholes are flooding. This limitation is not due to hydraulic constraints within the existing storm drain piping but due to Fryer Creek backwater effects. No improvement project is proposed for this line at this time.

11) Line F-9 – The storm drain outlet at the upstream end of the roadside ditch located adjacent to the Mountain Cemetery is shown as not meeting the 1-foot freeboard requirement in Figure 6-1; however, the actual freeboard is only three hundredths of a foot from meeting this requirement. For all practical purposes, this line is meeting its freeboard requirements. None of the F-9 line is surcharged in this vicinity, and there are no hydraulic constraints within the existing roadside ditches or storm drain piping. No improvement project is proposed for this line at this time.

12) Line F-9-3 – The storm drain inlet/manhole located along this line at W Spain Street where the line turns north to serve the existing development does not meet the 1-foot freeboard requirement. However, this line is not surcharged during the 10-year, 24-hour event, and this limitation appears to be related to minimal cover over the existing storm drain pipe. There are no hydraulic constraints within Line F-9-3. No improvement project is proposed for this line at this time.

13) Line F-12 – The four most upstream storm drain inlets/manholes along Line F-12 do not meet the 1-foot freeboard requirement during the 10-year, 24-hour design event. These inlets/manholes are along Robinson Road north of the Sonoma Bike Path. They are also flooding during the 10-year, 24-hour event.

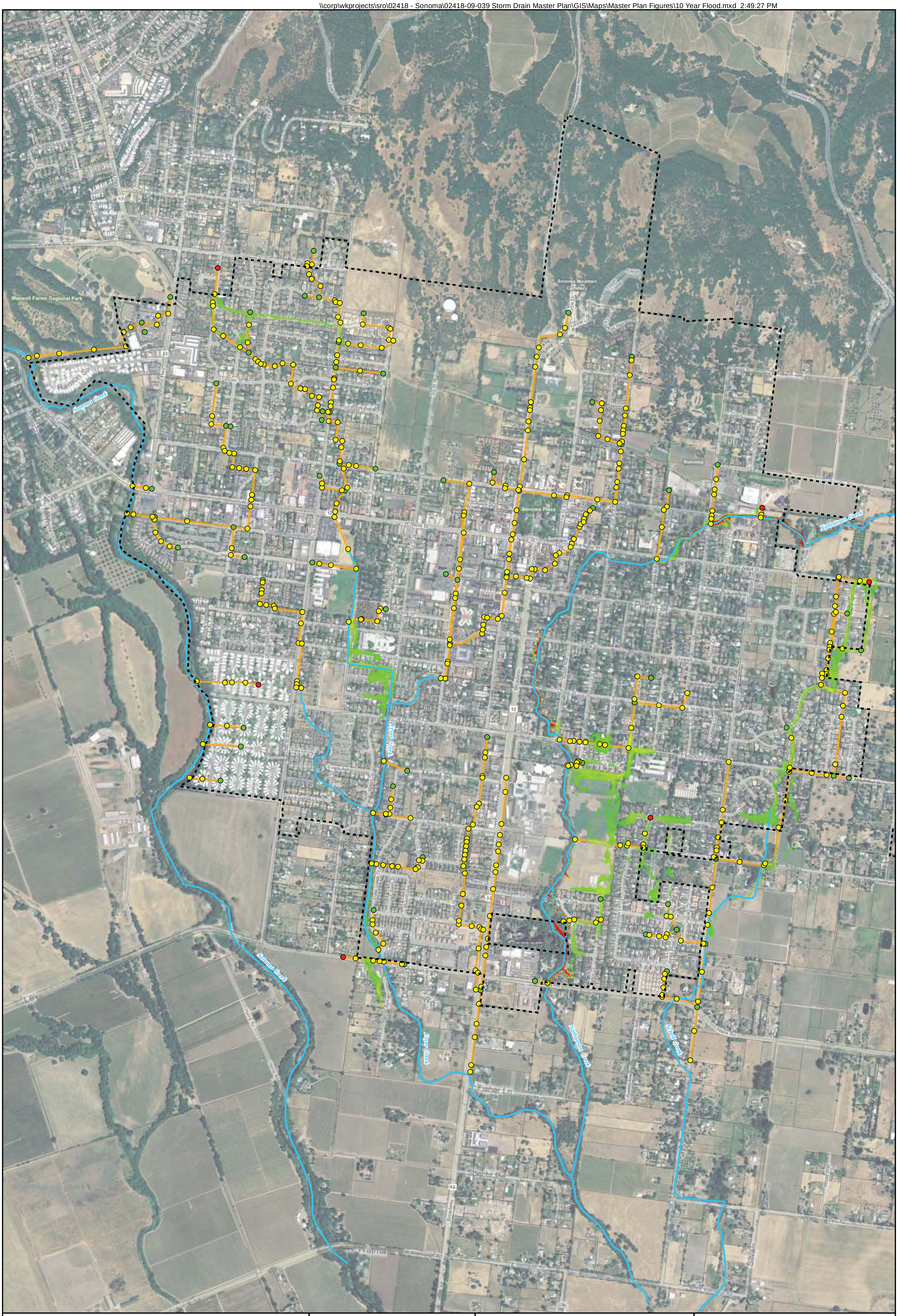
These limitations are due to excessive headloss through the existing 27-inch storm drain pipe. An improvement project is proposed to resolve hydraulic constraints within Line F-12, and will be discussed further in Section 7.

14) Line SON-4 – The three most upstream storm drain inlets/manholes located along this line do not meet the 1-foot freeboard requirement. These inlets/manholes are surcharging and flooding, but this limitation is not due to hydraulic constraints within the existing storm drain piping but due to Sonoma Creek backwater effects. No improvement project is proposed for this line at this time.

In addition to meeting the design criteria for the 10-year, 24-hour design event, the Flood Control and Design Criteria also include criteria that no storm drain infrastructure shall cause overland flooding to structures during the 100-year event. For the purposes of this SDMP, damage caused to structures was assumed to be caused by flooding greater than 6-inches of depth, a standard curb height at which point flooding has the potential to exceed street overland flow routes confined by the curbs. The following list summarizes areas within the City where flow paths resulting from the surcharging storm drain system during the 100-year, 24-hour storm results in downstream flooding of structures.

1) Line F-12 – There are flood depths of greater than 6-inches caused by surcharging storm drain infrastructure resulting in overland flow along Line F-12 in the area bounded by the confluence of Lines F-12-2 and F-12-3. There is also some overland flooding greater than 6-inches south along the F-12 alignment in between W Spain St and W Napa St. These limitations are due to hydraulic constraints within Line F-12. There are several potential improvement projects being considered that could alleviate this overland flooding including overflow bypasses to Sonoma Creek. These will be discussed further in Section 7.
2) Line N-5 – There are flood depths of greater than 6-inches caused by surcharging storm drain infrastructure on E MacArthur Street flooding the high school track and some structures along MacArthur Lane. As discussed prior, this segment of Line N-5 has been targeted for CIP improvements due to hydraulic limitations associated with the 10-year design criteria. The effects of these improvements on the 100-year overland flooding will be discussed further in Section 7.

The remainder of overland flooding caused by surcharging storm drain infrastructure during the 100-year storm is maintained within the roadways and not assumed to have the potential to cause overland flooding of structures during the 100-year storm. Figure 6-1 displays 10-year, 24-hour storm baseline flooding results.



City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets

Storm Drain Manholes Freeboard (ft)
> 1.0
0.0 - 1.0
< 0.0

10 Year Flood Depth (ft)
>1
>0

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, 10 Year Flood.

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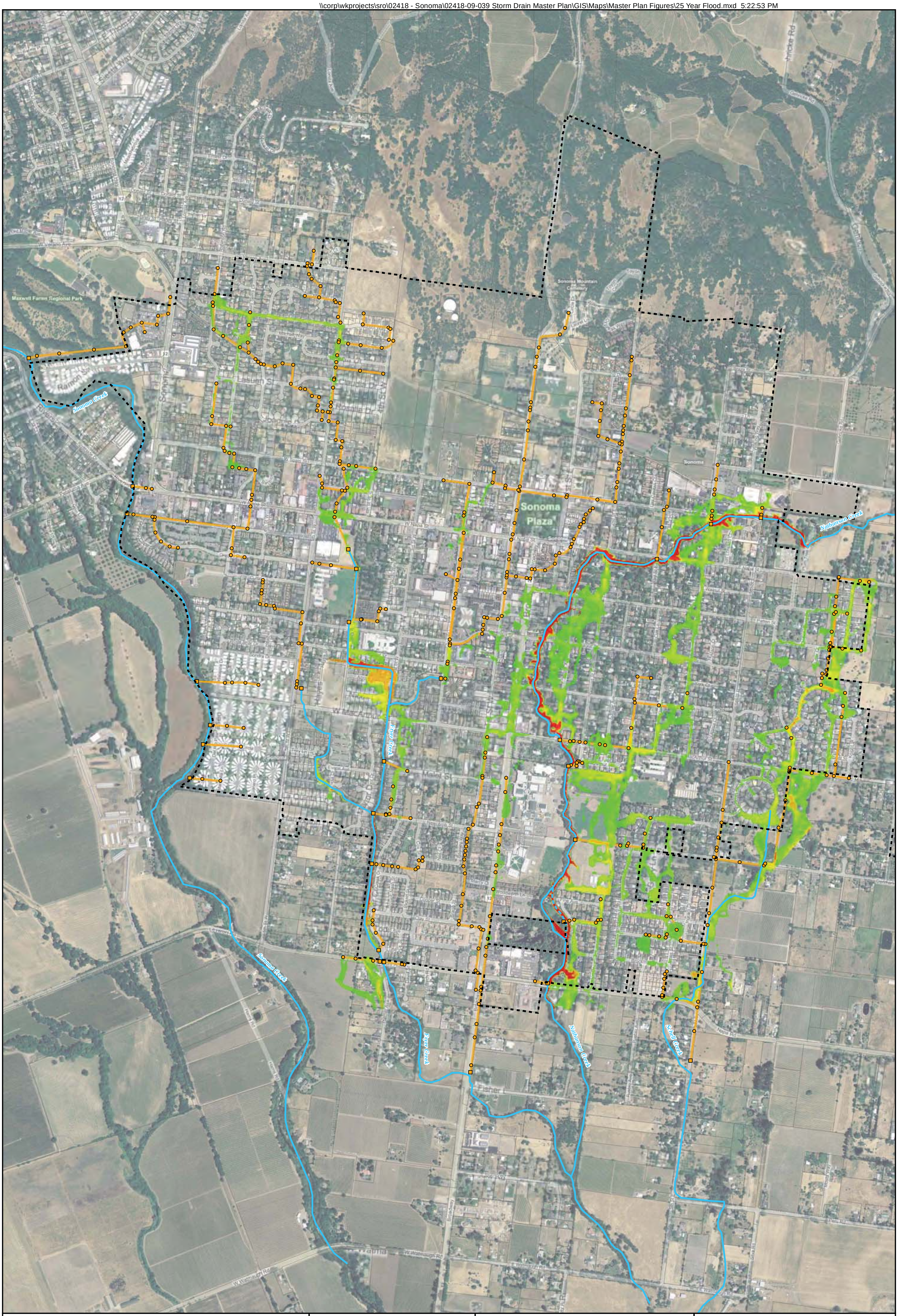
Cartography	Date	Project #
AF	5/12/2011	0241809039

Figure 6-1
10 Year Baseline Flood Map and Storm Drain Hydraulic Results

Storm Drain Master Plan

City of Sonoma



City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Manholes
Storm Drain Outlets

25 Year Flood

Depth (ft)

>1

>0

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, 25 Year Flood.

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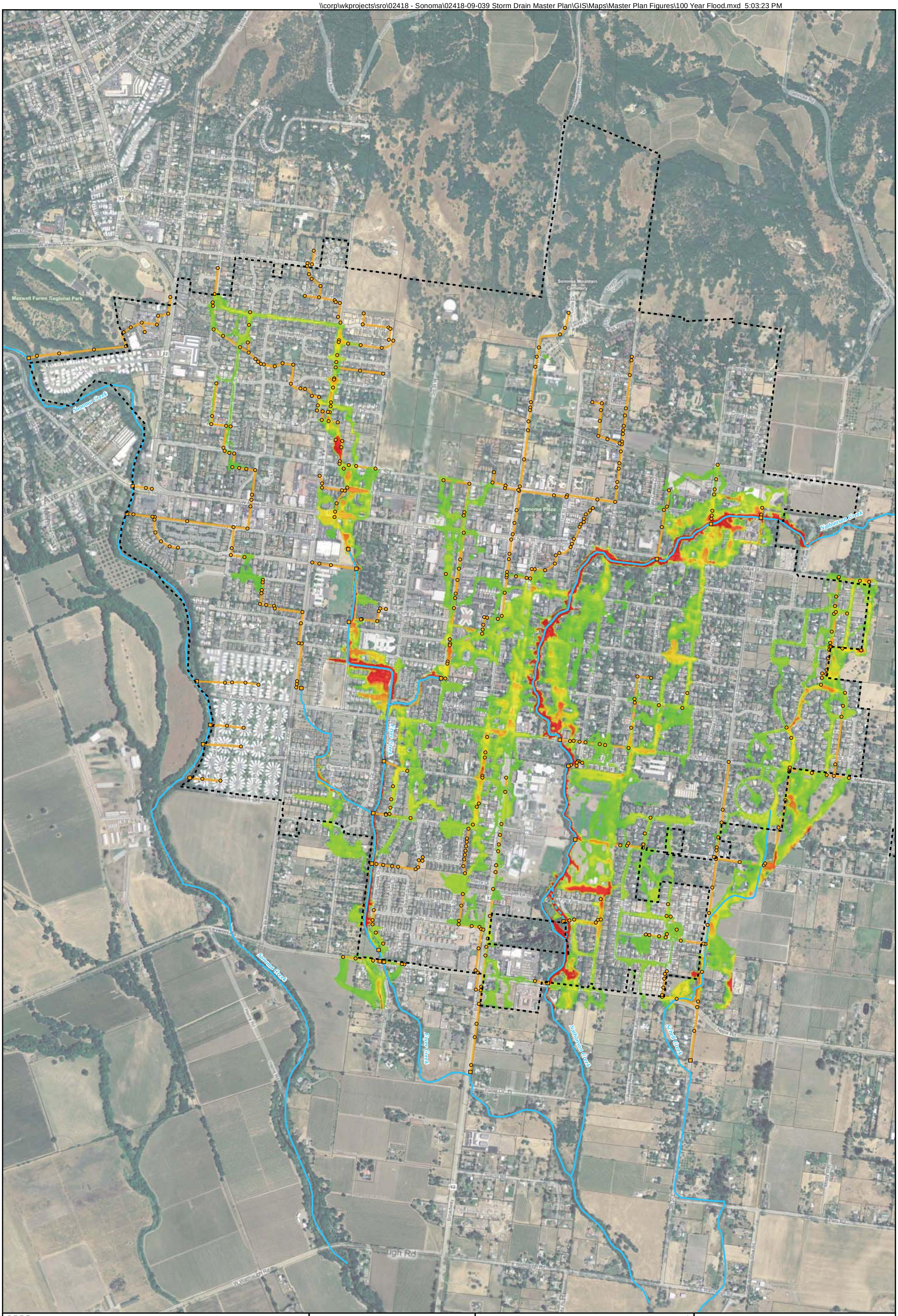
Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 6-2
25 Year Baseline Flood Map

Storm Drain Master Plan

City of Sonoma



City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets
Storm Drain Manholes

100 Year Flood
Depth (ft)
>1
>0

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, 100 Year Flood.

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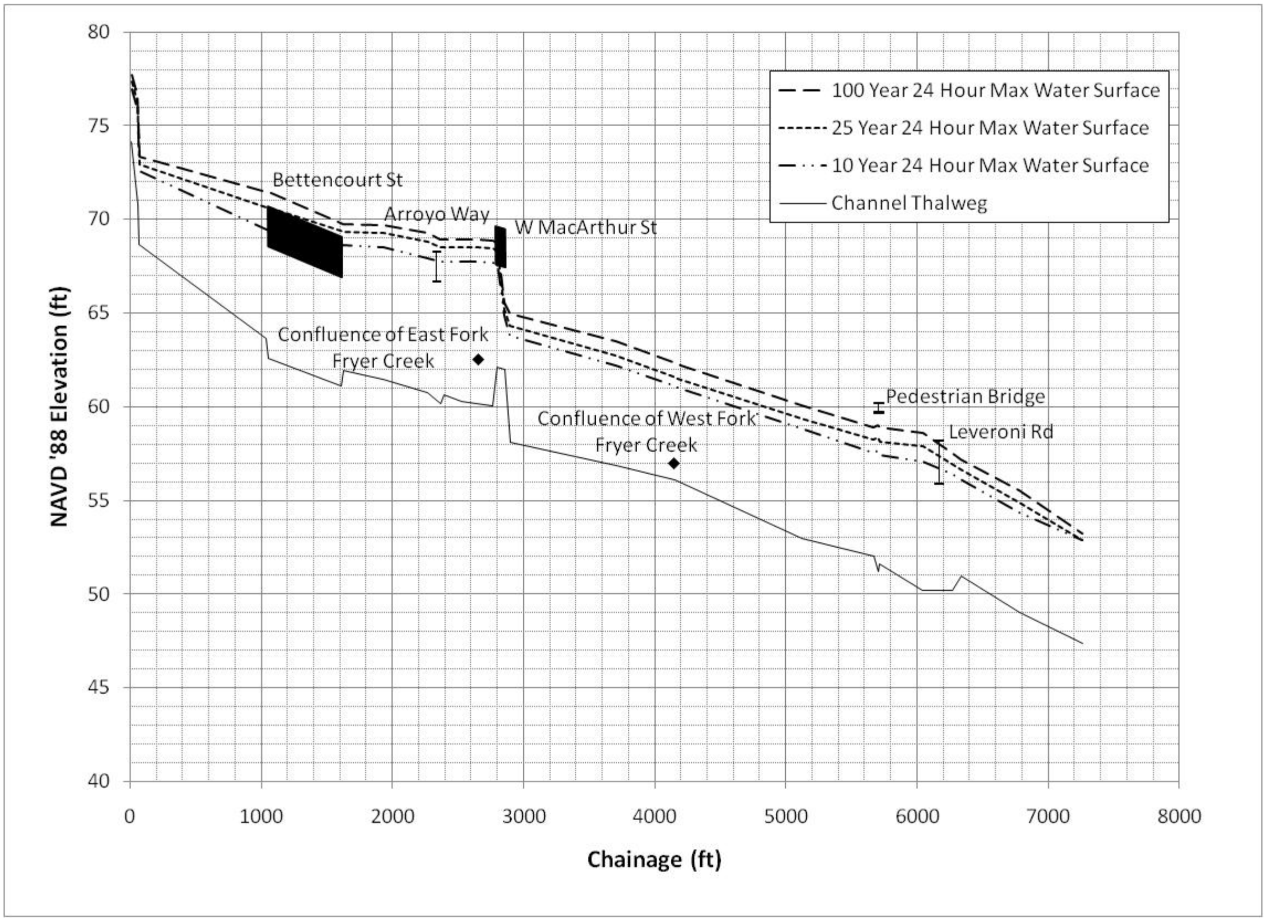
Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 6-3
100 Year Baseline Flood Map

Storm Drain Master Plan

City of Sonoma

Figure 6-4. Maximum Water Surface Profiles for Fryer Creek.



WINZLER & KELLY

Figure 6-5. 25-Year, 24-Hour Design Storm Results for Fryer Creek.

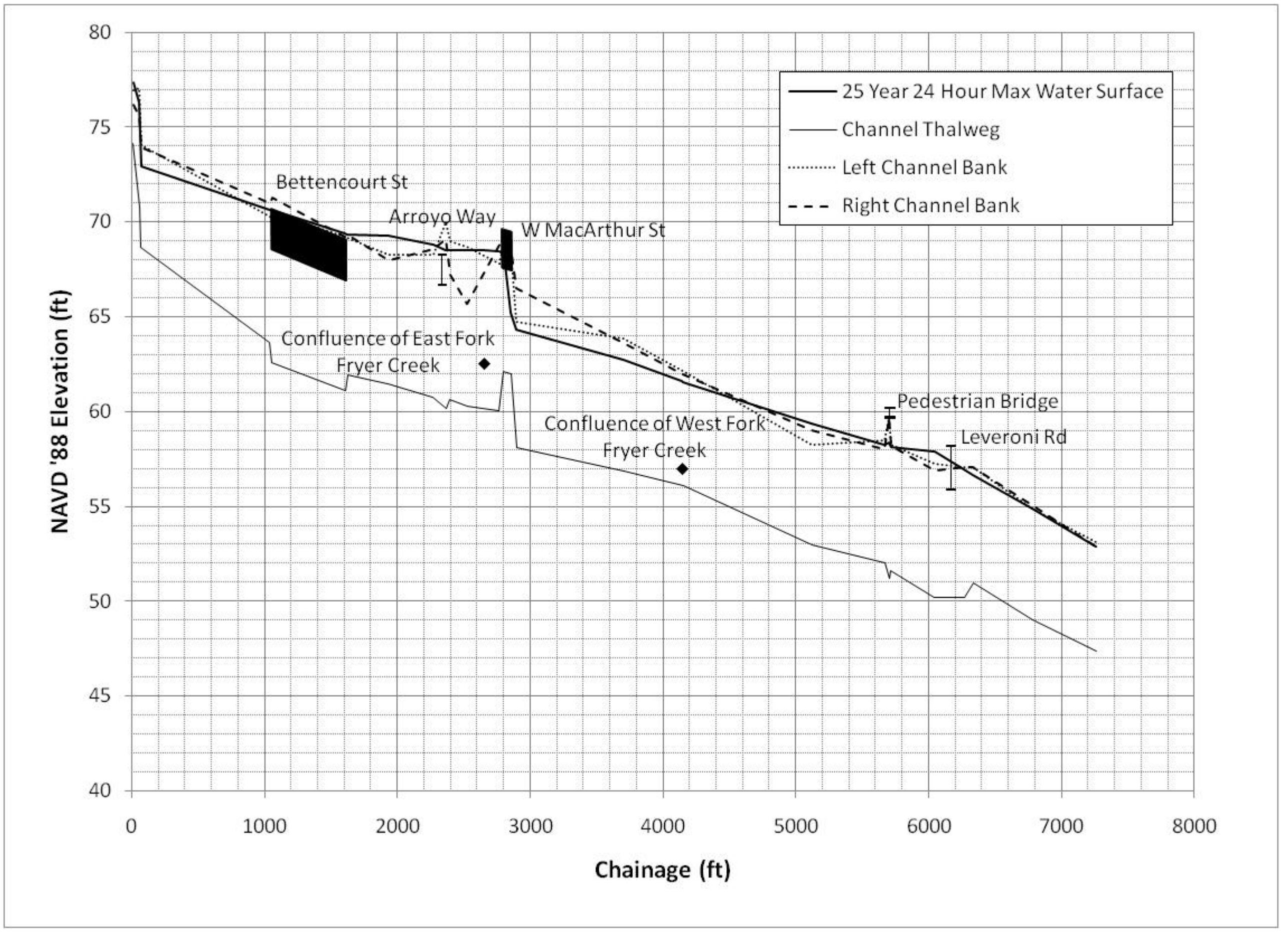


Figure 6-6. Maximum Water Surface Profiles for West Fork of Fryer Creek.

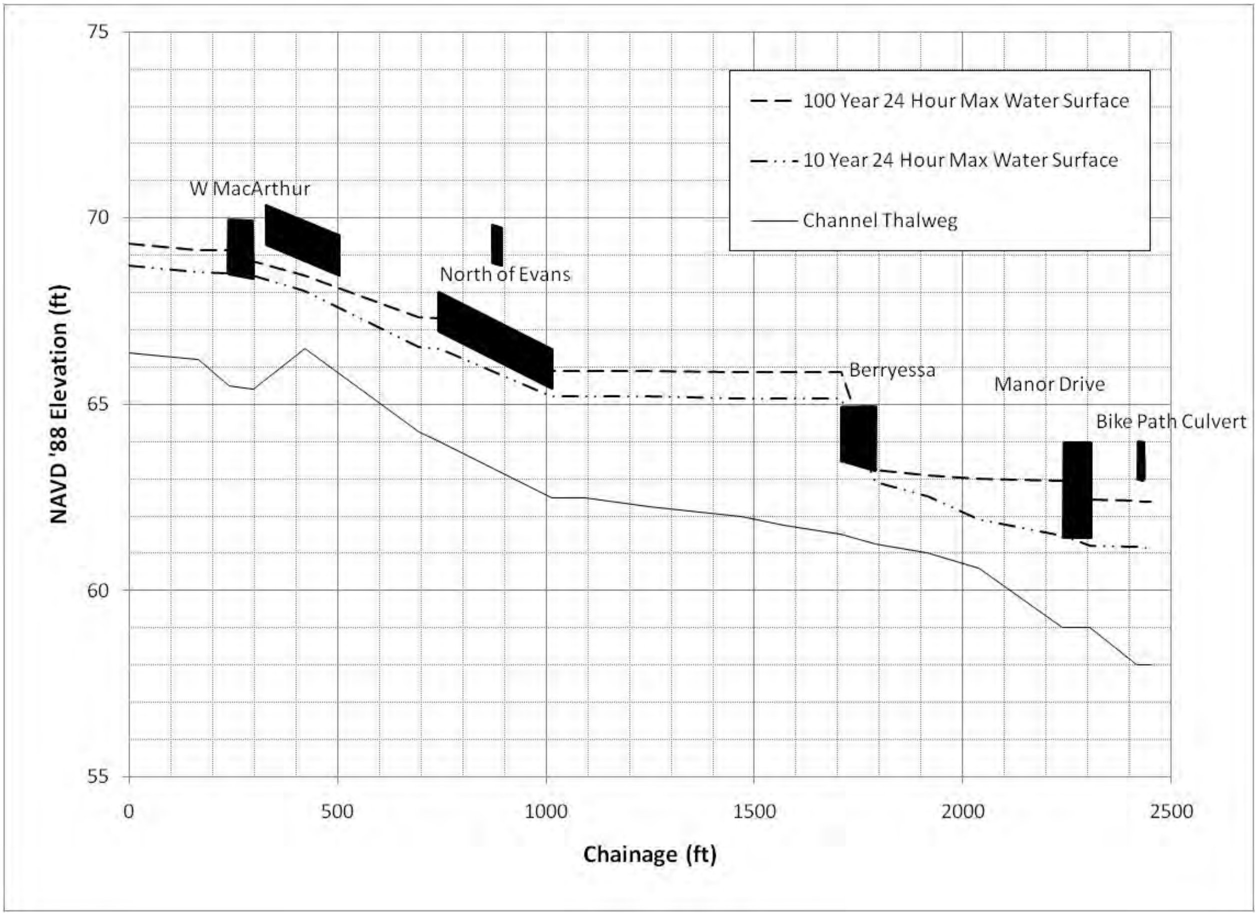


Figure 6-7. 10-Year, 24-Hour Design Storm Results for West Fork of Fryer Creek.

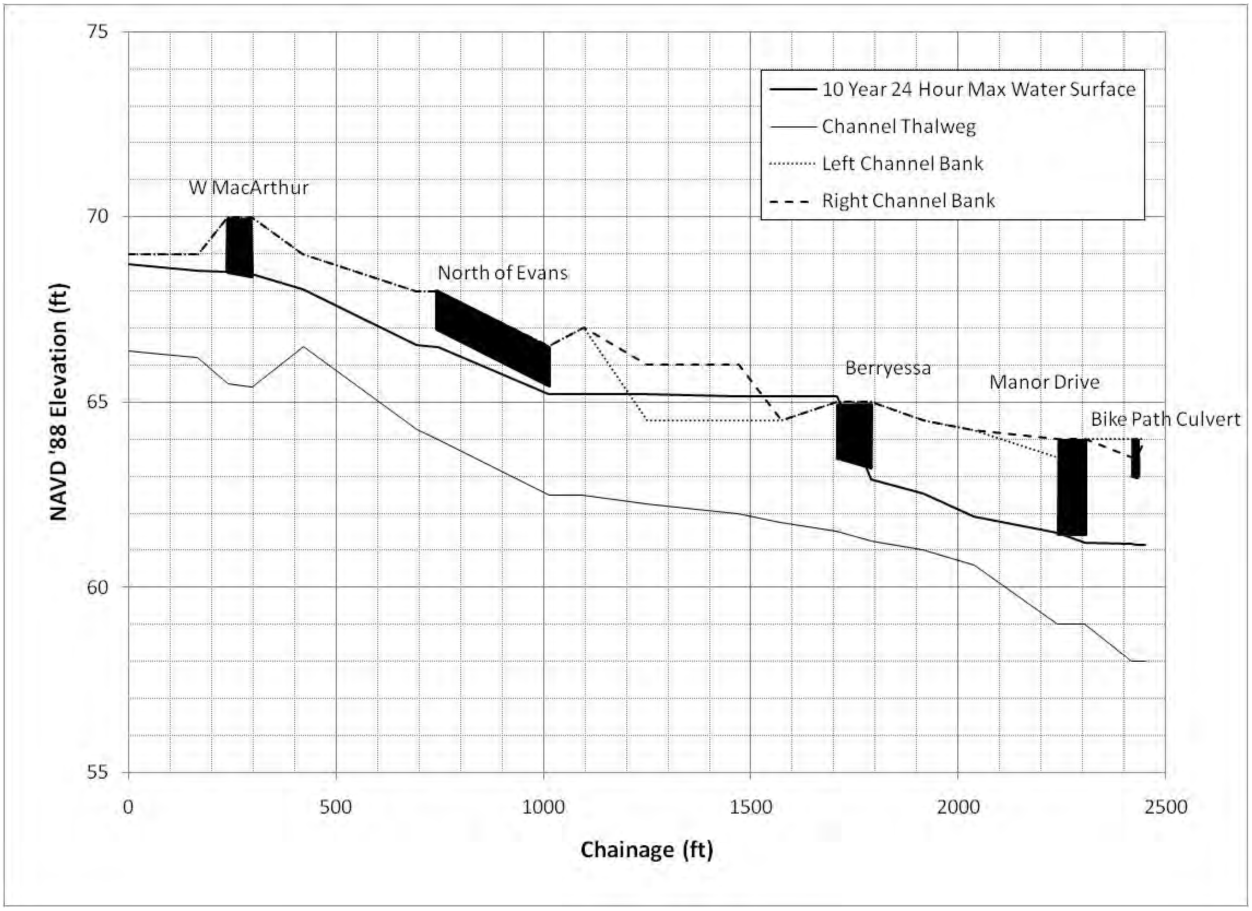


Figure 6-8. Maximum Water Surface Profiles for East Fork of Fryer Creek.

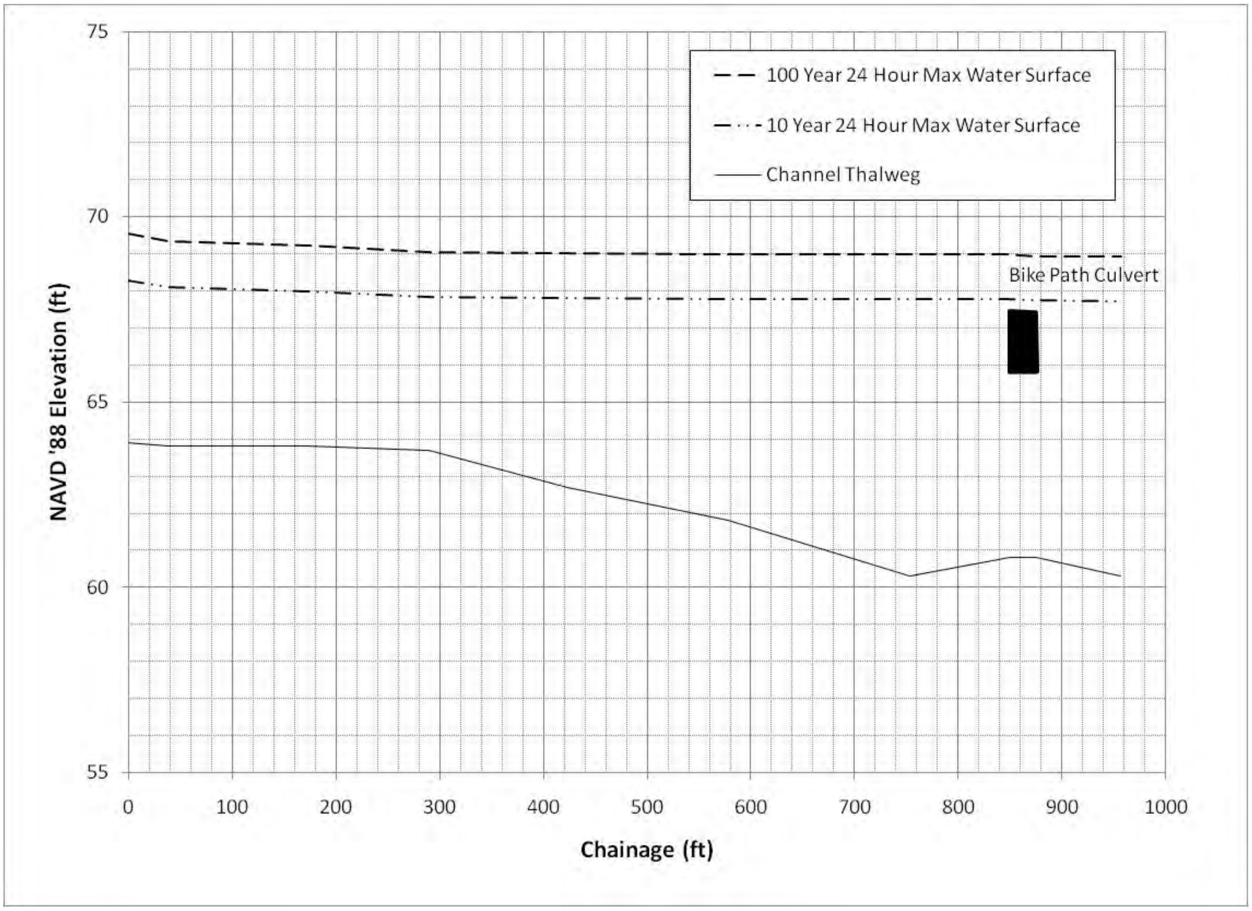


Figure 6-9. 25-Year, 24-Hour Design Storm Results for East Fork of Fryer Creek.

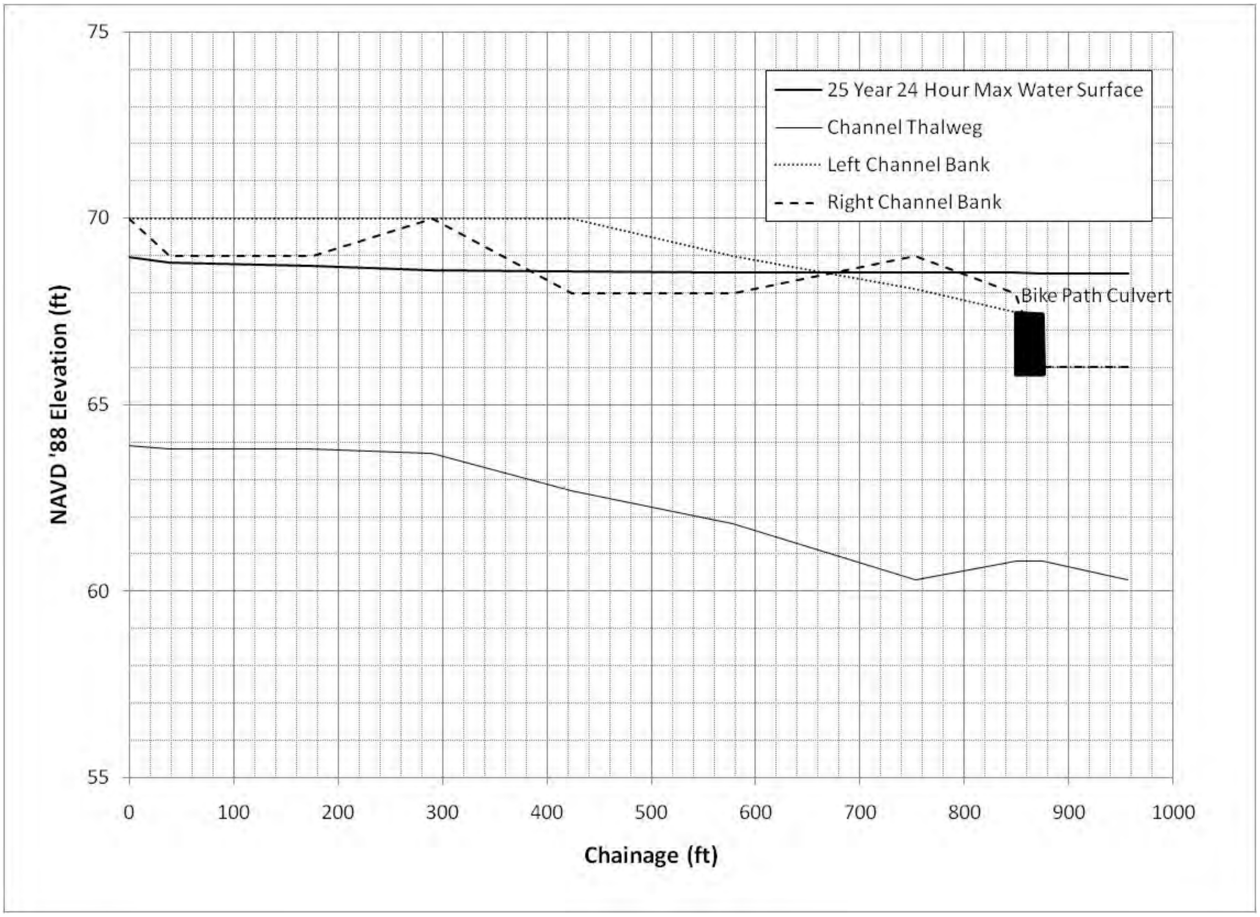


Figure 6-10. Maximum Water Surface Profiles for Nathanson Creek.

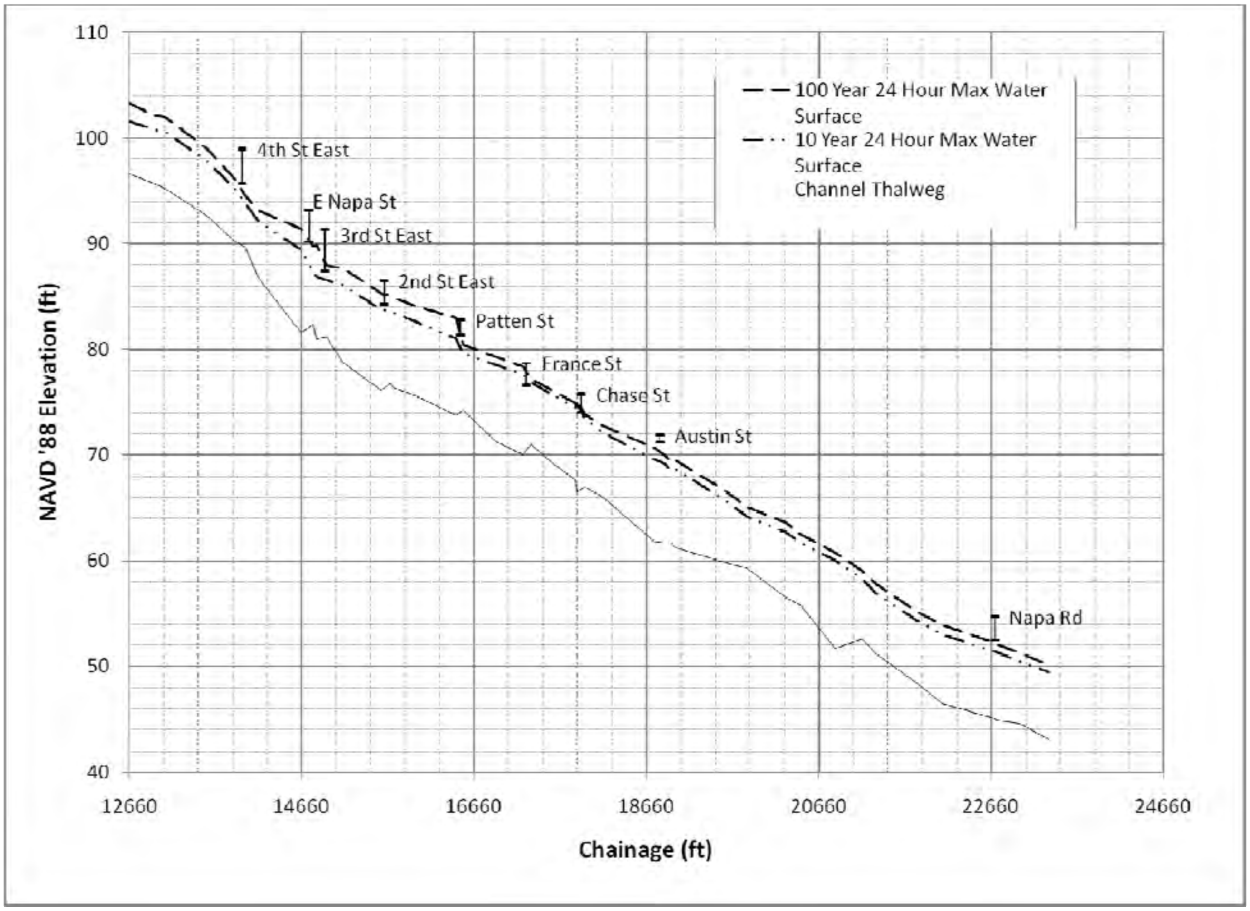
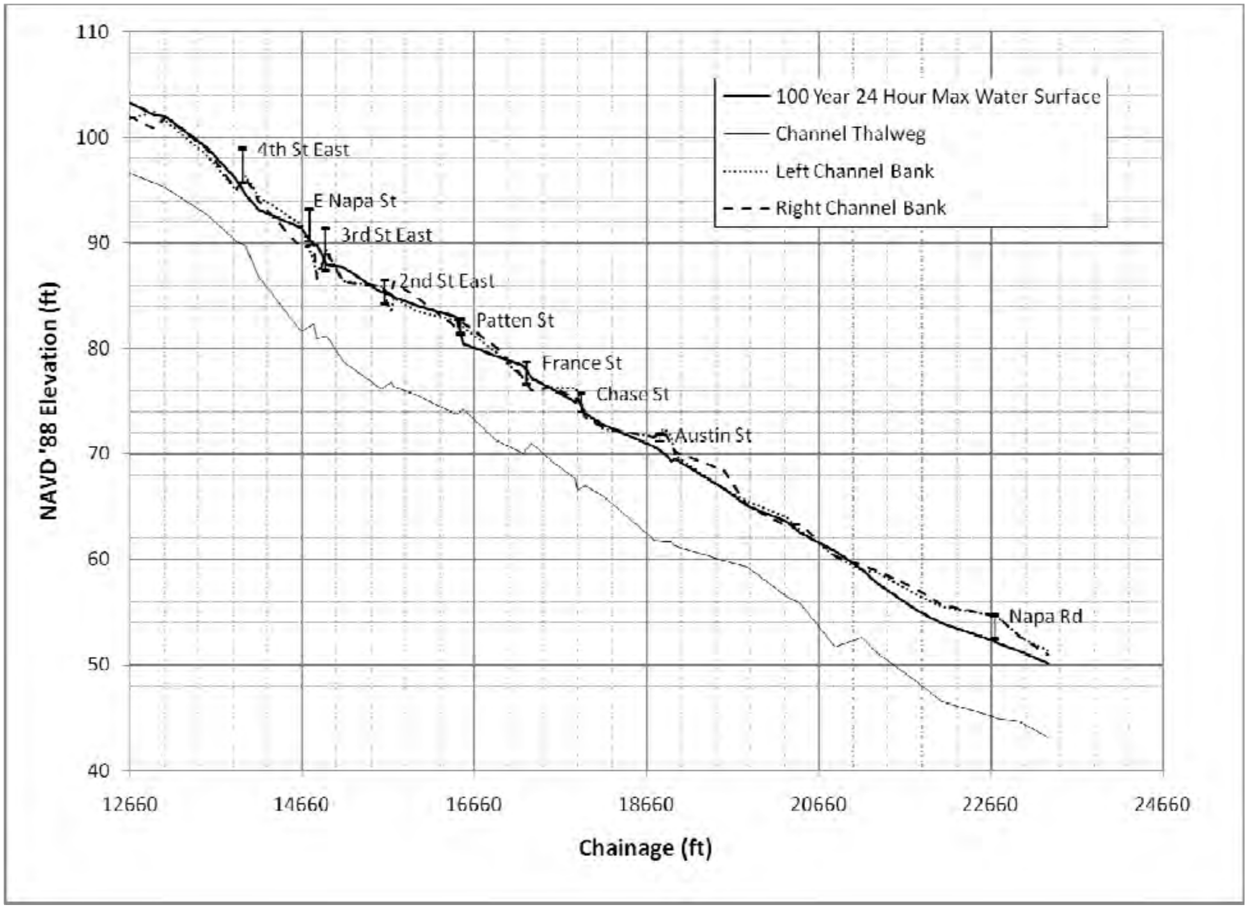


Figure 6-11. 100-year, 24-hour design storm results for Nathanson Creek.



7.0 CAPITAL IMPROVEMENT PROGRAM

This chapter presents modeling results associated with CIP projects identified for the City of Sonoma, and also presents opinions of probable costs associated with the projects. Proposed CIP projects include both improvements to the Fryer and Nathanson Creek channels, and improvements to the City's storm drain system. As previously discussed, the scope of the CIP was focused on identifying storm drain system improvements; however, due to the dynamics between the storm drain system, the Fryer Creek and Nathanson Creek channel systems, and the City's street system, recommendations could not be made for the storm drain system without consideration for potential channel system improvements that may be more cost-effective in handling City flooding.

Storm drain infrastructure CIP projects are recommended based on assessment of system deficiencies based on meeting FCDC guidelines. Storm drain system hydraulics were analyzed to determine if hydraulic constrictions were present which could be alleviated by CIP projects, or if the storm drain system hydraulics were being governed by backwater elevations in Nathanson or Fryer Creeks, in which case improvements to the storm drain system would have no net effect. CIP projects related to Fryer Creek and Nathanson Creek channel improvements are also recommended based on assessment of deficiencies with respect to not meeting SCWA's FCDC guidelines. Channel hydraulics were analyzed to determine where floodwalls could be located to reduce overbank flows resulting in significant street flooding or structure improvements to improve hydraulic grade line conditions within the Creeks.

This section first presents CIP projects and model results related to channel improvements within Fryer Creek and Nathanson Creek, and then presents model results associated with storm drain infrastructure improvements. Channel improvements were investigated first because some potential storm drain infrastructure improvements may be negated if channel improvements are implemented. This would occur if bypass pipes were proposed to transport overbank flows caused by breaches of either Fryer or Nathanson Creek. The channel improvements were also considered to be more economically feasible than some of the required bypass systems that would need to be implemented if channel improvements were not implemented first. Effort was made to spread the 10-year total CIP costs evenly across each fiscal year (FY) excepting FY 2010/2011.

Figure 7-1 summarizes the channel and storm drain system CIP projects identified as part of the SDMP. A full size figure (22"x34") is included under separate attachment.

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City Limits
Parcel Boundaries
Creeks
Bypass Channel
Modeled Storm Drain Pipes
Storm Drain Manholes
Storm Drain Outlets

CIP Project Type
Structural Improvements
Channel Improvements
Storm Drain Improvements

0 600 1,200 ft
1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits; Winzler and Kelly GIS: Creeks, Storm Drain System.

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Cartography	Date	Project #
AF	5/12/2011	0241809039

Figure 7-1
Proposed CIP Projects Location Map

Storm Drain Master Plan

City of Sonoma

7.1 Channel Improvement Projects

Channel improvement projects may require the City to obtain permanent easements from private property owners. SCWA currently possesses channel easements (primarily for brush clearing) on Nathanson Creek and other easements exist for Fryer Creek. In addition to permanent easements, the City may also need to acquire temporary construction easements for the work involved with channel improvement projects. Neither costs for preparing easement descriptions nor costs for actual easement acquisitions are included in CIP project costs for associated channel improvement projects.

The following channel improvements were identified for inclusion within the City's CIP. These projects were identified from analyzing the baseline model results presented in Section 6 of this report. The first two projects address backwatering effects caused by structures within Fryer Creek and Nathanson Creek, while the third project addresses channel breaches within Nathanson Creek.

TABLE 7-1 Channel Improvement Project Summary.

Project ID	Project Location	Existing Condition	Proposed Improvement
CIP-1	Fryer Creek at W MacArthur St	Existing 5.5'x12.5' culvert is perched approximately two feet above the channel thalweg causing significant backwater effects upstream	A new 8'x15' box culvert with invert elevation equal to channel thalweg
CIP-2	Nathanson Creek Patten St Bridge	Patten St Bridge causes backwater effects at high flows raising upstream HGL	Raise bridge deck by 1.5' to reduce backwatering effects
CIP-3	Nathanson Creek Floodwalls	No floodwalls currently exist.	Install floodwall along northern and southern banks of upper Nathanson Creek to reduce City flooding

The channel improvement projects summarized above are explained in further detail below.

7.1.1 Channel Improvement Project CIP-1

The existing culvert on Fryer Creek at W MacArthur Street is a 5.5' x 12.5' box culvert that is perched above the channel bottom creating a significant backwater condition upstream of this culvert. The upstream invert of the box culvert is raised approximately 2-feet above the channel thalweg at the upstream face of the culvert, while the downstream invert of the box culvert is raised approximately 4- feet above the channel thalweg at the downstream face of the culvert. The perched nature of the existing box culvert creates a significant energy loss, increasing upstream hydraulic grade lines within Fryer Creek by approximately 4-feet during both the 25-year, 24-hour design storm and the 100-year, 24-hour storm. The Fryer Creek hydraulic profile under baseline and improvement conditions is provided in Figure 7-4.

The proposed improvement project consists of removing the existing box culvert and replacing with a larger culvert with inverts equal to the channel thalweg. The new box culvert was modeled as an 8’ x 15’ box culvert with channel bottoms equal to the upstream and downstream thalwegs of Fryer Creek.

Costs related with Project 1 are presented in Table 7-3.

7.1.2 Channel Improvement Project CIP-2

The existing bridge deck on Nathanson Creek at Patten Street has a soffit elevation of 81.39-feet and a top deck elevation of 82.79-feet. This bridge structure causes the largest backwater effect on Nathanson Creek during the 100-year, 24-hour design storm as shown in the baseline condition hydraulic profile for Nathanson Creek in Figure 6-10. The backwater effect is approximately 1.5-feet during the 100-year, 24-hour storm.

The proposed improvement project consists of replacing the existing bridge with a new bridge with slightly elevated bridge deck elevations. The new bridge structure was modeled with a new bridge soffit elevation of 82.89-feet, and a new bridge deck elevation of 84.29-feet, effectively raising the bridge by 1.5-feet equal to the energy losses seen across the bridge under baseline conditions.

Costs related to Project 2 are presented in Table 7-4.

7.1.3 Channel Improvement Project CIP-3

The upstream reach of Nathanson Creek experiences significant overbank flooding during the 100-year, 24-hour design storm as shown in the baseline flood mapping presented in Figure 6-3. The locations at which overbank breaches are occurring are evident in Figure 6-11, showing the 100-year, 24-hour water surface profiles with respect to the left channel and right channel bank elevations. Breaches occur upstream of the 4th Street East bridge, East Napa Street bridge, 3rd Street East bridge, 2nd Street East bridge, Patten Street bridge, and France Street bridges, with the most significant overland and street flooding occurring from the 4th Street East breach, the 2nd Street East breach, and the Patten Street East breach.

The proposed improvement project consists of installing floodwalls mainly along the southern and eastern banks (left channel bank looking downstream) of Nathanson Creek, with some floodwalls to a lesser extent along the northern and western banks (right channel bank looking downstream) of Nathanson Creek required as a result of the left channel bank floodwalls slightly elevating the water surface profile along the upstream reach of Nathanson Creek. Floodwalls were modeled assuming 3-foot heights.

Left channel bank floodwalls were modeled extending from approximately 5th Street East to 2nd Street East and again from Patten Street to East MacArthur Street. Right channel bank floodwalls were modeled just in the vicinity of 2nd Street East (approximately ½ block each way) and from Patten Street to East MacArthur Street. These extents may not necessarily be required but were modeled conservatively to determine what level of improvement could be achieved with the floodwalls. This level of accuracy was not achieved with the SDMP. Further design and hydraulic modeling would be needed to determine exactly where water surface elevations exceed existing right and left channel bank elevations in order to refine floodwall locations.

Costs associated with Project 3 are presented later in Table 7-5. These costs do not include provision for possible required easement acquisition from private property owners.

7.2 Channel Improvement Model Results

The MU/MF model results associated with the channel improvement projects described above are presented for the 25-year, 24-hour storm and the 100-year, 24-hour storm in Figures 7-2 and 7-3. Full size foldouts of these Figures are included in a separate attachment.

The figures show significant reduction in overbank flooding along Nathanson Creek as a result of the floodwall project for both storm events. The reduced flooding is seen along Broadway Street and in the neighborhoods bound by Nathanson Creek to the west and north and West MacArthur Street to the south. There is also some alleviation of flooding along Fryer Creek upstream of West MacArthur Street as a result of the culvert replacement project. No net increase in flooding within the City is seen under the 25-year, 24-hour storm as a result of the proposed channel improvement; however, there is an increase in downstream flooding along Nathanson Creek for the 100-year, 24-hour storm. This increased flooding is contained within the Sonoma Valley High School and Adele Harrison Middle School properties with some slight increased flooding at Train Town.

Water surface profiles for Fryer Creek and Nathanson Creek with channel improvement projects incorporated are included as Figures 7-4 and 7-5. These figures present both the baseline water surface profiles and the water surface profiles with channel improvement projects in place for comparison purposes. Only 100-year, 24-hour water surface profiles are shown to demonstrate the effectiveness of the channel improvements for both creeks under this design condition. Existing channel thalweg elevations for Fryer Creek are shown although the perched culvert on Fryer Creek was lowered under the channel improvement condition.

Figure 7-4 shows a reduction in water surface elevation immediately upstream of the West MacArthur Street culvert of approximately 1.5-feet as a result of Project CIP-1. Over time, the channel bottom has aggraded upstream of this culvert. And it is likely that the channel would scour upstream of the culvert to match the culvert invert elevation. The upstream invert of the culvert could be lowered slightly beyond its modeled elevation to allow for sediment buildup to flush through the system. This could further decrease upstream water surface elevations.

Figure 7-5 shows an increase in water surface elevations from 4th St East to Austin St as a result of incorporating floodwalls in Project 3. Energy losses at the Patten Street bridge have been greatly reduced as a result of increasing the bridge soffit and deck height on Nathanson Creek.

These projects should be modeled with greater detail and precision prior to design/construction in an effort to refine project scopes, limits and costs.

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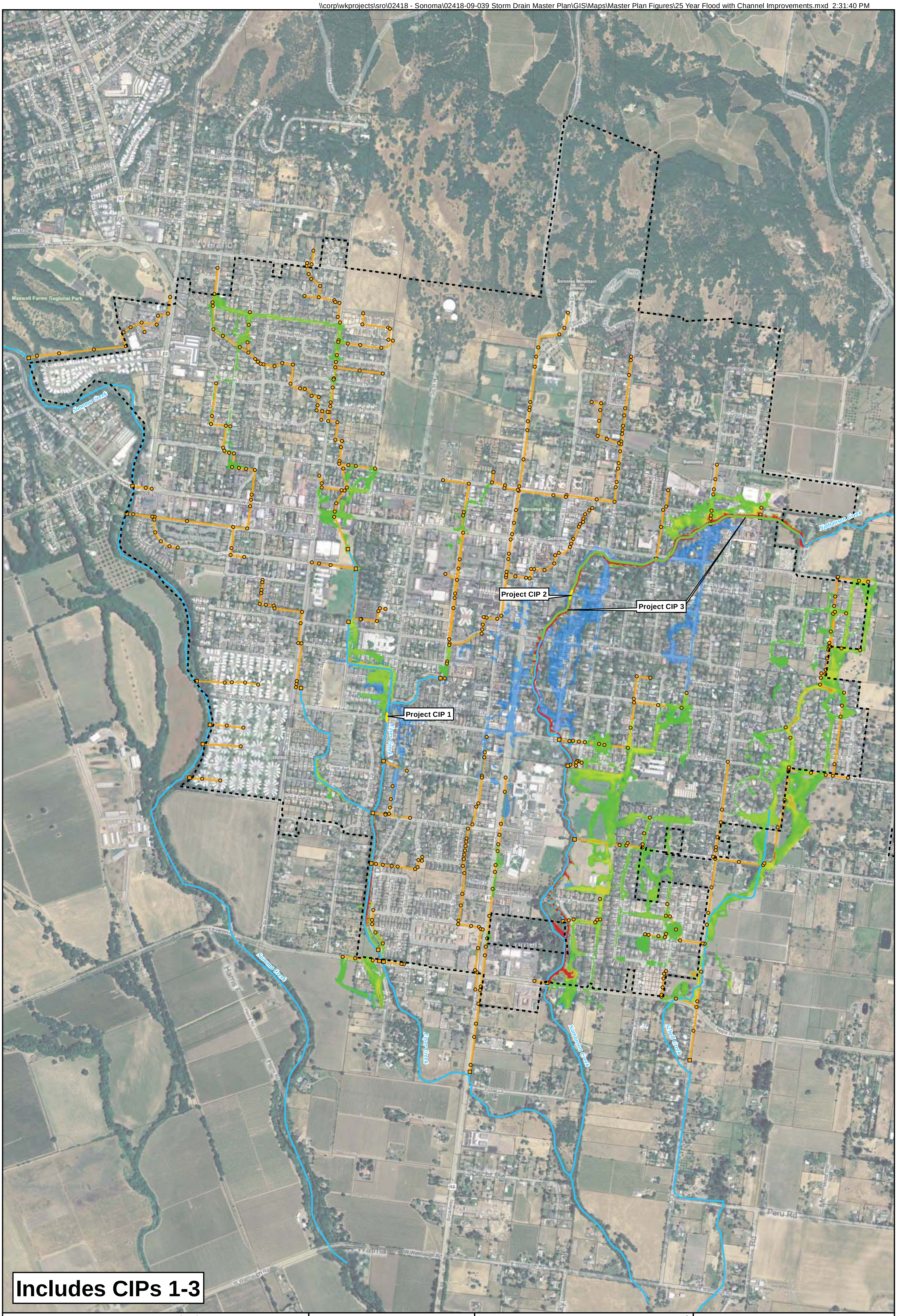

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets
Storm Drain Manholes

25 Year Flood with Channel Improvements
Depth (ft)
>1
>0
Flooding Avoided with Channel Improvements

CIP Project Type
Structual Improvements
Channel Improvements
Storm Drain Improvements

0 600 1,200 ft
1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, Model Results.

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Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 7-2
25 Year Flood Map with Channel Improvements

Storm Drain Master Plan

SEAL OF THE CITY OF SONOMA CALIFORNIA

City of Sonoma

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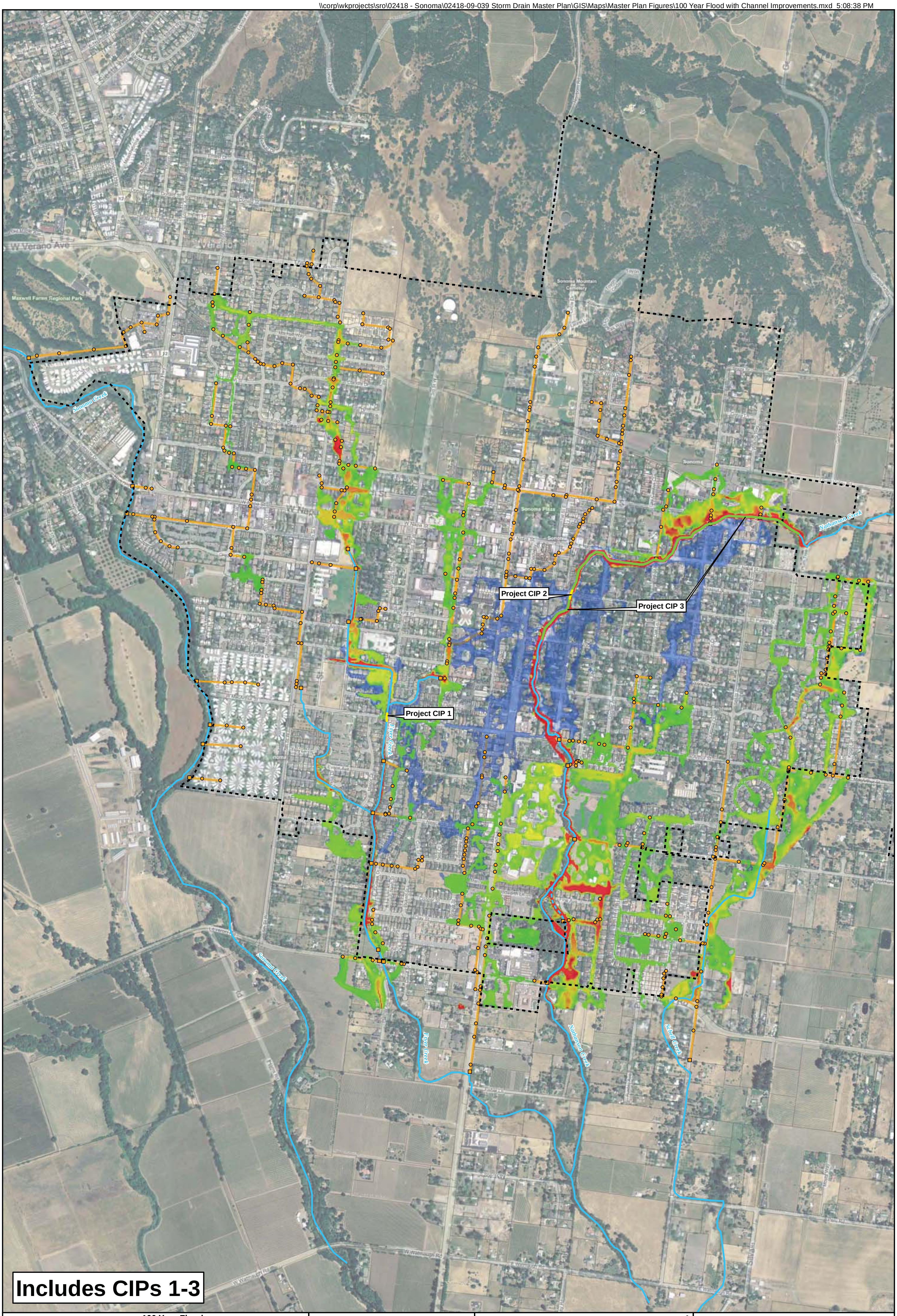

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets
Storm Drain Manholes

100 Year Flood with Channel Improvements
Depth (ft)
>1
>0

Flooding Avoided with Channel Improvements

CIP Project Type
Structual Improvements
Channel Improvements
Storm Drain Improvements

0 600 1,200 ft
1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, Model Results.

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Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 7-3
100 Year Flood Map with Channel Improvements

Storm Drain Master Plan

City of Sonoma

Figure 7-4. Comparison of 100-Year, 24-Hour Water Surface Profiles for Fryer Creek Under Baseline and Channel Improvement Conditions.

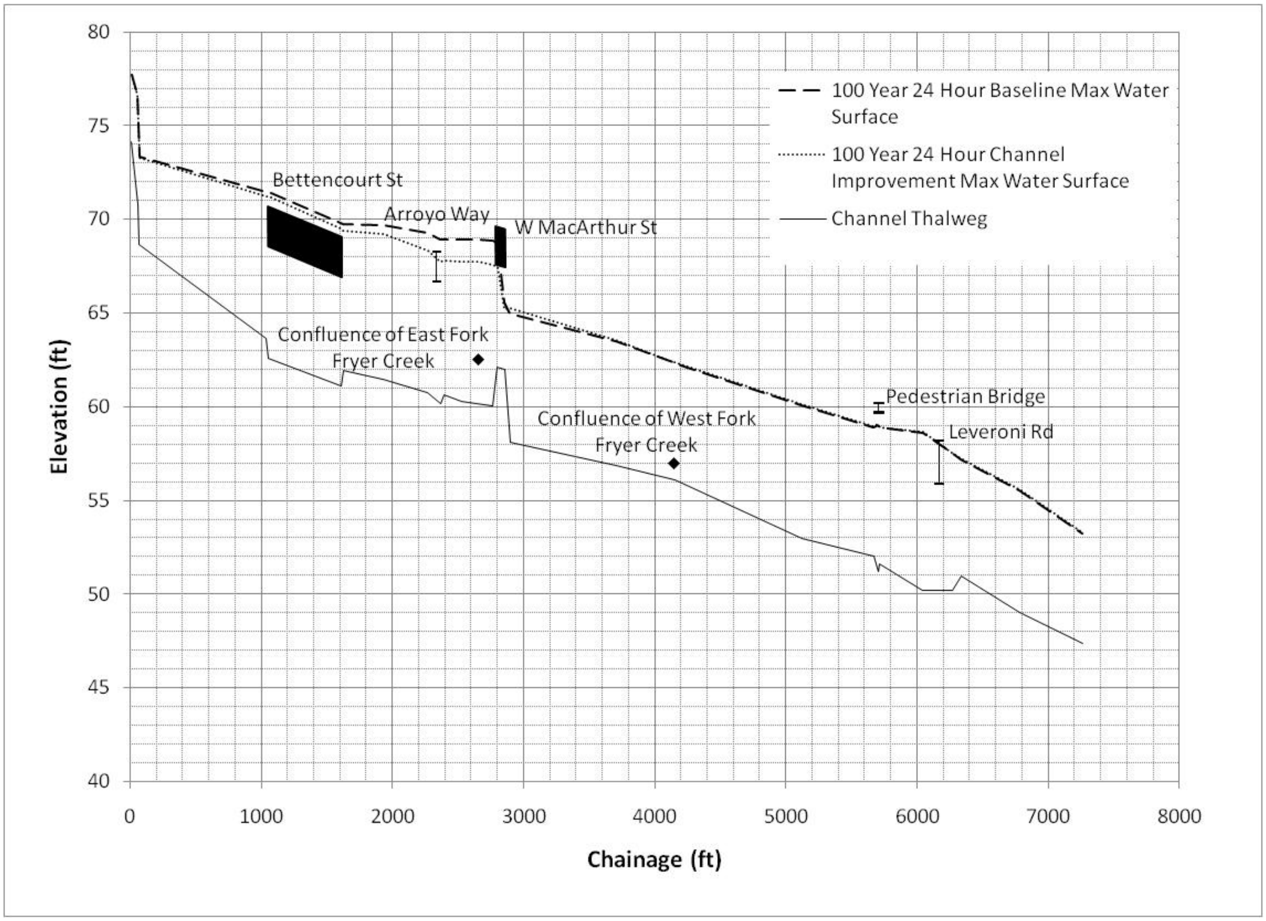
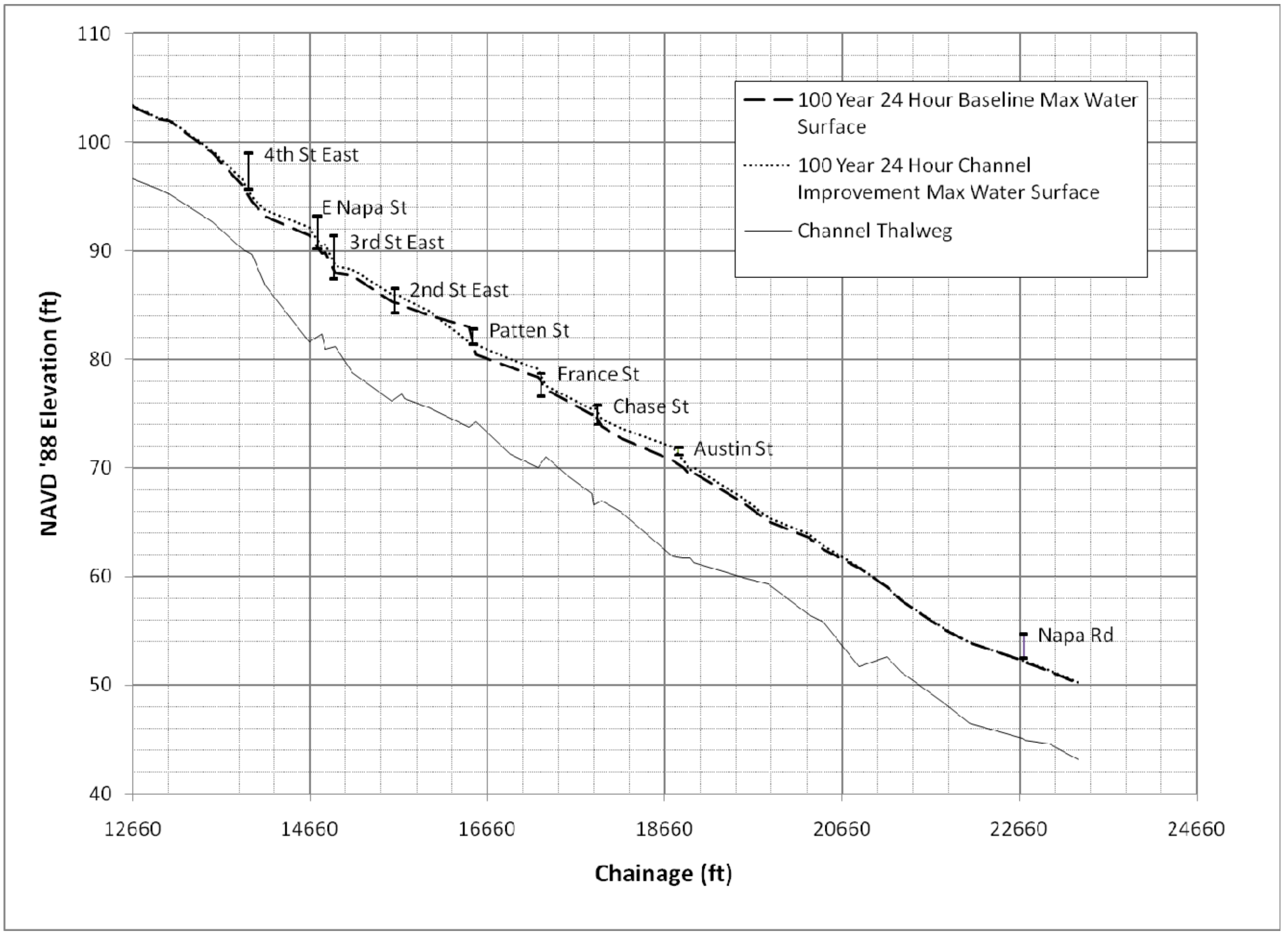


Figure 7-5. Comparison of 100-Year, 24-Hour Water Surface Profiles for Nathanson Creek Under Baseline and Channel Improvement Conditions.



7.3 Storm Drain System Improvement Projects

Storm drain system deficiencies resulting from hydraulic deficiencies rather than backwatering effects from the creeks (summarized in Chapter 6) are included in the City's CIP project list. Table 7-2 summarizes the storm drain system CIP projects.

TABLE 7-2 Storm Drain Improvement Project Summary.

Project ID	Storm Drain System Designation	Existing Condition	Proposed Improvement
CIP-4	Line F-12	Approximately 835 ft of 27-in piping and 156 ft of open ditch	Replace existing pipe and open ditch with 36-in diameter RCP and drop existing invert elevations by 1-ft
CIP-5	New Bypass between Line F-12 and SON-5	No existing pipe connecting the two systems; piping is undersized along SON-5 to handle the new flows	772 ft of new 36-in RCP tying F-12 and SON-5 lines; approximately 1,420 ft of upgrade from 36-in and 42-in existing SD to 54-in RCP; approximately 1,450-ft of existing 54-in SD to 72-in diameter RCP
CIP-6	Line F-1	Approximately 491 ft of existing 24-in diameter SD	Replace existing pipe with 36-in diameter RCP
CIP-7	Line N-3	Approximately 412 ft of existing 24-in diameter SD	Replace existing pipe with 36-in diameter RCP
CIP-8	Line N-5	Approximately 940 ft of existing 30-in diameter SD	Replace existing pipe with 42-in diameter RCP and drop existing invert elevations by 1-ft
CIP-9	Line S-1	Approximately 32 ft of existing 30-in diameter SD and Approximately 1,735-ft of existing 36-in and 42-in diameter SD	Replace existing pipe with 48-in diameter RCP
CIP-10	Line S-1	Approximately 1351 ft of existing 30-in diameter SD	Replace existing pipe with 36-in diameter RCP

The storm drain system improvement projects summarized above are explained in further detail below.

7.3.1 Storm Drain Project CIP-4

The most upstream limits of Line F-12 do not meet the FCDC design criteria during the 10-year, 24-hour design storm. This project includes upsizing approximately 835 linear feet (LF) of existing 27-inch diameter storm drain piping located north of the Sonoma Bike Path on Robinson Road and 156 LF of open ditch along the Sonoma Bike Path. The project incorporates new 36-inch diameter RCP to replace the existing piping and open ditch upstream of Node_535, shown in the storm drain profile for Line F-12 in Appendix E. Existing invert elevations require reduction by 1-foot depth to provide adequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-6.

7.3.2 Storm Drain Project CIP-5

Storm drain project CIP-5 includes a new bypass line to divert water from the upper Fryer Creek drainage within Line F-12 to Line SON-5, which is currently oversized and has excess capacity even during the 100-year, 24-hour storm event. The bypass line will reduce flows within Fryer Creek, which is undersized to handle current design flows and experiences more extensive flooding during higher return period events. In effect, Project CIP-5 is needed to offset the increased flows in Line F-12 associated with Project CIP-4, which increases flows to Fryer Creek that previously were attenuated by street flooding.

The proposed bypass line is a 36-inch RCP that ties into existing Node_534 on line F-12 (located at the intersection of Robinson Road and the Sonoma Bike Path), and then ties into existing Node_538 on Line SON-5 (located just south of the intersection of Robinson Rd and Lasuen St). The new bypass line also triggers the need to upsize some piping on Line SON-5 in order to not create flooding problems along this line. Improvements to SON-5 include:

- Upsizing approximately 1,450 LF of existing 54-inch storm drain piping from Node_560 to the outlet at Sonoma Creek (Node_1057) to new 72-inch diameter RCP.
- Upsizing approximately 1,420 LF of existing 36-inch and 42-inch piping from Node_538 to Node_542 to new 48-inch diameter RCP.

The proposed upgraded segments can be seen in the storm drain profile for Line SON-5 in Appendix G. Existing invert elevations can remain the same due to adequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-7.

7.3.3 Storm Drain Project CIP-6

Storm drain project CIP-6 includes replacing approximately 491 LF of existing 24-inch diameter pipe along Line F-1 (located on Broadway) to 36-inch diameter RCP. These improvements consist of two pipe segments (Link_167 and Link_164) that are currently 24-inch diameter but have existing 36-inch diameter piping both upstream and downstream. Therefore, the existing 24-inch pipes represent bottlenecks within Line F-1.

This line did not meet the FCDC of 1-foot freeboard requirement during the 10-year storm, and also resulted in overland flooding during the 100-year design storm. These improvements will significantly reduce overland flooding during the 100-year design storm and improve 10-year system hydraulics as well.

The proposed upsized segments are shown in the storm drain profile for Line F-1 in Appendix G. Existing invert elevations are assumed to remain the same assuming adequate ground cover and due to the improvements being located beyond paved limits in Broadway.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-8.

7.3.4 Storm Drain Project CIP-7

Storm drain project CIP-7 includes replacing approximately 412 LF of existing 24-inch diameter pipe along Line N-3 (located along Denmark Street just east of Nathanson Creek) to new 36-inch diameter RCP. This segment of storm drain pipe did not meet the one-foot freeboard requirement for the 10-year, 24-hour design storm, and also resulted in significant overland flooding during higher period event storms due to excessive headloss through existing undersized piping.

The improvements are proposed along Line N-3 from Node_904 to Node_908, at which point the piping increases to 36-inches to the outlet with Nathanson Creek. The proposed upsized segment is shown in the storm drain profile for Line N-3 in Appendix G. Existing invert elevations are assumed to remain the same due to adequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-9.

7.3.5 Storm Drain Project CIP-8

Storm drain project CIP-8 includes replacing approximately 940 LF of existing 30-inch diameter pipe along Line N-5 (located along East MacArthur St just east of Nathanson Creek) to new 42-inch diameter RCP. This segment of storm drain pipe did not meet the one-foot freeboard requirement for the 10-year, 24-hour design storm, and also resulted in significant overland flooding during higher period event storms due to excessive headloss through the undersized existing piping.

The improvements are proposed along Line N-5 from Node_845 to the outlet with Nathanson Creek (Node_854). The proposed upsized segment is shown in the storm drain profile for Line N-5 in Appendix G. Existing invert elevations are assumed to decrease by 1 foot in elevation due to inadequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-10.

7.3.6 Storm Drain Project CIP-9

Storm drain project CIP-9 includes replacing a short 32 LF segment of existing 30-inch storm drain piping which represents a significant bottleneck in Line S-1 with 48-inch diameter RCP. This CIP also includes replacing approximately 1,735 LF of existing 36-inch and 42-inch storm drain piping with 48-inch diameter RCP. This line did not meet the one-foot freeboard requirement for the 10-year, 24-hour design storm, and also resulted in significant overland flooding during higher period event storms due to excessive head loss through the undersized existing piping.

The short segment improvement proposed for Line S-1 represents Link_70 bounded by Node_827 and Node_828 and is located just downstream of the confluence of Line S-1 and Line S-1-4 on the southern side of the intersection of East MacArthur St and Cordilleras Drive. The longer proposed improvement segment is located along Line S-1 from Node_817 to Node_827, representing the pipeline from the intersection of Avenue del Oro and Appleton Way, downstream to the confluence of Line S-1 and Line S-1-4. These proposed upsized segments are shown in the storm drain profile for Line S-1 in Appendix G. Existing invert elevations are assumed to remain the same due to adequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-11.

7.3.7 Storm Drain Project CIP-10

Storm drain project CIP-10 includes replacing approximately 1,351 LF of existing 30-inch storm drain piping with 36-inch diameter RCP. This line did not meet the one-foot freeboard requirement for the 10-year, 24-hour design storm, resulting in significant overland flooding during higher period event storms due to excessive headloss through the undersized existing piping.

This segment improvement proposed for Line S-1 represents all piping upstream of the confluence of Line S-1 and Line S-1-6 (Node_793 to Node_804). This represents all of Line S-1 north of William Cunningham Ave. The proposed upsized segments are shown in the storm drain profile for Line S-1 in Appendix G. Existing invert elevations are assumed to remain the same due to adequate ground cover.

The project extents are included in Figure 7-1. Costs associated with this project are presented in Table 7-12.

7.4 Final CIP Model Results

The final CIP model results described in this section include all CIP projects associated with both channel improvements and storm drain system improvements. The MU/MF model results are presented for the 10-year, 25-year, and the 100-year, 24-hour storms in Figures 7-6, 7-7, and 7-8, respectively. Full size foldouts of these Figures are included under separate attachment.

Figure 7-6 presents the flood map resulting from the channel improvement CIP projects described in Section 7.1 and the storm drain CIP projects aimed at correcting deficiencies related to the FCDC design criteria. These storm drain system deficiencies were described in detail in Section 6.1.2.3, and associated projects correcting those deficiencies are described above in Section 7.3. The CIP projects significantly decrease flooding within the City of Sonoma as shown in Figure 7-6. All storm drain lines that previously flooded streets during the 10-year baseline condition do not produce any overland flooding with the CIP projects in place. Storm drain lines previously not meeting the FCDC criteria now meet the criteria as a result of the CIP projects. Updated storm drain profiles for the storm drain lines included in the CIP project list are shown in Appendix G.

Figure 7-7 and Figure 7-8 present flood mapping results with CIP projects in place for the 25-year, 24-hour design storm and the 100-year, 24-hour design storm, respectively. Figure 7-7 shows that even under the 25-year, 24-hour design storm, street flooding improves as a result of the identified storm drain CIP projects. The most notable reductions in flooding are in the upper

Fryer Creek watershed, where Line F-12 no longer generates street flooding due to the upgrades recommended on this line and the new proposed bypass project on Robinson Rd. Flooding is also reduced along Lines S-1, N-3 and N-5 due to the upgrades recommended at these locations. Reduction in street flooding associated with the CIP projects is evident for the 25-year design storm, but is less pronounced for the 100-year design storm due to some reduction in street flooding as a result of the storm drain system CIP projects identified and shown in Figure 7-8.

Water surface profiles for Fryer and Nathanson Creek remain the same as those presented in Section 7.2.

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets

Storm Drain Manholes
Freeboard (ft)
> 1.0
0.0 - 1.0
< 0.0

10 Year Flood with CIP Improvements Depth (ft)
>1
>0

Flooding Avoided with CIP Projects

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, 10 Year Flood.

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Cartography	Date	Project #
AF	5/12/2011	0241809039

Figure 7-6
10 Year Baseline Flood Map with CIP Projects

Storm Drain Master Plan

City of Sonoma

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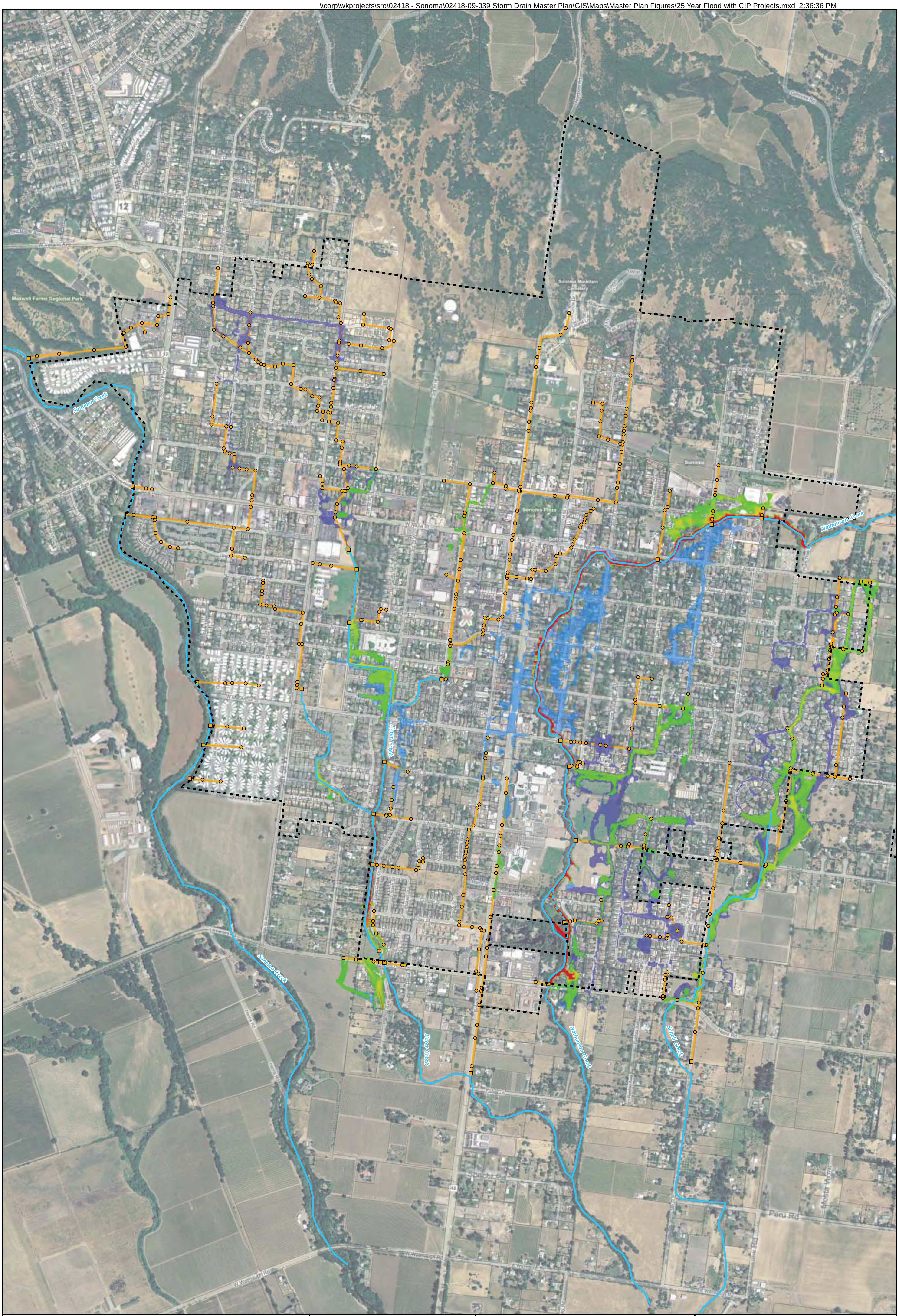

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets
Storm Drain Manholes

25 Year Flood with CIP Projects

Depth (ft)

>1

>0

Flooding Avoided with Channel Improvements

Flooding Avoided with Pipeline Improvements

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, Model Results.

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Cartography	Date	Project #
AF	5/16/2011	0241809039

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Figure 7-7
25 Year Flood Map with CIP Projects

Storm Drain Master Plan

City of Sonoma

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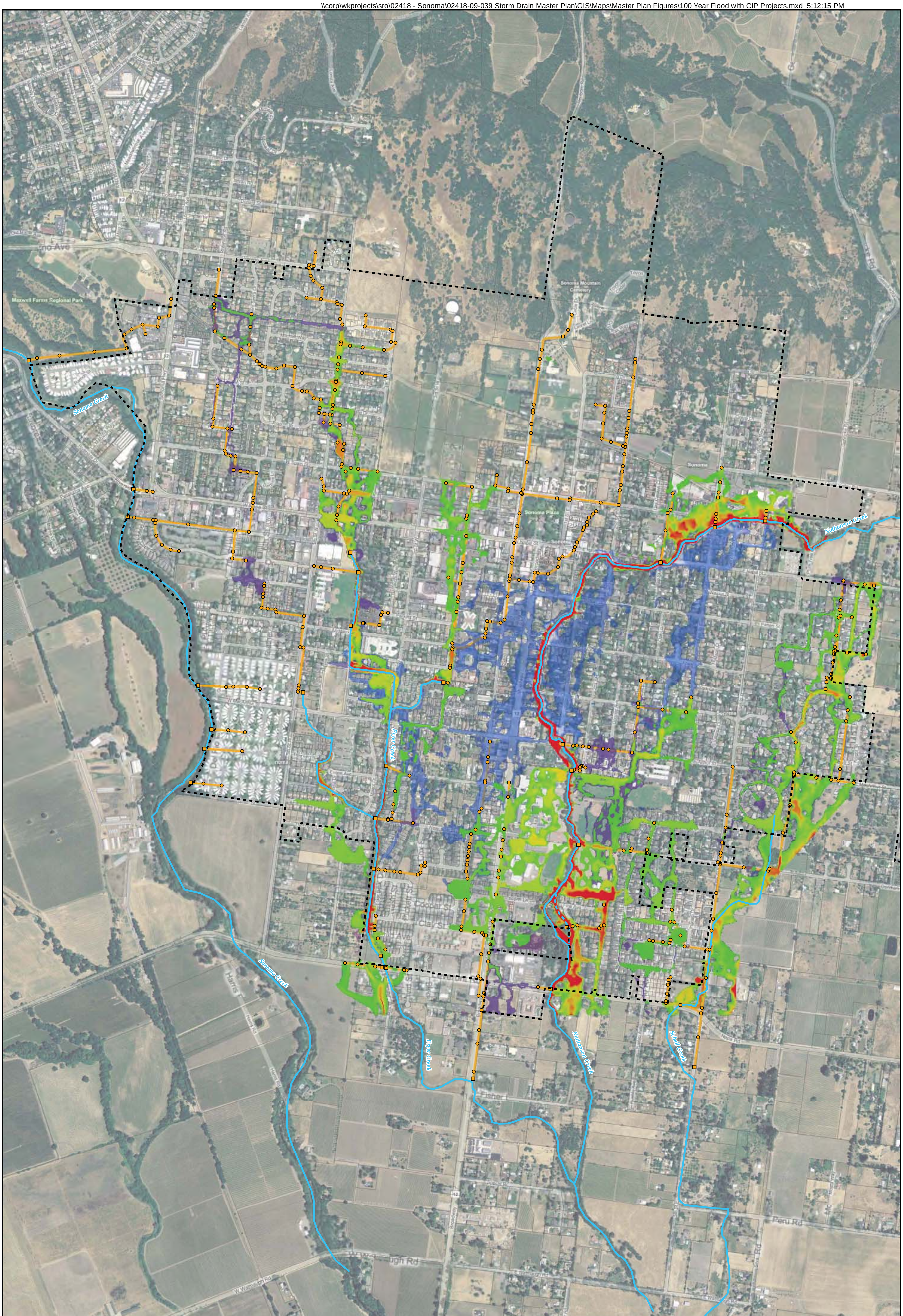

City Limits
Parcel Boundaries
Creeks
Bypass Channel
Storm Drain Pipes
Storm Drain Outlets
Storm Drain Manholes

100 Year Flood with CIP Projects
Depth (ft)
>1
>0

Flooding Avoided with Pipeline Improvements

Flooding Avoided with Channel Improvements

0 600 1,200 ft

1 inch = 600 feet printed at 22x34

N

Sources: ESRI Basemap: Imagery, Transportation; Sonoma County GIS: City Limits, Parcels; Winzler and Kelly GIS: Creeks, Storm Drain System, Model Results.

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Cartography	Date	Project #
AF	5/16/2011	0241809039

Figure 7-8
100 Year Flood Map with CIP Projects

Storm Drain Master Plan

City of Sonoma

7.5 CIP Project Opinions of Probable Costs

Opinions of probable costs associated with the CIP projects identified as part of the SDMP are included below. The costs presented herein are Class 4 (study or feasibility level) estimates of probable costs as defined by the Association for the Advancement of Cost Engineering, International (AACE). AACE defines the "Class 4" estimate as follows:

> *Generally prepared on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval, and typically engineering is 1% to 15% complete. Some examples of estimating methods would include equipment factors, gross unit costs/ratios, and other parametric and modeling techniques. Typically, very little time is expended in the development of this estimate. The typical expected accuracy ranges for this class estimate are -15% to -30% on the low side and +20% to +50% on the high side.*

It is important to note that contingency is not directly related to the stated accuracy range for a Class 4 estimate. Determination of construction cost contingency is intended to cover unforeseen aspects of construction that are not evaluated during master planning-level analysis.

The opinions of probable costs, include a 30% contingency on top of probable construction costs, and also include estimated engineering and construction management costs. Construction costs are indexed to the Engineering News Record Construction Cost Index (ENR CCI) of 10148, which is for heavy construction in the San Francisco area in February 2011. An evaluation of market trends should be considered for programming of project costs once the anticipated construction schedule is known.

Below are Tables 7-3 through 7-12 with opinions of probable costs presented for each of the CIP projects identified for the SDMP. Appendix H includes all CIP projects and a strategy to finance them over a 10-year timeframe.

Table 7-3 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 1 - Fryer Creek at West MacArthur Street ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$50,000	$50,000
Water Pollution and Erosion Control	1	LS			$50,000	$50,000
Clearing and Grubbing	1	LS			$50,000	$50,000
Pavement Removal and Disposal	50	CY		$10	$10	$500
Site Excavation, Remove Existing 5.5'x12.5' Concrete Box Culvert and Disposal	920	CY	$40	$20	$60	$55,200
Structural Concrete - Place New 8'x15' Concrete Box Culvert and Wingwalls	400	CY	$500	$300	$800	$320,000
Asphalt Concrete Pavement	20	TON	$50	$50	$100	$2,000
Tubular Handrailing	100	LF	$40	$20	$60	$6,000
Concrete Curb and Gutter	100	LF	$30	$15	$45	$4,500
Concrete Sidewalk	1,260	SF	$5	$3	$8	$10,080
Traffic Stripping and Pavement Markings	50	LF	$2	$1	$3	$150
Subtotal Materials	--	--	$251,200	--		
9% Sales Tax Materials						$22,608
Construction Subtotal						$571,038
Mobilization/Demobilization (4%)						$21,937
Contractor's Bonds and Insurance (3%)						$16,453
Contractor's Overhead and Profit (15%)						$82,265
Estimated Bid Price						$691,693
Construction Contingency (30%)						$207,508
Total Estimate of Probable Construction Cost						$899,200
Engineering/CM						
- Pre-Design (6%)	1	LS				$53,952
- Contract Documents (14%)	1	LS				$125,888
- Engineering Support During Construction - Office (4%)	1	LS				$35,968
- Construction Management - Field (14%)	1	LS				$125,888
Grand Total						**$1,240,897**

Table 7-4 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 2 - Nathanson Creek at Patten Street ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$50,000	$50,000
Water Pollution and Erosion Control	1	LS			$80,000	$80,000
Clearing and Grubbing	1	LS			$80,000	$80,000
Pavement Removal and Disposal	40	CY		$10	$10	$400
Remove Existing Bridge and Disposal	1	LS			$100,000	$100,000
Site Excavation and Disposal	37	CY	$20	$10	$30	$1,110
Structural Concrete - Bridge Abutment and Wingwalls	200	CY	$500	$500	$1,000	$200,000
Asphalt Concrete Pavement	25	TON	$50	$50	$100	$2,500
Tubular Handrailing	100	LF	$40	$20	$60	$6,000
Concrete Curb and Gutter	80	LF	$20	$10	$30	$2,400
Concrete Sidewalk	600	SF	$5	$3	$8	$4,800
Traffic Stripping and Pavement Markings	50	LF	$2	$1	$3	$150
Subtotal Materials	--	--	$110,690	--		
9% Sales Tax Materials						$9,962
Construction Subtotal						$537,322
Mobilization/Demobilization (4%)						$21,094
Contractor's Bonds and Insurance (3%)						$15,821
Contractor's Overhead and Profit (15%)						$79,104
Estimated Bid Price						$653,341
Construction Contingency (30%)						$196,002
Total Estimate of Probable Construction Cost						$849,344
Engineering/CM						
- Pre-Design (6%)	1	LS				$50,961
- Contract Documents (14%)	1	LS				$118,908
- Engineering Support During Construction - Office (4%)	1	LS				$33,974
- Construction Management - Field (14%)	1	LS				$118,908
Grand Total						**$1,172,094**

Table 7-5 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 3 - Nathanson Creek Floodwalls ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$5,000	$5,000
Water Pollution and Erosion Control	1	LS			$20,000	$20,000
Clearing and Grubbing	1	LS			$20,000	$20,000
Structural Concrete - Flood Wall and Foundation (7,950 LF)	2,945	CY	$400	$200	$600	$1,767,000
Landscaping	1	LS			$10,000	$10,000
Subtotal Materials	--	--	$1,178,000	--		
9% Sales Tax Materials						$106,020
Construction Subtotal						$1,928,020
Mobilization/Demobilization (4%)						$72,880
Contractor's Bonds and Insurance (3%)						$54,660
Contractor's Overhead and Profit (15%)						$273,300
Estimated Bid Price						$2,328,860
Construction Contingency (30%)						$698,658
Total Estimate of Probable Construction Cost						$3,027,518
Engineering/CM						
- Pre-Design (5%)	1	LS				$151,376
- Contract Documents (11%)	1	LS				$333,027
- Engineering Support During Construction - Office (4%)	1	LS				$121,101
- Construction Management - Field (14%)	1	LS				$423,853
Grand Total						**$4,056,874**

Table 7-6 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 4 - Line F-12 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$6,000	$6,000
Pavement Removal and Disposal	50	CY		$10	$10	$500
Trench Shoring	1	LS			$13,000	$13,000
Sawcut (initial and final)	3,340	LF		$3	$3	$10,020
Trench Excavation	1,010	CY		$5	$5	$5,050
Disposal of Excess Material	1,010	CY		$10	$10	$10,100
Remove Existing 27" RCP and Disposal	835	LF		$10	$10	$8,350
36-inch RCP	995	LF	$50	$50	$100	$99,500
Trench Bedding and Backfill	950	CY	$25	$10	$35	$33,250
Backfill Compaction	950	CY		$15	$15	$14,250
Manholes and Covers	2	EA	$7,000	$3,000	$10,000	$20,000
Connection to Existing Storm Drain Pipes	4	EA	$2,000	$1,000	$3,000	$12,000
Asphalt Concrete Pavement	100	TON	$50	$50	$100	$10,000
Traffic Stripping and Pavement Markings	995	LF	$2	$1	$3	$2,985
Subtotal Materials	--	--	$102,490	--		
9% Sales Tax Materials						$9,224
Construction Subtotal						$254,229
Mobilization/Demobilization (4%)						$9,800
Contractor's Bonds and Insurance (3%)						$7,350
Contractor's Overhead and Profit (15%)						$36,751
Estimated Bid Price						$308,130
Construction Contingency (30%)						$92,439
Total Estimate of Probable Construction Cost						$400,569
Engineering/CM						
- Pre-Design (6%)	1	LS				$24,034
- Contract Documents (14%)	1	LS				$56,080
- Engineering Support During Construction - Office (4%)	1	LS				$16,023
- Construction Management - Field (14%)	1	LS				$56,080
Grand Total						**$552,786**

Table 7-7 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 5 - New Bypass between Line F-12 and SON-5 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$15,000	$15,000
Pavement Removal and Disposal	263	CY		$10	$10	$2,630
Trench Shoring	1	LS			$30,000	$30,000
Sawcut (initial and final)	14,600	LF		$3	$3	$43,800
Trench Excavation	7,755	CY		$5	$5	$38,775
Disposal of Excess Material	7,755	CY		$10	$10	$77,550
Remove Existing 36", 42" and 54" RCP and Disposal	2,870	LF		$10	$10	$28,700
36-inch RCP	780	LF	$50	$50	$100	$78,000
54-inch RCP	1,420	LF	$85	$85	$170	$241,400
72-inch RCP	1,450	LF	$100	$100	$200	$290,000
Trench Bedding and Backfill	5,200	CY	$25	$10	$35	$182,000
Backfill Compaction	5,200	CY		$15	$15	$78,000
Manholes and Covers	10	EA	$7,000	$3,000	$10,000	$100,000
Storm Drain Catch Basins	4	EA	$2,000	$2,000	$4,000	$16,000
Connection to Existing Storm Drain Pipes	20	EA	$2,000	$1,000	$3,000	$60,000
Asphalt Concrete Pavement	480	TON	$50	$50	$100	$48,000
Traffic Stripping and Pavement Markings	3,650	LF	$2	$1	$3	$10,950
Subtotal Materials	--	--	$584,000	--		
9% Sales Tax Materials						$52,560
Construction Subtotal						$1,393,365
Mobilization/Demobilization (4%)						$53,632
Contractor's Bonds and Insurance (3%)						$40,224
Contractor's Overhead and Profit (15%)						$201,121
Estimated Bid Price						$1,688,342
Construction Contingency (30%)						$506,503
Total Estimate of Probable Construction Cost						$2,194,845
Engineering/CM						
- Pre-Design (5%)	1	LS				$109,742
- Contract Documents (11%)	1	LS				$241,433
- Engineering Support During Construction - Office (4%)	1	LS				$87,794
- Construction Management - Field (14%)	1	LS				$307,278
Grand Total						**$2,941,092**

Table 7-8 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 6 - Line F-1 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$2,500	$2,500
Pavement Removal and Disposal	30	CY		$10	$10	$300
Trench Shoring	1	LS			$6,000	$6,000
Sawcut (inintial and final)	1,980	LF		$3	$3	$5,940
Trench Excavation	600	CY		$5	$5	$3,000
Disposal of Excess Material	600	CY		$10	$10	$6,000
Remove Existing 24" RCP and Disposal	495	LF		$10	$10	$4,950
36-inch RCP	495	LF	$50	$50	$100	$49,500
Trench Bedding and Backfill	470	CY	$25	$10	$35	$16,450
Backfill Compaction	470	CY		$15	$15	$7,050
Manholes and Covers	2	EA	$7,000	$3,000	$10,000	$20,000
Connection to Existing Storm Drain Pipes	4	EA	$2,000	$1,000	$3,000	$12,000
Asphalt Concrete Pavement	50	TON	$50	$50	$100	$5,000
Traffic Stripping and Pavement Markings	495	LF	$2	$1	$3	$1,485
Subtotal Materials	--	--	$61,990	--		
9% Sales Tax Materials						$5,579
Construction Subtotal						$145,754
Mobilization/Demobilization (4%)						$5,607
Contractor's Bonds and Insurance (3%)						$4,205
Contractor's Overhead and Profit (15%)						$21,026
Estimated Bid Price						$176,593
Construction Contingency (30%)						$52,978
Total Estimate of Probable Construction Cost						$229,570
Engineering/CM						
- Pre-Design (6%)	1	LS				$13,774
- Contract Documents (14%)	1	LS				$32,140
- Engineering Support During Construction - Office (4%)	1	LS				$9,183
- Construction Management - Field (14%)	1	LS				$32,140
Grand Total						**$316,807**

Table 7-9 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 7 - Line N-3 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$2,500	$2,500
Pavement Removal and Disposal	25	CY		$10	$10	$250
Trench Shoring	1	LS			$5,000	$5,000
Sawcut (inintial and final)	1,660	LF		$3	$3	$4,980
Trench Excavation	500	CY		$5	$5	$2,500
Disposal of Excess Material	500	CY		$10	$10	$5,000
Remove Existing 24" RCP and Disposal	415	LF		$10	$10	$4,150
36-inch RCP	415	LF	$50	$50	$100	$41,500
Trench Bedding and Backfill	395	CY	$25	$10	$35	$13,825
Backfill Compaction	395	CY		$15	$15	$5,925
Manholes and Covers	1	EA	$7,000	$3,000	$10,000	$10,000
Connection to Existing Storm Drain Pipes	2	EA	$2,000	$1,000	$3,000	$6,000
Asphalt Concrete Pavement	45	TON	$50	$50	$100	$4,500
Traffic Stripping and Pavement Markings	415	LF	$2	$1	$3	$1,245
Subtotal Materials	--	--	$44,705	--		
9% Sales Tax Materials						$4,023
Construction Subtotal						$111,398
Mobilization/Demobilization (4%)						$4,295
Contractor's Bonds and Insurance (3%)						$3,221
Contractor's Overhead and Profit (15%)						$16,106
Estimated Bid Price						$135,021
Construction Contingency (30%)						$40,506
Total Estimate of Probable Construction Cost						$175,527
Engineering/CM						
- Pre-Design (6%)	1	LS				$10,532
- Contract Documents (14%)	1	LS				$24,574
- Engineering Support During Construction - Office (4%)	1	LS				$7,021
- Construction Management - Field (14%)	1	LS				$24,574
Grand Total						**$242,228**

Table 7-10 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 8 - Line N-5 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$5,000	$5,000
Pavement Removal and Disposal	60	CY		$10	$10	$600
Trench Shoring	1	LS			$12,000	$12,000
Sawcut (inintial and final)	3,760	LF		$3	$3	$11,280
Trench Excavation	1,340	CY		$5	$5	$6,700
Disposal of Excess Material	1,340	CY		$10	$10	$13,400
Remove Existing 24" RCP and Disposal	940	LF		$10	$10	$9,400
42-inch RCP	940	LF	$75	$75	$150	$141,000
Trench Bedding and Backfill	1,010	CY	$25	$10	$35	$35,350
Backfill Compaction	1,010	CY		$15	$15	$15,150
Manholes and Covers	3	EA	$7,000	$3,000	$10,000	$30,000
Connection to Existing Storm Drain Pipes	6	EA	$2,000	$1,000	$3,000	$18,000
Asphalt Concrete Pavement	105	TON	$50	$50	$100	$10,500
Traffic Stripping and Pavement Markings	940	LF	$2	$1	$3	$2,820
Subtotal Materials	--	--	$135,880	--		
9% Sales Tax Materials						$12,229
Construction Subtotal						$323,429
Mobilization/Demobilization (4%)						$12,448
Contractor's Bonds and Insurance (3%)						$9,336
Contractor's Overhead and Profit (15%)						$46,680
Estimated Bid Price						$391,893
Construction Contingency (30%)						$117,568
Total Estimate of Probable Construction Cost						$509,461
Engineering/CM						
- Pre-Design (6%)	1	LS				$30,568
- Contract Documents (14%)	1	LS				$71,325
- Engineering Support During Construction - Office (4%)	1	LS				$20,378
- Construction Management - Field (14%)	1	LS				$71,325
Grand Total						**$703,056**

Table 7-11 02418-09-039

City of Sonoma - Storm Drain CIP

Project No. 9 - Line S-1 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$10,000	$10,000
Pavement Removal and Disposal	115	CY		$10	$10	$1,150
Trench Shoring	1	LS			$25,000	$25,000
Sawcut (initial and final)	7,070	LF		$3	$3	$21,210
Trench Excavation	2,950	CY		$5	$5	$14,750
Disposal of Excess Material	2,950	CY		$10	$10	$29,500
Remove Existing 30"and 36" RCP and Disposal	1,770	LF		$10	$10	$17,700
48-inch RCP	1,770	LF	$80	$80	$160	$283,200
Trench Bedding and Backfill	2,150	CY	$25	$10	$35	$75,250
Backfill Compaction	2,150	CY		$15	$15	$32,250
Manholes and Covers	5	EA	$7,000	$3,000	$10,000	$50,000
Connection to Existing Storm Drain Pipes	10	EA	$2,000	$2,000	$4,000	$40,000
Asphalt Concrete Pavement	210	TON	$50	$50	$100	$21,000
Traffic Stripping and Pavement Markings	1,770	LF	$2	$1	$3	$5,310
Subtotal Materials	--	--	$264,390	--		
9% Sales Tax Materials						$23,795
Construction Subtotal						$650,115
Mobilization/Demobilization (4%)						$25,053
Contractor's Bonds and Insurance (3%)						$18,790
Contractor's Overhead and Profit (15%)						$93,948
Estimated Bid Price						$787,906
Construction Contingency (30%)						$236,372
Total Estimate of Probable Construction Cost						$1,024,277
Engineering/CM						
- Pre-Design (5%)	1	LS				$51,214
- Contract Documents (11%)	1	LS				$112,670
- Engineering Support During Construction - Office (4%)	1	LS				$40,971
- Construction Management - Field (14%)	1	LS				$143,399
Grand Total						**$1,372,531**

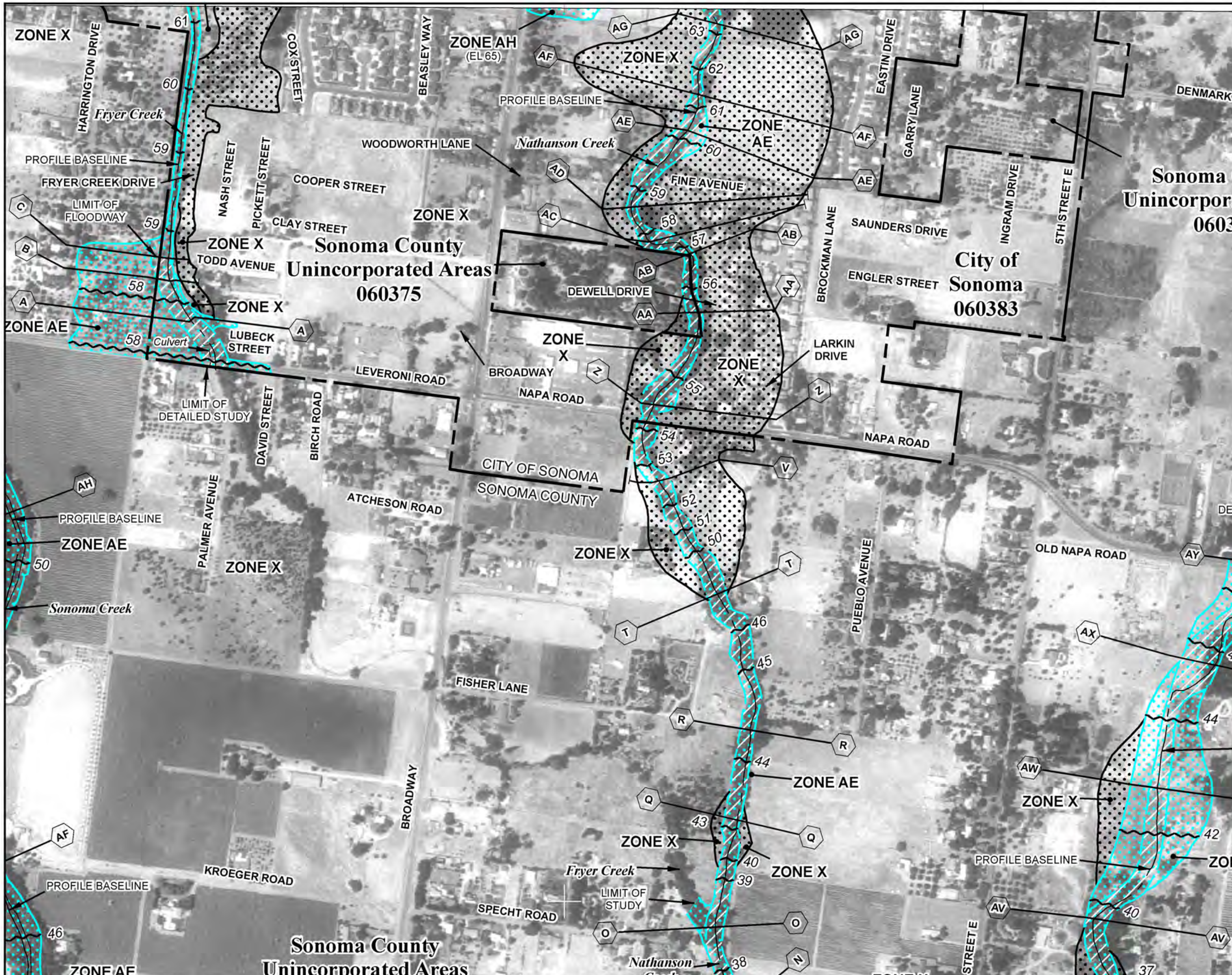
Table 7-12 02418-09-039

City of Sonoma - Storm Drain CIP

Project No.10 - Line S-1 ENR CCI 10148.04 February-11

	QUANTITY		COST			
ITEM DESCRIPTION	**No.**	**Unit**	**Material**	**Labor**	**Total**	**TOTAL COST**
General						
Temporary Traffic Controls Systems	1	LS			$7,000	$7,000
Pavement Removal and Disposal	75	CY		$10	$10	$750
Trench Shoring	1	LS			$18,000	$18,000
Sawcut (inintial and final)	1,660	LF		$3	$3	$4,980
Trench Excavation	5,410	CY		$5	$5	$27,050
Disposal of Excess Material	5,410	CY		$10	$10	$54,100
Remove Existing 30" RCP and Disposal	1,355	LF		$10	$10	$13,550
36-inch RCP	1,355	LF	$50	$50	$100	$135,500
Trench Bedding and Backfill	1,280	CY	$25	$10	$35	$44,800
Backfill Compaction	1,280	CY		$15	$15	$19,200
Manholes and Covers	4	EA	$7,000	$3,000	$10,000	$40,000
Connection to Existing Storm Drain Pipes	8	EA	$2,000	$1,000	$3,000	$24,000
Asphalt Concrete Pavement	140	TON	$50	$50	$100	$14,000
Traffic Stripping and Pavement Markings	1,355	LF	$2	$1	$3	$4,065
Subtotal Materials	--	--	$153,460	--		
9% Sales Tax Materials						$13,811
Construction Subtotal						$420,806
Mobilization/Demobilization (4%)						$16,280
Contractor's Bonds and Insurance (3%)						$12,210
Contractor's Overhead and Profit (15%)						$61,049
Estimated Bid Price						$510,345
Construction Contingency (30%)						$153,104
Total Estimate of Probable Construction Cost						$663,449
Engineering/CM						
- Pre-Design (6%)	1	LS				$39,807
- Contract Documents (14%)	1	LS				$92,883
- Engineering Support During Construction - Office (4%)	1	LS				$26,538
- Construction Management - Field (14%)	1	LS				$92,883
Grand Total						**$915,559**

Appendix A
FEMA Flood Insurance Rate Maps



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METER

NFIP

PANEL 0939E

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 939 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

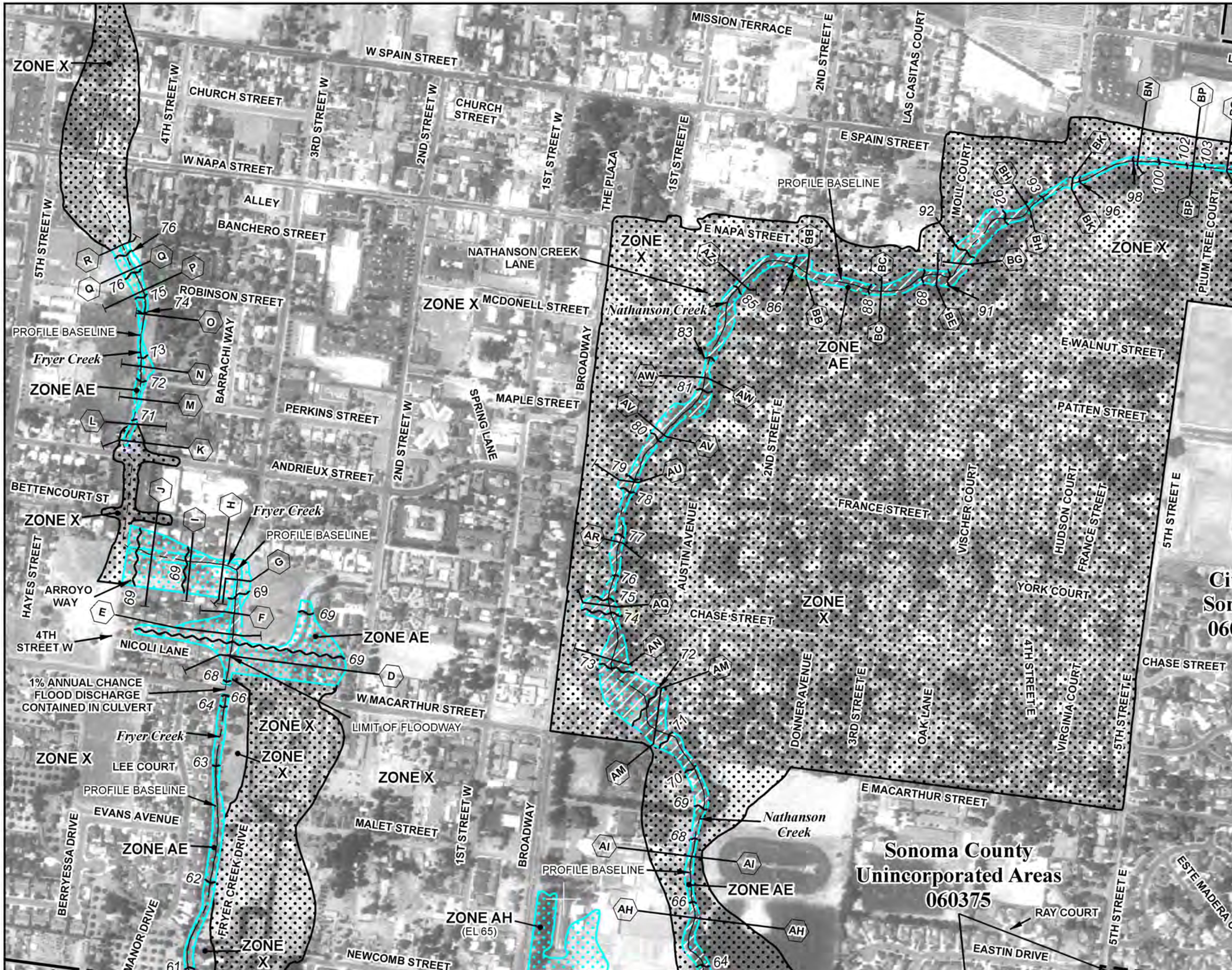
COMMUNITY	NUMBER	PANEL	SUFFIX
SONOMA COUNTY	060375	0939	E
SONOMA, CITY OF	060383	0939	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06097C0939E

EFFECTIVE DATE
DECEMBER 2, 2008

Federal Emergency Management Agency



MAP SCALE 1" = 500'

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0937E

FIRM

FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 937 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SONOMA COUNTY	060375	0937	E
SONOMA, CITY OF	060383	0937	E

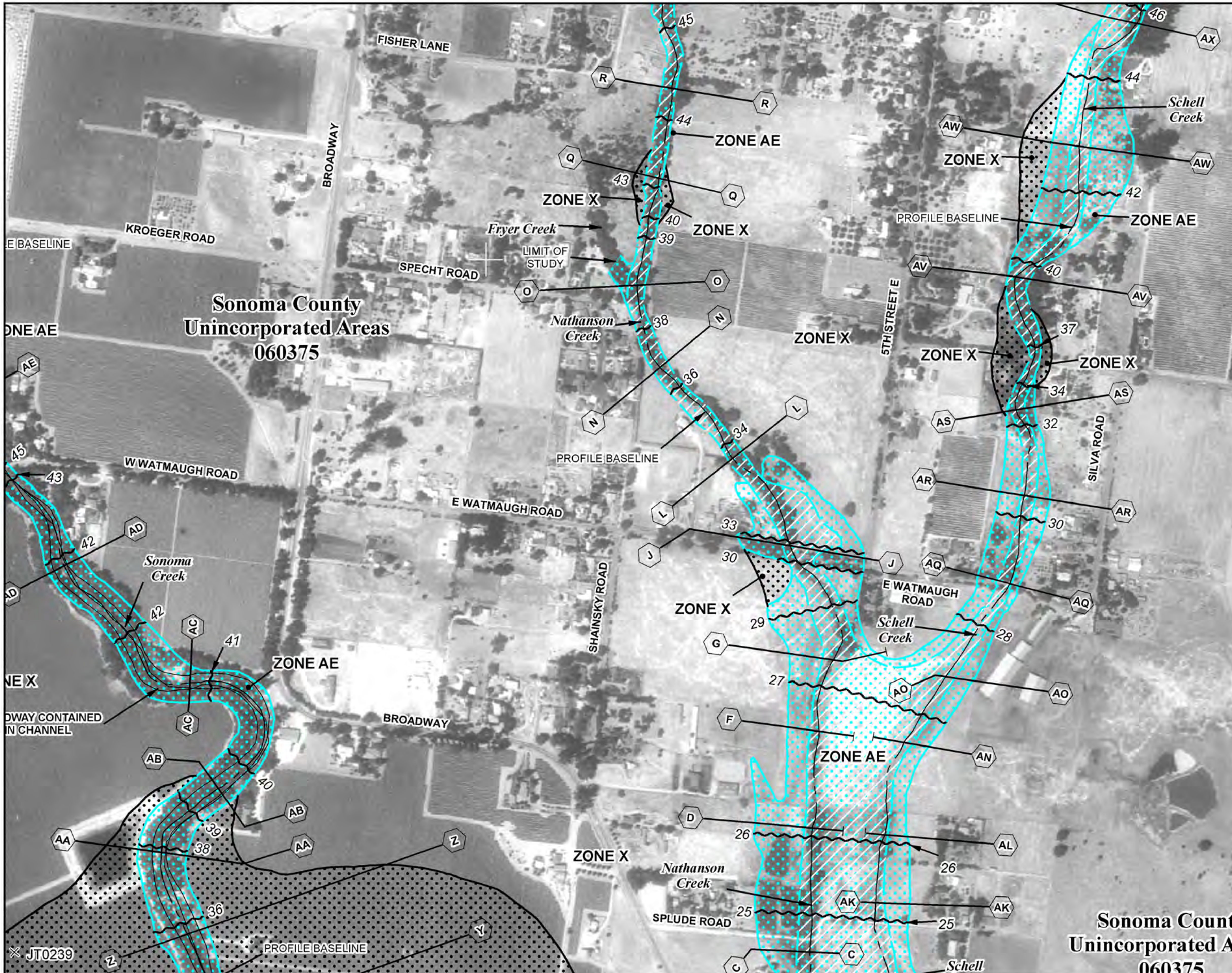
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06097C0937E

EFFECTIVE DATE
DECEMBER 2, 2008

Federal Emergency Management Agency

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



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0939E

FIRM

FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 939 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SONOMA COUNTY	060375	0939	E
SONOMA, CITY OF	060383	0939	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06097C0939E

EFFECTIVE DATE
DECEMBER 2, 2008

Federal Emergency Management Agency

Appendix B
Summary of Data Collection

DATA LISTING

REPORTS

City of Sonoma, Campobello Estates Subdivision, October 2001, Nathanson Creek Overbank Flow Analysis and Capacity Analysis of Proposed Creek Overflow Bypass Channel

National Oceanic and Atmospheric Administration (NOAA), 1973, Atlas 2 - Precipitation Frequency Atlas of the Western United States, Volume XI - California

Federal Emergency Management Agency (FEMA), December 2008, Sonoma County, California and Incorporated Areas Flood Insurance Study (FIS)

Federal Emergency Management Agency, March 1975, HEC-2 Input and Output Data for hydraulic Modeling of Nathanson Creek

Federal Emergency Management Agency, May 1991, HEC-2 Input and Output Data for hydraulic Modeling of Fryer Creek

Soil Conservation Service, May 1972, Soil Survey of Sonoma County, California

Sonoma County Water Agency, August 1983, Flood Control Design Criteria

MAPPING

Aerial Photo Map of City of Sonoma – flown December 18, 2009 (Scale: 1’ = 300’)

City of Sonoma, Storm Drain System Map, May 1996

City of Sonoma, Improvement Plans for Holden Subdivision, January 1999, Oberkamper & Associates Civil Engineers, Inc.

City of Sonoma, Improvement Plans for The Lodge at Sonoma, April 1998, Riechers Spence & Associates Incorporated Consulting Civil Engineers.

City of Sonoma, Improvement Plans for Fifth Street East/Peru Road Conduit, February 2003, Department of Public Works

City of Sonoma, Improvement Plans for Spring Lane Subdivision, July 1989, Sandine and Associates

Sonoma County Water Agency, Sonoma Drainage Master Plan, September 1978

Sonoma County Water Agency, First Street West Conduit (West Napa Street to Vicinity Andrieux Street) – Valley of the Moon Zone 3A, July 1996

ELECTRONIC FILES

File Name	Description	Remarks
StormMains.shp	Storm drain system geometry	Provided by the City
StormStructures.shp	Storm drain system geometry	Provided by the City
Contours.shp	1’ contours, 2010	Provided by the City
Streets.shp	Street geometry and names	Provided by the City
CityLimits.shp	Sonoma City Limits	Provided by the City
Aerials	High resolution ortho-rectified	Provided by the City
Aerials	2009 Naip Imagery, County	Provided by USDA
DRG-S-CA097.5, D	Sonoma County Quad map	Provided by USGS

SURVEY/MISC. DOCUMENTATION

Horizontal Control is based on the California Coordinate System Zone 2, NAD ’83. Epoch: 2002.0000. Winzler & Kelly’s Survey Crew employed survey grade Leica System 1200 Real Time Kinematic GPS equipment to control the aerial survey. Six hours of continuous data was logged at the base station and processed through the National Geodetic Survey’s Online Positioning User Service (OPUS).

Vertical Datum is NAVD ’88. The elevation published as part of the Central Coast Height Modernization Project 2007 (CENCHM2007) on the monument HPGN D CA 04 LF was held as the benchmark.

Benchmark Data:
Designation - HPGN D CA 04 LF
PID: JT9620
Elevation: 119.86 feet (36.533 meters) (CENCHM2007)
Description: The station is located near the intersection of State Highway 12 and Verano Avenue in the Maxwell Farms Regional Park. From the intersection of State Highway 12 and Verano Avenue go west on Verano Avenue for about 350 feet to a side road left, the entrance to Maxwell Farms Regional Park. Turn left and go southerly then westerly on the entrance road for about 350 feet to a paved parking lot and the station in the northeast corner of the parking lot. The station is a survey disc encased in PVC pipe with access cover set in concrete flush with the ground, 248.0 feet southeast of and across the street from the southeast corner of a log building, 136.8 feet northeast of a dedication monument made of bronze and stone, 108.0 feet south of the centerline of Verano Avenue and 25.2 feet north of the centerline of the park entrance road.

Appendix C
Technical Memorandum

TECHNICAL MEMORANDUM NO. 1
Data Review and Design Criteria/Methodology
City of Sonoma

PREPARED FOR: Milenka Bates, City of Sonoma
Phil Wadsworth, Sonoma County Water Agency
Toni Bertolero, City of Sonoma

PREPARED BY: Rick Jorgensen, Winzler & Kelly

REVIEWED BY: Raymond Wong, Winzler & Kelly
Stacy Creviston, Winzler & Kelly

DATE: June 8, 2010

JOB #: 02418.09.039-32020

CITY TASK #: 2009-23

CITY PROJECT #: 0918

INTRODUCTION

The City of Sonoma (City) has undergone periodic flooding in the past during severe storm events. Both Nathanson Creek and Fryer Creek periodically exceed their banks though the City maintenance staff believe that some of the storm drain networks are also undersized. The City has requested its City Engineering Consultant, Winzler & Kelly (W&K), to provide engineering services to prepare a Storm Drain Master Plan (Study) for the City. The Study shall develop a storm drain system model within the Zone 3A watershed boundaries. The Study area consists of three sub-basins: Nathanson Creek, Fryer Creek, and Sonoma Creek. The channel modeling will include Nathanson Creek and Fryer Creek only. FEMA has already conducted modeling of the Sonoma Creek sub-basin and the results of that effort will be utilized for this Study. The pipe network modeling will include all three watersheds. This memo summarizes the collection and review of data as well as development of the proposed design criteria to be utilized in the development of the Study.

DATA REVIEW

W&K has completed the collection and review of technical data relating to the Study for the City. Detailed lists of key documents and other materials collected to date are provided in the appendices. Also included is a list of outstanding documents not collected that would aid in the preliminary design phase, if they became available.

Our data collection efforts included requesting data from FEMA, the City and Sonoma County Water

Agency (SCWA) and Permit and Resource Management Department (PRMD). The data collected to date is summarized in Appendix A.

DESIGN CRITERIA/METHODOLOGY

SCWA developed design criteria and methodology for hydrologic and hydraulic design in the *Flood Control Design Criteria*, revised August 1983. These criteria will be used in this Study to develop the design flows at each point of analysis and proper sizing of drainage facilities.

Design Criteria

The design criteria used in the hydrologic/hydraulic analysis is based on SCWA Standards. These criteria include:

- For watersheds of four square miles or more (major waterways), the design storm is a 100-year event.
- For watersheds of one to four square miles (secondary waterways), the design storm is a 25-year event.
- For watersheds less than one square mile (minor waterways), the design storm is a 10-year event.
- Secondary or minor waterways outletting into major or secondary downstream waterways shall be designed to operate against a 25-year or 10-year flow respectively in the major or secondary downstream waterway, provided that the ground elevation along the secondary or minor system shall be above the 100-year water surface elevation in the major or secondary downstream waterway.
- Secondary or minor waterways in closed conduits shall have surface routes to carry the incremental 100-year flows with no inundation of structures or be sized for the full 100-year flows.
- Closed conduits shall be designed with maximum surcharging to within one foot of top of rim or grade for purposes of determining hydraulic capacity.
- Minimum pipe diameter is 12-inches with a minimum velocity of 2.5 feet per second (fps) when flowing full.
- Downstream boundary conditions will be based on existing water surface elevations taken from FEMA models for creeks and hydraulic models for pipes when available
- Detention basins will generally be sized for 100-year, 24-hour storm events assuming no increase in runoff from existing conditions

Design Methodology

SCWA allows using various methods for hydrologic and hydraulic analysis. MIKE Software; MIKE URBAN (MU) and MIKE FLOOD (MF) will be utilized in this study. MU coupled with MF allows development of runoff hydrographs and routing these flows through a pipe and open channel network.

The modeling will allow 2-dimensional unsteady state routing of flows including overland street routing and floodplain routing.

Hydrology Utilizing MIKE URBAN:

This Section describes the MU model development process including drainage basin delineation, loss rate method, transform method, baseflow method, and precipitation event. The hydrology model will be developed in MIKE URBAN (MU) for subsequent coupling with the MF model. MU simulates precipitation-runoff and routing processes and allows for the coupling of subbasin hydrographs to a storm drain system for subsequent routing and ultimate discharge to a creek. MU was selected in part because of its compatibility with the MF model and the ability to couple the City's storm drain system with MF models of Fryer and Nathanson Creeks.

The hydrologic runoff procedures outlined in the USDA-NRCS (formally Soil Conservation Service) Technical Release No. 55 (TR-55) will be followed and implemented for developing and simulating hydrology within MU. TR-55 is widely used as a hydrological basis for flood studies and accepted in the industry.

Drainage Basin Delineation

The first step of model development is division of the major watersheds (Sonoma Creek, Fryer Creek and Nathanson Creek) into sub-drainages, referred hereinafter as *sub-basins*. A sub-basin element represents a complete watershed that is separated into three distinct processes: *loss rate, transform, and baseflow.* The quantity of rainfall that falls and infiltrates is represented by a loss rate method. The excess rainfall which does not infiltrate and becomes runoff is represented by a transform method. Groundwater contributions to channel flow rate are represented with a baseflow method.

Loss Rate Method

Following TR-55 principles, the empirical curve number method will be utilized in MU to estimate total excess precipitation. The curve number (CN) represents the soil cover, land cover and antecedent moisture conditions of a watershed and its sub-basins. The CN method determines runoff using the amount of precipitation and the infiltration parameters associated with soil type, soil moisture, preceding rainfall, and surface retention. The amount of rainfall is converted to runoff using the CN. The CN ranges from 0 to 100, where a value of 100 represents zero losses or a completely impermeable surface (USDA, 1986). Impermeable pavements typically are assigned a CN of 98.

Surface soils are classified into four hydrologic soil groups (HSG) A, B, C, and D according to their minimum infiltration rate. Antecedent moisture conditions are classified as either low (AMC I), average (AMC II), or high (AMC III). For the purpose of this study, it will be assumed that AMC II curve numbers be applied. AMC II assumes that 0.5-inches to 1.1-inches of rain had fallen in the watershed of interest over the course of 5-days prior to the initiation of the design storm. Curve numbers developed for AMC II are the most widely used in hydrologic analysis when utilizing the SCS method.

The diverse land coverage within the watersheds will be identified from City and County of Sonoma zoning/land use GIS layer data assuming full build-out conditions. Because most sub-basins consist of multiple HSGs and multiple land uses, an area weighted composite CN will be calculated for each sub-basin. Table 1 summarizes curve numbers that will be utilized in this study.

TABLE 1

Land use and Curve Numbers (CN)
Based on Hydrologic Soil Group (HSG) and AMC II

Land Use	Curve Number (CN)			
	Hydrologic Soil Group (HSG)			
	A	B	C	D
City				
Agricultural	39	61	74	80
Commercial (15 d.u./acre, max)	89	92	94	95
Commercial-Gateway (15 d.u./acre, max)	89	92	94	95
Mixed Use (12 d.u./acre, max)	80	88	93	95
Public Facility	80	88	93	95
Park	39	61	74	80
High Density (11-15 d.u./acre)	80	88	93	95
Hillside Residential (1 d.u./10 acres, max)	46	65	77	82
Low Density Residential (2-5 d.u./acre)	61	75	83	87
Medium Density Residential (7-11 d.u./acre)	78	86	91	93
Housing Opportunity (15-20 d.u./acre)	89	92	94	95
Mobile Home Park (7 d.u./acre, max)	77	85	90	92
Rural Residential (2 d.u./acre, maximum)	46	65	77	82
Sonoma Residential	62	76	84	88

(3-8 d.u./acre)				
Wine Production	65	75	82	86
County				
Diverse Agriculture	39	61	74	80
General Commercial	89	92	94	95
General Industrial	81	88	91	93
Land Extensive Agriculture	49	69	79	84
Land Intensive Agriculture	63	75	83	87
Limited Commercial	80	88	93	95
Limited Industrial	78	86	91	93
Public/Quasi-Public (buildout)	80	88	93	95
Recreation/Visitor Serving Commercial	89	92	94	95
Resources/Rural Development	61	75	83	87
Rural Residential (< 2 units/acre)	54	70	80	85
Urban Residential (2-4 units/acre)	61	75	83	87
Curve Numbers (CN) reported are for Antecedent Moisture Condition II (AMC II)				

Transform Method

Following TR-55 principles, the SCS Unit Hydrograph (UH) model will be used in MU as the direct-runoff transform method. The model is based upon averages of UH derived from gauged rainfall and runoff for a large number of small agricultural watersheds throughout the United States. The SCS UH model uses a dimensionless, single-peaked unit hydrograph. Utilizing the UH method in MU requires the lag time for each sub-basin. The lag time (L) is defined as the difference in time between the center of mass of effective rainfall and the center of mass of runoff produced (Viessman, 1995). The lag time can be related to time of concentration (Tc) by the formula:

$$Tc = 5/3L$$

The primary flow path for each sub-basin will be obtained through digitization using the aerial 1-foot contour topographic data recently completed for the City. For sub-basins outside the city limits, United States Geologic Survey (USGS) quadrangle maps will be used. The flow paths will be digitized in GIS and elevations required to determine sub-basin slopes were also obtained from the topographic data.

Principles outlined in TR-55 will be utilized to calculate the time of concentration and converting to lag time based on sheet, shallow concentrated, and channel/pipe flow through each sub-basin. The hydraulic routing time used in this study will assume full pipe and full channel flow velocities along the sub-basin flowpath. Manning's Equation will be utilized for full channel capacity calculations using 'n' valued tabulated below in Table 2. Utilizing the information discussed above, the lag time will be determined for each sub-basin and input into the MU hydrology model.

TABLE 2

Manning's 'n' Values Used in Full Channel Flow Calculation

Type of Channel and Description	n
Concrete Trench Drain	0.011
Concrete Swale	0.015
Earth: Short grass, few weeds	0.035
Earth: Light brush on banks	0.05
Earth: Dense weeds	0.08
Natural Channel	varies

Baseflow Method

Baseflow accounts for the quantity of flow contributed from groundwater, and not direct precipitation-runoff. For modeling design storms, each sub-basin requires an initial baseflow. Because most flowpaths within the study area are only occupied with flow during precipitation events, the baseflow for each sub-basin is assumed to be zero.

Precipitation Events

MU offers various methods for assigning and modeling precipitation events. For the purpose of simulating design precipitation events, the 24-hour SCS Hypothetical Storm method was utilized. This method requires the 24-hour rainfall amount associated with a specific frequency. The method also requires the determination of a rainfall distribution. The SCS has defined four distributions within the United States based on storm intensity. Sonoma County is considered to have a Type IA distribution (NRCS, 1986). For the purpose of this study, 24-hour rainfall depths will be obtained from the NOAA Atlas 2.

Hydraulic Channel and Pipe Routing Utilizing MIKE FLOOD and MIKE URBAN:

The MF/MU model development process requires input of the channel network including channel cross sections, bridges and culverts; defining of boundary conditions and initial conditions; and input of floodplain and street network topography. The MF model is a tool that integrates both MIKE 11 and MIKE 21 into a single, dynamically coupled model. MIKE 11 is the basic one-dimensional hydrodynamic model capable of modeling a network of one-dimensional channels and is based on the St. Venant equations for one-dimensional unsteady flow. MIKE 21 is the basic two-dimensional hydrodynamic model based on a flexible mesh and is capable of modeling overland flow within floodplains and street networks and also simulates wetting and drying of floodplain accurately. MU is a hydrodynamic model capable of routing runoff from sub-basins through closed conduit and open channel reaches referred to in the model as *links*. Links will be digitized in the model based on the City of Sonoma GIS storm drain network supplemented with field investigations and represent all storm drain pipes greater than 24 inches in diameter. Link data such as invert elevations, ground elevations, diameter, material, and length will be input into the MU model. Nodes will be digitized in the model to represent storm drain manholes and catch basins.

ATTACHMENTS

Appendix A – Summary of Data Collection

APPENDIX A

SUMMARY OF DATA COLLECTION

REPORTS

City of Sonoma, Campobello Estates Subdivision, October 2001, Nathanson Creek Overbank Flow Analysis and Capacity Analysis of Proposed Creek Overflow Bypass Channel

National Oceanic and Atmospheric Administration (NOAA), 1973, Atlas 2 - Precipitation Frequency Atlas of the Western United States, Volume XI - California

Federal Emergency Management Agency (FEMA), December 2008, Sonoma County, California and Incorporated Areas Flood Insurance Study (FIS)

Federal Emergency Management Agency, March 1975, HEC-2 Input and Output Data for hydraulic Modeling of Nathanson Creek

Federal Emergency Management Agency, May 1991, HEC-2 Input and Output Data for hydraulic Modeling of Fryer Creek

Soil Conservation Service, May 1972, Soil Survey of Sonoma County, California

Sonoma County Water Agency, August 1983, Flood Control Design Criteria

MAPPING

Aerial Photo Map of City of Sonoma – flown December 18, 2009 (Scale: 1' = 300')

City of Sonoma, Improvement Plans for Holden Subdivision, January 1999, Oberkamper & Associates Civil Engineers, Inc.

City of Sonoma, Improvement Plans for The Lodge at Sonoma, April 1998, Riechers Spence & Associates Incorporated Consulting Civil Engineers.

City of Sonoma, Improvement Plans for Fifth Street East/Peru Road Conduit, February 2003, Department of Public Works

City of Sonoma, Improvement Plans for Spring Lane Subdivision, July 1989, Sandine and Associates

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Appendix D
Hydrology Results

APPENDIX D- MIKE URBAN Hydrology Results

Catchment	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
Catchment_1	4.8	6.8	10.0
Catchment_2	31.9	40.3	52.9
Catchment_3	3.9	4.9	6.3
Catchment_4	2.6	3.4	4.4
Catchment_5	694.5	975.7	1417.6
Catchment_6	14.1	18.5	25.1
Catchment_7	5.1	6.8	9.4
Catchment_8	10.3	13.5	18.3
Catchment_9	3.9	5.0	6.7
Catchment_10	14.4	18.5	24.5
Catchment_11	2.3	2.8	3.7
Catchment_12	6.3	8.8	12.5
Catchment_13	9.6	12.2	16.1
Catchment_14	10.2	12.8	16.7
Catchment_15	3.5	4.4	5.9
Catchment_16	2.1	2.7	3.4
Catchment_17	17.7	23.1	31.2
Catchment_18	7.1	9.3	12.4
Catchment_19	4.9	6.3	8.3
Catchment_20	3.2	4.1	5.4
Catchment_21	6.9	9.0	12.3
Catchment_22	2.9	3.8	5.2
Catchment_23	3.0	4.1	5.8
Catchment_24	60.0	82.0	116.0
Catchment_25	3.6	4.5	5.8
Catchment_26	2.5	3.2	4.4
Catchment_27	47.5	67.5	98.9
Catchment_28	15.1	20.3	28.2
Catchment_29	49.0	67.9	97.2
Catchment_30	3.9	6.2	9.9
Catchment_31	7.8	11.2	16.6
Catchment_32	6.3	8.1	10.8
Catchment_33	5.8	7.3	9.5
Catchment_34	0.8	1.0	1.4
Catchment_35	9.5	12.5	17.0
Catchment_36	13.9	18.4	25.3
Catchment_37	3.4	4.3	5.6
Catchment_38	3.6	4.6	6.1
Catchment_39	3.5	4.4	5.7
Catchment_40	7.6	9.9	13.5
Catchment_41	9.9	12.7	16.8
Catchment_42	4.2	5.4	7.2
Catchment_43	4.7	5.9	7.6
Catchment_44	6.9	8.6	11.2
Catchment_45	1.9	2.4	3.3

Catchment	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
Catchment_46	3.1	4.2	5.9
Catchment_47	0.7	1.0	1.3
Catchment_48	6.3	8.6	12.1
Catchment_49	8.1	11.2	16.0
Catchment_50	3.5	4.5	6.1
Catchment_51	26.7	35.2	47.9
Catchment_52	1.2	1.5	1.9
Catchment_53	6.3	8.3	11.5
Catchment_54	1.3	1.6	2.1
Catchment_55	2.8	3.7	5.1
Catchment_56	13.6	18.8	26.9
Catchment_57	47.6	65.8	94.0
Catchment_58	6.7	8.9	12.2
Catchment_59	1.2	1.5	1.9
Catchment_60	4.7	5.8	7.6
Catchment_61	2.6	3.4	4.5
Catchment_62	3.4	4.2	5.4
Catchment_63	7.4	10.1	14.1
Catchment_64	0.6	0.8	1.0
Catchment_65	11.3	14.1	18.3
Catchment_66	12.7	15.8	20.5
Catchment_67	4.5	5.7	7.3
Catchment_68	2.3	3.0	3.9
Catchment_69	1.9	2.5	3.4
Catchment_70	3.6	4.5	5.8
Catchment_71	1.6	2.1	2.9
Catchment_72	3.5	4.4	5.8
Catchment_73	4.1	5.3	7.1
Catchment_74	15.5	19.2	24.8
Catchment_75	8.4	10.5	13.5
Catchment_76	13.6	17.1	22.5
Catchment_77	8.3	10.7	14.3
Catchment_78	4.9	6.2	8.1
Catchment_79	9.0	11.6	15.5
Catchment_80	2.7	3.4	4.5
Catchment_81	4.9	6.3	8.5
Catchment_82	8.0	10.5	14.4
Catchment_83	15.7	19.5	25.2
Catchment_84	16.7	21.3	28.2
Catchment_85	3.7	4.7	6.2
Catchment_86	24.0	31.6	43.2
Catchment_87	12.6	15.9	20.9
Catchment_88	14.3	18.6	25.0
Catchment_89	12.6	17.2	24.4
Catchment_90	6.1	7.7	10.1
Catchment_91	7.6	9.6	12.5
Catchment_92	5.4	7.1	9.7

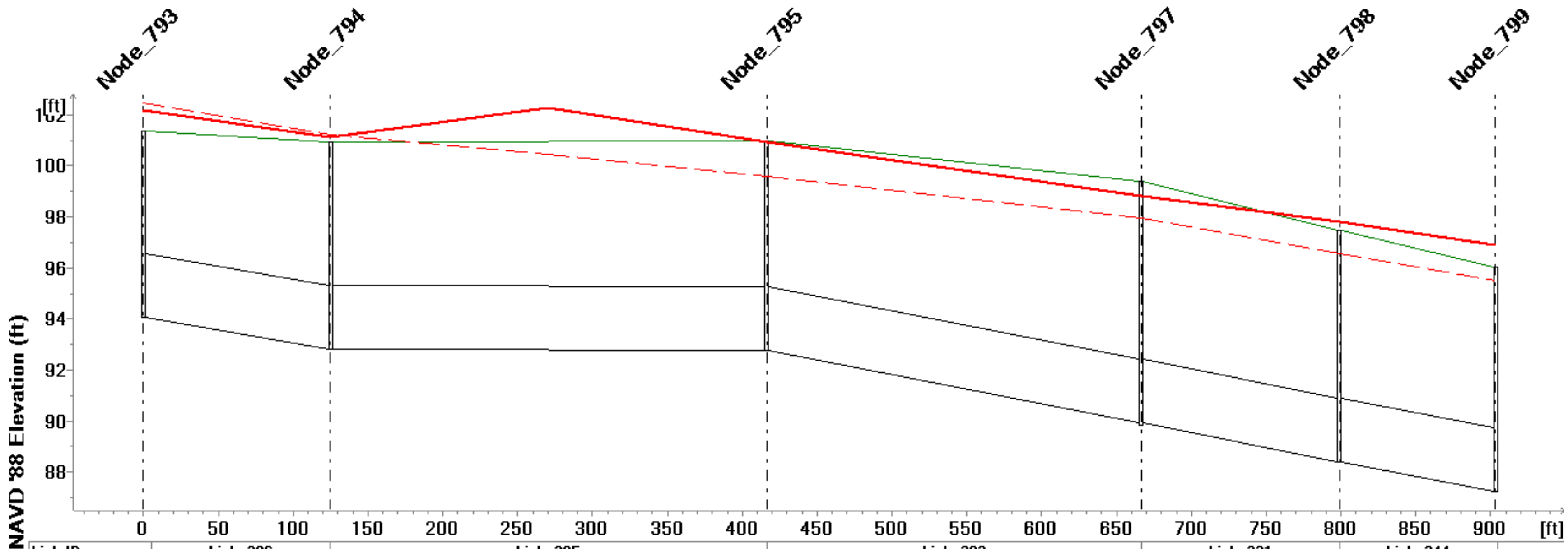
Catchment	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
Catchment_93	6.1	8.0	10.9
Catchment_94	14.9	21.2	31.2
Catchment_95	6.0	7.6	10.0
Catchment_96	8.7	11.4	15.5
Catchment_97	18.7	25.6	36.1
Catchment_98	4.4	5.7	7.6
Catchment_99	11.6	14.8	19.5
Catchment_100	3.9	5.2	7.1
Catchment_101	13.2	18.6	27.1
Catchment_102	21.5	32.2	49.5
Catchment_103	23.0	32.9	48.7
Catchment_104	3.3	4.3	5.7
Catchment_105	7.8	10.2	13.8
Catchment_106	4.3	5.5	7.3
Catchment_107	12.0	16.5	23.5
Catchment_108	4.5	5.7	7.5
Catchment_109	3.3	4.3	5.9
Catchment_110	4.7	6.1	8.1
Catchment_111	8.5	12.5	19.0
Catchment_112	8.6	10.7	13.8
Catchment_113	0.7	1.2	2.1
Catchment_114	7.1	9.3	12.7
Catchment_115	6.2	7.8	10.1
Catchment_116	3.9	5.2	7.1
Catchment_117	7.1	9.1	12.1
Catchment_118	3.2	4.0	5.2
Catchment_119	8.1	10.1	13.1
Catchment_120	19.7	25.0	32.7
Catchment_121	3.5	4.4	5.8
Catchment_122	9.1	11.4	14.7
Catchment_123	2.7	3.5	4.8
Catchment_124	1.4	1.8	2.4
Catchment_125	9.1	12.0	16.4
Catchment_126	7.8	9.9	13.2
Catchment_127	2.0	2.6	3.5
Catchment_128	1.3	1.7	2.3
Catchment_129	2.0	2.7	3.7
Catchment_130	9.7	12.6	16.8
Catchment_131	10.8	14.2	19.3
Catchment_132	10.2	13.1	17.6
Catchment_133	3.9	5.0	6.8
Catchment_134	10.7	14.1	19.2
Catchment_135	17.7	24.8	35.9
Catchment_136	17.0	21.5	28.2
Catchment_137	12.1	16.1	22.2
Catchment_138	1.9	2.4	3.3

Appendix E
MIKE URBAN Storm Drain Profile Figures

Legend for Storm Drain System Profiles

	Ground Level
	Crown/Invert Level of Pipe
	Q10 HGL
	Q100 HGL

S-1 Profile

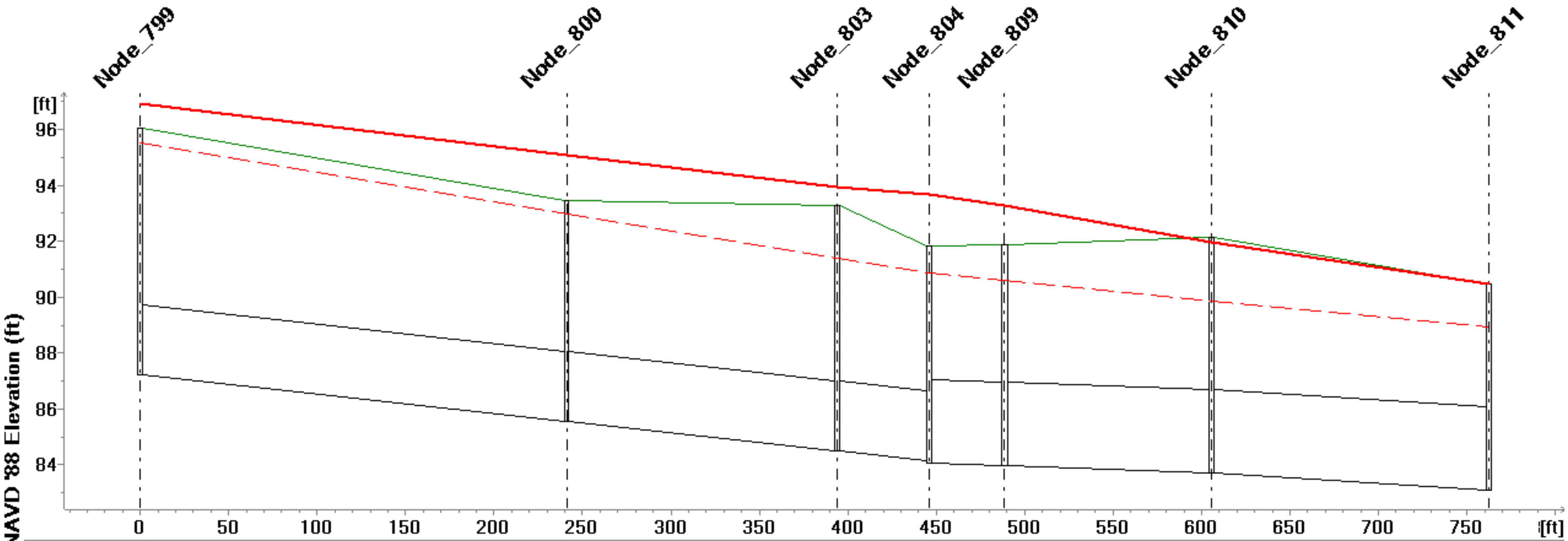


Link ID	Link_386	Link_385		Link_383	Link_231	Link_344
Q10 (cfs)	51.680	40.538	40.631	40.321	51.499	51.494
Q100 (cfs)	46.856	40.643	47.506	44.163	52.813	52.737
Length (ft)	124.782	291.395		250.402	132.288	104.135
Diameter (ft)	2.5000					

MUID	Node_793	Node_794	Node_795	Node_797	Node_798	Node_799
Ground Level (ft)	101.37	100.92	100.96	99.41	97.48	96.03
Invert Level (ft)	94.07	92.82	92.76	89.82	88.41	87.23
Q10 HGL (ft)	102.462	101.233	99.577	97.967	96.588	95.504
Q100 HGL (ft)	102.165	101.131	100.919	98.807	97.810	96.923

1/1/2004

S-1 Profile (cont.)



Link ID	Link_230	Link_114	Link_76	Link_482	Link_483	Link_484
Q10 (cfs)	51.481	51.464	51.453	57.944	57.945	57.948
Q100 (cfs)	52.683	52.664	70.405	72.202	83.674	73.394
Length (ft)	241.112	152.803	52.103	42.584	117.228	156.575
Diameter (ft)	2.5000			3.0000		

MUID	Node_799	Node_800	Node_803	Node_804	Node_809	Node_810	Node_811
Ground Level (ft)	96.03	93.46	93.27	91.85	91.86	92.12	90.46
Invert Level (ft)	87.23	85.56	84.51	84.05	83.96	83.71	83.09
Q10 HGL (ft)	95.504	92.989	91.399	90.858	90.597	89.878	88.918
Q100 HGL (ft)	96.923	95.077	93.942	93.669	93.284	91.981	90.484

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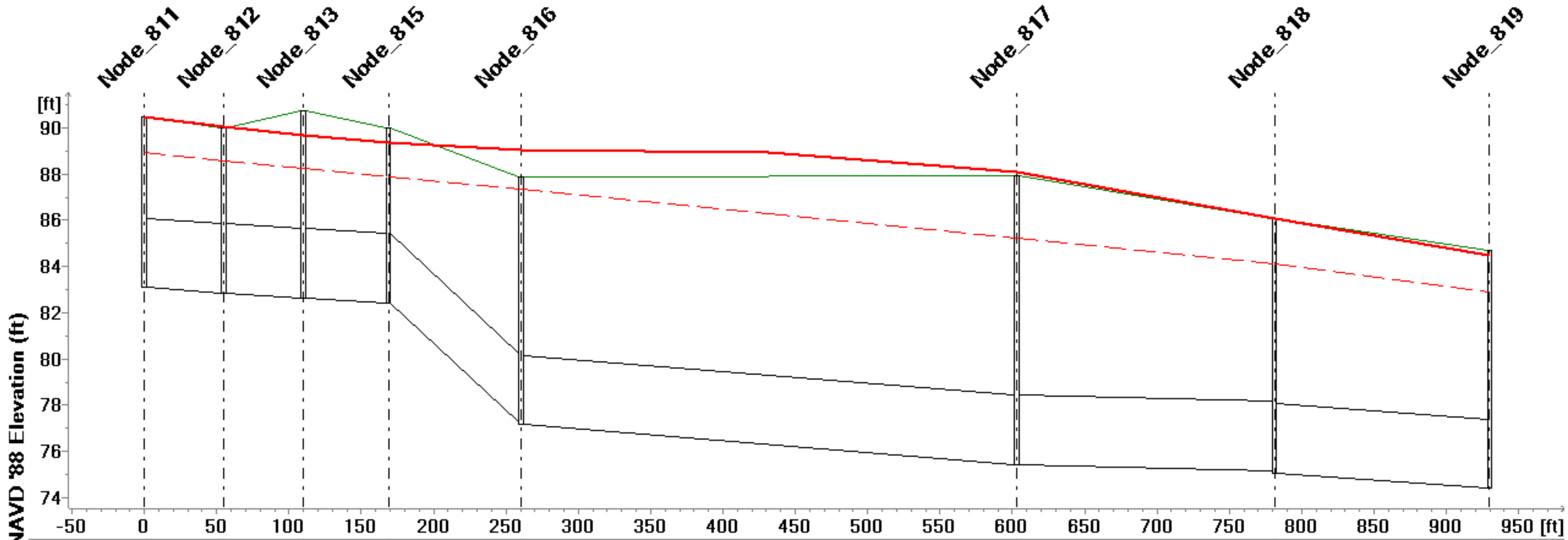
S-1 Profile (cont.)



Link ID	Link_485	Link_486	Link_77	Link_71	Link_63		Link_62	Link_61
Q10 (cfs)	57.952	57.956	57.959	57.964	57.970	57.975	57.987	67.364
Q100 (cfs)	70.005	68.226	68.837	74.104	61.487	61.130	79.533	80.957
Length (ft)	54.837	54.925	58.882	91.763	342.381		178.406	148.659
Diameter (ft)	3.0000							

MUID	......	Node_812	Node_813	Node_815	Node_816	Node_817	Node_818	Node_819
Ground Level (ft)	......	90.00	90.72	89.99	87.87	87.94	86.08	84.69
Invert Level (ft)	......	82.87	82.65	82.42	77.17	75.44	75.08	74.39
Q10 HGL (ft)	......	88.582	88.247	87.887	87.327	85.233	84.144	82.902
Q100 HGL (ft)	......	90.074	89.708	89.339	89.058	88.099	86.083	84.469

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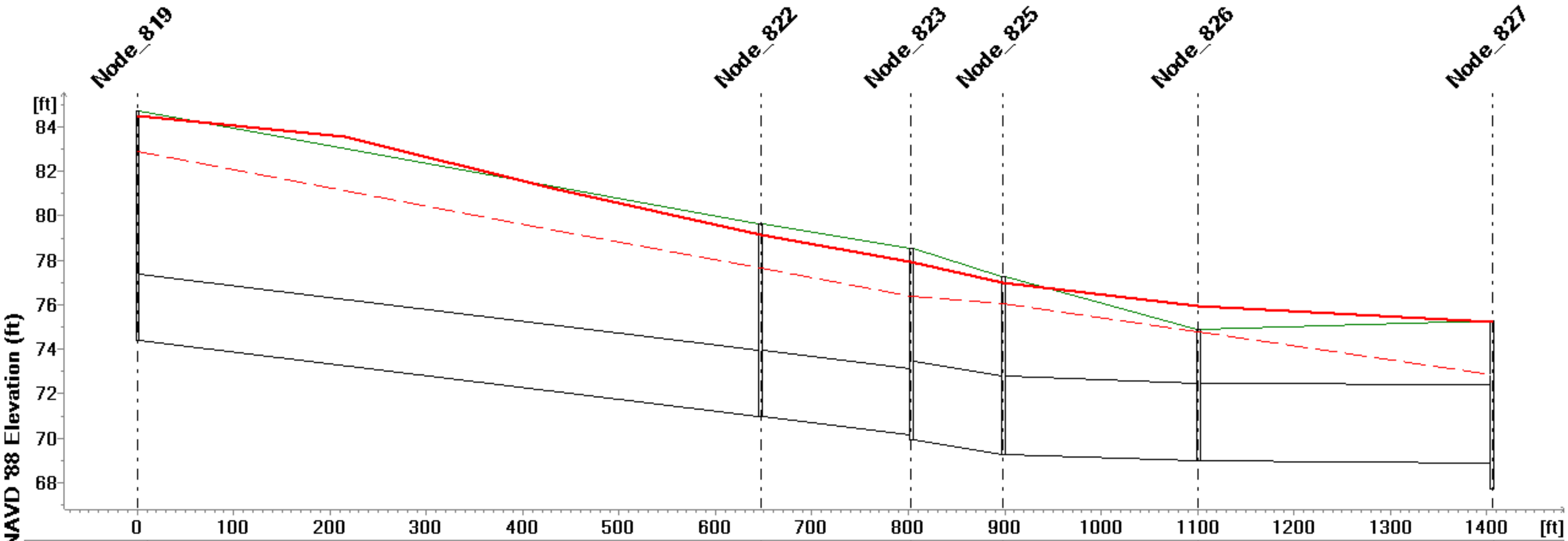
S-1 Profile (cont.)



Link ID	Link_59			Link_67	Link_69	Link_68	Link_66
Q10 (cfs)	67.366	67.367	67.369	67.375	67.383	88.596	88.602
Q100 (cfs)	70.593	71.552	77.063	73.587	109.768	98.365	96.668
Length (ft)	646.730			156.394	95.156	202.655	304.602
Diameter (ft)	3.0000				3.5000		

MUID	Node_819	Node_822	Node_823	Node_825	Node_826	Node_827
Ground Level (ft)	84.69	79.62	78.53	77.28	74.89	75.28
Invert Level (ft)	74.39	70.96	69.93	69.28	68.99	67.69
Q10 HGL (ft)	82.902	77.630	76.391	76.060	74.775	72.842
Q100 HGL (ft)	84.469	79.138	77.923	77.014	75.938	75.214

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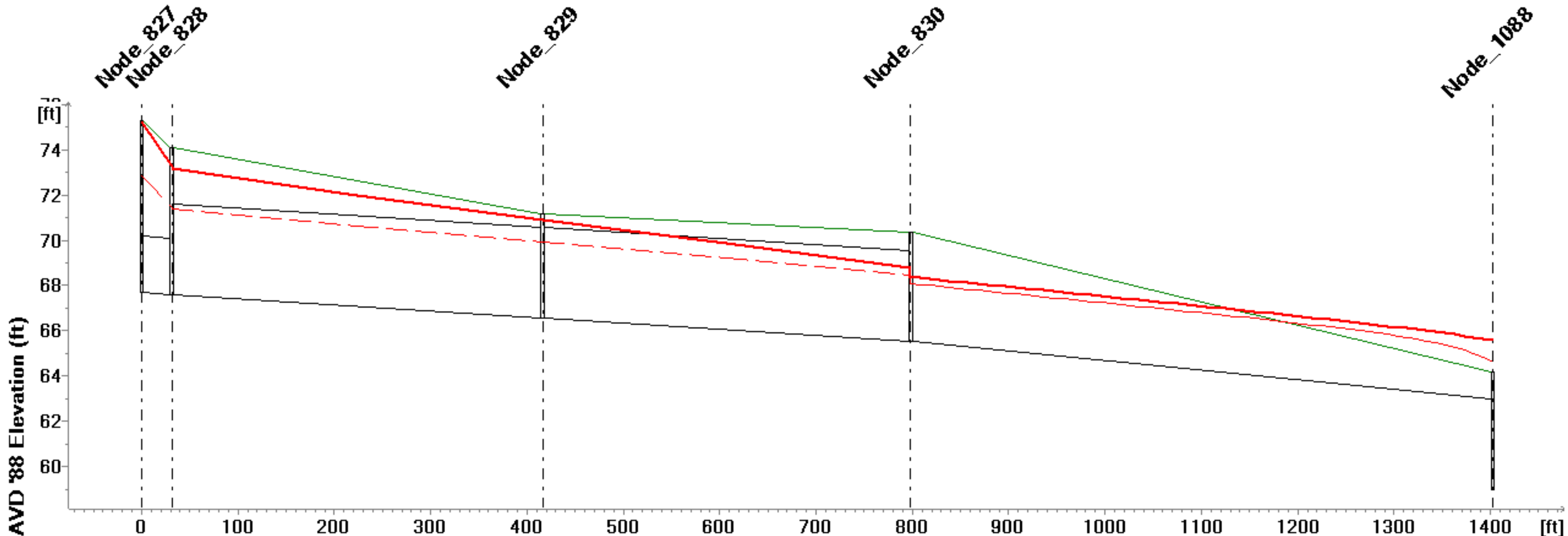
S-1 Profile (cont.)



Link ID	....	Link_84		Link_541		Link_542
Q10 (cfs)	....	95.663	95.657	95.653	95.654	102.794
Q100 (cfs)	....	120.108	119.877	119.108	118.669	
Length (ft)	....	384.977		381.700		604.310
Diameter (ft)	....	4.0000				

MUID	Node_828	Node_829	Node_830	Node_1088
Ground Level (ft)	74.09	71.16	70.35	64.20
Invert Level (ft)	67.60	66.55	65.55	59.00
Q10 HGL (ft)	71.380	69.942	68.083	62.290
Q100 HGL (ft)	73.167	70.902	68.370	65.589

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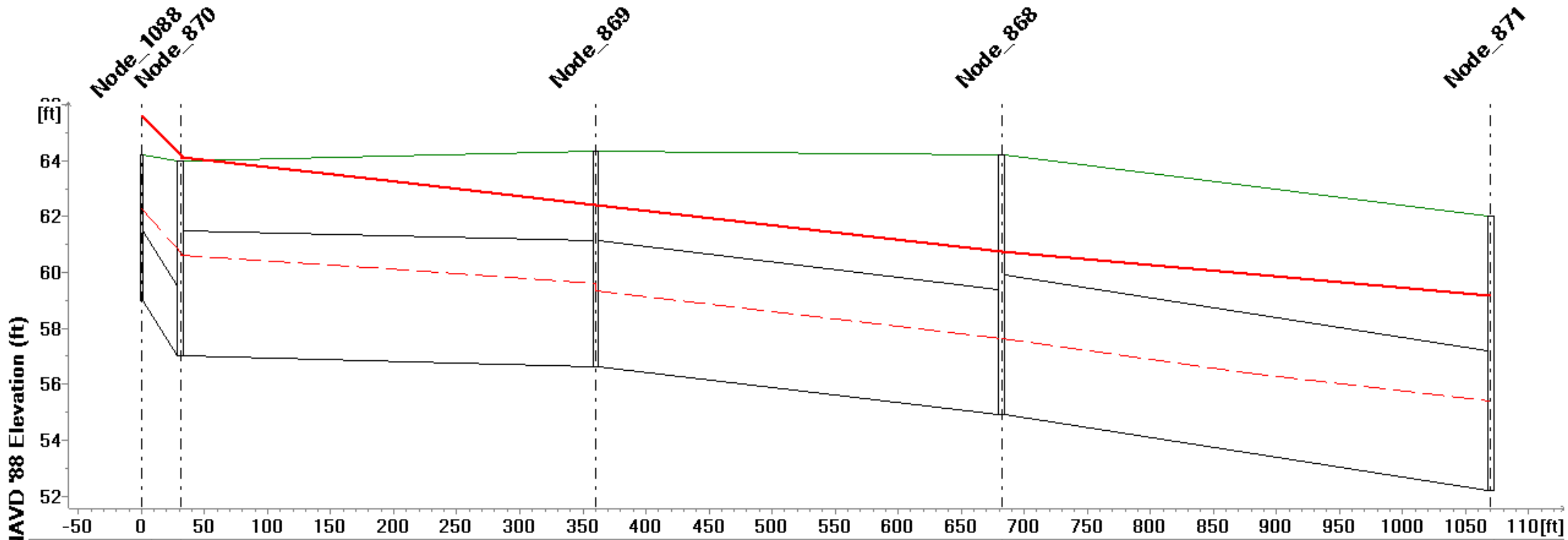
S-1 Profile (cont.)



Link ID	......	Link_17		Link_16	Link_21	
Q10 (cfs)	......	105.840	105.845	105.851	130.528	130.512
Q100 (cfs)	......	159.909		159.907	188.172	188.159
Length (ft)	......	329.548		321.773	387.903	
Diameter (ft)	......	4.5000			5.0000	

MUID	..	Node_870	Node_869	Node_868	Node_871
Ground Level (ft)	..	64.00	64.34	64.20	62.00
Invert Level (ft)	..	57.00	56.64	54.90	52.20
Q10 HGL (ft)	..	60.603	59.333	57.619	55.383
Q100 HGL (ft)	..	64.122	62.416	60.759	59.169

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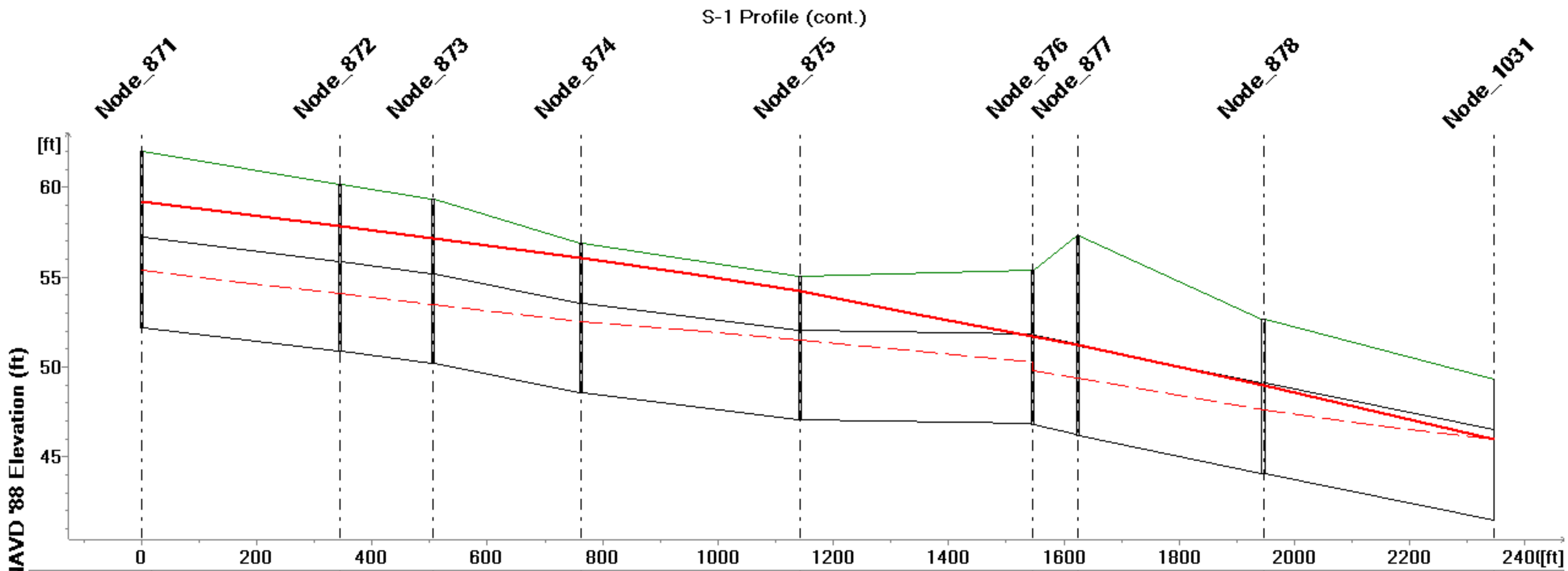

Link ID	Link_24		Link_22	Link_26	Link_25		Link_23			Link_20	Link_152	
Q10 (cfs)	130.492	130.460	130.413	136.719	148.378	148.332	148.331	148.325	....	158.079	164.118	164.127
Q100 (cfs)	188.123	188.119	188.109	197.196	217.455	217.475	223.017	222.600	....	242.340	248.318	248.317
Length (ft)	344.154		161.809	256.988	379.677		402.957		....	321.649	399.904	
Diameter (ft)	5.0000											

MUID	Node_871	Node_872	Node_873	Node_874	Node_875	Node_876	Node_877	Node_878	Node_1031
Ground Level (ft)	62.00	60.16	59.30	56.87	55.07	55.37	57.26	52.62	49.34
Invert Level (ft)	52.20	50.86	50.20	48.57	47.07	46.77	46.16	44.08	41.49
Q10 HGL (ft)	55.383	54.079	53.481	52.494	51.523	49.816	49.373	47.613	46.000
Q100 HGL (ft)	59.169	57.800	57.158	56.061	54.204	51.720	51.257	48.978	46.000

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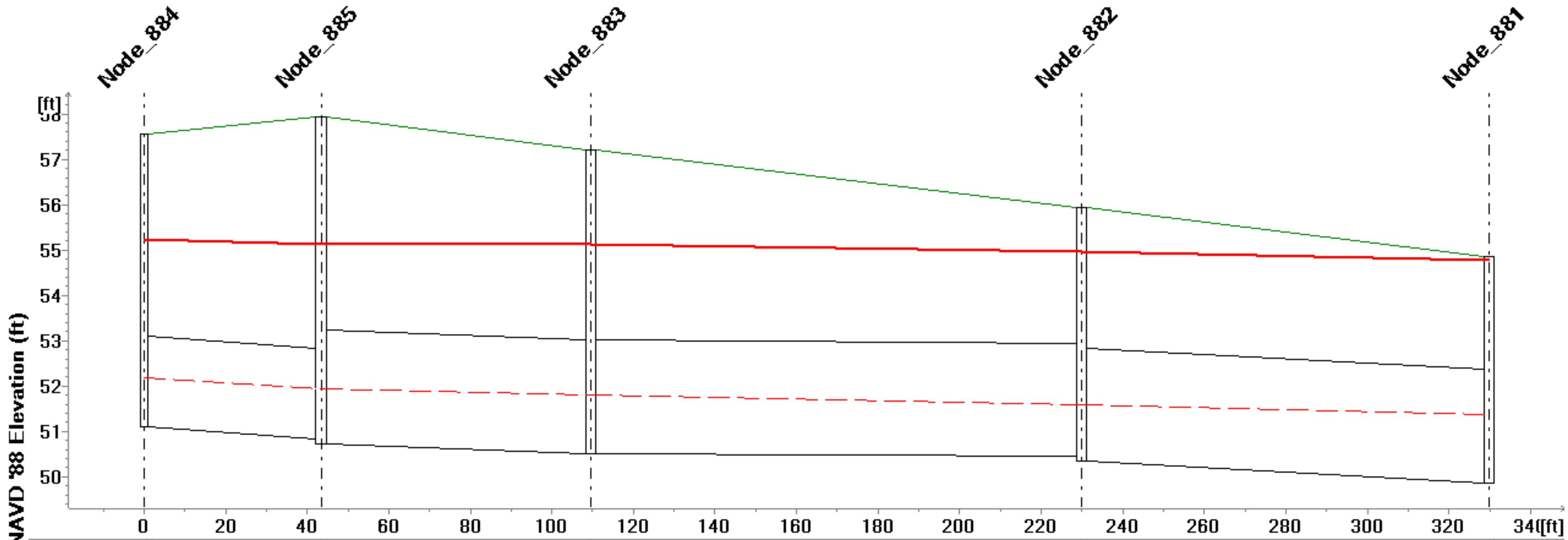
S-1-1 Profile



Link ID	Link_3	Link_148	Link_2	Link_4
Q10 (cfs)	10.164	10.152	10.127	10.083
Q100 (cfs)	17.558			
Length (ft)	43.397	66.141	120.283	99.943
Diameter (ft)	2.0000	2.5000		

MUID	Node_884	Node_885	Node_883	Node_882	Node_881
Ground Level (ft)	57.57	57.94	57.21	55.94	54.87
Invert Level (ft)	51.11	50.74	50.51	50.34	49.87
Q10 HGL (ft)	52.176	51.946	51.799	51.584	51.382
Q100 HGL (ft)	55.246	55.129	55.116	54.964	54.778

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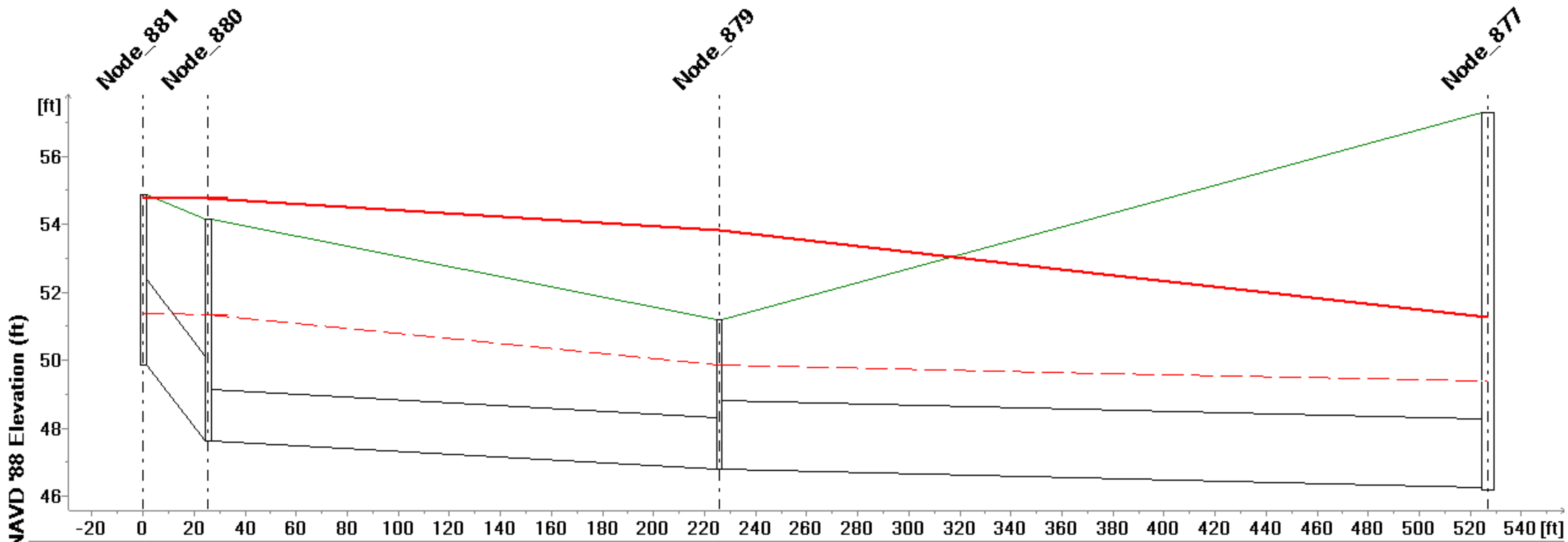
S-1-1 Profile (cont.)



Link ID	Link_5	Link_6	Link_14	
Q10 (cfs)	10.055	10.054	10.053	
Q100 (cfs)	19.258	15.338	24.295	24.331
Length (ft)	25.441	200.146	301.126	
Diameter (ft)	2.5000	1.5000	2.0000	

MUID	.....	Node_880	Node_879	Node_877
Ground Level (ft)	.....	54.14	51.21	57.26
Invert Level (ft)	.....	47.62	46.80	46.16
Q10 HGL (ft)	.....	51.347	49.848	49.373
Q100 HGL (ft)	.....	54.772	53.837	51.257

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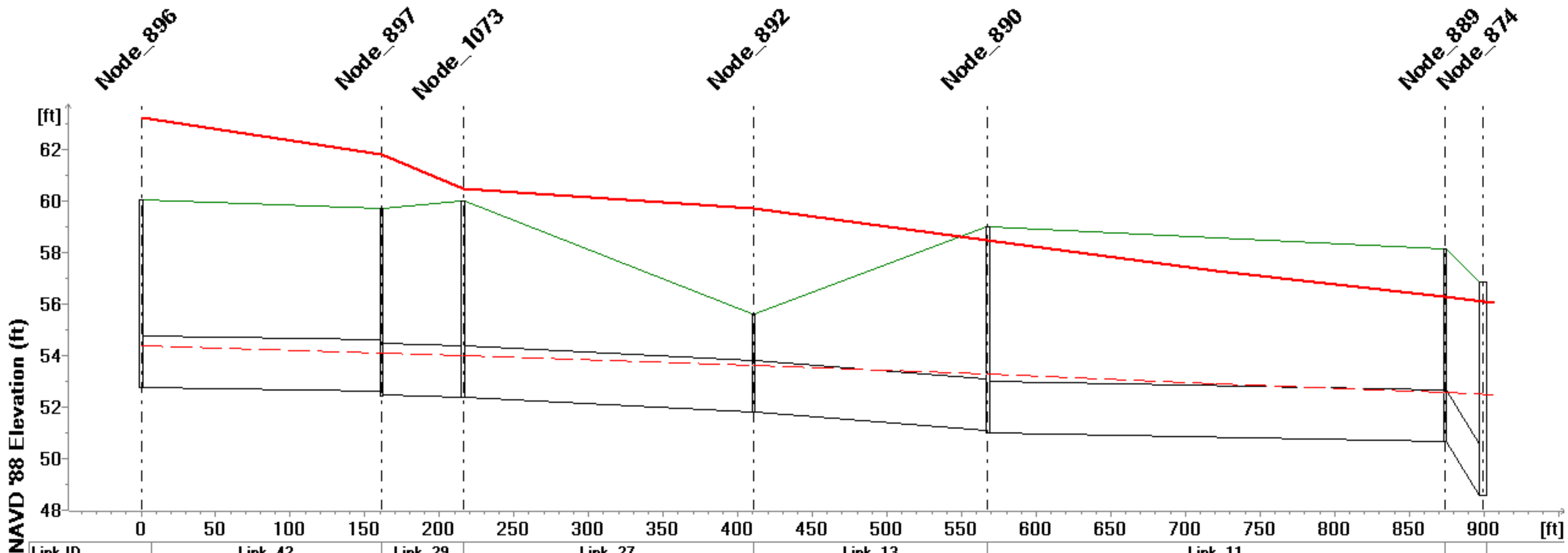
S-1-2 Profile



Link ID	Link_42	Link_29	Link_27	Link_13	Link_11		....
Q10 (cfs)	10.677	10.645	10.607	12.156	12.149	12.130	....
Q100 (cfs)	23.476	23.588	20.985	22.914	22.058	22.052	....
Length (ft)	161.109	54.760	194.667	157.070	306.398		....
Diameter (ft)	2.0000						

MUID	Node_896	Node_897	Node_1073	Node_892	Node_890	Node_889	....
Ground Level (ft)	60.06	59.72	59.99	55.60	59.00	58.14	....
Invert Level (ft)	52.76	52.42	52.39	51.80	51.00	50.64	....
Q10 HGL (ft)	54.377	54.086	53.984	53.629	53.261	52.565	....
Q100 HGL (ft)	63.240	61.791	60.473	59.718	58.471	56.267	....

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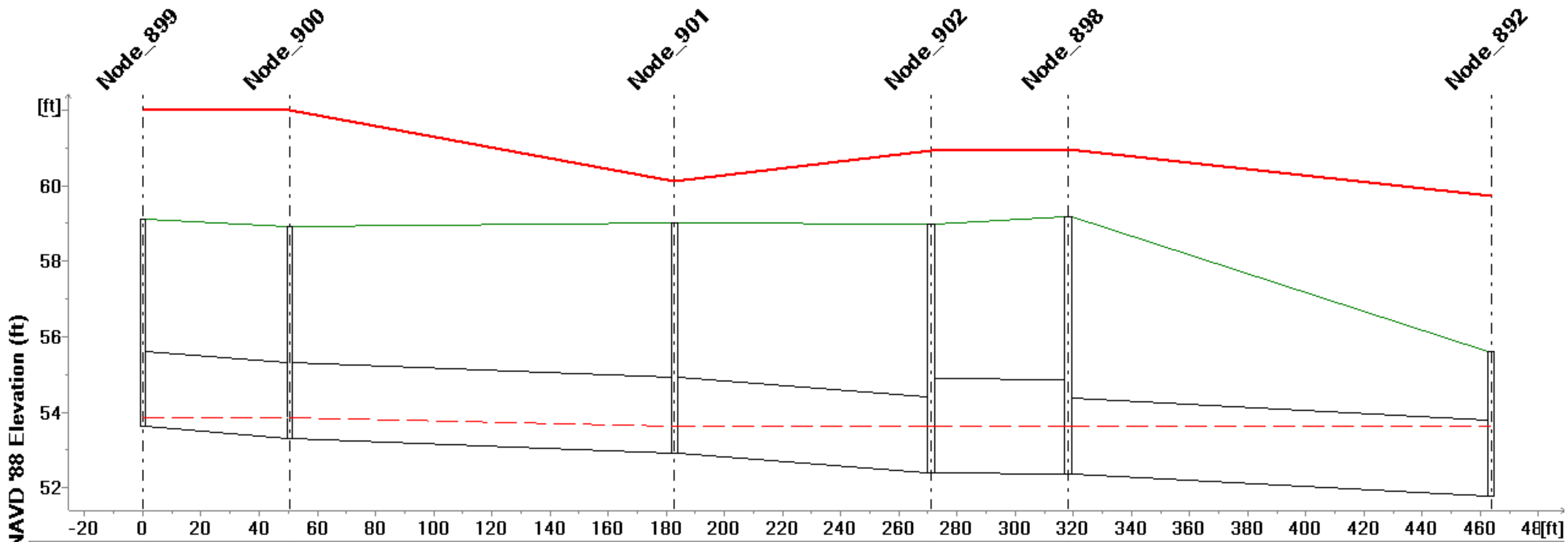
S-1-2-1 Profile



Link ID	Link_48	Link_47	Link_45	Link_119	Link_30	
Q10 (cfs)	0.025	1.938	2.095	1.966	2.090	
Q100 (cfs)	2.171	4.757	3.805	4.074	6.304	
Length (ft)	50.570	132.265	88.364	46.909	145.542	
Diameter (ft)		2.0000		2.5000	2.0000	

MUID	....	Node_900	Node_901	Node_902	Node_898	Node_892	
Ground Level (ft)	59.12	58.91	59.02	59.00	59.17	55.60	
Invert Level (ft)	53.62	53.31	52.92	52.40	52.37	51.80	
Q10 HGL (ft)	53.867	53.871	53.630	53.639	53.636	53.629	
Q100 HGL (ft)	61.997	62.000	60.113	60.929	60.945	59.718	

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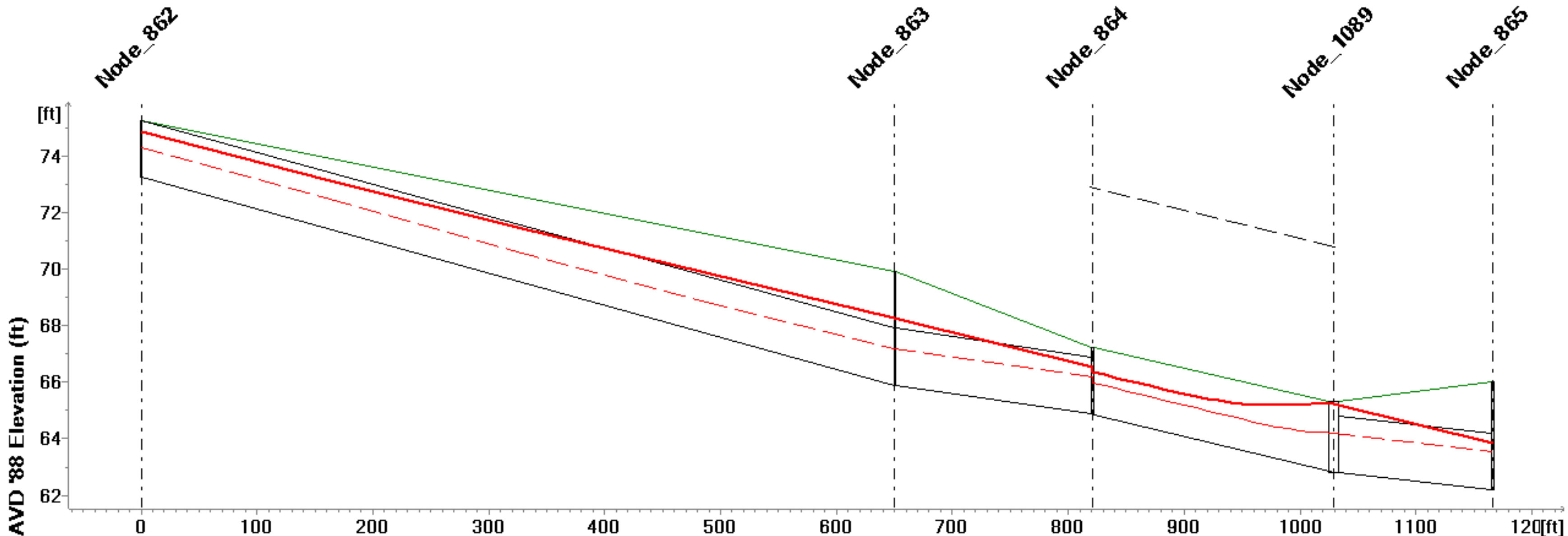
S-1-3 Profile



Link ID	Link_85				Link_57	Link_557	Link_558
Q10 (cfs)	14.100			14.097	14.091	14.092	14.083
Q100 (cfs)	25.047	24.992	24.977	24.974			24.955
Length (ft)	650.417				170.971	207.593	137.333
Diameter (ft)	2.0000						2.0000

MUID	Node_862	Node_863	Node_864	Node_1089	Node_865
Ground Level (ft)	75.25	69.90	67.21	65.30	66.01
Invert Level (ft)	73.25	65.90	64.90	62.80	62.21
Q10 HGL (ft)	74.286	67.177	65.981	64.179	62.855
Q100 HGL (ft)	74.842	68.248	66.360	65.216	63.140

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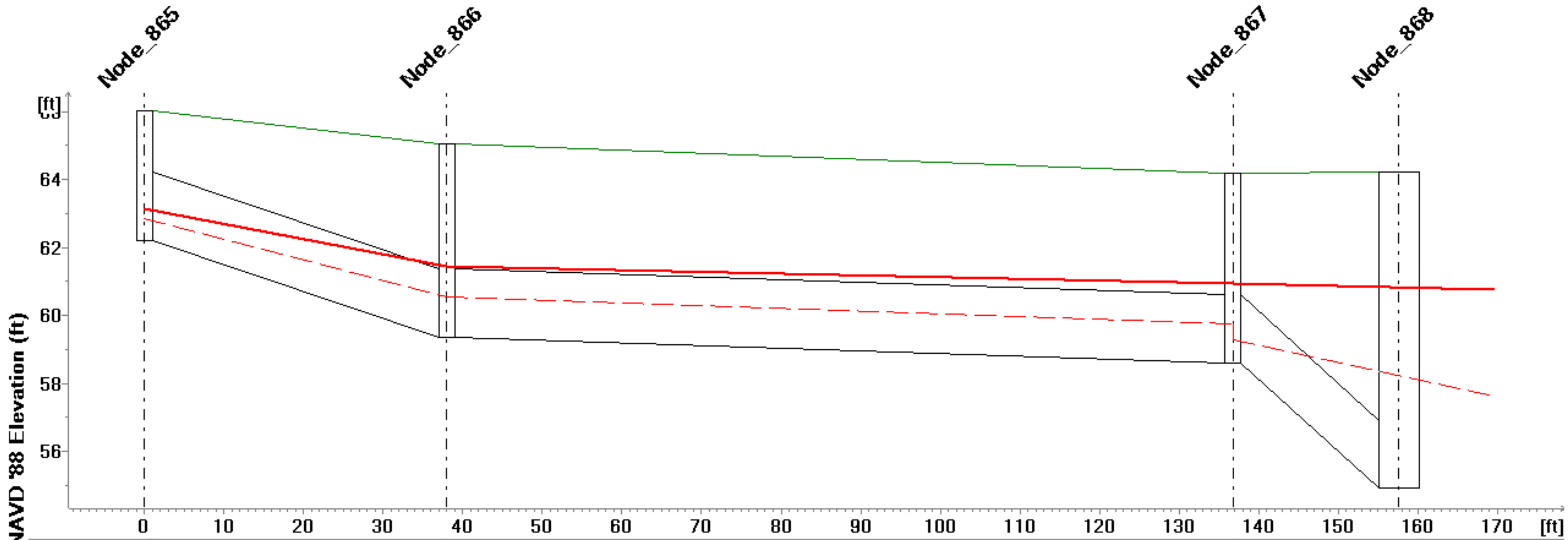
S-1-3 Profile (cont.)



Link ID	Link_28	Link_19	Link_18
Q10 (cfs)	14.083	14.084	14.085
Q100 (cfs)	24.955	24.956	24.954
Length (ft)	37.979	98.788	20.858
Diameter (ft)	2.0000		

MUID	Node_865	Node_866	Node_867	Node_868
Ground Level (ft)	66.01	65.06	64.20	
Invert Level (ft)	62.21	59.36	58.60	54.90
Q10 HGL (ft)	62.855	60.527	59.281	57.619
Q100 HGL (ft)	63.140	61.439	60.924	60.759

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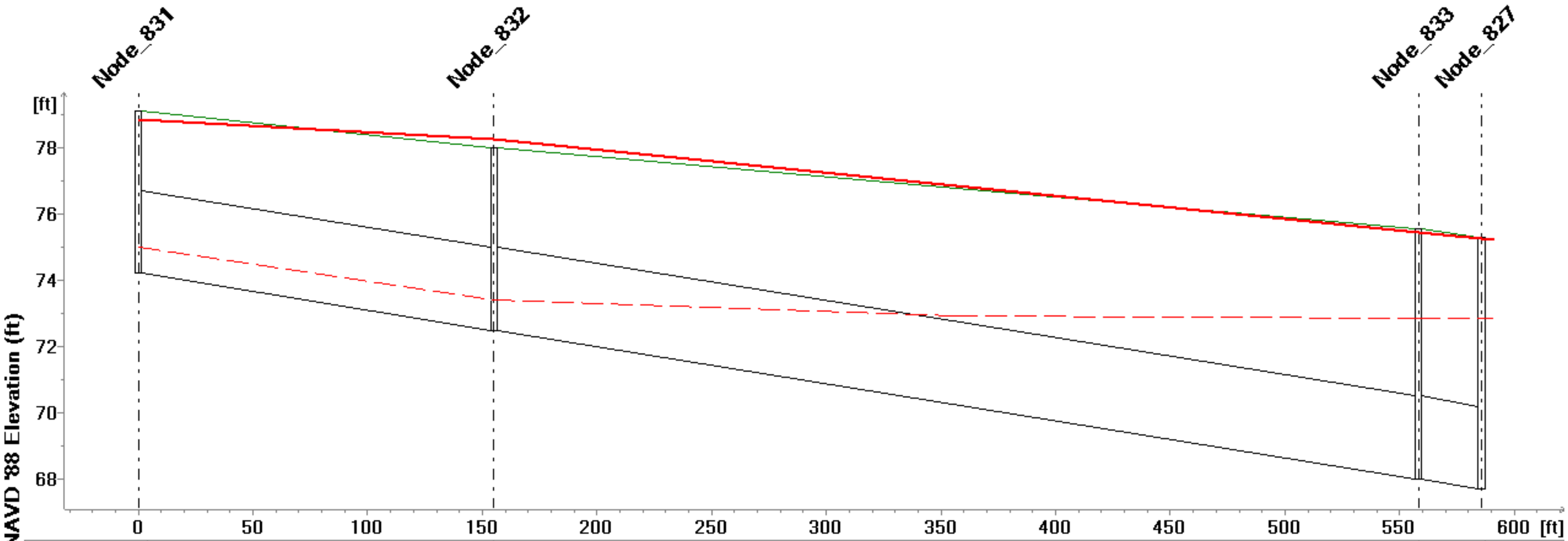
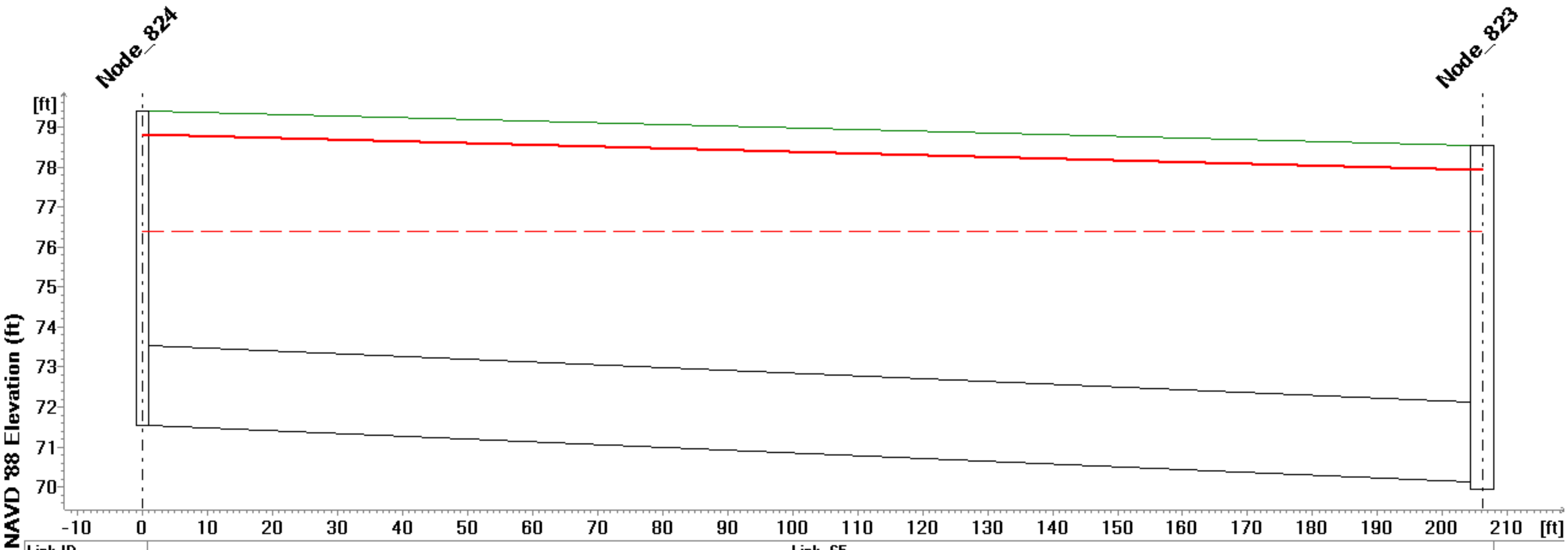
S-1-4 Profile



Link ID	Link_99	Link_87		Link_544
Q10 (cfs)	9.547	9.648	9.508	9.503
Q100 (cfs)	29.182	39.914	40.139	41.718
Length (ft)	155.013	403.234		27.511
Diameter (ft)	2.5000			
MUID	Node_831	Node_832	Node_833	......
Ground Level (ft)	79.08	77.99	75.56	......
Invert Level (ft)	74.21	72.49	68.00	......
Q10 HGL (ft)	74.981	73.419	72.850	......
Q100 HGL (ft)	78.844	78.232	75.429	......

1/1/2004

S-1-5 Profile



Link ID	Link_65	
Q10 (cfs)	0.209	
Q100 (cfs)	22.553	
Length (ft)	206.095	
Diameter (ft)	2.0000	
MUID	Node_824	Node_823
Ground Level (ft)	79.38	78.53
Invert Level (ft)	71.54	69.93
Q10 HGL (ft)	76.391	
Q100 HGL (ft)	78.829	77.923

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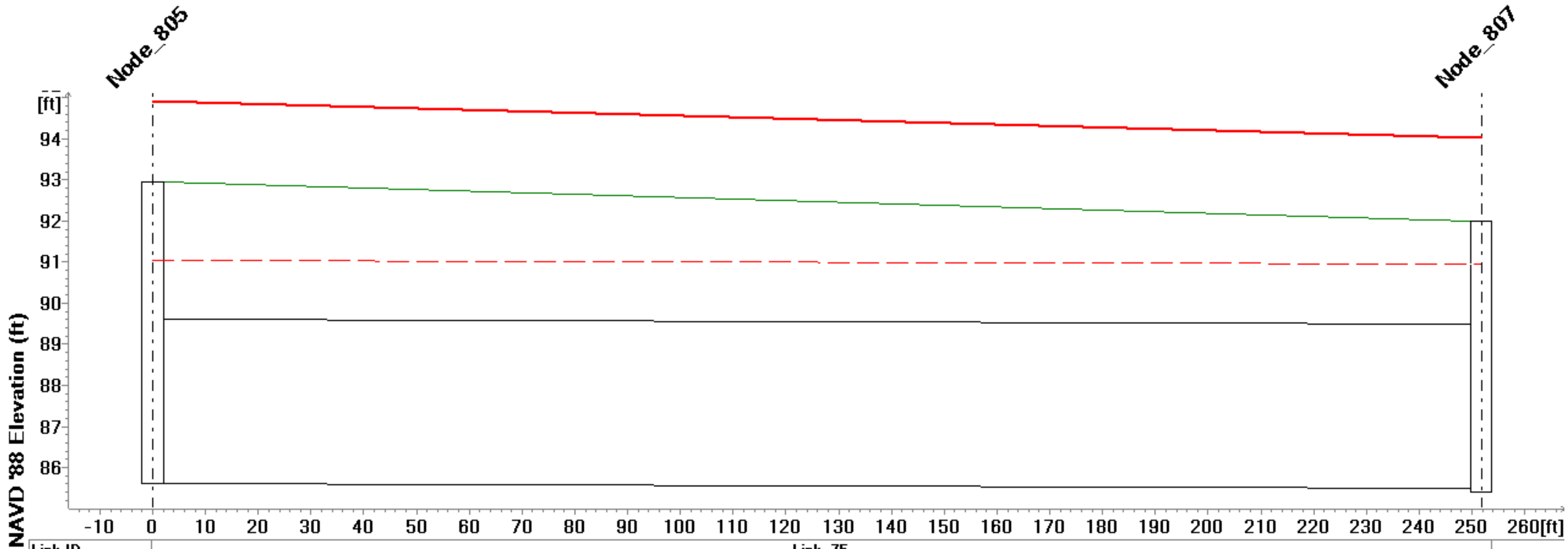
S-1-6 Profile



Link ID	Link_75	
Q10 (cfs)	9.550	
Q100 (cfs)	57.151	
Length (ft)	251.740	
Diameter (ft)	4.0000	
MUID	Node_805	Node_807
Ground Level (ft)	92.96	92.00
Invert Level (ft)	85.61	85.40
Q10 HGL (ft)	91.034	90.939
Q100 HGL (ft)	94.925	94.028

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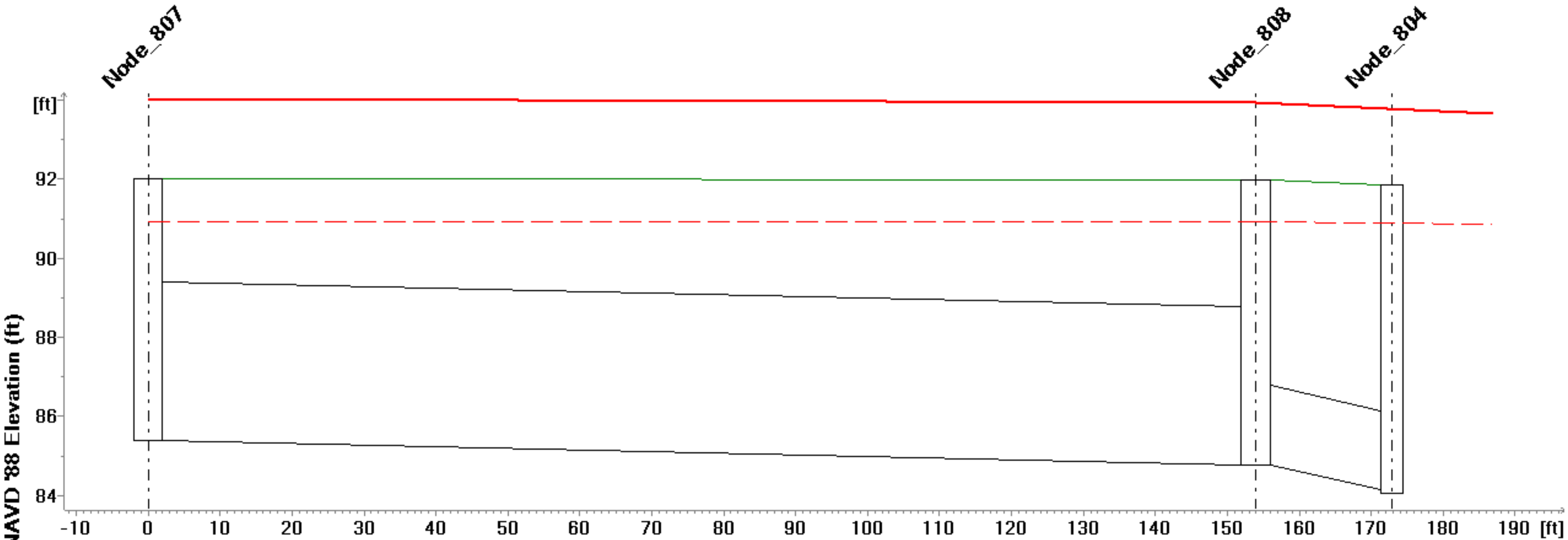
S-1-6 Profile (cont.)



Link ID	Link_74	Link_78
Q10 (cfs)	11.504	14.879
Q100 (cfs)	59.157	36.786
Length (ft)	153.969	18.869
Diameter (ft)	4.0000	2.0000

MUID	Node_807	Node_808	Node_804
Ground Level (ft)	92.00	91.98	91.85
Invert Level (ft)	85.40	84.78	84.05
Q10 HGL (ft)	90.939	90.929	90.858
Q100 HGL (ft)	94.028	93.934	93.669

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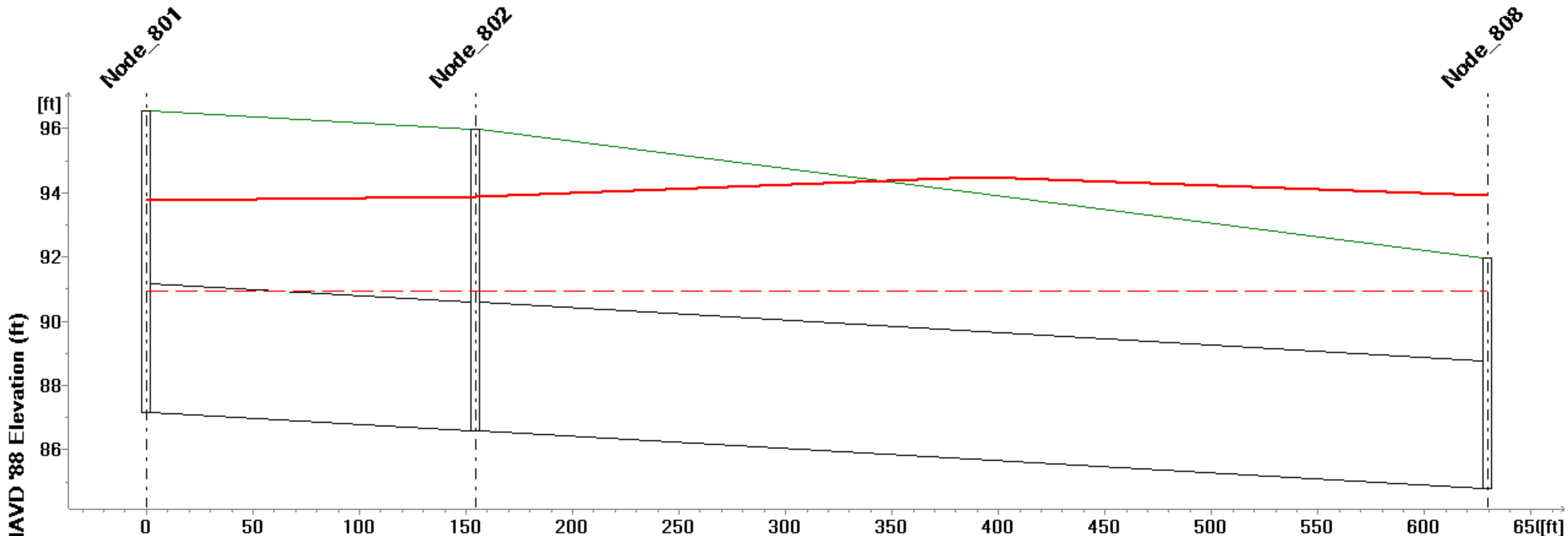
S-1-6-1 Profile



Link ID	Link_228		Link_473	
Q10 (cfs)	0.826		2.316	3.890
Q100 (cfs)	8.382		18.022	21.272
Length (ft)	154.441		475.013	
Diameter (ft)	4.0000			
MUID	Node_801	Node_802		Node_808
Ground Level (ft)	96.53	95.99		91.98
Invert Level (ft)	87.18	86.59		84.78
Q10 HGL (ft)	90.931	90.930		90.929
Q100 HGL (ft)	93.765	93.870		93.934

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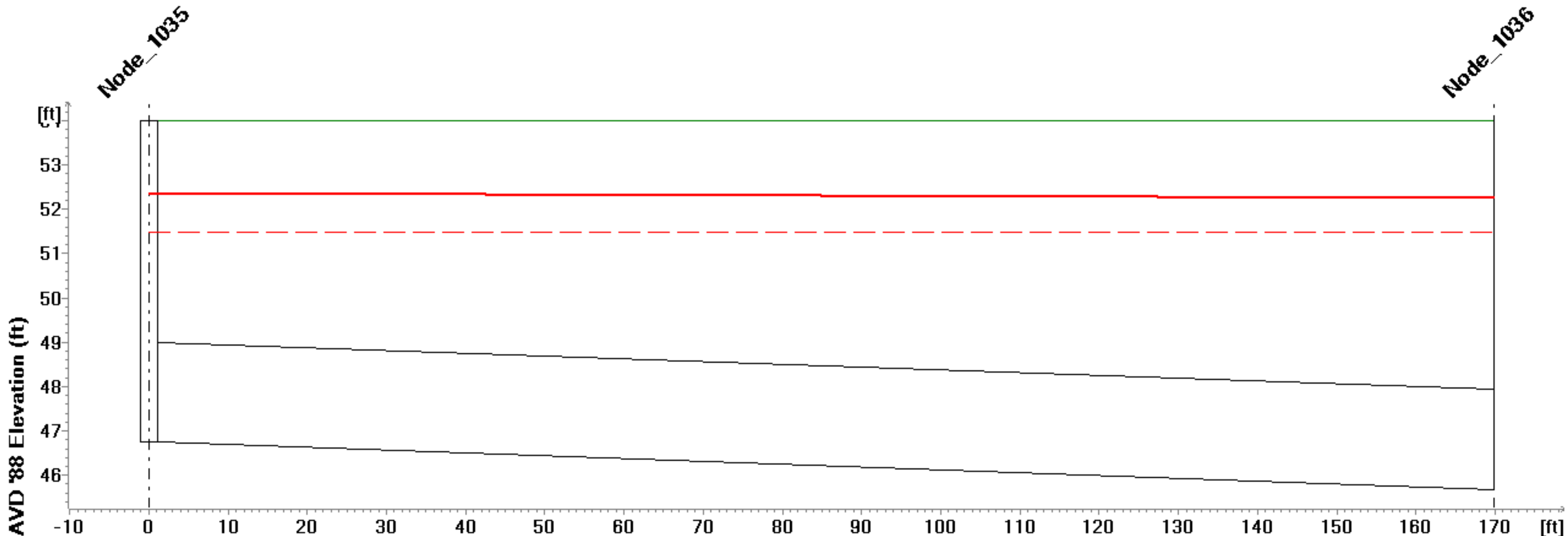
N-1 Profile



Link ID	Link_153	
Q10 (cfs)	5.807	
Q100 (cfs)	9.514	
Length (ft)	169.850	
Diameter (ft)	2.2500	
MUID	Node_1035	Node_1036
Ground Level (ft)	54.00	
Invert Level (ft)	46.75	45.68
Q10 HGL (ft)	51.483	51.472
Q100 HGL (ft)	52.356	52.242

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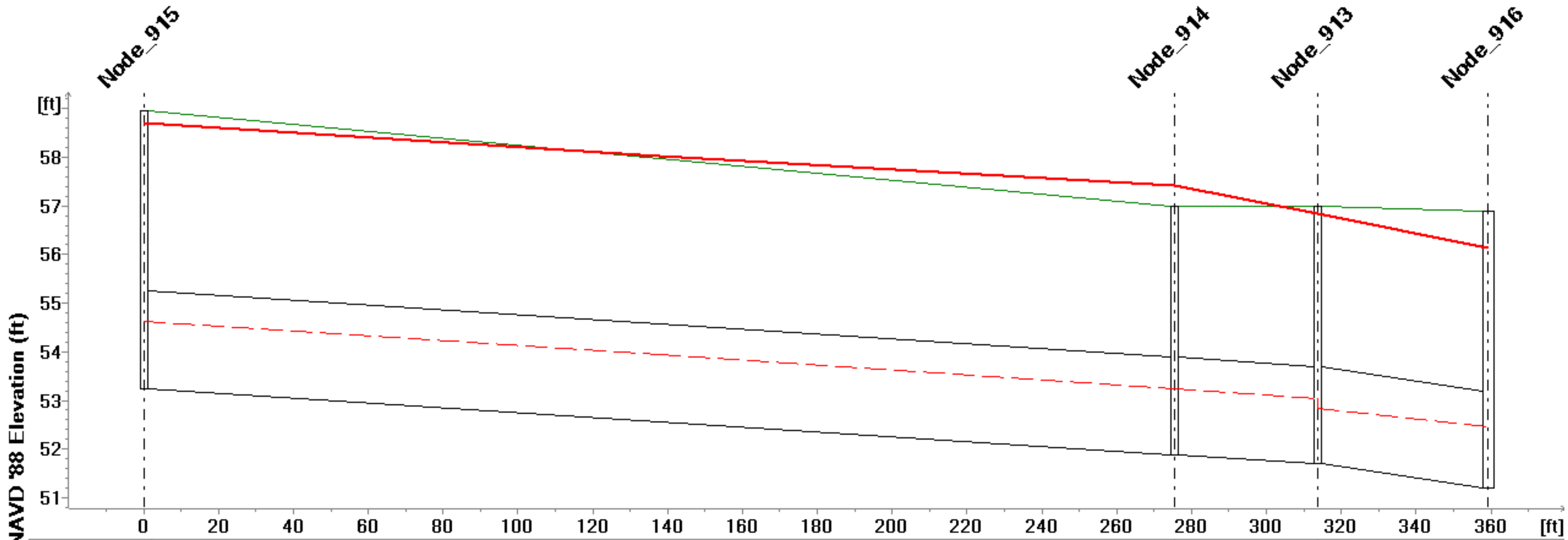
N-2 Profile



Link ID	Link_35		Link_43		Link_34	
Q10 (cfs)	14.428	14.421	14.418		14.416	
Q100 (cfs)	24.524	24.523	33.728		33.712	
Length (ft)	275.415		38.186		45.700	
Diameter (ft)	2.0000					
MUID	Node_915	Node_914		Node_913		Node_916
Ground Level (ft)	58.95	57.00				56.89
Invert Level (ft)	53.25	51.89		51.70		51.19
Q10 HGL (ft)	54.623	53.242		52.847		52.458
Q100 HGL (ft)	58.701	57.430		56.844		56.143

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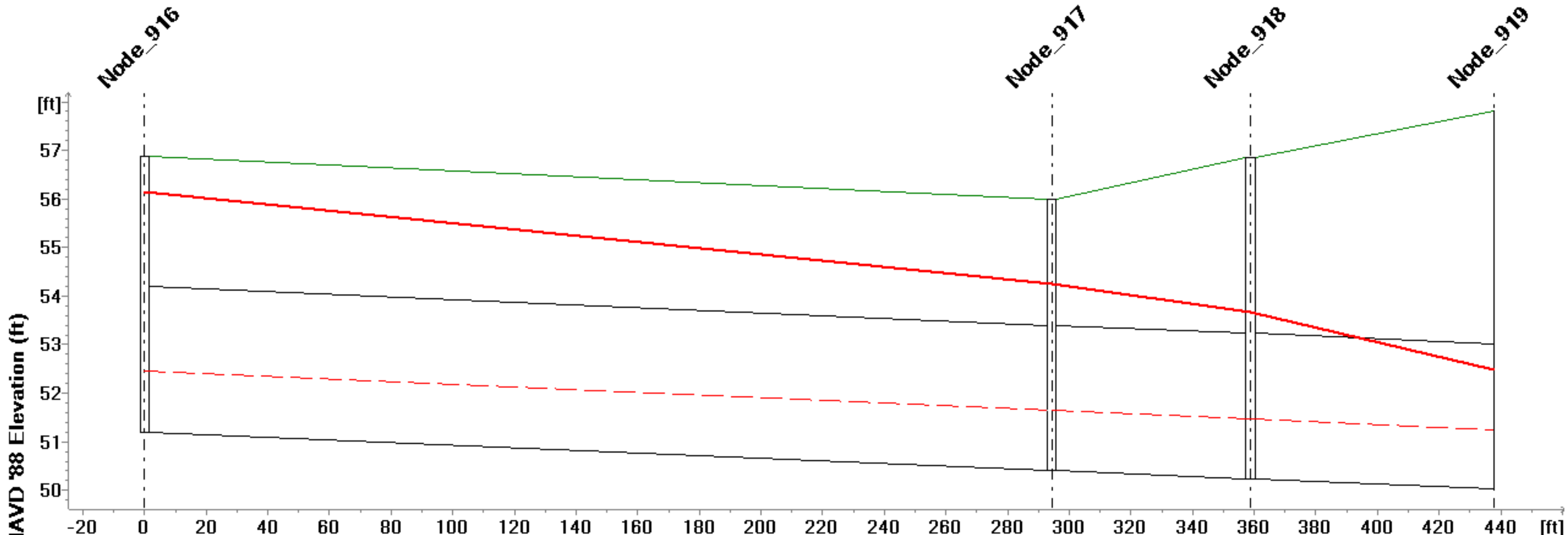
N-2 Profile (cont.)



Link ID	Link_33	Link_31	Link_32
Q10 (cfs)	14.406	14.408	
Q100 (cfs)	59.282	69.163	90.713
Length (ft)	294.331	64.342	79.091
Diameter (ft)	3.0000		

MUID	Node_916	Node_917	Node_918	Node_919
Ground Level (ft)	56.89	56.00	56.86	57.80
Invert Level (ft)	51.19	50.40	50.23	50.02
Q10 HGL (ft)	52.458	51.654	51.469	51.232
Q100 HGL (ft)	56.143	54.243	53.681	52.484

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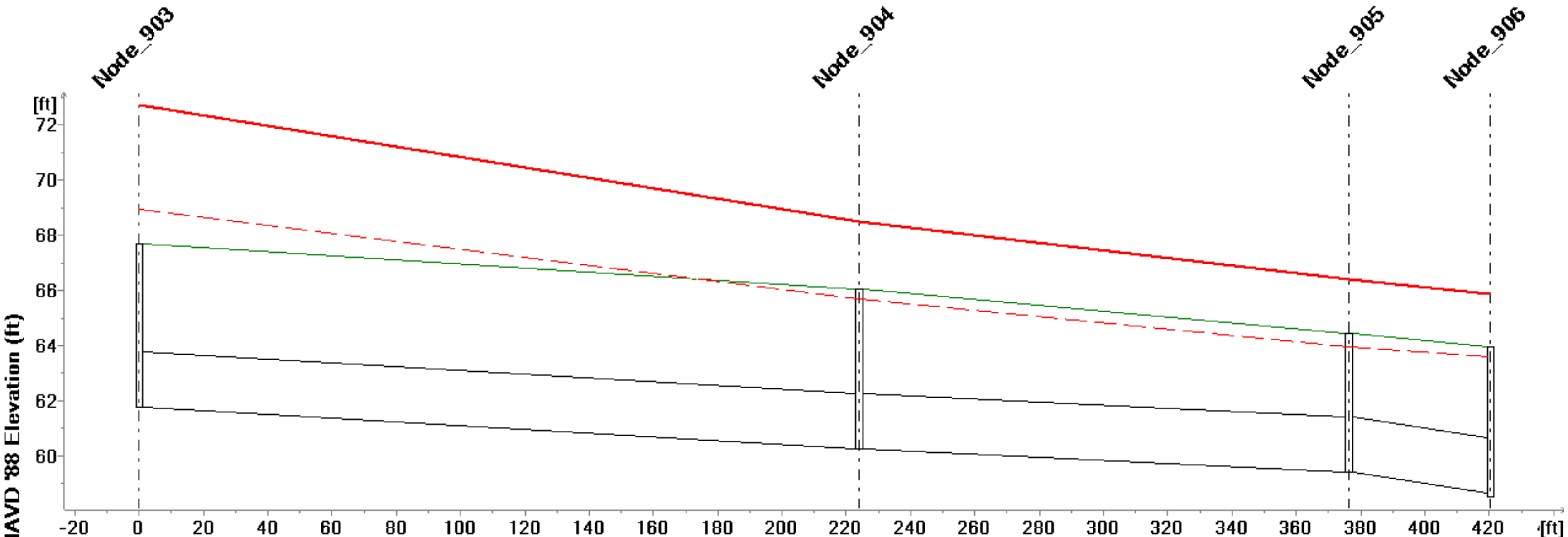
N-3 Profile



Link ID	Link_46	Link_50	Link_53
Q10 (cfs)	32.254	28.094	27.242
Q100 (cfs)	40.041	32.908	29.948
Length (ft)	224.037	152.347	43.987
Diameter (ft)	2.0000		

MUID	Node_903	Node_904	Node_905	Node_906
Ground Level (ft)	67.69	66.06	64.43	63.94
Invert Level (ft)	61.79	60.26	59.43	58.54
Q10 HGL (ft)	68.949	65.686	63.972	63.603
Q100 HGL (ft)	72.714	68.518	66.426	65.881

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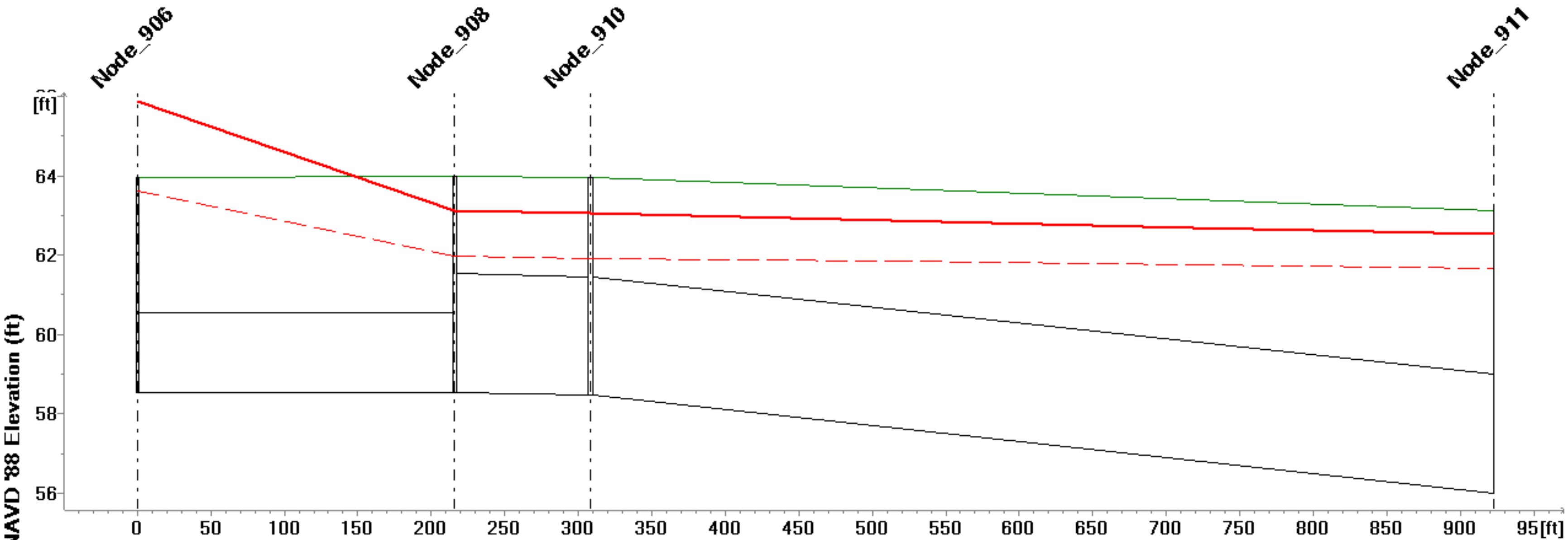
N-3 Profile (cont.)

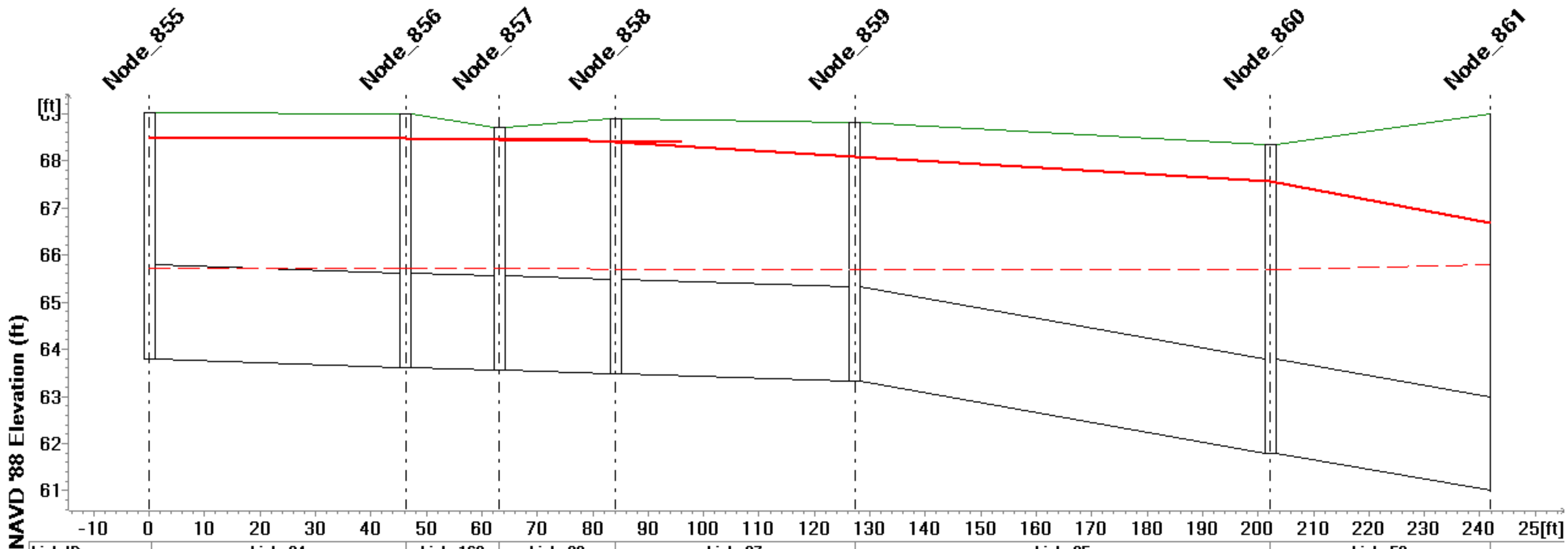


Link ID	Link_55	Link_52	Link_44		
Q10 (cfs)	26.734	26.645	26.864	26.244	26.246
Q100 (cfs)	31.793	30.566	29.513	29.444	29.441
Length (ft)	215.861	92.433	614.470		
Diameter (ft)	2.0000	3.0000			

MUID	Node_906	Node_908	Node_910	Node_911
Ground Level (ft)	63.94	64.00	63.96	63.13
Invert Level (ft)	58.54		58.46	56.00
Q10 HGL (ft)	63.603	61.963	61.926	61.679
Q100 HGL (ft)	65.881	63.105	63.046	62.526

1/1/2004

N-4 Profile

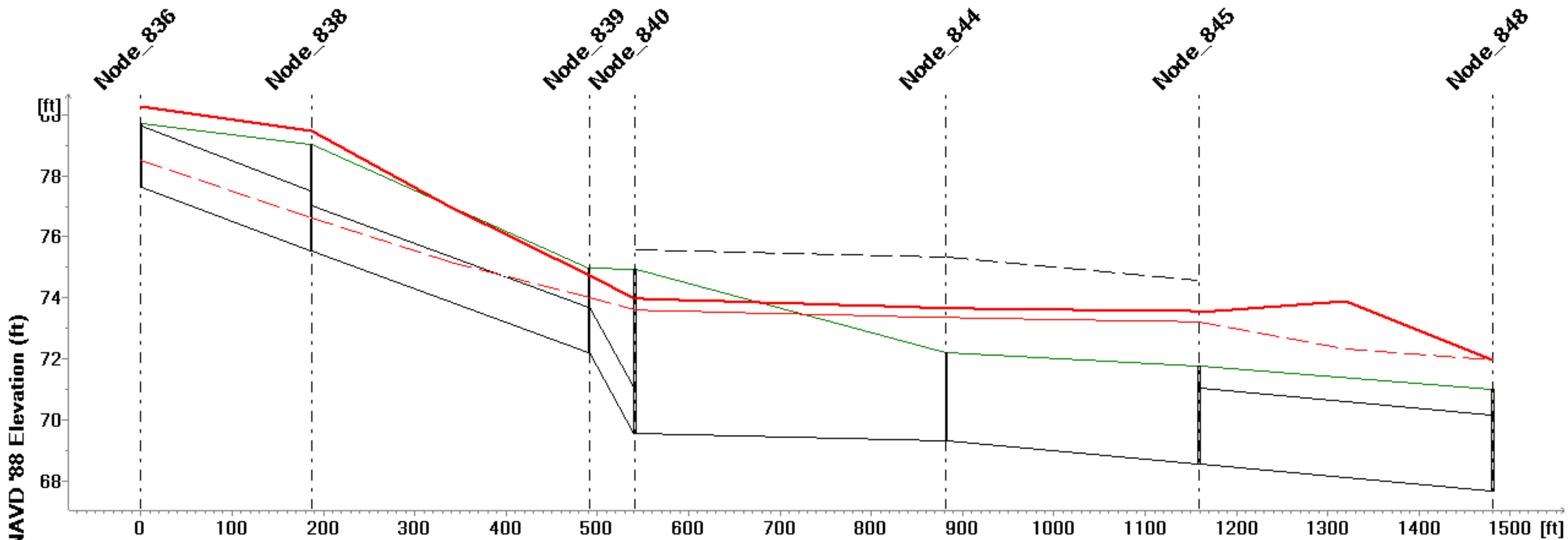


Link ID	Link_94	Link_169	Link_98	Link_97	Link_95	Link_58
Q10 (cfs)	1.913	2.284	2.714	3.351	3.333	4.149
Q100 (cfs)	3.894	4.643	10.506	20.928		37.096
Length (ft)	46.250	16.880	20.969	43.138	75.022	39.616
Diameter (ft)	2.0000					

MUID	Node_855	Node_856	Node_857	Node_858	Node_859	Node_860	Node_861
Ground Level (ft)	69.00		68.70	68.89	68.82	68.34	69.00
Invert Level (ft)	63.80	63.62	63.56	63.48	63.32	61.80	61.00
Q10 HGL (ft)	65.705		65.703	65.701	65.696	65.688	65.789
Q100 HGL (ft)	68.504	68.472	68.441	68.387	68.084	67.559	66.690

1/1/2004

N-5 Profile

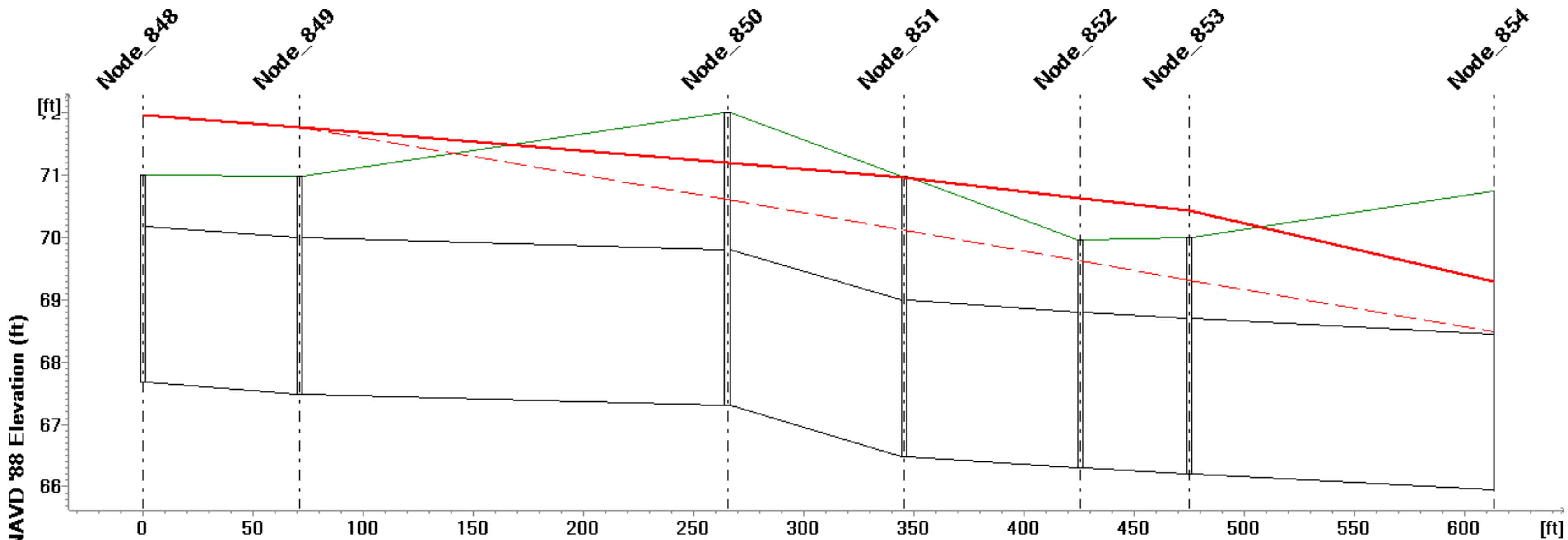


Link ID	Link_102	Link_107			Link_109	Link_101	Link_106	
Q10 (cfs)	10.319	10.300	10.291			35.830	23.892	27.721
Q100 (cfs)	17.091	14.931	14.891				23.890	28.191
Length (ft)	186.672	304.156			341.294	277.297	321.190	
Diameter (ft)	2.0000	1.5000			2.5000			

MUID	Node_836	Node_838	Node_839	Node_840	Node_844	Node_845	Node_848
Ground Level (ft)	79.72	79.02	74.99	74.94	72.21	71.75	71.01
Invert Level (ft)	77.62	75.52	72.19	69.58	69.34	68.56	67.68
Q10 HGL (ft)	78.511	76.641	73.995	73.604	73.374	73.221	71.962
Q100 HGL (ft)	80.257	79.458	74.740	73.968	73.650	73.550	71.965

1/1/2004

N-5 Profile (cont.)

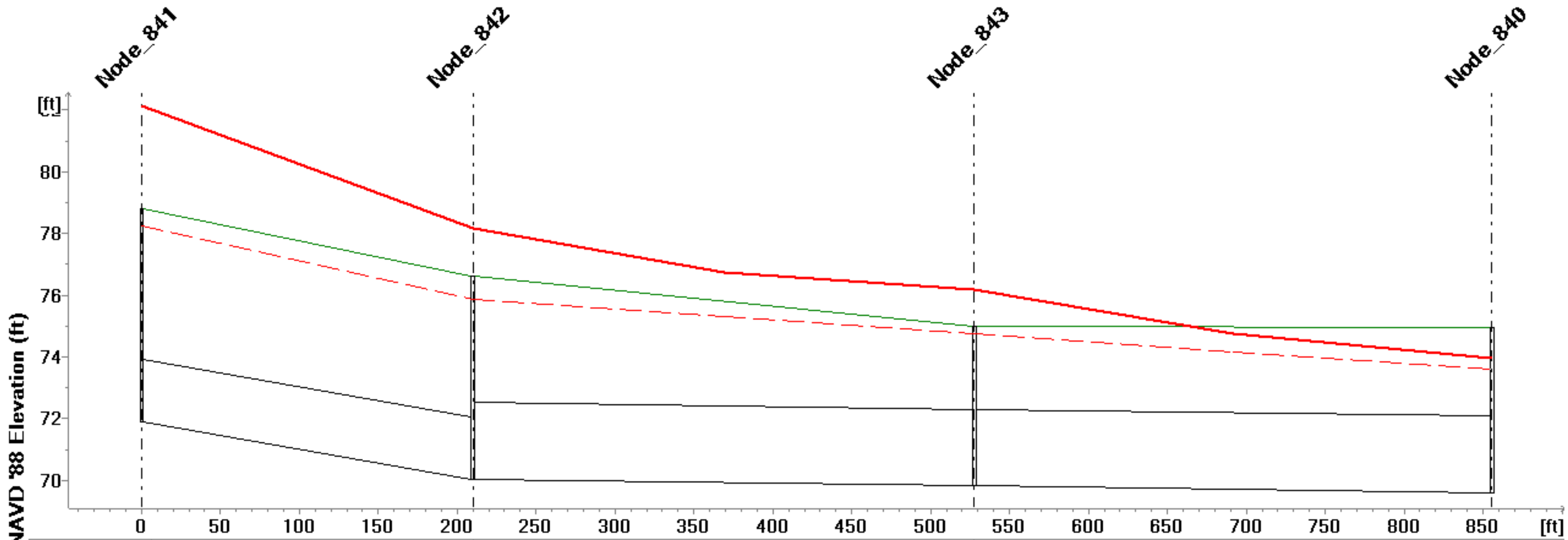


Link ID	Link_91	Link_90	Link_88	Link_89	Link_93	Link_96
Q10 (cfs)	36.647	36.631	37.264	37.782	38.082	38.561
Q100 (cfs)	36.664	36.591	37.044	37.978	38.658	41.345
Length (ft)	71.128	194.385	80.267	79.935	49.319	138.440
Diameter (ft)	2.5000					

MUID	....	Node_849	Node_850	Node_851	Node_852	Node_853	Node_854
Ground Level (ft)	71.01	70.99	72.00	70.99	69.96	70.00	70.75
Invert Level (ft)	67.68	67.49	67.30	66.49	66.31	66.20	65.94
Q10 HGL (ft)	71.962	71.778	70.619	70.124	69.624	69.313	68.497
Q100 HGL (ft)	71.965	71.773	71.195	70.970	70.632	70.426	69.287

1/1/2004

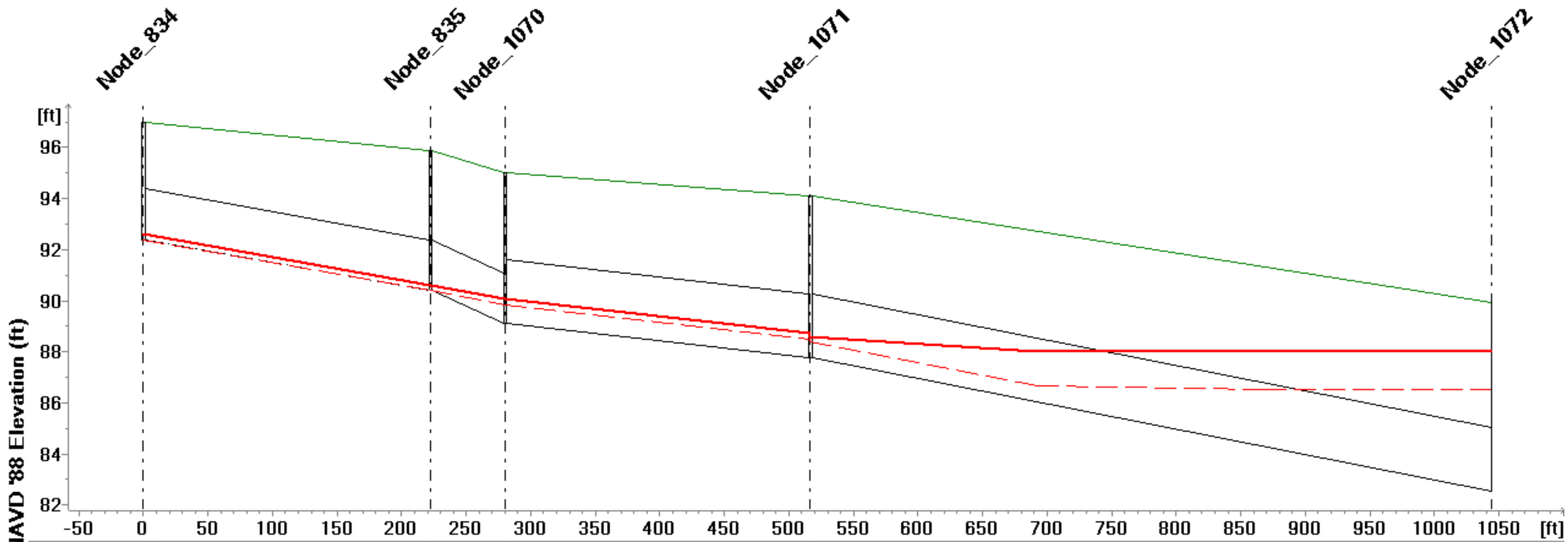
N-5-1 Profile



Link ID	Link_108		Link_112		Link_111		
Q10 (cfs)	26.722			26.723		26.724	
Q100 (cfs)	38.812		31.780	28.357	32.785	32.603	
Length (ft)	210.122		317.618		327.895		
Diameter (ft)	2.0000		2.5000				
MUID	Node_841	Node_842		Node_843		Node_840	
Ground Level (ft)	78.81	76.63		74.99		74.94	
Invert Level (ft)	71.91	70.03		69.81		69.58	
Q10 HGL (ft)	78.246	75.847		74.743		73.604	
Q100 HGL (ft)	82.144	78.165		76.161		73.968	

1/1/2004

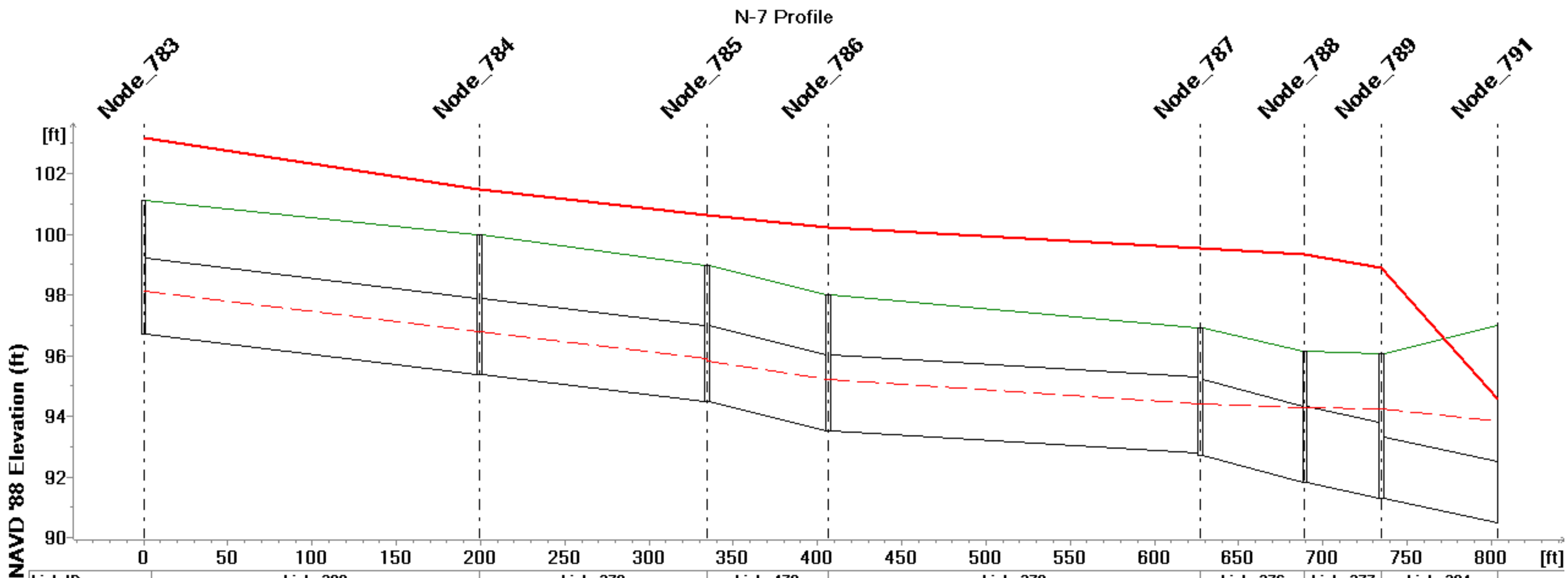
N-6 Profile



Link ID	Link_105	Link_512	Link_513	Link_514		
Q10 (cfs)	0.001	0.003	6.317		6.310	6.250
Q100 (cfs)	0.633	0.636	10.760	10.753	10.854	11.386
Length (ft)	222.258	58.040	236.280	527.750		
Diameter (ft)	2.0000		2.5000			

MUID	Node_834	Node_835	Node_1070	Node_1071	Node_1072
Ground Level (ft)	96.99	95.89	95.00	94.09	89.95
Invert Level (ft)	92.39	90.39	89.10	87.75	82.55
Q10 HGL (ft)	92.399	90.404	89.827	88.385	86.507
Q100 HGL (ft)	92.614	90.601	90.063	88.602	87.991

1/1/2004



Link ID	Link_380	Link_379	Link_479	Link_378	Link_376	Link_377	Link_384	
Q10 (cfs)	22.744	22.741	22.737	22.731	26.263	26.221	26.185	
Q100 (cfs)	50.521	49.038	47.545	41.493	49.277	55.734	68.135	
Length (ft)	199.368	135.005	72.025	220.728	62.089	45.667	68.598	
Diameter (ft)	2.5000						2.0000	

MUID	Node_783	Node_784	Node_785	Node_786	Node_787	Node_788	Node_789	....
Ground Level (ft)	101.10	100.00	98.99	98.02	96.90	96.13	96.07	97.00
Invert Level (ft)	96.70	95.38	94.49	93.52	92.70	91.83	91.30	90.50
Q10 HGL (ft)	98.121	96.802	95.819	95.229	94.414	94.298	94.241	93.841
Q100 HGL (ft)	103.189	101.490	100.611	100.223	99.523	99.316	98.881	94.581

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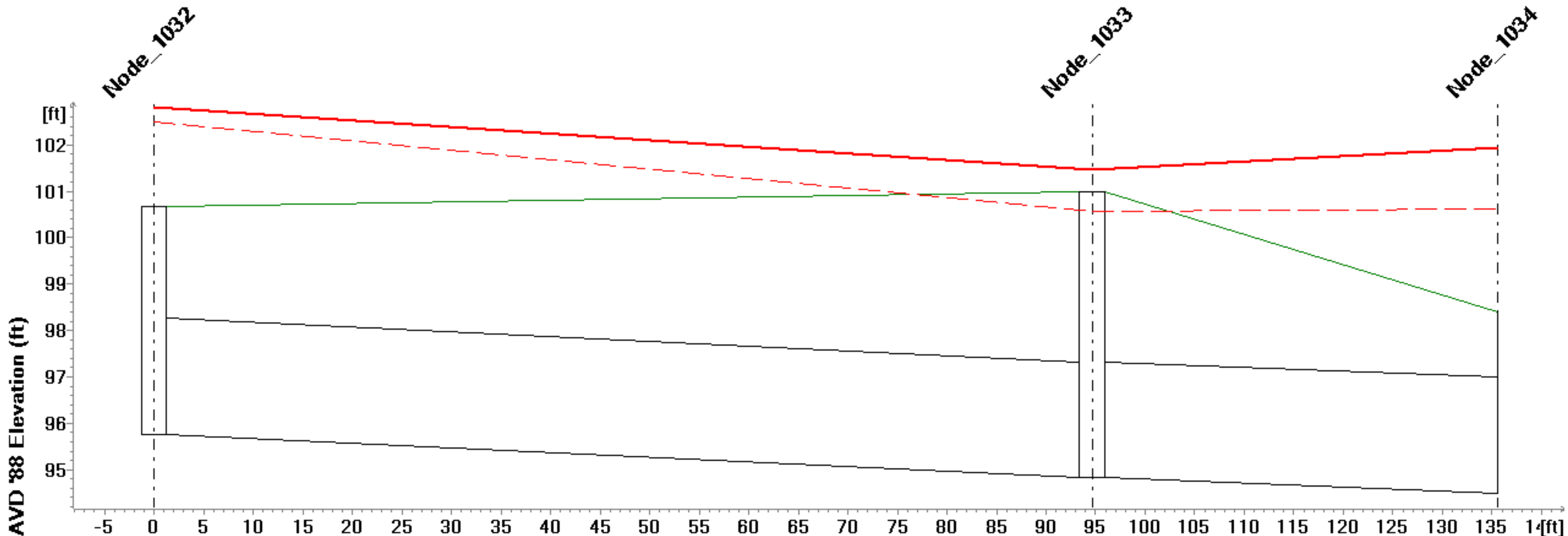
N-8 Profile



Link ID	Link_156		Link_155	
Q10 (cfs)	15.537		16.069	
Q100 (cfs)	24.575		2.078	
Length (ft)	94.641		40.870	
Diameter (ft)	2.5000			
MUID	Node_1032	Node_1033		Node_1034
Ground Level (ft)	100.67	101.00		98.39
Invert Level (ft)	95.77	94.82		94.50
Q10 HGL (ft)	102.503	100.559		100.613
Q100 HGL (ft)	102.808	101.460		101.932

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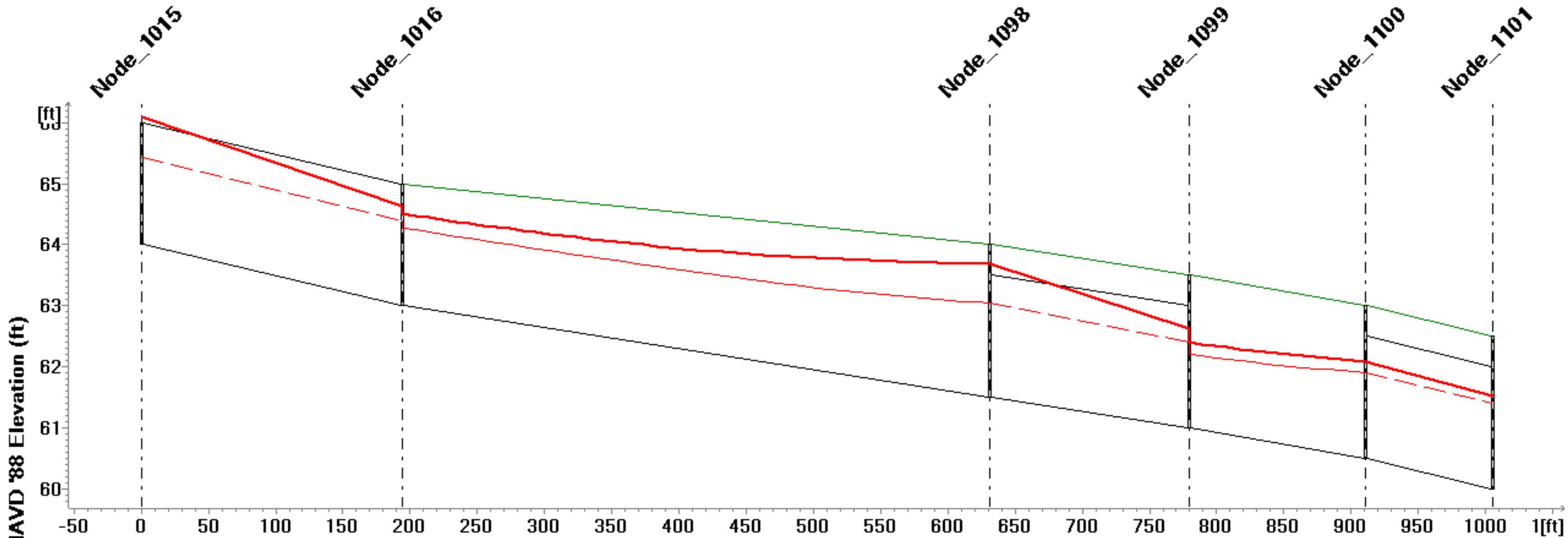
F-1 Profile



Link ID	Link_165	Link_570	Link_571	Link_572	Link_573
Q10 (cfs)	15.669	15.668 15.667 15.666 ... 15.661 ... 15.654	15.653	... 15.649	15.648
Q100 (cfs)	21.923	...	21.117	21.118 ...	18.799
Length (ft)	194.460	436.890	148.190	131.480	94.190
Diameter (ft)	2.0000		2.0000		2.0000

MUID	Node_1015	Node_1016	Node_1098	Node_1099	Node_1100	....
Ground Level (ft)	66.00	65.00	64.00	63.50	63.00	62.50
Invert Level (ft)	64.00	63.00	61.50	61.00	60.50	60.00
Q10 HGL (ft)	65.430	64.274	63.049	62.211	61.913	60.908
Q100 HGL (ft)	66.105	64.506	63.682	62.401	62.094	61.056

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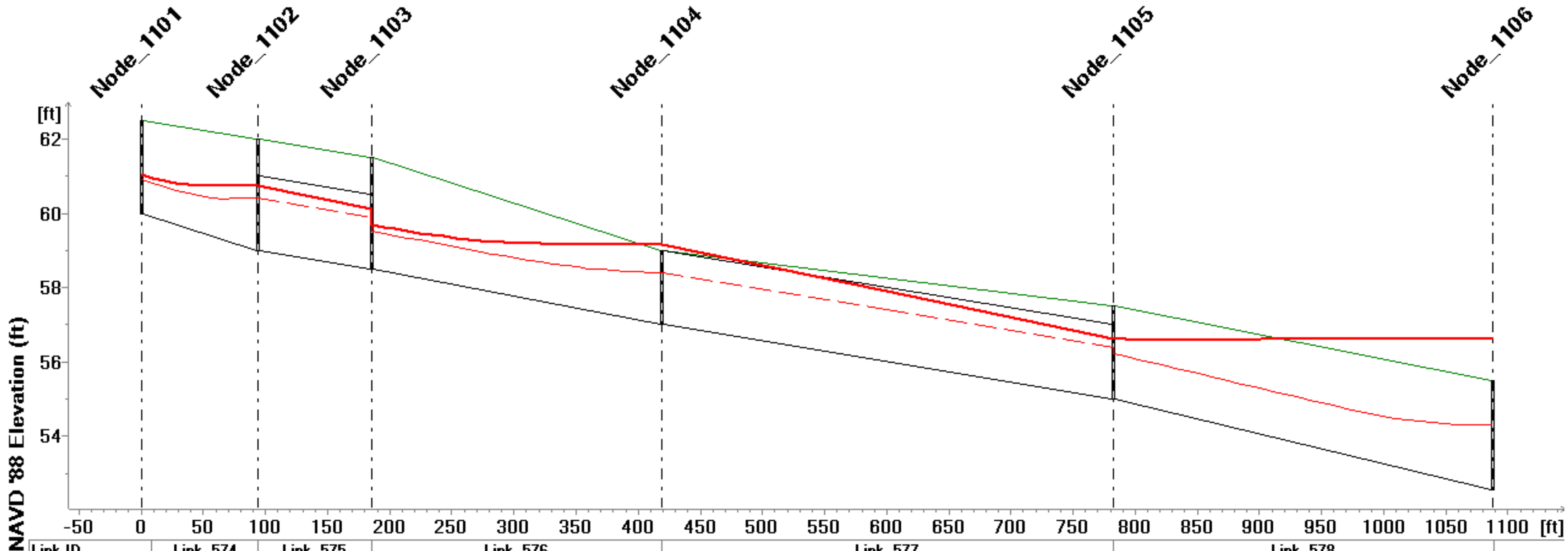
F-1 Profile (cont.)

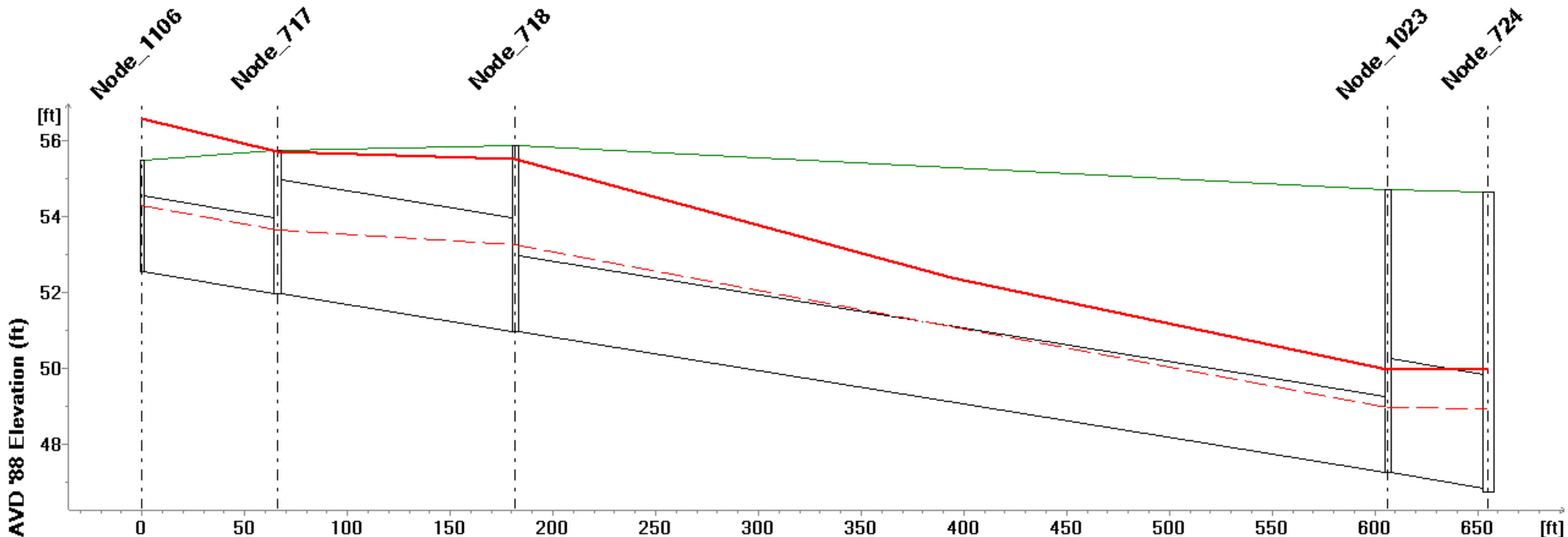


Link ID	Link_574	Link_575	Link_576	Link_577	Link_578
Q10 (cfs)	.....	15.647	15.646 15.645 15.644	15.640	25.224 25.222
Q100 (cfs)		20.938		20.917 20.924	
Length (ft)	94.190	91.030	233.510	363.250	305.660
Diameter (ft)		2.0000		2.0000	

MUID	....	Node_1102	Node_1103	Node_1104	Node_1105	Node_1106
Ground Level (ft)	62.50	62.00	61.50	59.00	57.50	55.50
Invert Level (ft)	60.00	59.00	58.50	57.00	55.00	52.56
Q10 HGL (ft)	60.908	60.404	59.526	58.407	56.229	54.320
Q100 HGL (ft)	61.056	60.756	59.695	59.175	56.633	56.606

1/1/2004

F-1 Profile (cont.)



Link ID	Link_167	Link_436	Link_164		Link_159
Q10 (cfs)	25.201	25.203	25.205	25.203	25.207
Q100 (cfs)	30.405	30.736	30.616		30.639
Length (ft)	65.947	115.580	424.890		48.747
Diameter (ft)	2.0000	3.0000	2.0000		3.0000

MUID	....	Node_717	Node_718	Node_1023	....
Ground Level (ft)	55.50	55.77	55.89	54.74	54.66
Invert Level (ft)	52.56	51.99	50.98	47.28	46.76
Q10 HGL (ft)	54.320	53.649	53.263	48.997	48.961
Q100 HGL (ft)	56.606	55.716	55.519	49.973	49.975

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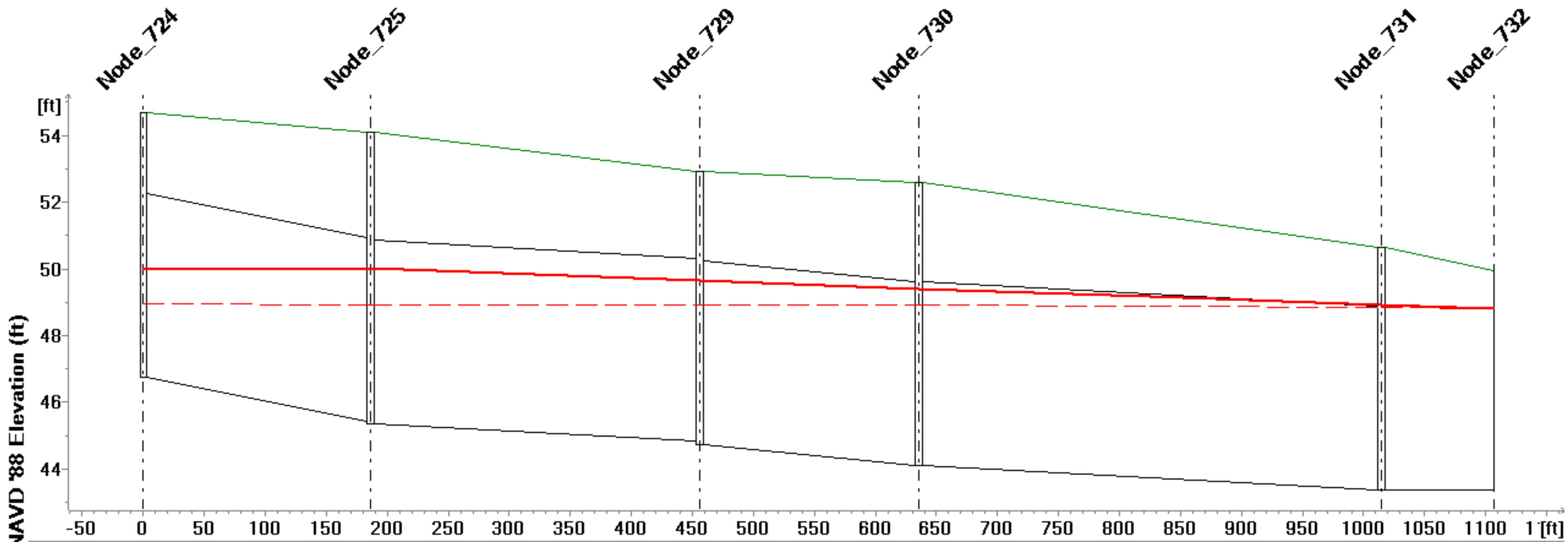
F-1 Profile (cont.)



Link ID	Link_441	Link_439	Link_403	Link_363		Link_430
Q10 (cfs)	63.938	63.999	64.125	64.070	64.096	64.104
Q100 (cfs)	134.725	134.720	134.724	134.728		
Length (ft)	186.251	269.850	179.388	378.970		92.304
Diameter (ft)	5.5000					

MUID	Node_724	Node_725	Node_729	Node_730	Node_731	....
Ground Level (ft)	54.66	54.10	52.93	52.57	50.66	49.96
Invert Level (ft)	46.76	45.35	44.73	44.11	43.38	43.36
Q10 HGL (ft)	48.961	48.933	48.934	48.908	48.828	48.800
Q100 HGL (ft)	49.975	50.002	49.646	49.410	48.922	48.800

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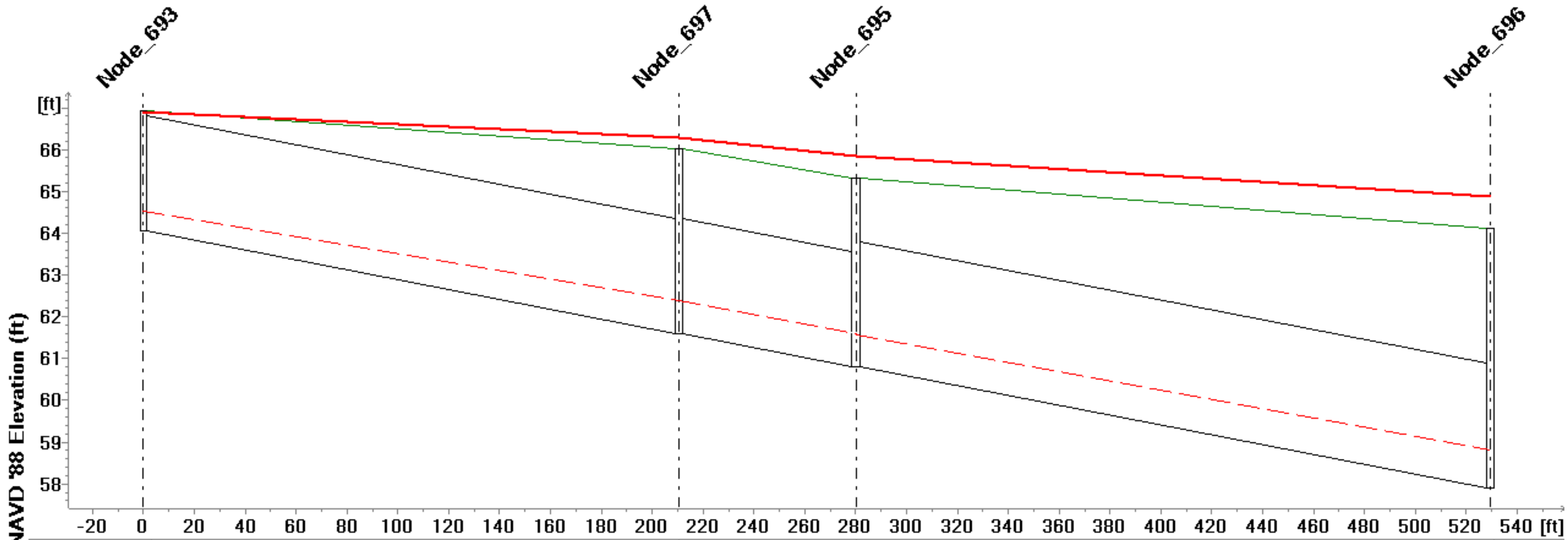
F-1-1 Profile

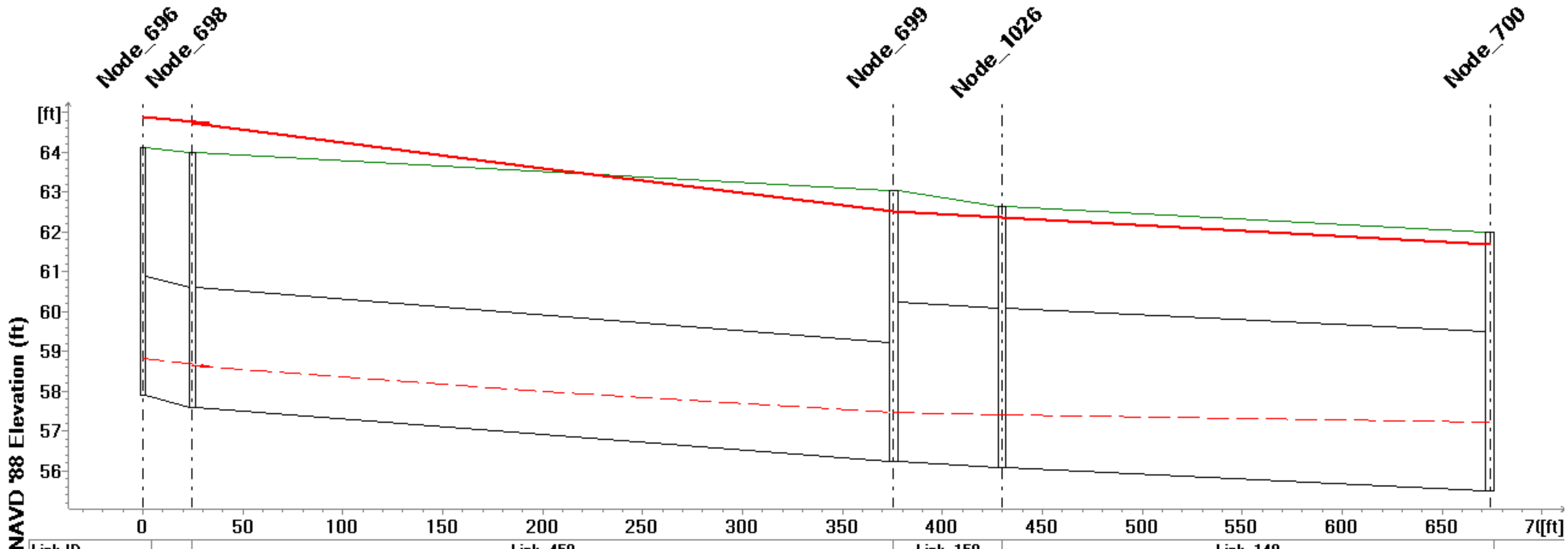


Link ID	Link_415	Link_431	Link_429
Q10 (cfs)	3.565	11.313	11.309
Q100 (cfs)	31.716	50.361	62.492
Length (ft)	210.670	69.393	249.311
Diameter (ft)	2.7500		3.0000

MUID	Node_693	Node_697	Node_695	Node_696
Ground Level (ft)	66.92	66.01	65.32	64.12
Invert Level (ft)	64.07	61.61	60.80	57.89
Q10 HGL (ft)	64.529	62.398	61.574	58.812
Q100 HGL (ft)	66.896	66.276	65.857	64.881

1/1/2004

F-1-1 Profile (cont.)

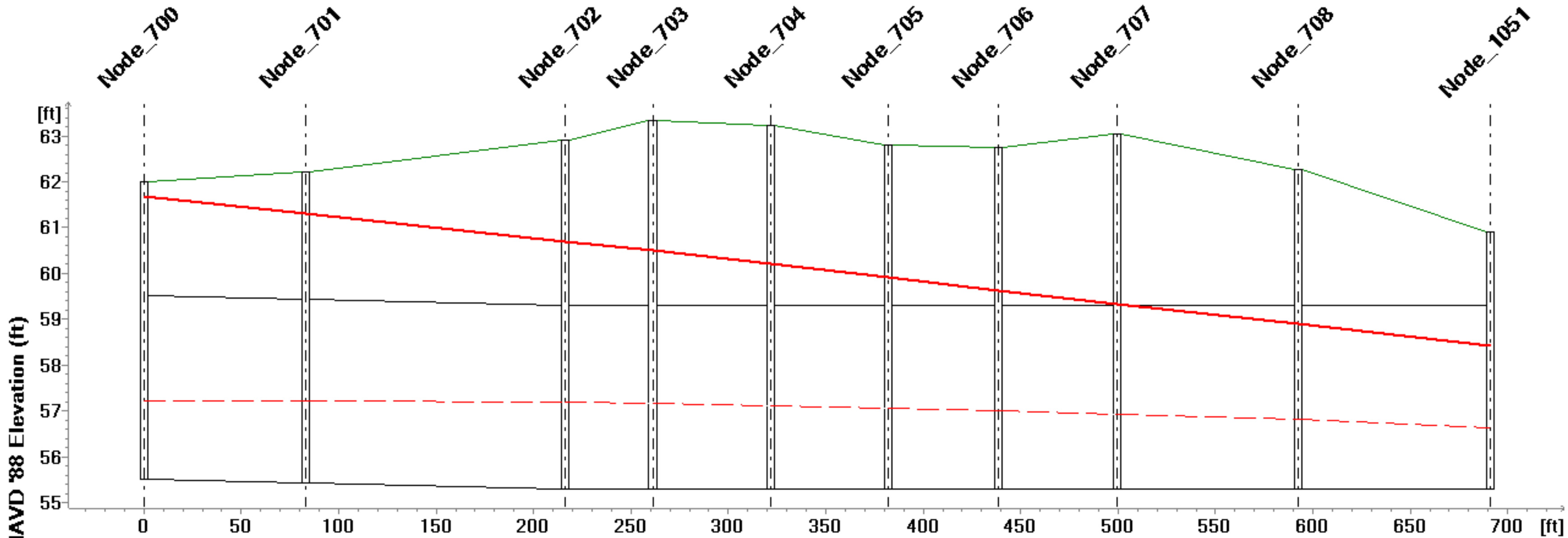


Link ID	....	Link_450		Link_150	Link_149
Q10 (cfs)	....	11.305	11.304	11.299	11.292
Q100 (cfs)	....	75.837	75.802	80.757	85.558
Length (ft)	....	350.940		54.274	244.101
Diameter (ft)		3.0000		4.0000	

MUID	...	Node_698	Node_699	Node_1026	Node_700
Ground Level (ft)	...	64.00	63.03	62.63	62.01
Invert Level (ft)	...	57.60	56.23	56.09	55.51
Q10 HGL (ft)	...	58.628	57.470	57.407	57.231
Q100 HGL (ft)	...	64.726	62.510	62.373	61.683

1/1/2004

F-1-1 Profile (cont.)



Link ID	Link_449	Link_447	Link_448	Link_452	Link_455	Link_453	Link_457	Link_456	Link_493
Q10 (cfs)	11.309	11.372	16.373	20.276	20.274	20.272	20.270	20.267	20.263
Q100 (cfs)	107.353	106.369	108.899	110.686	110.481	110.341	110.230	110.103	110.049
Length (ft)	82.987	133.326	44.862	60.452	60.593	56.179	61.215	92.894	98.389
Diameter (ft)	4.0000								

MUID	Node_700	Node_701	Node_702	Node_703	Node_704	Node_705	Node_706	Node_707	Node_708	Node_1051
Ground Level (ft)	62.01	62.22	62.90	63.34	63.24	62.80	62.75	63.04	62.26	60.90
Invert Level (ft)	55.51	55.43	55.30							
Q10 HGL (ft)	57.231	57.215	57.196	57.170	57.118	57.062	57.005	56.935	56.812	56.369
Q100 HGL (ft)	61.683	61.303	60.705	60.494	60.199	59.905	59.634	59.338	58.891	57.844

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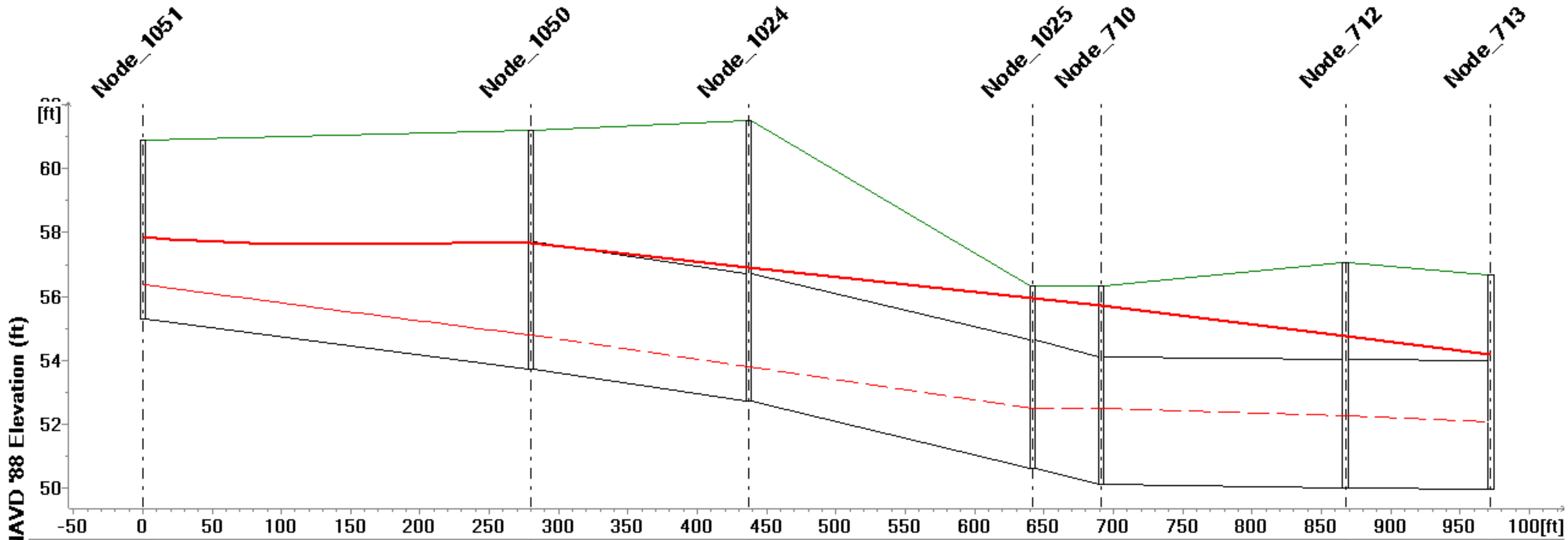
F-1-1 Profile (cont.)



Link ID	Link_569	Link_494	Link_158	Link_454	Link_446	Link_451
Q10 (cfs)	20.258	20.248	20.373	22.697	38.174	37.644
Q100 (cfs)		109.013	108.963	108.957	117.801	117.797
Length (ft)	280.070	156.920	204.721	49.581	176.239	104.707
Diameter (ft)		4.0000				

MUID	Node_1051	Node_1050	Node_1024	Node_1025	Node_710	Node_712	Node_713
Ground Level (ft)	60.90	61.19	61.51	56.33	56.32	57.06	56.68
Invert Level (ft)	55.30	53.71	52.73	50.63	50.12	50.03	49.98
Q10 HGL (ft)	56.369	54.797	53.805	52.486	52.488	52.255	52.091
Q100 HGL (ft)	57.844	57.660	56.920	55.955	55.722	54.751	54.175

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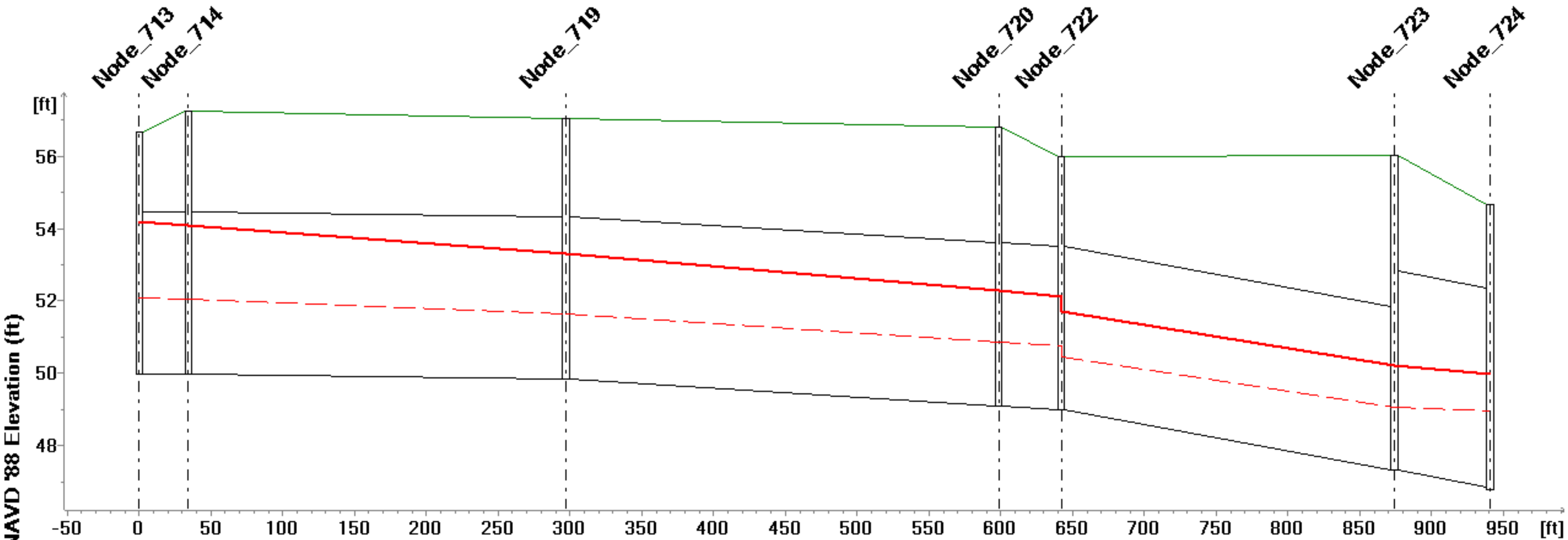
F-1-1 Profile (cont.)

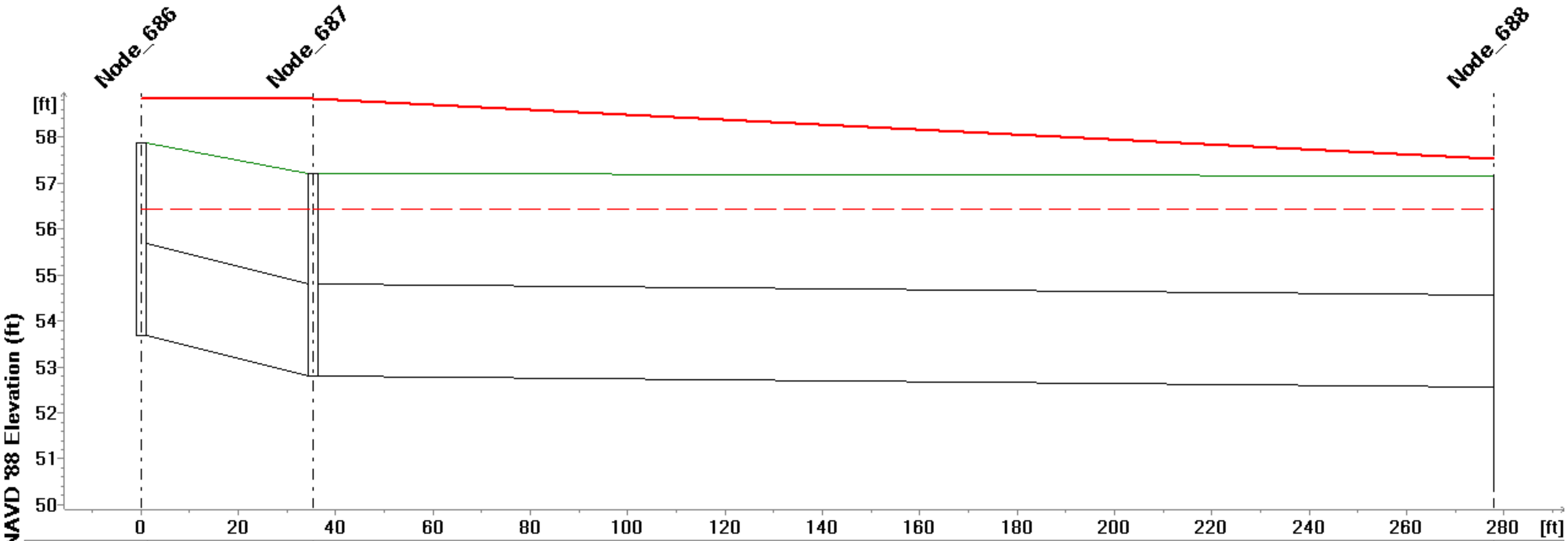


Link ID	....	Link_437	Link_435	....	Link_434	Link_438	
Q10 (cfs)	....	37.244	37.099	37.094	39.194	39.193	
Q100 (cfs)	....	117.746	117.737		118.804	118.797	
Length (ft)	....	263.113	301.146	43.879	231.931	66.193	
Diameter (ft)	4.5000					5.5000	

MUID	...	Node_714	Node_719	Node_720	Node_722	Node_723	....	
Ground Level (ft)	...	57.24	57.03	56.81	55.99	56.01	54.66	
Invert Level (ft)	...	49.96	49.83	49.11	48.99	47.33	46.76	
Q10 HGL (ft)	...	52.041	51.637	50.873	50.461	49.056	48.961	
Q100 HGL (ft)	...	54.074	53.302	52.303	51.713	50.208	49.975	

1/1/2004

F-2 Profile

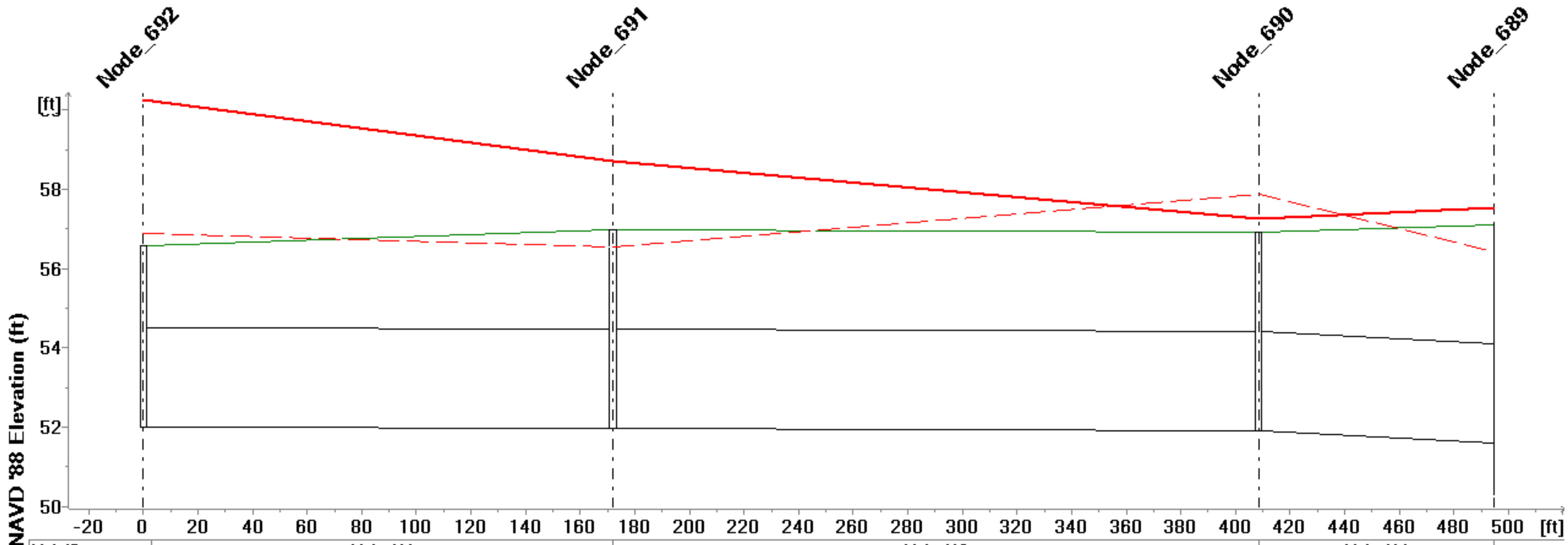


Link ID	Link_409	Link_412	
Q10 (cfs)	2.349	2.255	
Q100 (cfs)	4.827	10.012	
Length (ft)	35.365	242.559	
Diameter (ft)	2.0000		

MUID	Node_686	Node_687	Node_688
Ground Level (ft)	57.88	57.20	57.16
Invert Level (ft)	53.68	52.80	50.30
Q10 HGL (ft)	56.441	56.439	56.431
Q100 HGL (ft)	58.848	58.840	57.530

1/1/2004

F-3 Profile

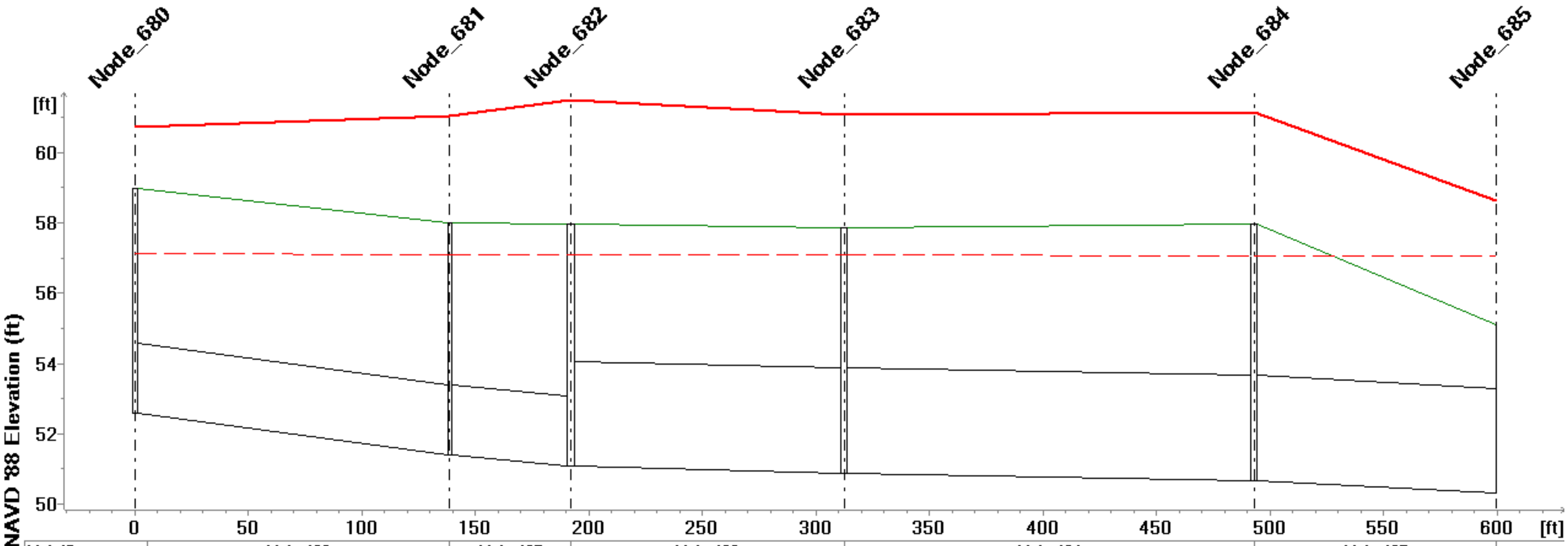


Link ID	Link_411	Link_413	Link_414
Q10 (cfs)	7.889	7.635	17.165
Q100 (cfs)	16.484	23.818	22.153
Length (ft)	172.058	236.419	86.178
Diameter (ft)	2.5000		

MUID	Node_692	Node_691	Node_690	Node_689
Ground Level (ft)	56.59	56.98	56.91	57.10
Invert Level (ft)	52.01	51.98	51.91	50.30
Q10 HGL (ft)	56.879	56.543	57.860	56.431
Q100 HGL (ft)	60.250	58.723	57.267	57.530

1/1/2004

F-4 Profile

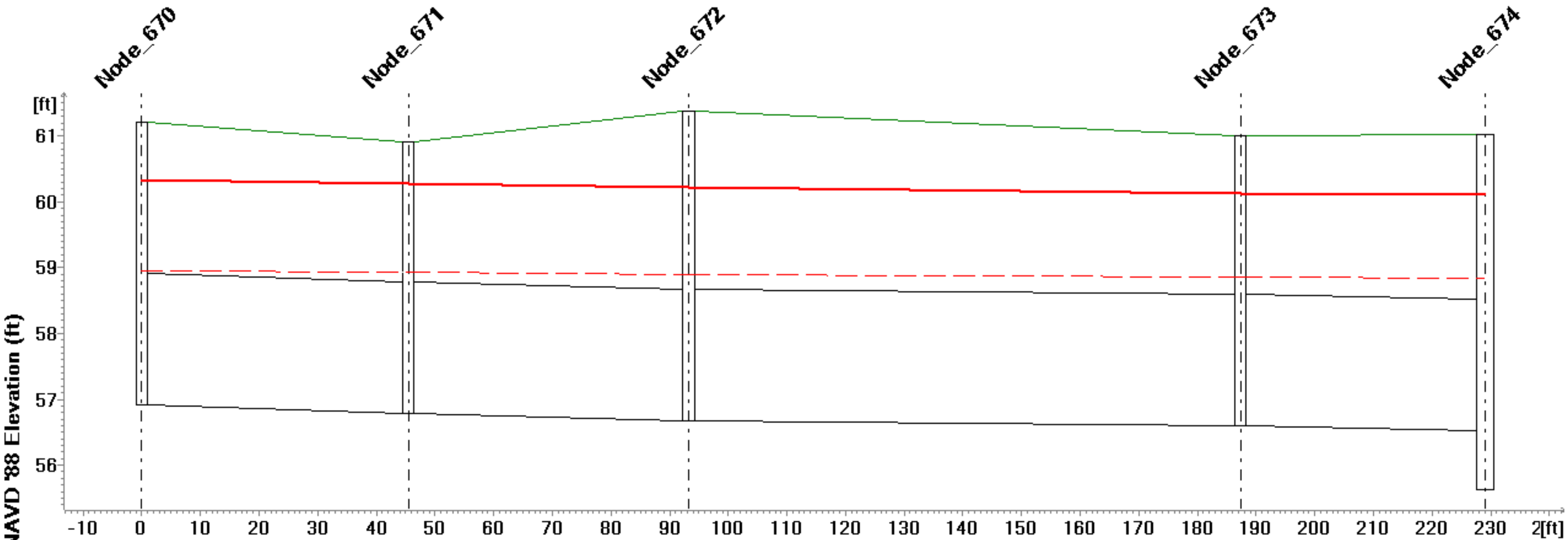


Link ID	Link_408	Link_407	Link_406	Link_404	Link_405
Q10 (cfs)	4.896	4.892	4.885	8.040	8.031
Q100 (cfs)	8.352	8.176	16.093	29.321	37.007
Length (ft)	138.691	53.136	120.568	180.581	106.910
Diameter (ft)	2.0000		3.0000		

MUID	Node_680	Node_681	Node_682	Node_683	Node_684	Node_685
Ground Level (ft)	58.99	58.00	57.97	57.87	57.96	55.12
Invert Level (ft)	52.59	51.40	51.07	50.87	50.66	50.30
Q10 HGL (ft)	57.126	57.098	57.088	57.085	57.074	57.068
Q100 HGL (ft)	60.729	61.028	61.483	61.081	61.144	58.619

1/1/2004

F-5 Profile



Link ID	Link_423	Link_426	Link_424	Link_428
Q10 (cfs)	6.870	6.866	6.863	6.860
Q100 (cfs)	12.259	12.258	12.257	12.256
Length (ft)	45.473	47.804	94.056	41.651
Diameter (ft)	2.0000			

MUID	Node_670	Node_671	Node_672	Node_673	Node_674
Ground Level (ft)	61.21	60.92	61.37	61.01	61.02
Invert Level (ft)	56.91	56.79	56.67	56.61	55.62
Q10 HGL (ft)	58.944	58.925	58.905	58.865	58.848
Q100 HGL (ft)	60.340	60.284	60.226	60.137	60.107

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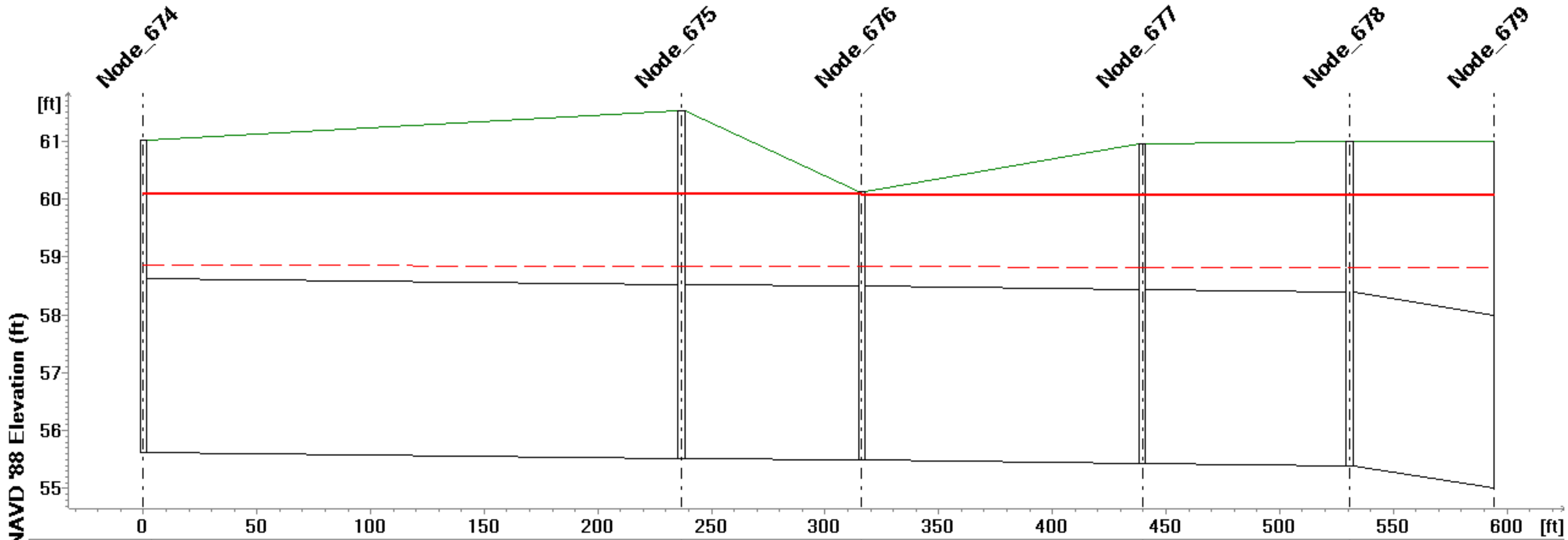
F-5 Profile (cont.)

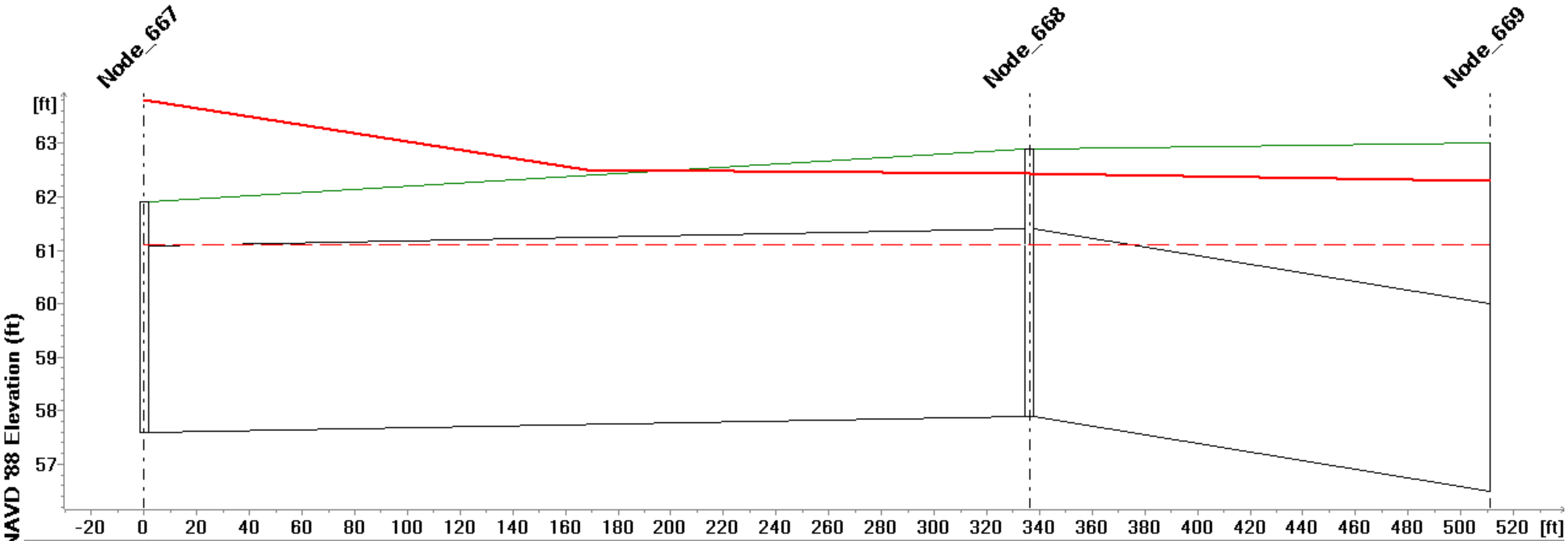


Link ID	Link_427	Link_425	Link_417	Link_422	Link_416
Q10 (cfs)	6.849	6.837	6.829	6.822	6.817
Q100 (cfs)	12.253	12.250	12.247	12.245	12.242
Length (ft)	236.604	79.513	123.436	91.341	63.375
Diameter (ft)	3.0000				

MUID	Node_674	Node_675	Node_676	Node_677	Node_678	Node_679
Ground Level (ft)	61.02	61.51	60.13	60.95	61.00	
Invert Level (ft)	55.62	55.52	55.49	55.44	55.40	55.00
Q10 HGL (ft)	58.848	58.836	58.832	58.826	58.821	58.818
Q100 HGL (ft)	60.107	60.088	60.082	60.072	60.065	60.060

1/1/2004

F-6 Profile

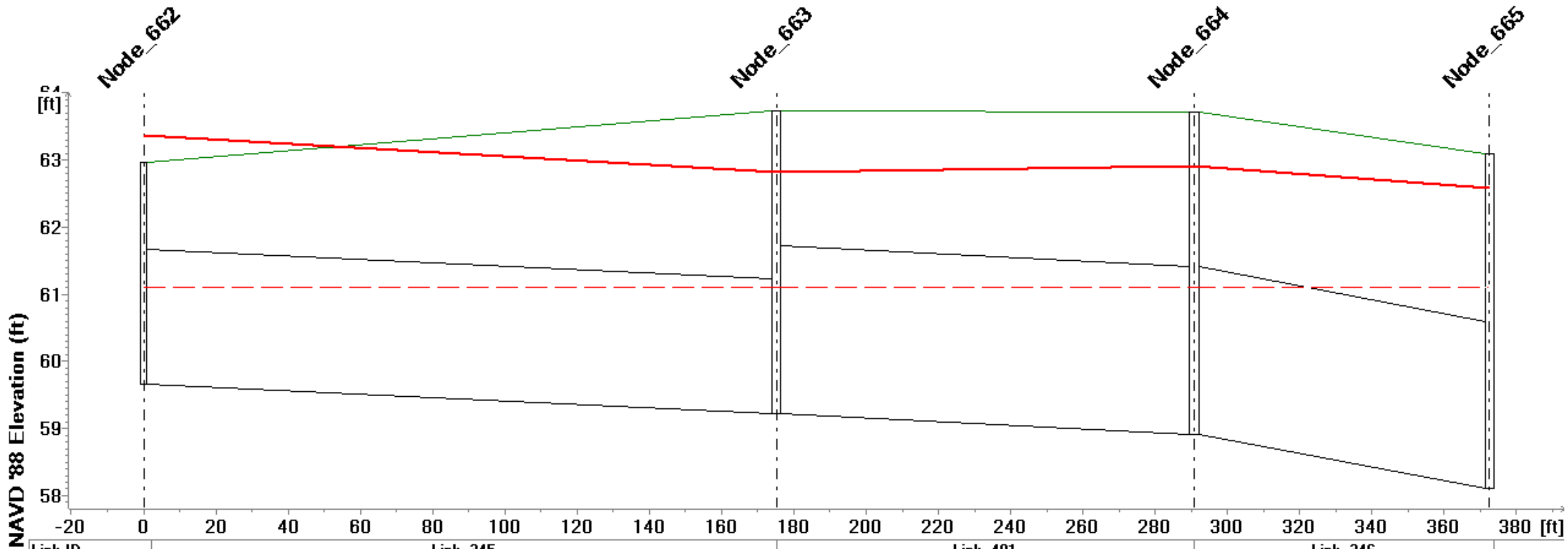


Link ID	Link_420		Link_419
Q10 (cfs)	3.008	2.928	4.546
Q100 (cfs)	13.136	12.893	27.007
Length (ft)	336.142		174.928
Diameter (ft)	3.5000		

MUID	Node_667	Node_668	Node_669
Ground Level (ft)	61.90	62.90	63.00
Invert Level (ft)	57.59	57.90	56.50
Q10 HGL (ft)	61.098	61.096	61.094
Q100 HGL (ft)	63.812	62.439	62.303

1/1/2004

F-6-1Profile

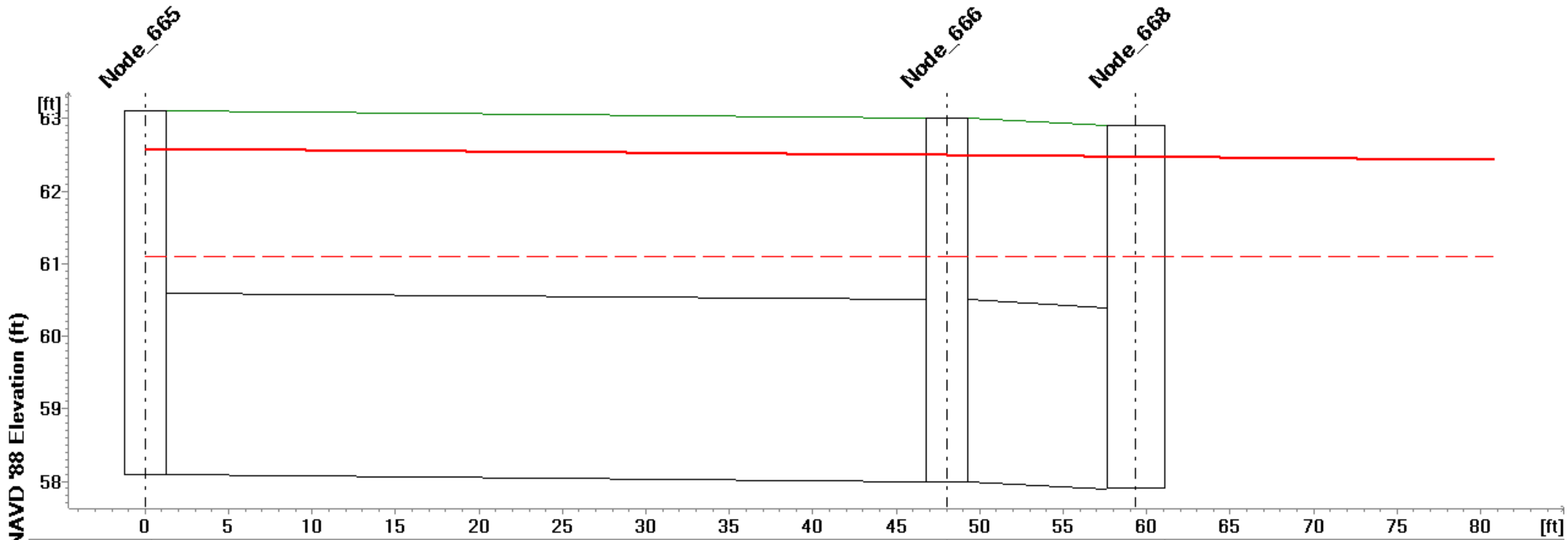


Link ID	Link_345	Link_401	Link_346
Q10 (cfs)	1.841	1.769	1.719
Q100 (cfs)	14.215	14.392	18.729
Length (ft)	175.184	115.550	81.760
Diameter (ft)	2.0000	2.5000	

MUID	Node_662	Node_663	Node_664	Node_665
Ground Level (ft)	62.96	63.72		63.10
Invert Level (ft)	59.66	59.22	58.92	58.10
Q10 HGL (ft)	61.097	61.098		61.097
Q100 HGL (ft)	63.370	62.811	62.904	62.585

1/1/2004

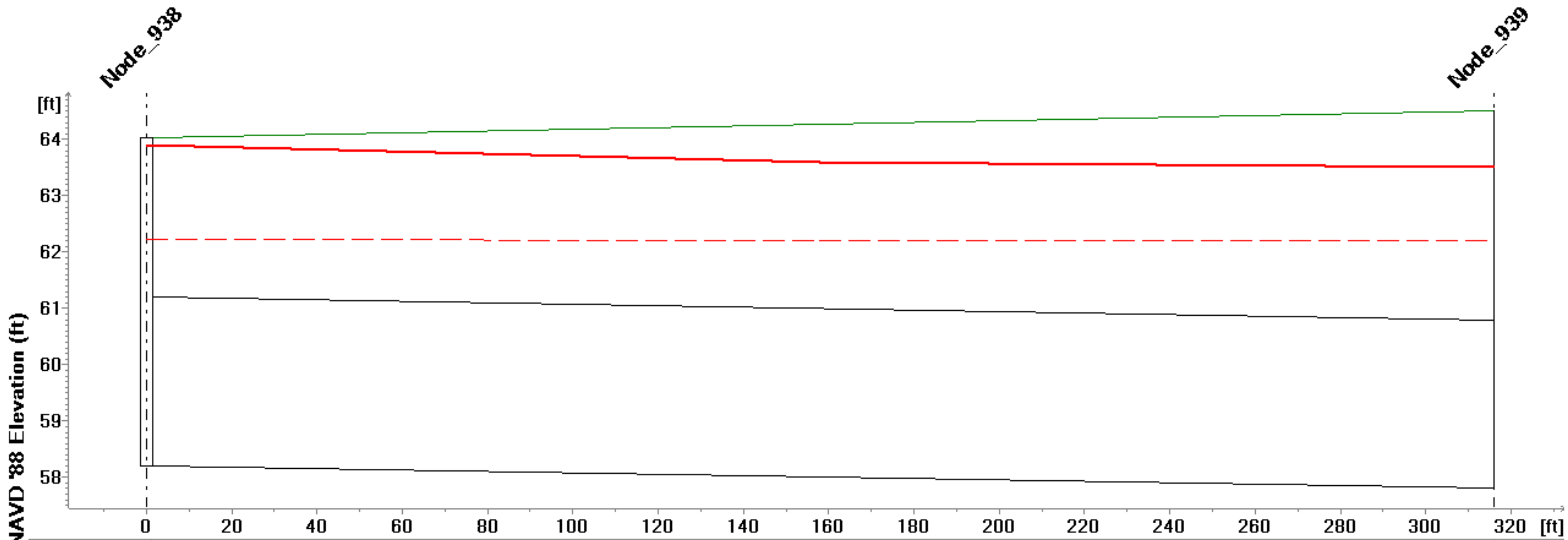
F-6-1 Profile (cont.)



Link ID	Link_421		Link_418		
Q10 (cfs)	1.715		1.713		
Q100 (cfs)	19.495		19.328		
Length (ft)	48.006		11.345		
Diameter (ft)	2.5000				
MUID	Node_665	Node_666		Node_668	
Ground Level (ft)	63.10	63.00		62.90	
Invert Level (ft)	58.10	58.00		57.90	
Q10 HGL (ft)	61.097			61.096	
Q100 HGL (ft)	62.585	62.498		62.439	

1/1/2004

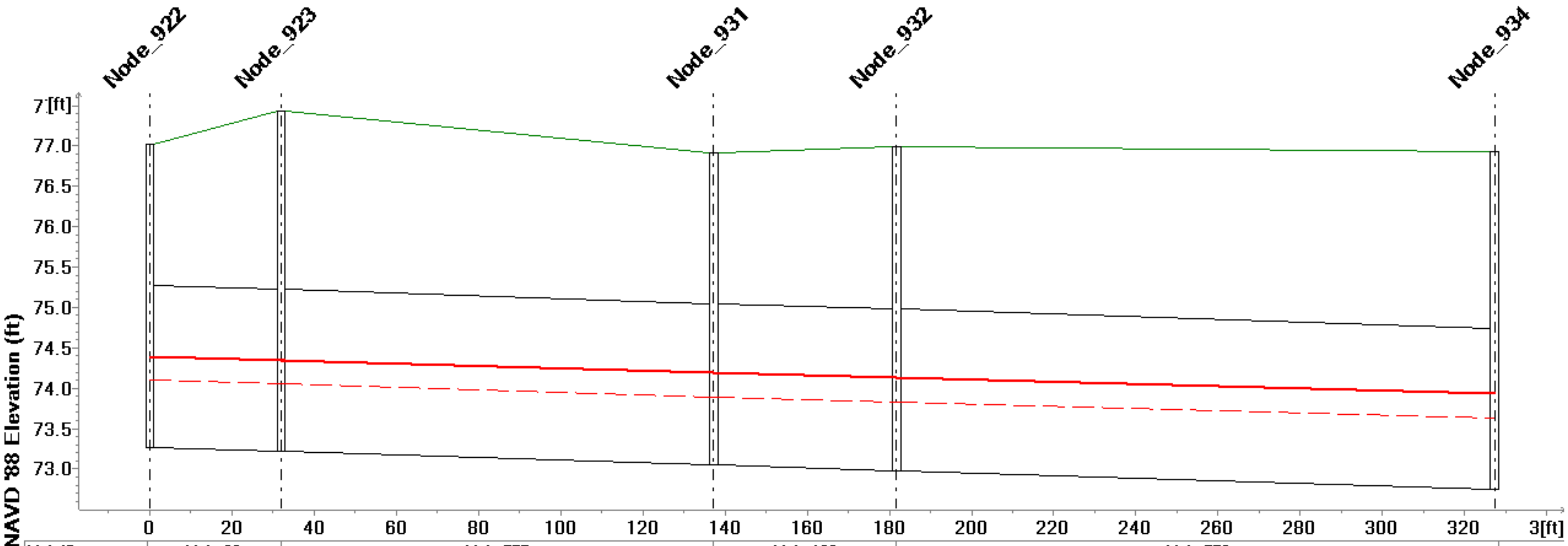
F-7 Profile



Link ID	Link_187	
Q10 (cfs)	7.749	7.748
Q100 (cfs)	19.043	19.042
Length (ft)	316.000	
Diameter (ft)	3.0000	
MUID	Node_938	Node_939
Ground Level (ft)	64.02	64.50
Invert Level (ft)	58.20	57.80
Q10 HGL (ft)	62.216	62.198
Q100 HGL (ft)	63.892	63.502

1/1/2004

F-8 Profile

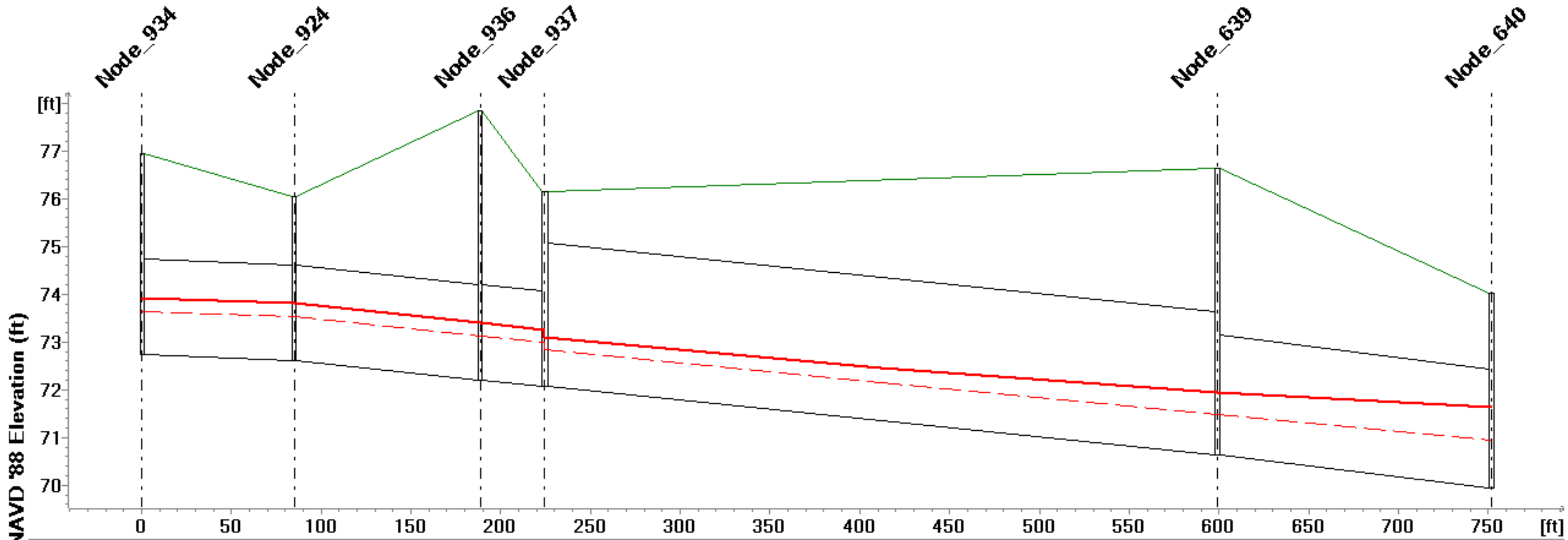


Link ID	Link_38	Link_555	Link_188	Link_556
Q10 (cfs)	3.526	3.525	3.523	3.522
Q100 (cfs)	5.771	5.770	5.769	5.768
Length (ft)	31.934	105.316	44.435	145.587
Diameter (ft)	2.0000			

MUID	....	Node_923	Node_931	Node_932	Node_934
Ground Level (ft)	77.02	77.43	76.91	76.99	76.94
Invert Level (ft)	73.27	73.22	73.05	72.98	72.74
Q10 HGL (ft)	74.103	74.053	73.894	73.830	73.627
Q100 HGL (ft)	74.390	74.341	74.188	74.126	73.927

1/1/2004

F-8 Profile (cont.)

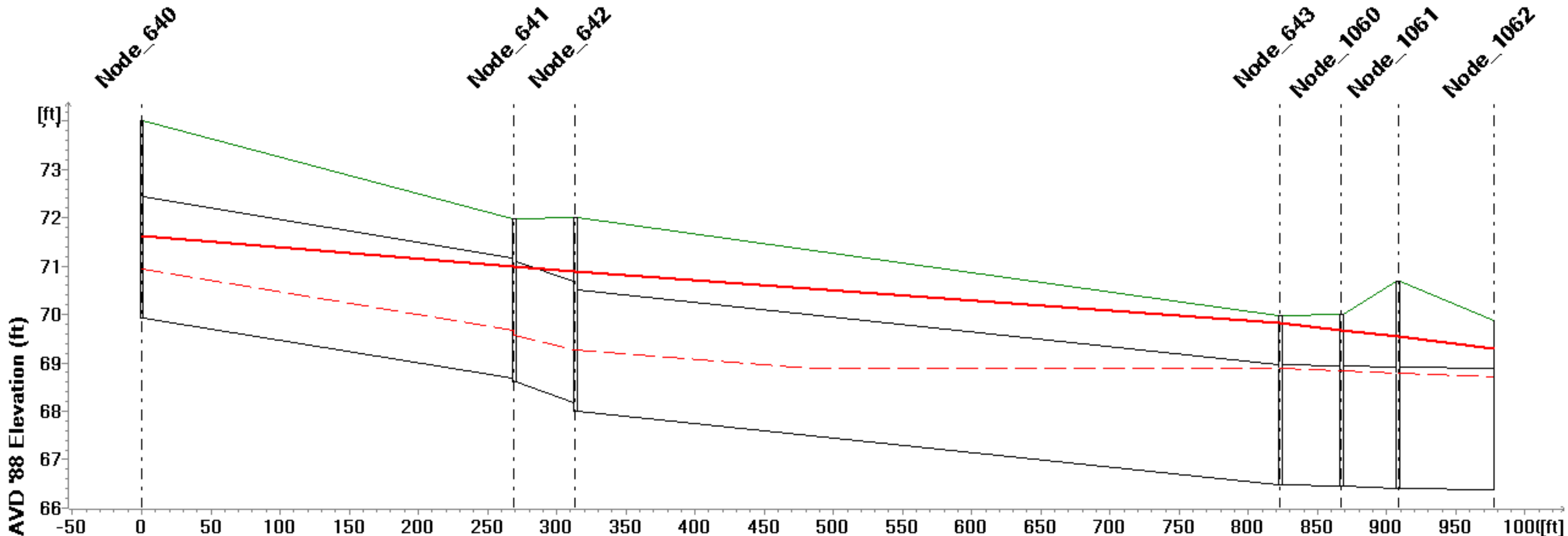


Link ID	Link_194	Link_198	Link_528	Link_195		Link_284
Q10 (cfs)	3.523	6.725	6.723	6.721		6.717
Q100 (cfs)	5.767	11.013	11.012	11.010	10.996	10.974
Length (ft)	84.877	103.604	36.004	374.790		152.661
Diameter (ft)	2.0000			3.0000		2.5000

MUID	....	Node_924	Node_936	Node_937	Node_639	Node_640
Ground Level (ft)	76.94	76.05	77.83	76.14	76.64	74.01
Invert Level (ft)	72.74	72.60	72.21	72.07	70.64	69.93
Q10 HGL (ft)	73.627	73.524	73.127	72.852	71.488	70.935
Q100 HGL (ft)	73.927	73.824	73.401	73.093	71.945	71.634

1/1/2004

F-8 Profile (cont.)

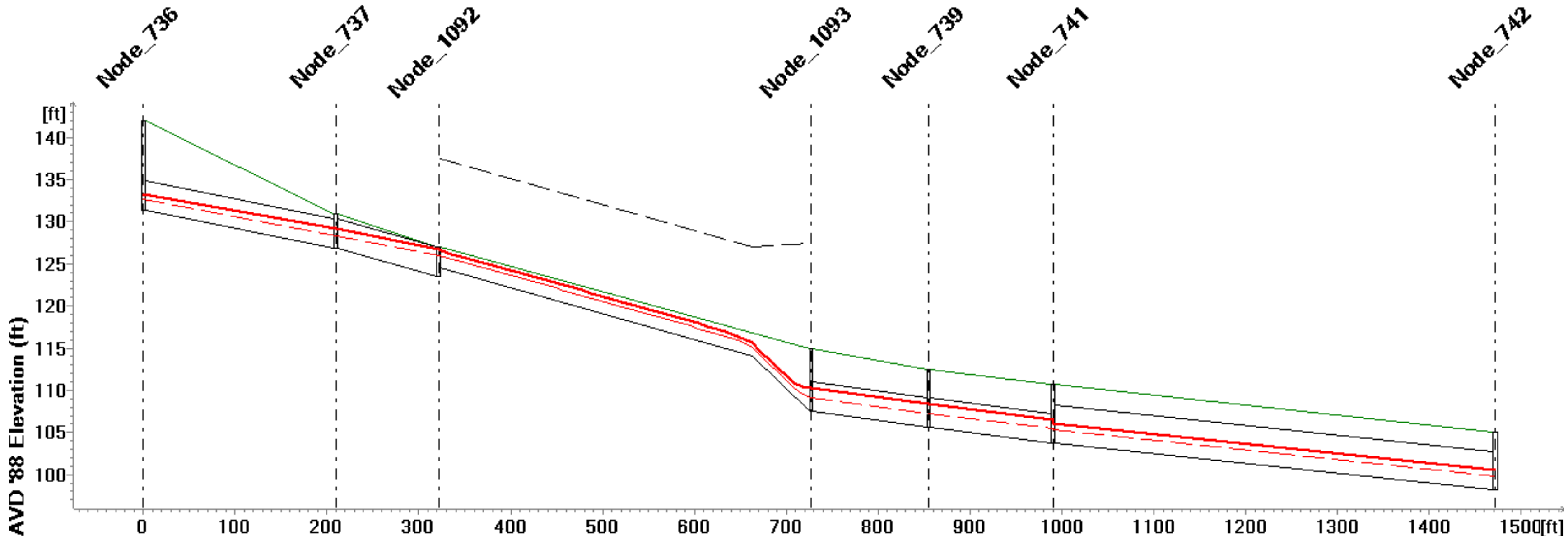


Link ID	Link_282	....	Link_279			....	....	Link_506
Q10 (cfs)	10.530	12.110	12.102	12.108	12.138	15.378	15.376	15.374
Q100 (cfs)	17.992	20.750	20.753	20.756	20.757	26.400	26.399	
Length (ft)	269.029	44.429	509.663			44.180	40.960	69.210
Diameter (ft)	2.5000							

MUID	Node_640	Node_641	Node_642	Node_643	....	....	....
Ground Level (ft)	74.01	71.98	72.00	69.97	70.00	70.70	69.88
Invert Level (ft)	69.93	68.60	68.00	66.47	66.44	66.41	66.38
Q10 HGL (ft)	70.935	69.576	69.272	68.896	68.845	68.798	68.718
Q100 HGL (ft)	71.634	70.987	70.894	69.828	69.678	69.539	69.304

1/1/2004

F-9 Profile

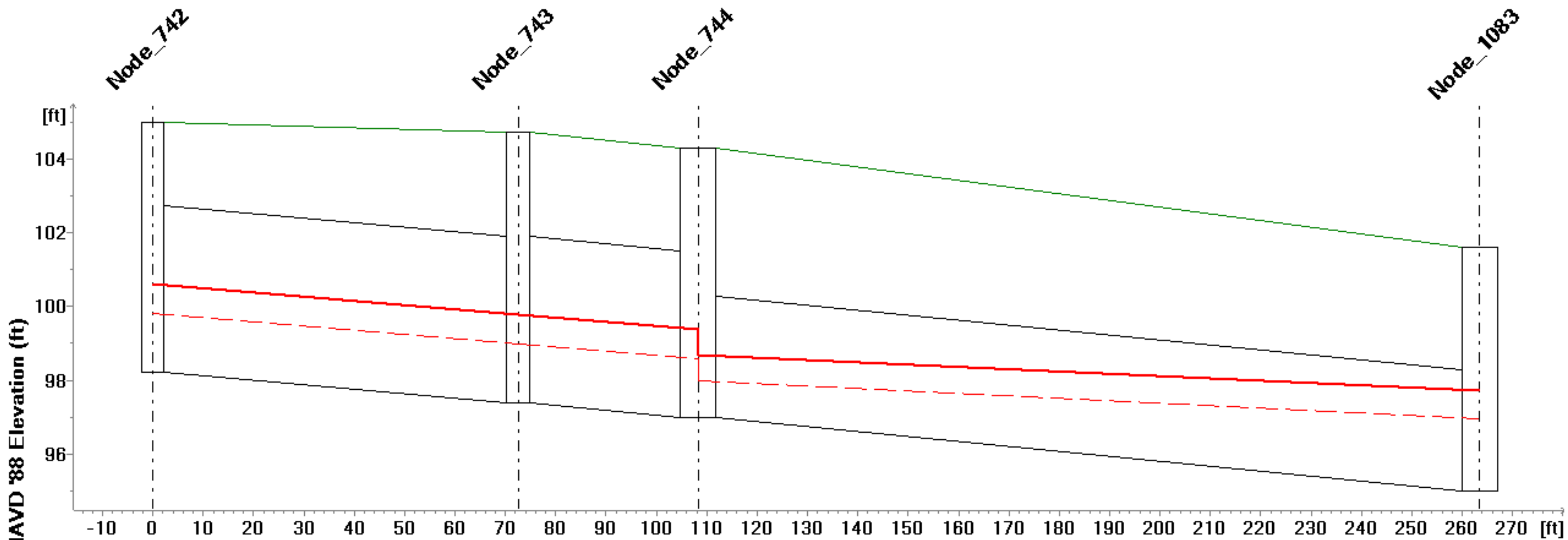


Link ID	Link_361	Link_563	Link_564	Link_362	Link_547	Link_367	
Q10 (cfs)	47.530	60.762		60.750	60.755	60.756	60.750
Q100 (cfs)	98.956	126.205		126.625	126.626	126.634	126.633
Length (ft)	209.835	111.780	405.500	127.810	135.136	481.247	
Diameter (ft)	3.5000			3.5000		4.5000	

MUID	Node_736	Node_737	Node_1092	Node_1093	Node_739	Node_741	Node_742
Ground Level (ft)	142.00	130.86	127.00	115.00	112.39	110.74	105.00
Invert Level (ft)	131.30	126.86	123.50	107.50	105.59	103.74	98.23
Q10 HGL (ft)	132.615	128.354	126.032	109.148	107.272	105.312	99.801
Q100 HGL (ft)	133.317	129.141	126.691	110.221	108.381	106.110	100.601

1/1/2004

F-9 Profile (cont.)

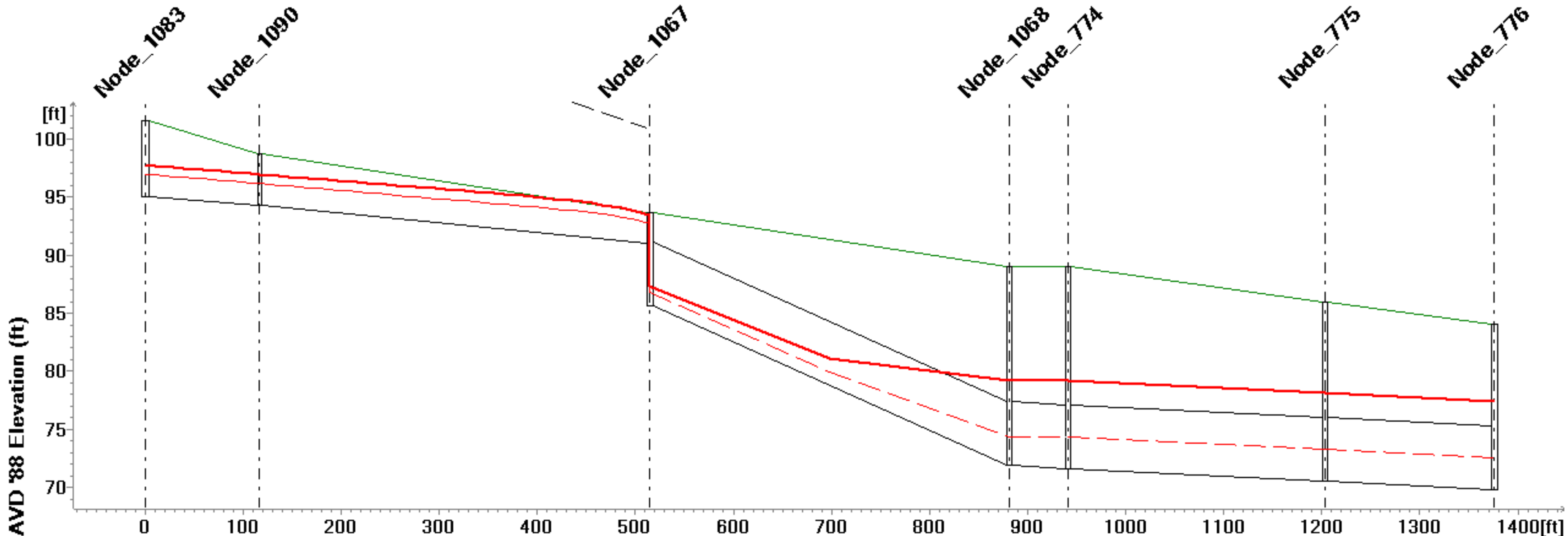


Link ID	Link_371	Link_370	Link_526
Q10 (cfs)	60.743	60.740	61.355
Q100 (cfs)	126.630	126.628	128.482
Length (ft)	72.549	35.748	155.160
Diameter (ft)	4.5000		3.3000

MUID	Node_742	Node_743	Node_744	Node_1083
Ground Level (ft)	105.00	104.75	104.29	101.60
Invert Level (ft)	98.23	97.40	96.99	95.00
Q10 HGL (ft)	99.801	98.974	97.992	96.954
Q100 HGL (ft)	100.601	99.775	98.681	97.719

1/1/2004

F-9 Profile (cont.)

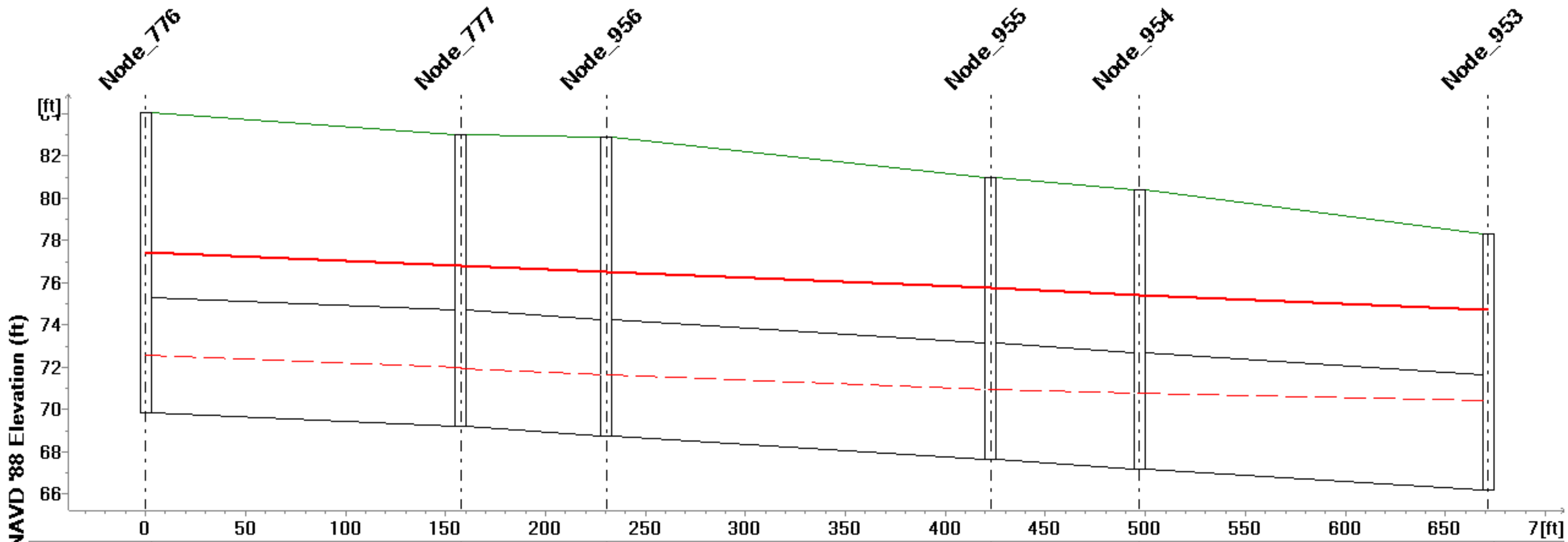


Link ID	Link_559	Link_560	Link_510		....	Link_396	Link_400
Q10 (cfs)	....	61.343 .... 61.320	64.706	64.711	64.824	118.732	118.673
Q100 (cfs)	....	....	135.376	135.294	135.292	233.153	233.186
Length (ft)	116.940	398.184	366.190		59.750	262.436	172.626
Diameter (ft)	4.5000	5.5000					

MUID	....	Node_1090	Node_1067	Node_1068	Node_774	Node_775	Node_776
Ground Level (ft)	101.60	98.70	93.64	89.02	88.98	86.00	84.03
Invert Level (ft)	95.00	94.30	85.64	71.88	71.58	70.52	69.82
Q10 HGL (ft)	96.954	96.172	86.757	74.327	74.345	73.288	72.597
Q100 HGL (ft)	97.719	96.947	87.298	79.243	79.163	78.130	77.450

1/1/2004

F-9 Profile (cont.)

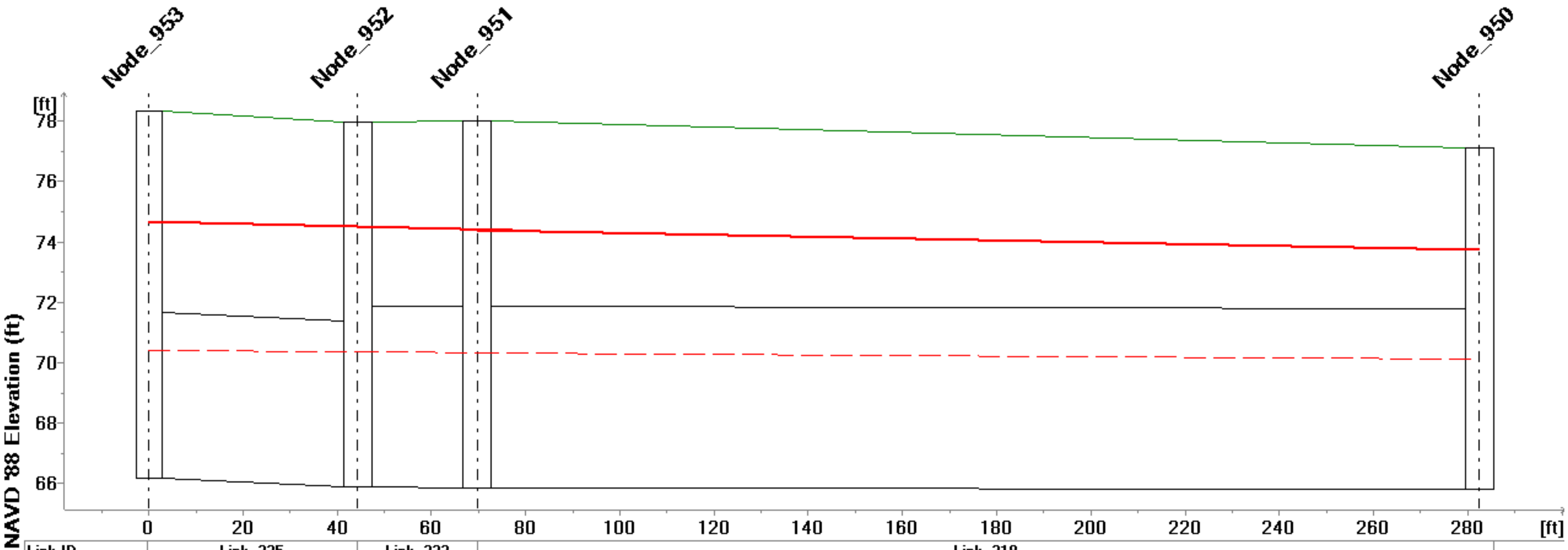


Link ID	Link_399	Link_224	Link_226	Link_227	Link_223
Q10 (cfs)	118.682	118.683	122.985	122.958	122.927
Q100 (cfs)	233.216	233.243	240.608	240.610	240.621
Length (ft)	157.747	72.782	192.080	74.252	174.618
Diameter (ft)	5.5000				

MUID	Node_776	Node_777	Node_956	Node_955	Node_954	Node_953
Ground Level (ft)	84.03	82.99	82.89	80.99	80.38	78.32
Invert Level (ft)	69.82	69.19	68.76	67.63	67.19	66.16
Q10 HGL (ft)	72.597	71.946	71.648	70.933	70.752	70.414
Q100 HGL (ft)	77.450	76.828	76.542	75.734	75.422	74.688

1/1/2004

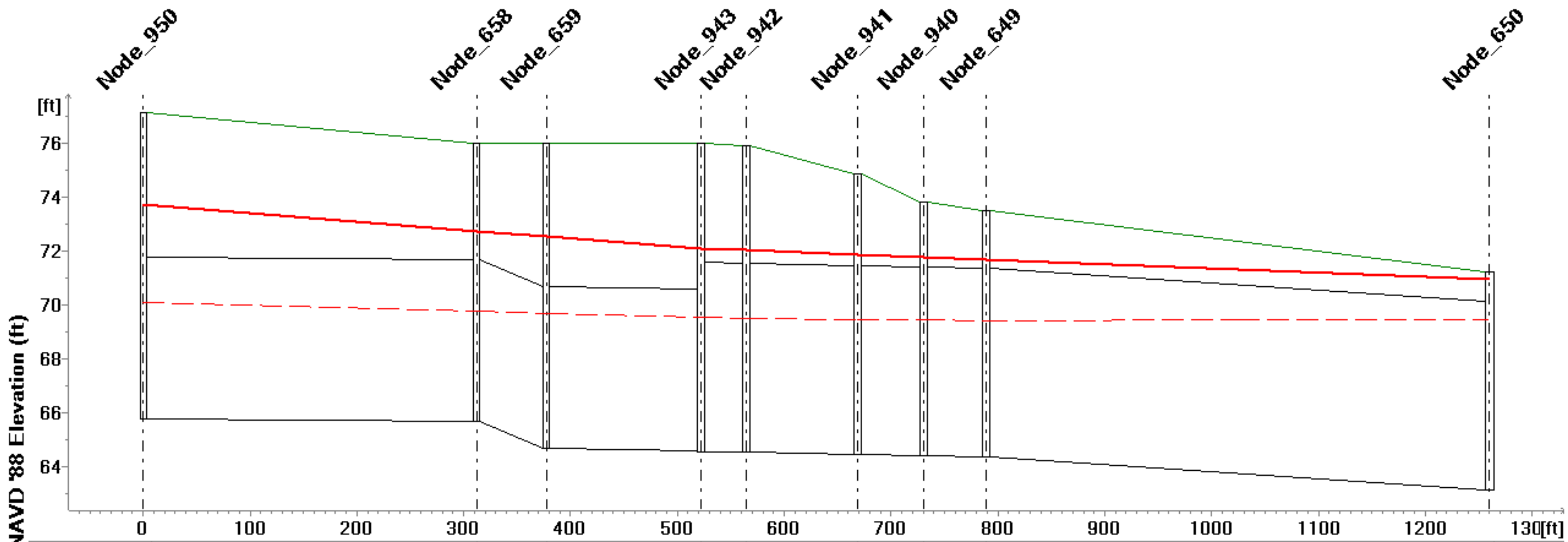
F-9 Profile (cont.)



Link ID	Link_225		Link_222	Link_218	
Q10 (cfs)	122.895		136.298	136.257	
Q100 (cfs)	240.635		262.980	262.984	
Length (ft)	44.284		25.374	212.842	
Diameter (ft)	5.5000		6.0000		
MUID	Node_953	Node_952	Node_951		Node_950
Ground Level (ft)	78.32	77.98	78.00		77.10
Invert Level (ft)	66.16	65.88	65.87		65.79
Q10 HGL (ft)	70.414	70.359	70.326		70.103
Q100 HGL (ft)	74.688	74.501	74.398		73.727

1/1/2004

F-9 Profile (cont.)

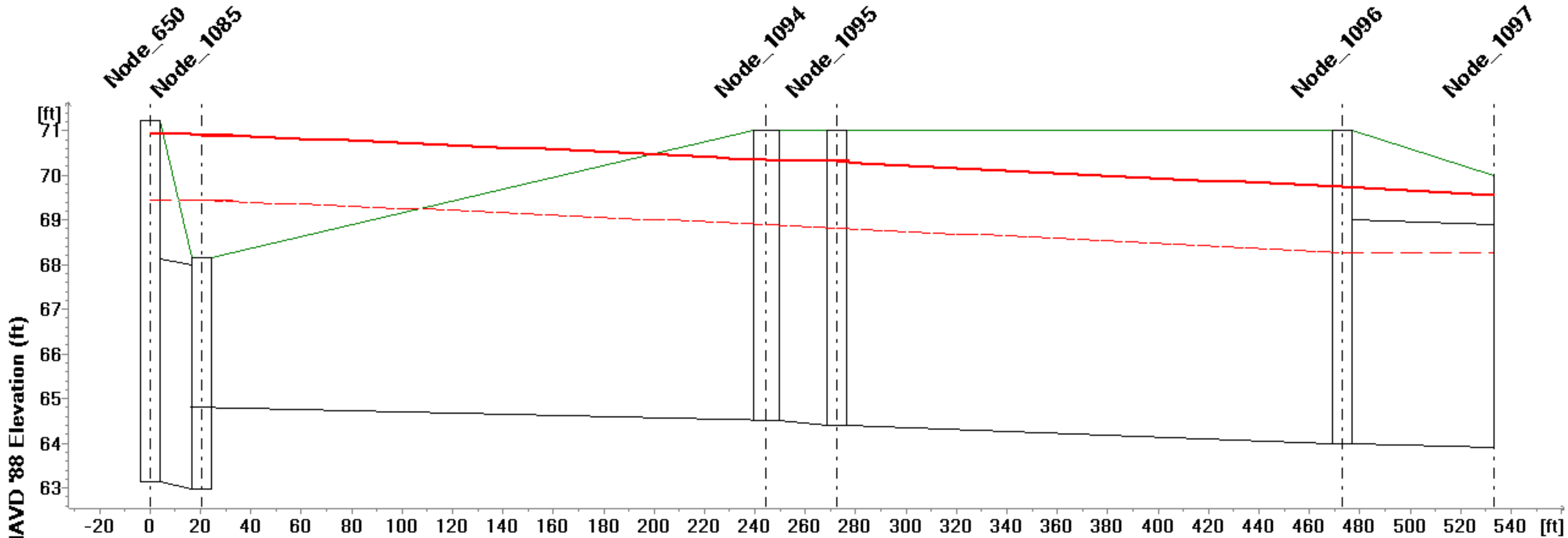


Link ID	Link_217	Link_270	Link_268	....	Link_178	Link_186	....	Link_263	
Q10 (cfs)	136.172	136.238	136.270	....	143.481	143.467	143.445	143.469	143.535
Q100 (cfs)	262.989	262.996	263.002	....	276.105	276.112	276.121	276.142	278.841
Length (ft)	312.221	65.273	144.780	....	104.510	62.308	57.855	471.315	
Diameter (ft)	6.0000			7.0000					

MUID	Node_950	Node_658	Node_659	Node_943	Node_942	Node_941	....	Node_649	Node_650
Ground Level (ft)	77.10	75.99	75.97	76.00	75.89	74.84	73.81	73.48	71.23
Invert Level (ft)	65.79	65.69	64.67	64.57	64.54	64.47	64.42	64.38	63.13
Q10 HGL (ft)	70.103	69.751	69.665	69.541	69.520	69.462	69.463	69.432	69.453
Q100 HGL (ft)	73.727	72.742	72.536	72.080	72.022	71.862	71.766	71.678	70.938

1/1/2004

F-9 Profile (cont.)

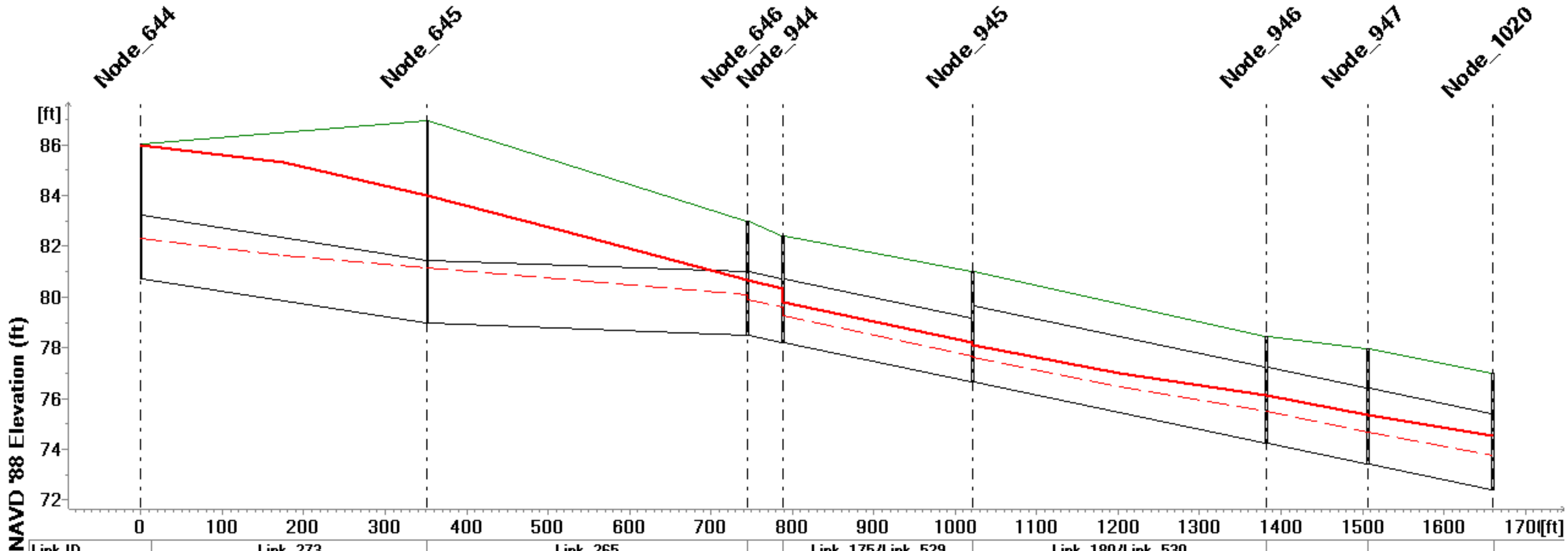


Link ID	....	Link_565	Link_566	Link_567	Link_568
Q10 (cfs)					210.609
Q100 (cfs)					394.242
Length (ft)	20.480	224.000	27.970	200.660	60.110
Diameter (ft)	5.0000				5.0000

MUID	....	Node_1085	Node_1094	Node_1095	Node_1096	....
Ground Level (ft)	....	68.15	71.00			70.00
Invert Level (ft)	....	62.98	64.50	64.40	64.00	63.90
Q10 HGL (ft)	....	69.440	68.887	68.814	68.266	68.269
Q100 HGL (ft)	....	70.893	70.335	70.311	69.754	69.549

1/1/2004

F-9-1 Profile

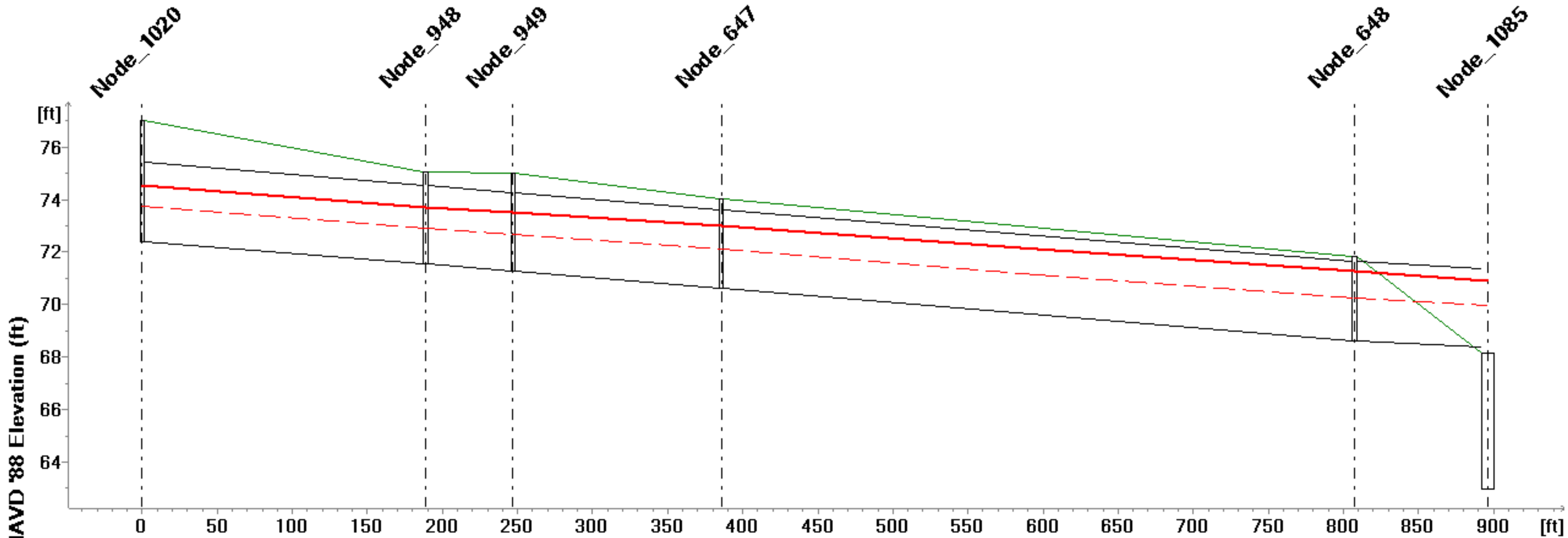


Link ID	Link_273		Link_265		....	Link_175/Link_529	Link_180/Link_530		....	....	
Q10 (cfs)	21.529	21.515	21.510	21.504	....	13.046	13.038	13.052	20.643	20.629	
Q100 (cfs)	38.498	39.904	42.090	42.139	....	26.479	27.110	27.114	40.207	40.195	
Length (ft)	351.590		392.835		....	232.968/232.968	360.418/360.418		....	152.968/152.968	
Diameter (ft)	2.5000					2.5000/2.5000	3.0000/3.0000				

MUID	Node_644	Node_645	Node_646	Node_944	Node_945	Node_946	Node_947	....
Ground Level (ft)	86.01	86.95	82.97	82.42	80.99	78.43	77.96	77.01
Invert Level (ft)	80.71	78.95	78.52	78.22	76.66	74.26	73.43	72.41
Q10 HGL (ft)	82.309	81.132	79.884	79.244	77.618	75.483	74.678	73.762
Q100 HGL (ft)	85.999	83.982	80.690	79.781	78.106	76.108	75.347	74.513

1/1/2004

F-9-1 Profile (cont.)

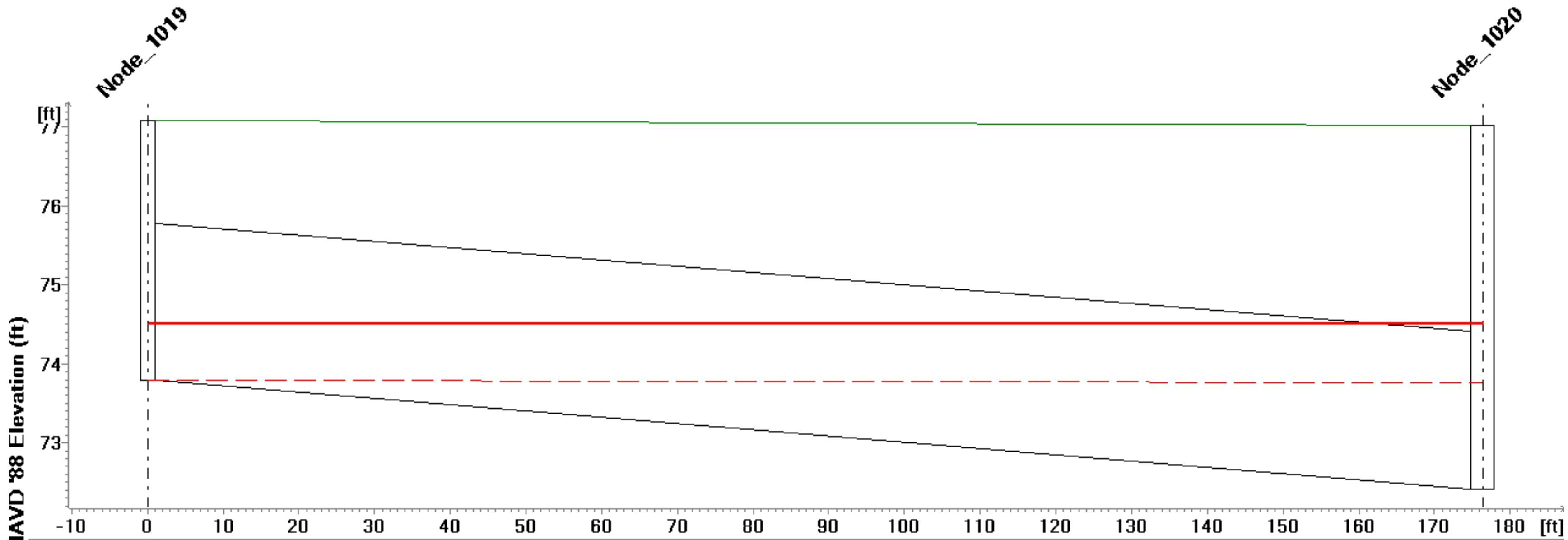


Link ID	Link_181/Link_533	....	Link_201/Link_535	Link_202/Link_536		Link_220/Link_537
Q10 (cfs)	20.615	20.622	20.626	24.567		24.564
Q100 (cfs)	40.169	40.162	40.156	46.639	46.609	47.130
Length (ft)	188.957/188.957	....	138.659/138.659	421.642/421.642		89.000/89.000
Diameter (ft)	3.0000/3.0000					

MUID	Node_1020	Node_948	Node_949	Node_647	Node_648	....
Ground Level (ft)	77.01	75.03	75.00	74.01	71.83	68.15
Invert Level (ft)	72.41	71.53	71.26	70.61	68.63	62.98
Q10 HGL (ft)	73.762	72.903	72.657	72.101	70.262	69.440
Q100 HGL (ft)	74.513	73.711	73.488	72.981	71.260	70.893

1/1/2004

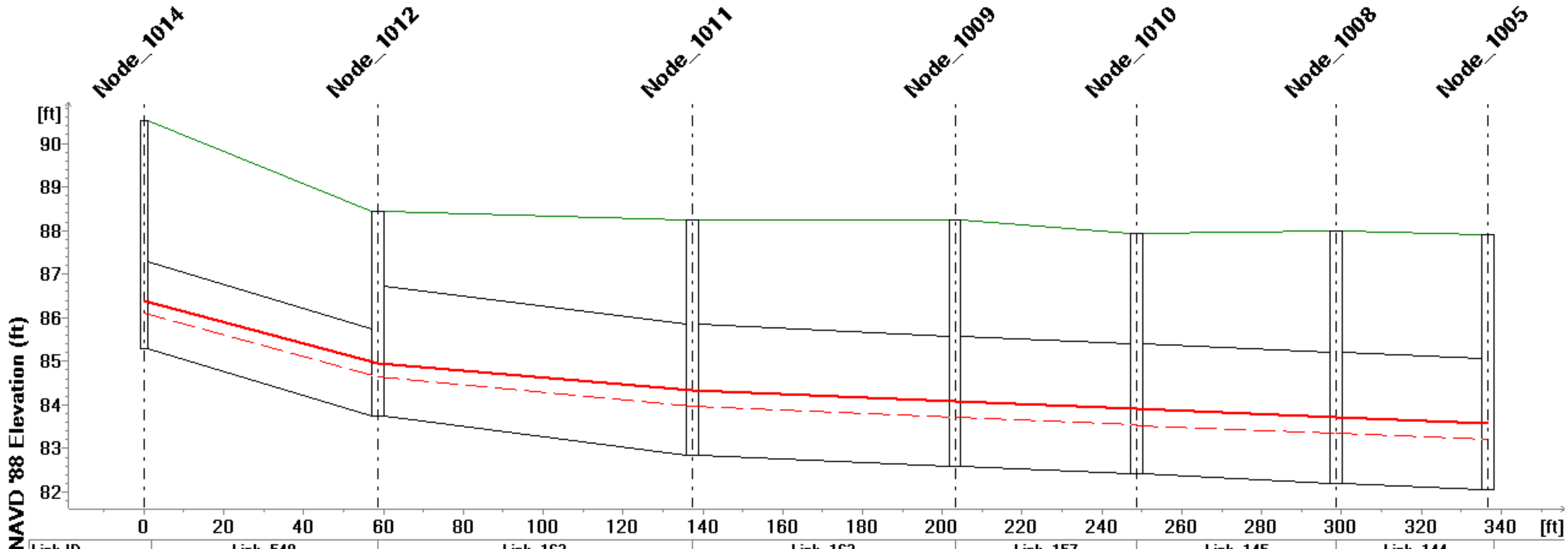
F-9-1-1 Profile



Link ID	Link_166	
Q10 (cfs)	0.013	
Q100 (cfs)	1.717	
Length (ft)	176.355	
Diameter (ft)	2.0000	
MUID	Node_1019	Node_1020
Ground Level (ft)	77.09	77.01
Invert Level (ft)	73.79	72.41
Q10 HGL (ft)	73.797	73.762
Q100 HGL (ft)	74.515	74.513

1/1/2004

F-9-2 Profile

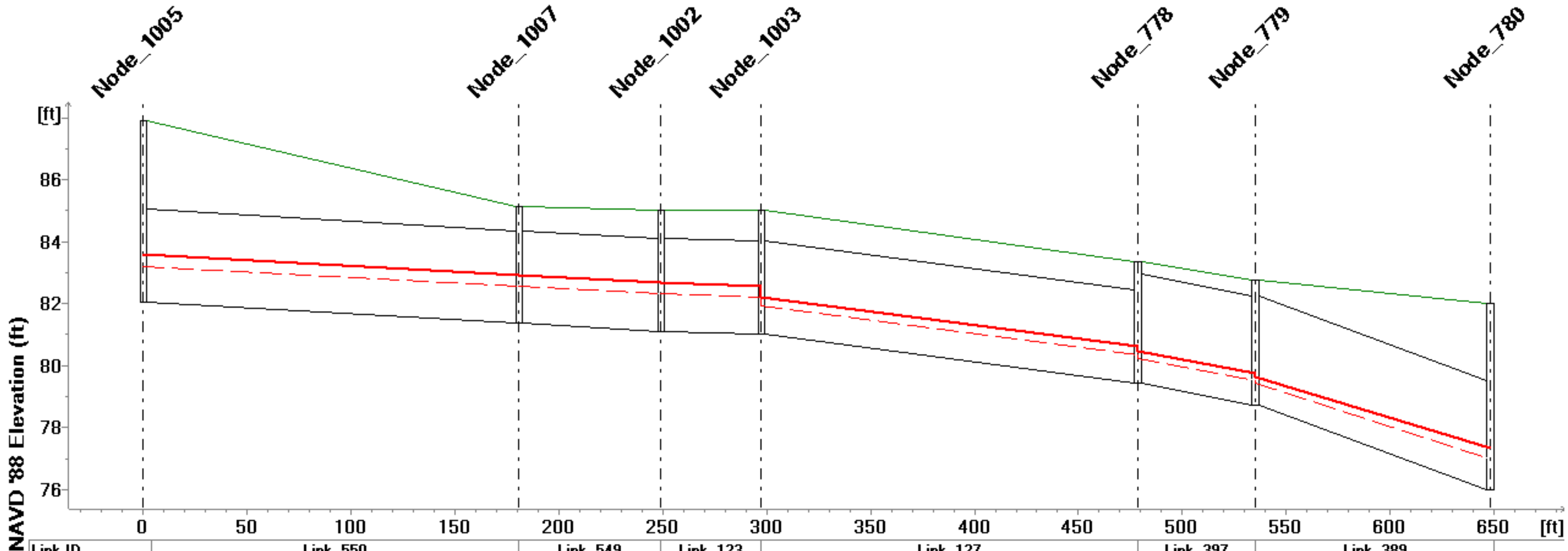


Link ID	Link_548	Link_162	Link_163	Link_157	Link_145	Link_144
Q10 (cfs)	13.562	13.560	13.557	13.555	13.553	13.552
Q100 (cfs)	22.463	22.462	22.460	22.458	22.457	22.455
Length (ft)	58.568	78.829	65.780	45.539	49.974	37.982
Diameter (ft)	2.0000	3.0000				

MUID	Node_1014	Node_1012	Node_1011	Node_1009	Node_1010	Node_1008	Node_1005
Ground Level (ft)	90.53	88.44	88.25	88.24	87.93	87.98	87.91
Invert Level (ft)	85.29	83.74	82.85	82.58	82.41	82.21	82.06
Q10 HGL (ft)	86.099	84.644	83.964	83.710	83.531	83.340	83.198
Q100 HGL (ft)	86.378	84.952	84.332	84.080	83.900	83.711	83.570

1/1/2004

F-9-2 Profile (cont.)

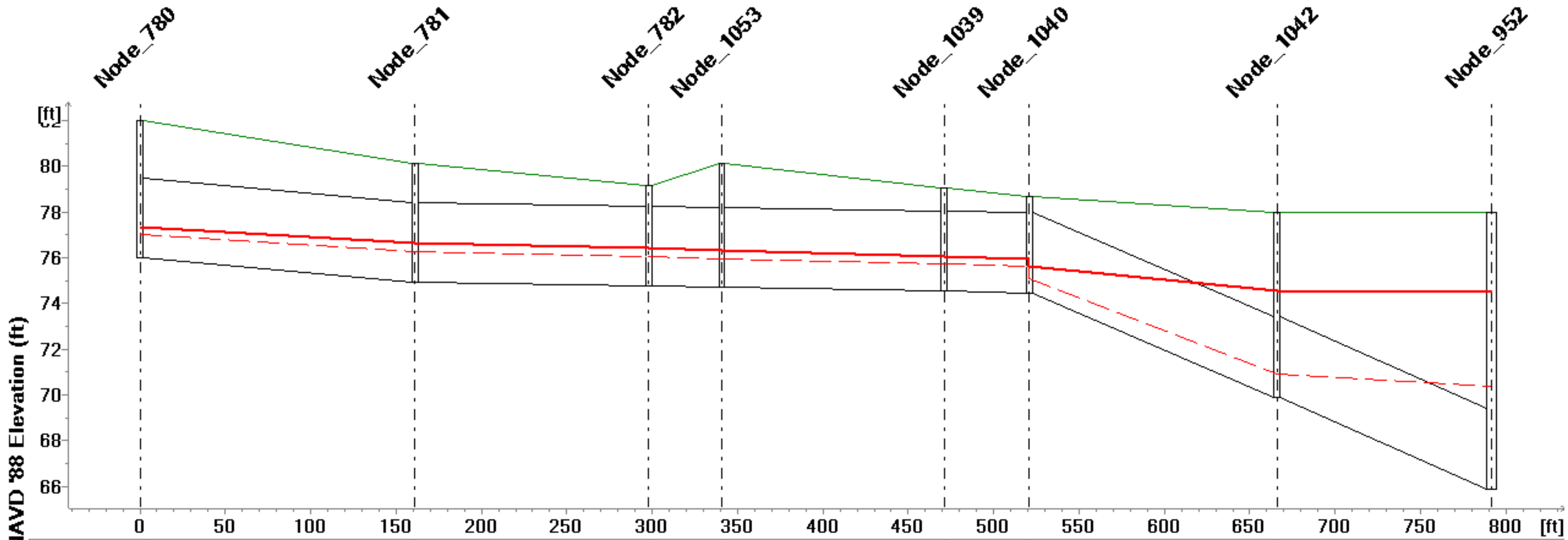


Link ID	Link_550	Link_549	Link_123	Link_127	Link_397	Link_389
Q10 (cfs)	13.547	13.543	13.544	13.547		
Q100 (cfs)	22.452	22.448	22.447	22.444	22.445	22.447
Length (ft)	180.838	68.326	48.247	181.021	56.928	112.762
Diameter (ft)	3.0000				3.5000	

MUID	Node_1005	Node_1007	Node_1002	Node_1003	Node_778	Node_779	Node_780
Ground Level (ft)	87.91	85.13	85.00	85.03	83.34	82.74	82.00
Invert Level (ft)	82.06	81.36	81.10	81.03	79.44	78.74	76.00
Q10 HGL (ft)	83.198	82.545	82.332	81.929	80.225	79.421	77.002
Q100 HGL (ft)	83.570	82.913	82.688	82.205	80.453	79.629	77.335

1/1/2004

F-9-2 Profile (cont.)

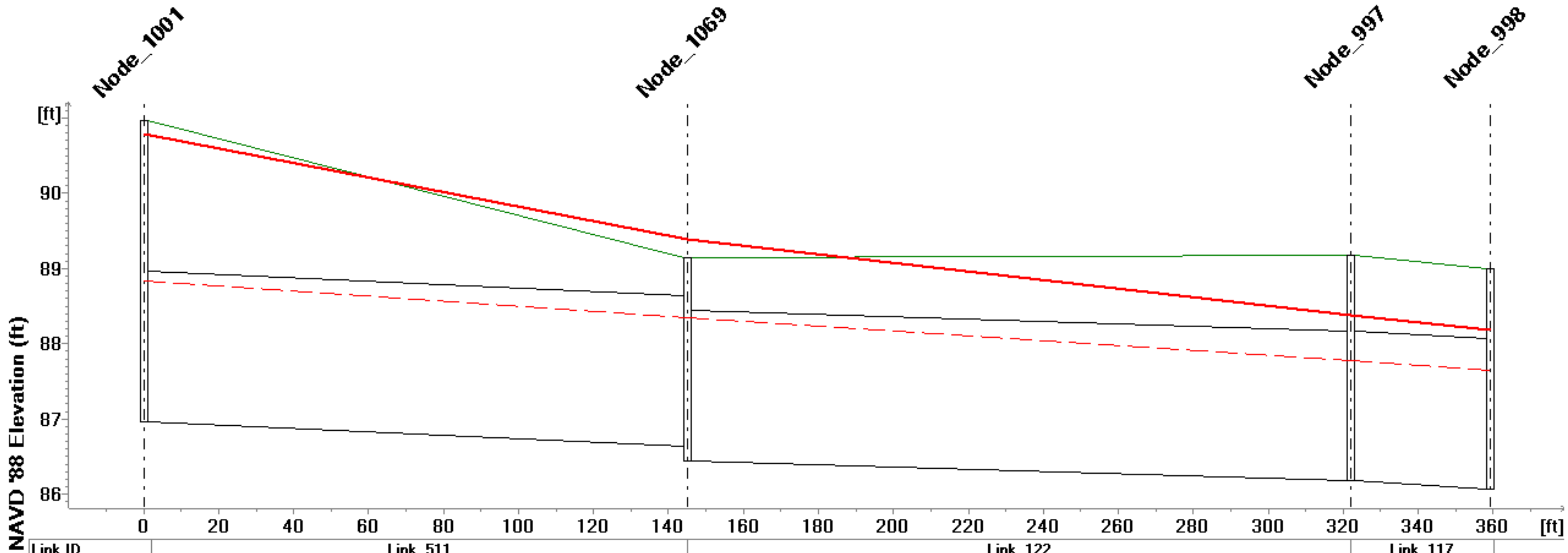


Link ID	Link_394	Link_388	Link_462	Link_467	Link_468	Link_469	Link_470
Q10 (cfs)	13.543	13.536		13.537	13.536	13.535	13.500
Q100 (cfs)	22.448	22.444	22.442	22.440	22.437	22.427	22.423
Length (ft)	160.925	136.887	42.952	130.192	49.980	144.999	125.809
Diameter (ft)	3.5000						

MUID	Node_780	Node_781	Node_782	Node_1053	Node_1039	Node_1040	Node_1042	Node_952
Ground Level (ft)	82.00	80.12	79.15	80.10	79.04	78.66	77.97	77.98
Invert Level (ft)	76.00	74.92	74.75	74.70	74.54	74.46	69.90	65.88
Q10 HGL (ft)	77.002	76.256	76.042	75.966	75.719	75.098	70.911	70.359
Q100 HGL (ft)	77.335	76.647	76.411	76.328	76.055	75.619	74.552	74.501

1/1/2004

F-9-3 Profile

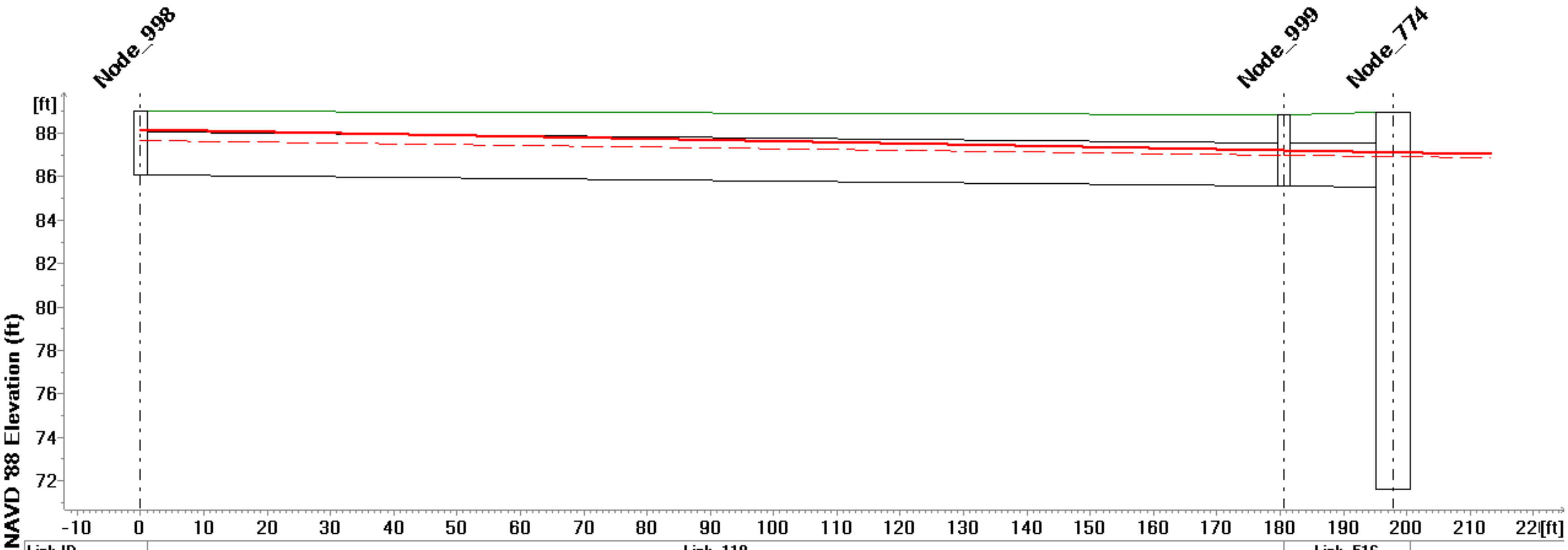


Link ID	Link_511		Link_122		Link_117
Q10 (cfs)	14.316		14.299		14.292
Q100 (cfs)	25.026		20.389		18.951
Length (ft)	144.970		177.037		37.178
Diameter (ft)	2.0000				

MUID	Node_1001	Node_1069	Node_997	Node_998
Ground Level (ft)	90.97	89.14	89.17	89.00
Invert Level (ft)	86.97	86.44	86.17	86.07
Q10 HGL (ft)	88.828	88.353	87.774	87.647
Q100 HGL (ft)	90.783	89.387	88.383	88.184

1/1/2004

F-9-3 Profile (cont.)



Link ID	Link_118		Link_516
Q10 (cfs)	14.290		14.292
Q100 (cfs)	18.288		18.287
Length (ft)	180.590		17.199
Diameter (ft)	2.0000		
MUID	Node_998	Node_999	Node_774
Ground Level (ft)	89.00	88.88	88.98
Invert Level (ft)	86.07	85.58	71.58
Q10 HGL (ft)	87.647	87.010	74.345
Q100 HGL (ft)	88.184	87.217	79.163

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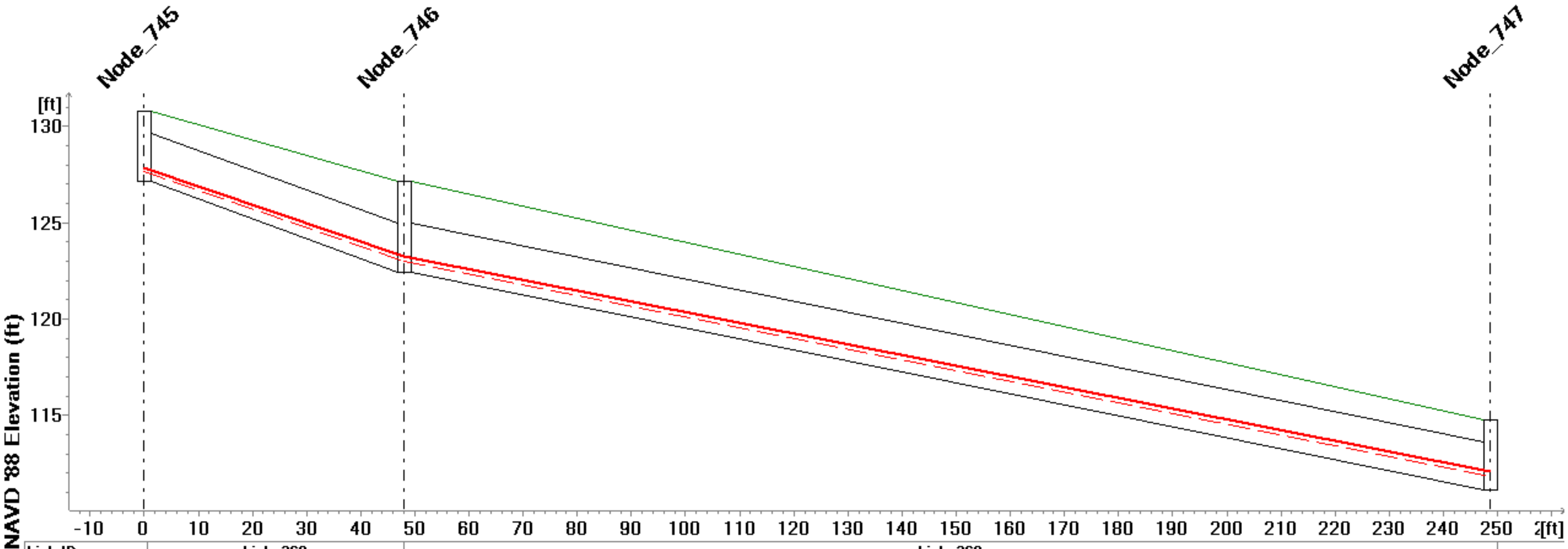
F-9-4 Profile



Link ID	Link_368		Link_360	
Q10 (cfs)	12.590		12.589	
Q100 (cfs)	24.364		24.363	
Length (ft)	47.993		200.657	
Diameter (ft)	2.5000			
MUID	Node_745	Node_746		Node_747
Ground Level (ft)	130.77	127.15		114.79
Invert Level (ft)	127.17	122.45		111.09
Q10 HGL (ft)	127.675	123.032		111.795
Q100 HGL (ft)	127.875	123.264		112.089

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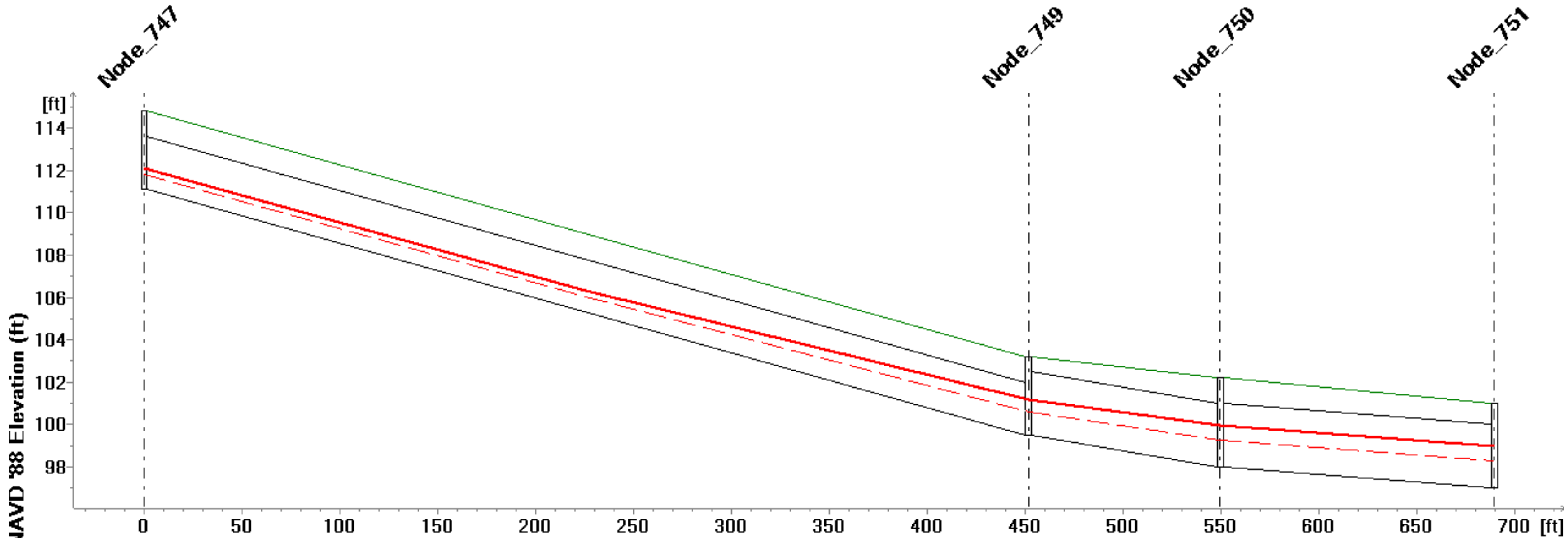
F-9-4 Profile (cont.)

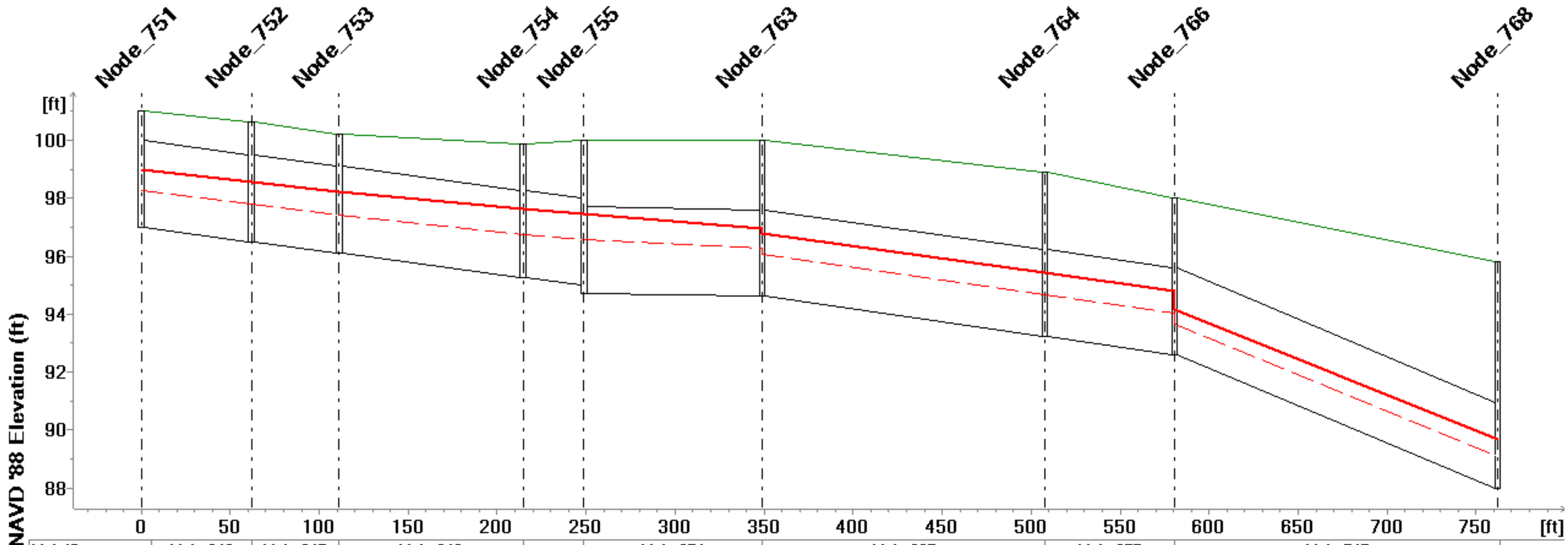


Link ID	Link_546		Link_351	Link_350
Q10 (cfs)	12.588	12.586	24.573	24.569
Q100 (cfs)	24.360	24.356	47.791	47.785
Length (ft)	451.557		97.870	139.842
Diameter (ft)	2.5000		3.0000	

MUID	Node_747	Node_749	Node_750	Node_751
Ground Level (ft)	114.79	103.21	102.25	101.00
Invert Level (ft)	111.09	99.51	97.98	96.99
Q10 HGL (ft)	111.795	100.611	99.296	98.273
Q100 HGL (ft)	112.089	101.161	99.964	98.977

1/1/2004

F-9-4 Profile (cont.)



Link ID	Link_349	Link_347	Link_348	....	Link_374	Link_387	Link_375	Link_545	
Q10 (cfs)	24.570	24.571	24.572	24.574	27.831	32.019	32.017	32.015	
Q100 (cfs)	47.783	47.784	47.786	47.788	53.587	60.798	60.782		
Length (ft)	61.823	49.402	103.283	34.297	100.282	158.438	73.214	181.312	
Diameter (ft)	3.0000								

MUID	....	Node_752	Node_753	Node_754	Node_755	Node_763	Node_764	Node_766	Node_768	
Ground Level (ft)	....	100.63	100.20	99.89	100.00	100.01	98.91	98.00	95.81	
Invert Level (ft)	96.99	96.50	96.10	95.27	94.70	94.61	93.23	92.60	87.96	
Q10 HGL (ft)	....	97.797	97.432	96.738	96.574	96.048	94.674	93.672	89.087	
Q100 HGL (ft)	....	98.547	98.229	97.632	97.476	96.806	95.435	94.143	89.663	

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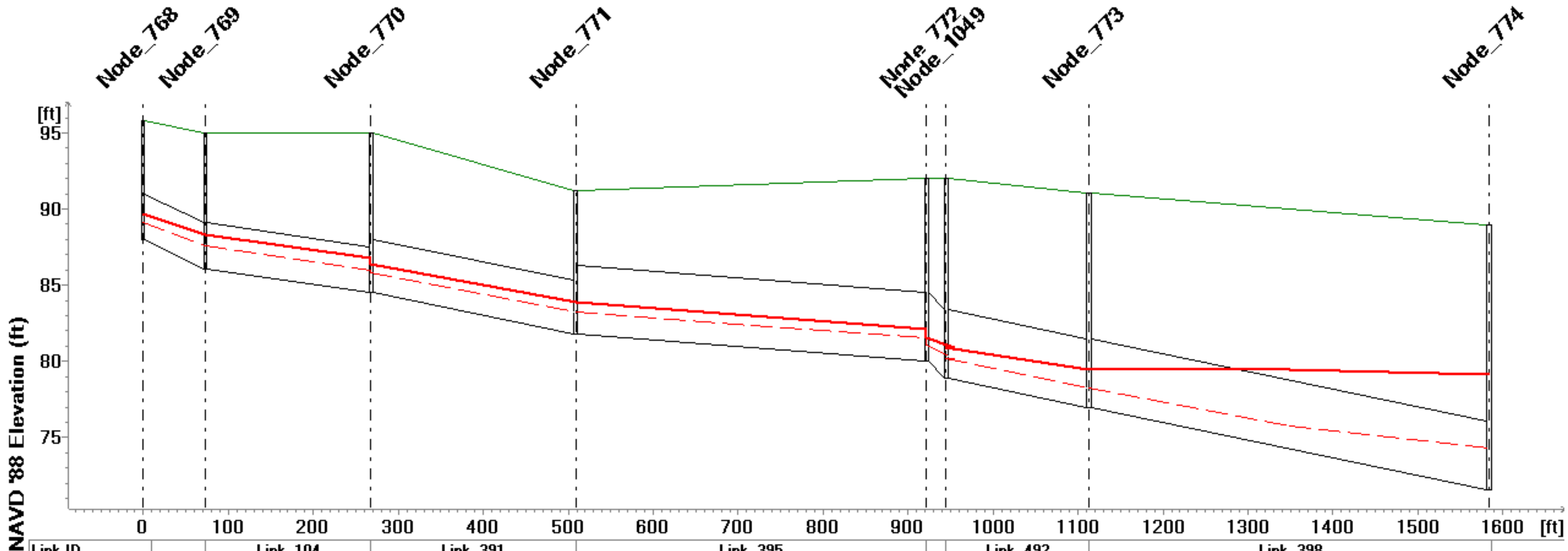
F-9-4 Profile (cont.)



Link ID	....	Link_104	Link_391	Link_395		....	Link_492	Link_398	
Q10 (cfs)	32.013	32.007	31.999	32.000	31.991	....	40.374	40.369	40.373
Q100 (cfs)	60.785		60.780	60.760	60.755	....	79.648	80.225	80.441
Length (ft)	73.155	194.605	241.151	412.853		....	167.891	471.289	
Diameter (ft)	3.0000		3.5000	4.5000					

MUID	....	Node_769	Node_770	Node_771	Node_772	Node_1049	Node_773	Node_774
Ground Level (ft)	....	94.99	95.02	91.20	92.06	92.03	91.03	88.98
Invert Level (ft)	....	86.09	84.52	81.80	80.06	78.90	76.98	71.58
Q10 HGL (ft)	....	87.558	85.785	83.254	81.077	80.173	78.274	74.345
Q100 HGL (ft)	....	88.352	86.346	83.860	81.587	80.871	79.440	79.163

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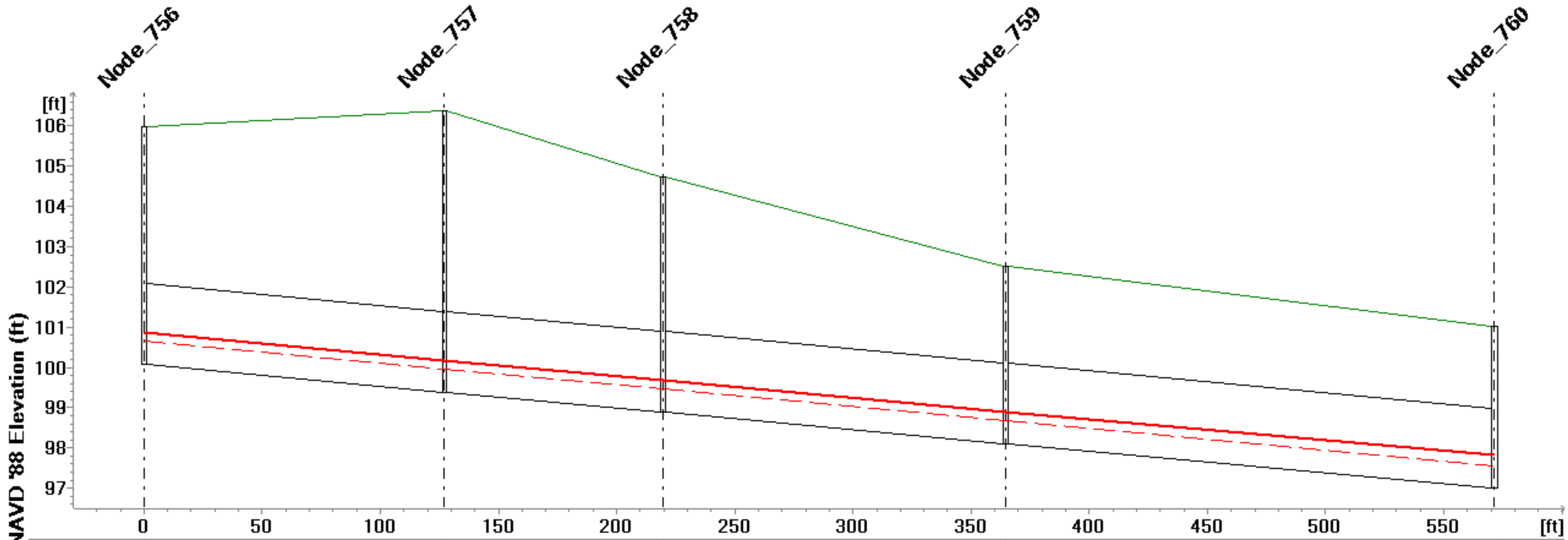
F-9-4-1 Profile



Link ID	Link_355	Link_353	Link_357	Link_356
Q10 (cfs)	3.308	3.307	3.306	3.305
Q100 (cfs)	5.880	5.878		5.875
Length (ft)	127.187	92.496	144.797	206.835
Diameter (ft)	2.0000			

MUID	Node_756	Node_757	Node_758	Node_759	Node_760
Ground Level (ft)	105.98	106.36	104.73	102.50	101.04
Invert Level (ft)	100.08	99.39	98.89	98.11	96.99
Q10 HGL (ft)	100.651	99.965	99.465	98.684	97.545
Q100 HGL (ft)	100.854	100.168	99.670	98.897	97.828

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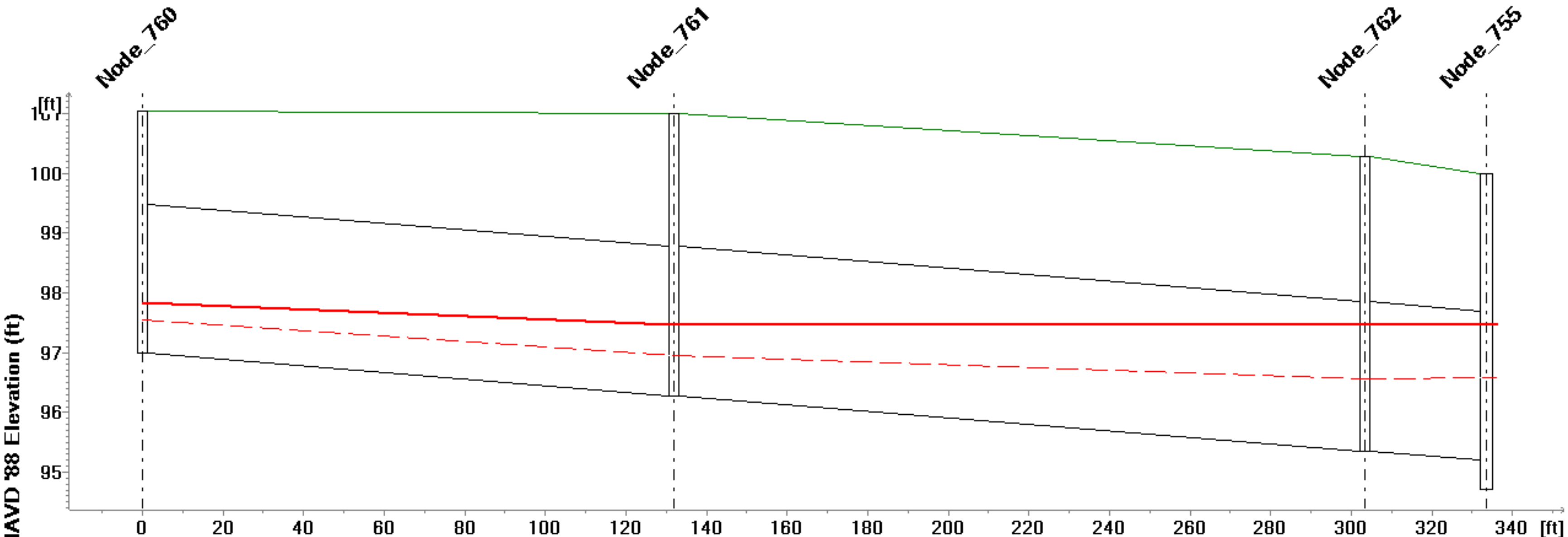
F-9-4-1 Profile



Link ID	Link_354	Link_358	Link_372	
Q10 (cfs)	3.304	3.296	3.284	
Q100 (cfs)	5.860	6.226	6.072	
Length (ft)	131.901	171.519	30.041	
Diameter (ft)	2.5000			
MUID	Node_760	Node_761	Node_762	....
Ground Level (ft)	101.04	101.01	100.28	100.00
Invert Level (ft)	96.99	96.28	95.36	94.70
Q10 HGL (ft)	97.545	96.946	96.571	96.574
Q100 HGL (ft)	97.828	97.457	97.475	97.476

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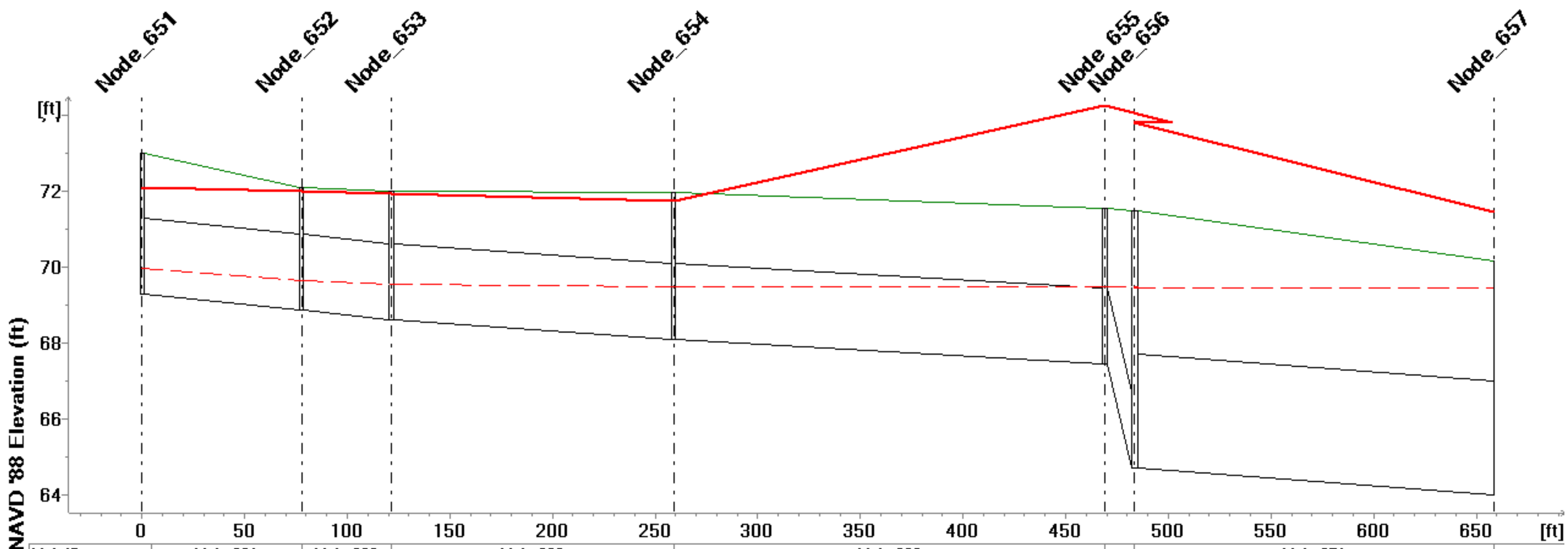
F-10 Profile



Link ID	Link_261	Link_262	Link_266	Link_269	......	Link_271
Q10 (cfs)	4.052	4.040	4.044	4.132	......	17.553
Q100 (cfs)	7.106	7.104	7.102	7.100	......	18.572
Length (ft)	77.702	43.839	137.369	210.100	......	175.200
Diameter (ft)	2.0000					3.0000

MUID	....	Node_652	Node_653	Node_654	Node_655	Node_656	Node_657
Ground Level (ft)	73.00	72.09	72.01	71.99	71.56	71.50	70.16
Invert Level (ft)	69.30	68.86	68.61	68.09	67.46	64.70	64.00
Q10 HGL (ft)	69.965	69.641	69.550	69.490	69.478	69.470	69.466
Q100 HGL (ft)	72.096	72.001	71.949	71.750	74.250	73.822	71.454

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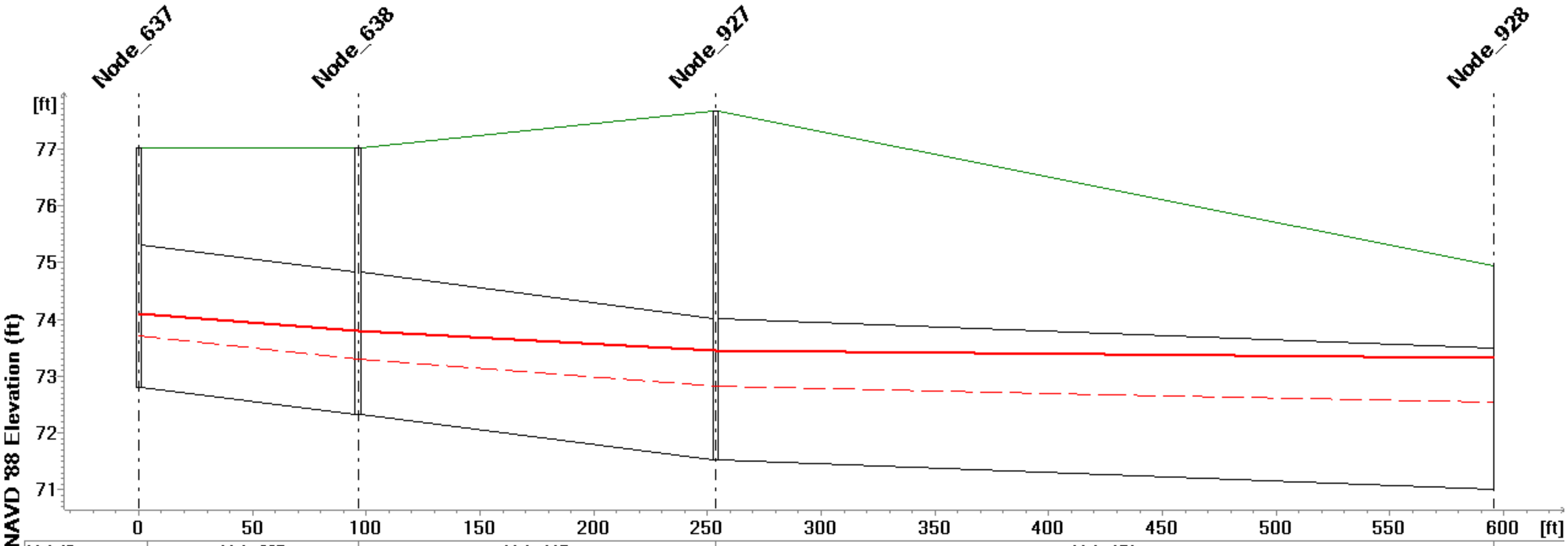
F-11 Profile



Link ID	Link_285	Link_115	Link_171	
Q10 (cfs)	8.369	8.356	8.358	8.357
Q100 (cfs)	13.544	13.526	13.492	13.457
Length (ft)	96.422	157.226	341.920	
Diameter (ft)	2.5000			

MUID	Node_637	Node_638	Node_927	Node_928
Ground Level (ft)	77.01	77.02	77.65	74.94
Invert Level (ft)	72.81	72.32	71.52	71.00
Q10 HGL (ft)	73.718	73.307	72.813	72.551
Q100 HGL (ft)	74.098	73.788	73.459	73.330

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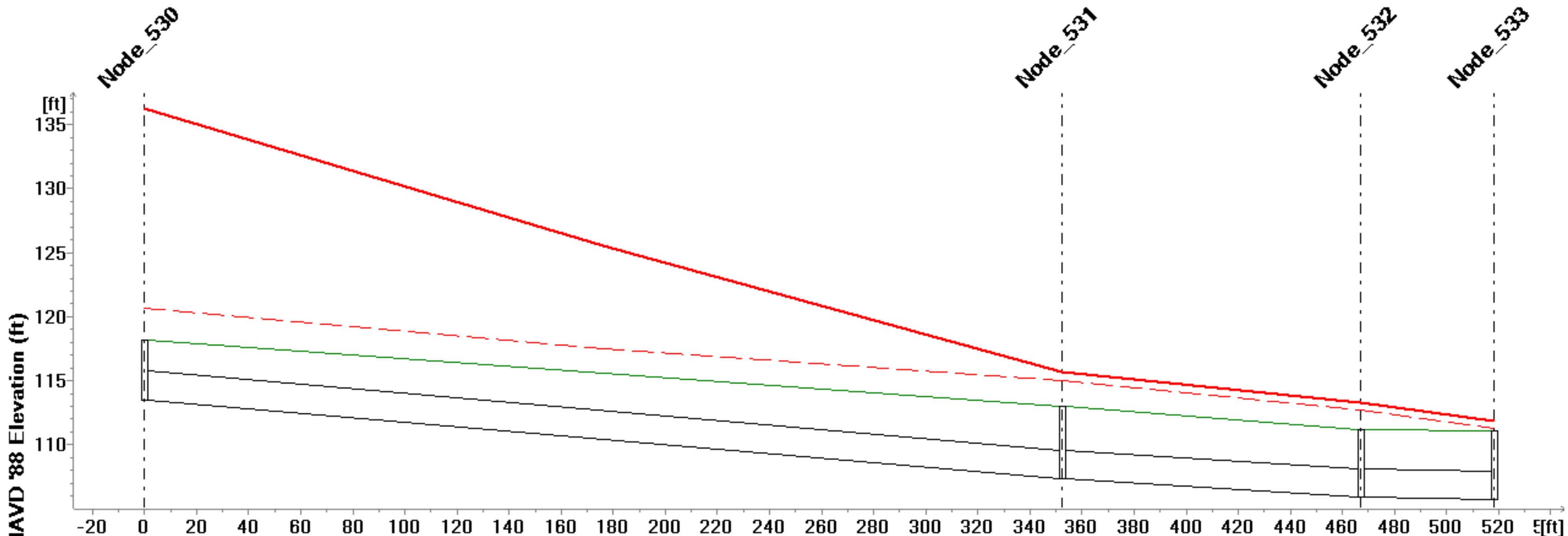
F-12 Profile



Link ID	Link_478			Link_306		Link_305	
Q10 (cfs)	47.427	45.354		53.719		57.026	
Q100 (cfs)	84.539	84.540		57.773		59.441	
Length (ft)	352.366			114.754		51.153	
Diameter (ft)	2.2500						
MUID	Node_530	Node_531			Node_532	....	
Ground Level (ft)	118.21	113.02			111.20	111.09	
Invert Level (ft)	113.51	107.32			105.90	105.69	
Q10 HGL (ft)	120.635	115.042			112.733	111.300	
Q100 HGL (ft)	136.264	115.727			113.300	111.812	

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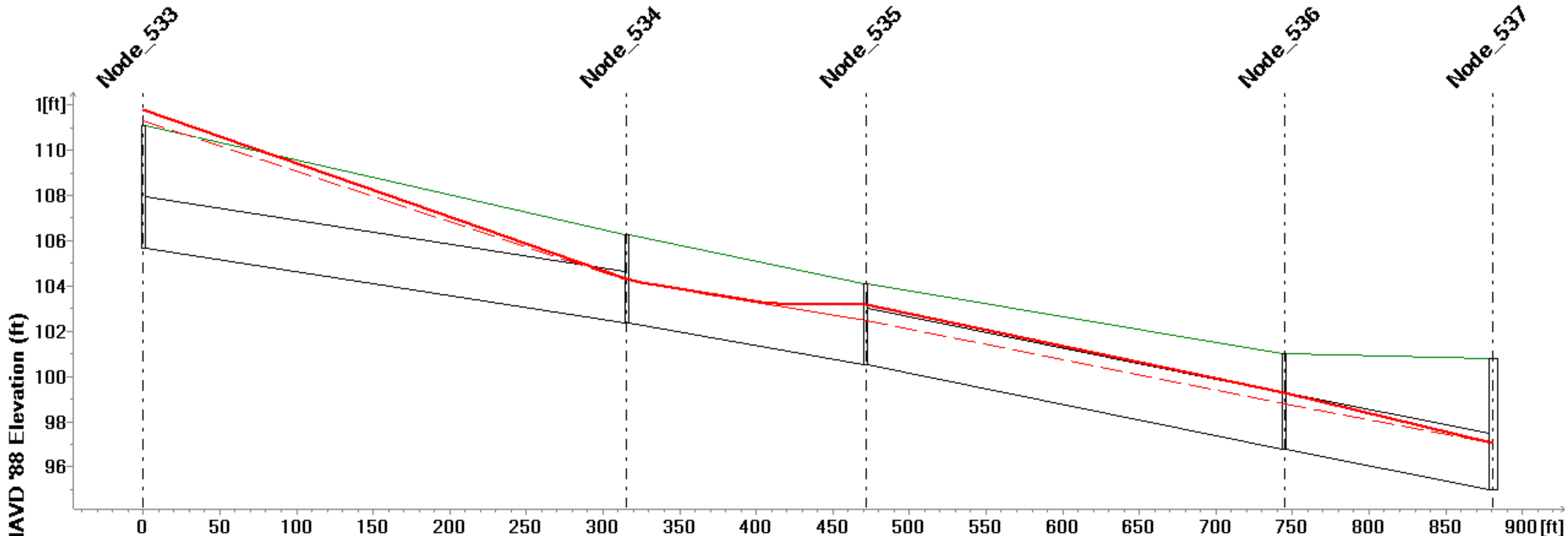
F-12 Profile (cont.)



Link ID	Link_303		Link_561	Link_304	Link_308
Q10 (cfs)	53.353	52.216		51.489	51.482
Q100 (cfs)	57.622	55.428		54.162	57.522
Length (ft)	315.316		156.400	272.820	136.556
Diameter (ft)	2.2500			2.5000	

MUID	Node_533	Node_534	Node_535	Node_536	Node_537
Ground Level (ft)	111.09	106.28	104.08	101.01	100.79
Invert Level (ft)	105.69	102.38	100.50	96.77	94.99
Q10 HGL (ft)	111.300	104.276	102.499	98.810	95.916
Q100 HGL (ft)	111.812	104.288	103.155	99.248	96.702

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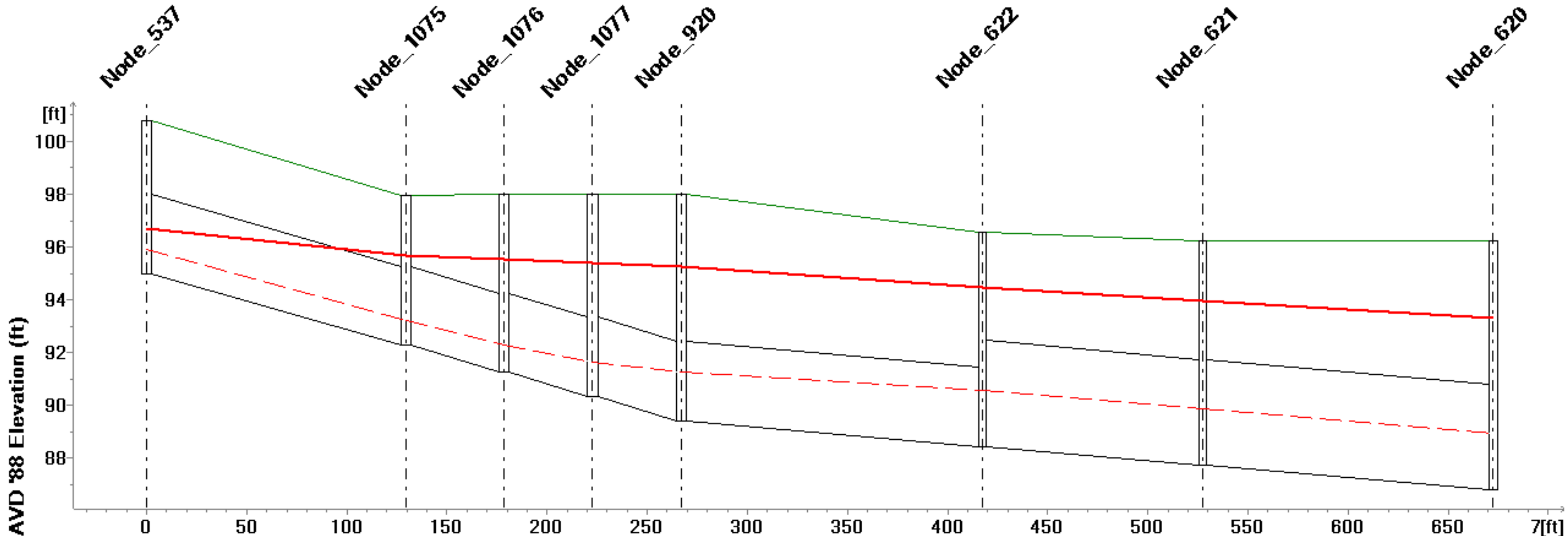
F-12 Profile (cont.)



Link ID	Link_518	Link_519	Link_520	Link_521	Link_37/Link_527	Link_239	Link_241
Q10 (cfs)	64.839	64.813	64.794	69.335	34.668	69.335	69.333
Q100 (cfs)	97.559	97.702	97.724	106.410	53.194	106.346	106.299
Length (ft)	129.670	48.960	44.090	44.080	150.574/150.574	110.074	144.967
Diameter (ft)	3.0000				3.0000/3.0000	4.0000	

MUID	Node_537	Node_1075	Node_1076	Node_1077	Node_920	Node_622	Node_621	Node_620
Ground Level (ft)	100.79	97.93	97.98	98.00	98.02	96.58	96.22	96.23
Invert Level (ft)	94.99	92.28	91.26	90.34	89.42	88.46	87.75	86.82
Q10 HGL (ft)	95.916	93.231	92.293	91.643	91.258	90.565	89.858	88.929
Q100 HGL (ft)	96.702	95.674	95.534	95.408	95.259	94.477	93.983	93.334

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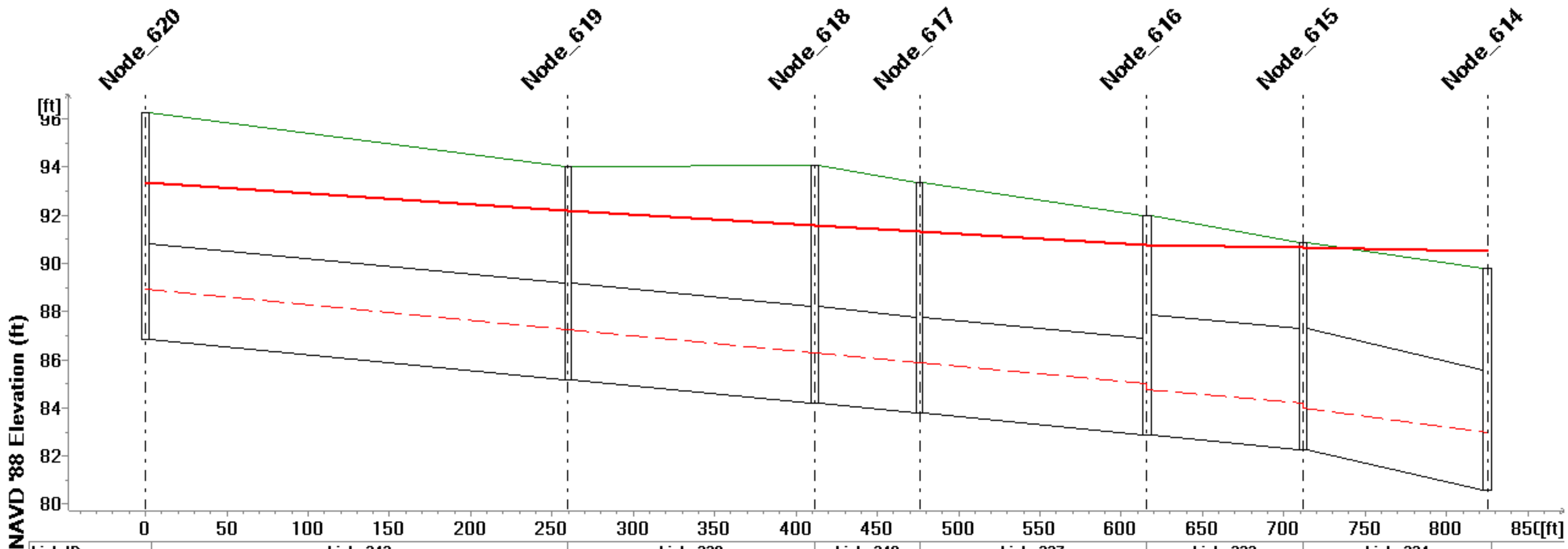
F-12 Profile (cont.)



Link ID	Link_242	Link_238	Link_240	Link_237	Link_232	Link_234
Q10 (cfs)	69.329	69.323	69.319	69.321	69.324	69.256
Q100 (cfs)	106.276	106.559	107.533	108.819	112.529	116.922
Length (ft)	259.827	151.752	64.352	139.715	96.226	113.412
Diameter (ft)	4.0000				5.0000	

MUID	Node_620	Node_619	Node_618	Node_617	Node_616	Node_615	Node_614
Ground Level (ft)	96.23	94.00	94.07	93.33	92.00	90.88	89.78
Invert Level (ft)	86.82	85.16	84.19	83.78	82.88	82.28	80.56
Q10 HGL (ft)	88.929	87.270	86.302	85.884	84.778	83.993	82.967
Q100 HGL (ft)	93.334	92.189	91.579	91.322	90.771	90.658	90.482

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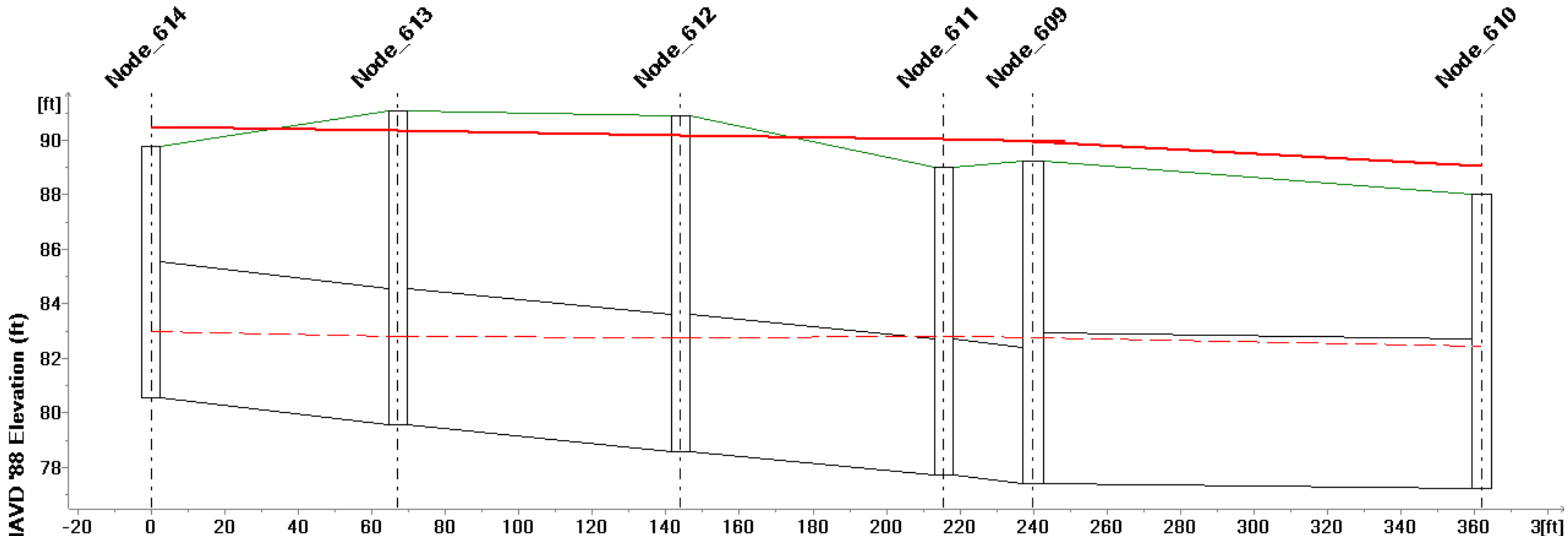
F-12 Profile (cont.)



Link ID	Link_235	Link_472	Link_244	Link_250	Link_253
Q10 (cfs)	68.866	69.362	79.577	80.358	195.734
Q100 (cfs)	135.255	135.770	156.001	151.078	334.825
Length (ft)	66.980	76.966	71.519	24.438	122.014
Diameter (ft)	5.0000				5.5000

MUID	Node_614	Node_613	Node_612	Node_611	Node_609	Node_610
Ground Level (ft)	89.78	91.05	90.91	89.00	89.22	88.01
Invert Level (ft)	80.56	79.55	78.60	77.72	77.42	77.21
Q10 HGL (ft)	82.967	82.793	82.773	82.800	82.778	82.440
Q100 HGL (ft)	90.482	90.338	90.196	90.037	89.947	89.073

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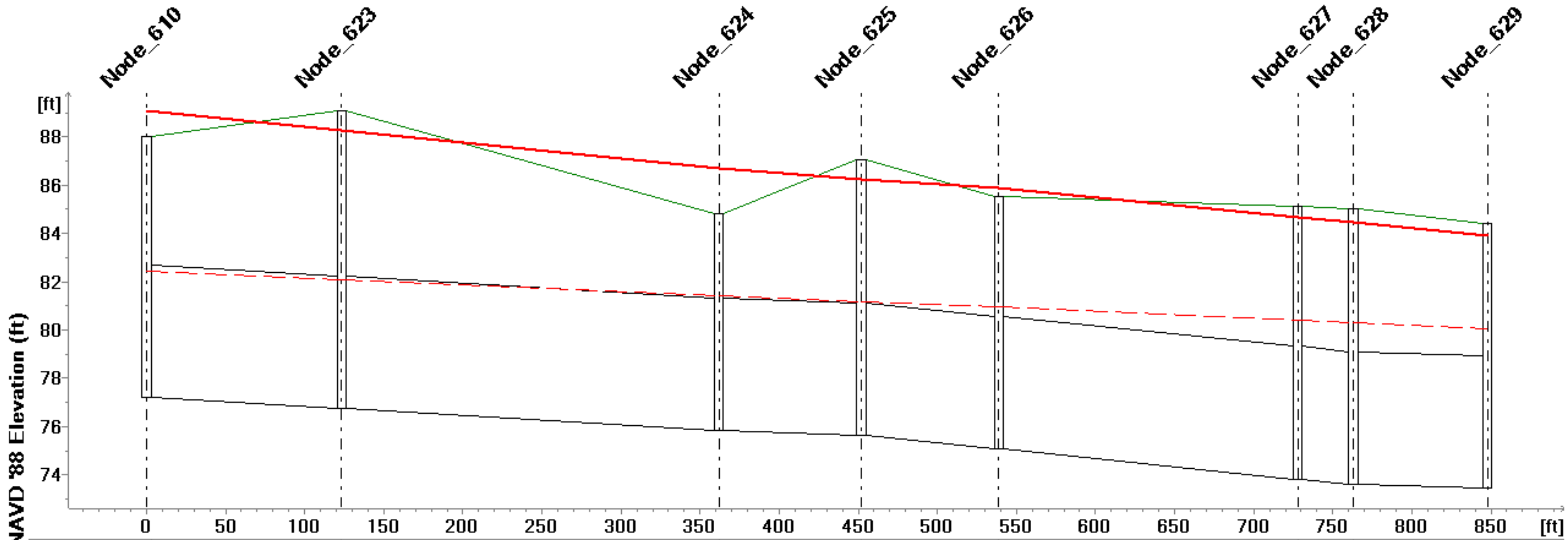
F-12 Profile (cont.)



Link ID	Link_113	Link_243	Link_257	Link_259	Link_272	....	Link_278
Q10 (cfs)	195.369	195.193	195.195			....	213.642
Q100 (cfs)	304.758	305.819	273.234	271.256	296.886	....	304.108
Length (ft)	123.220	238.742	89.961	86.975	188.845	35.152	84.827
Diameter (ft)	5.5000						

MUID	Node_610	Node_623	Node_624	Node_625	Node_626	Node_627	Node_628	Node_629
Ground Level (ft)	88.01	89.06	84.83	87.03	85.51	85.14	85.00	84.43
Invert Level (ft)	77.21	76.74	75.83	75.63	75.06	73.83	73.60	73.43
Q10 HGL (ft)	82.440	82.099	81.438	81.190	80.949	80.427	80.330	80.050
Q100 HGL (ft)	89.073	88.258	86.692	86.251	85.871	84.667	84.443	83.888

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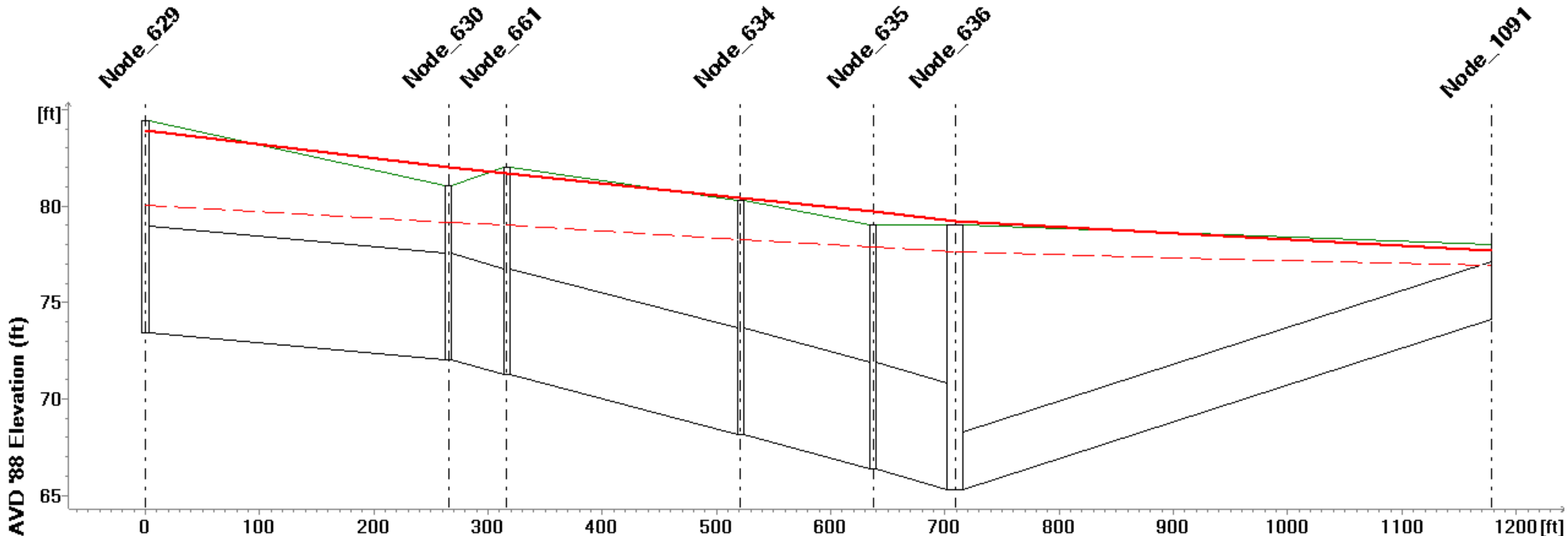
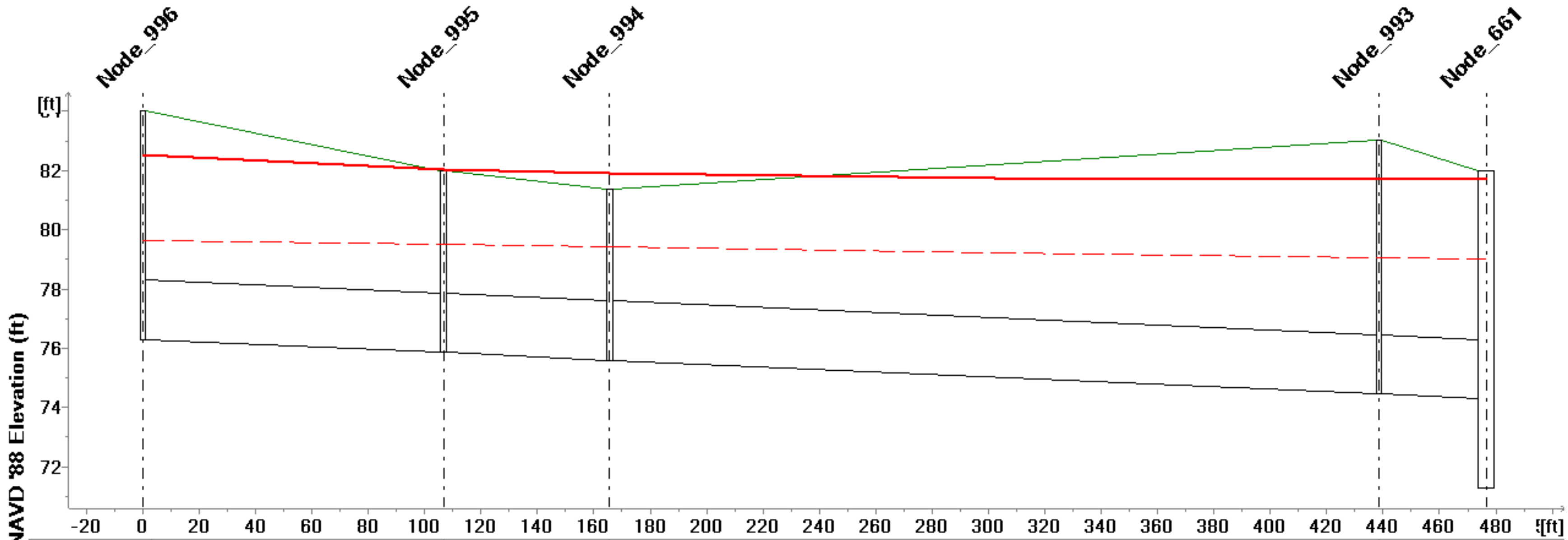
F-12 Profile (cont.)



Link ID	Link_277	....	Link_343	Link_283	Link_281	Link_562	
Q10 (cfs)	213.643	213.646	222.223	222.222	234.431	234.436	
Q100 (cfs)	311.743	299.535	304.068	300.871	316.991	353.198	353.082
Length (ft)	265.210	51.304	204.578	116.219	71.443	469.760	
Diameter (ft)	5.5000	3.0000					
MUID	Node_629	Node_630	Node_661	Node_634	Node_635	Node_636	Node_1091
Ground Level (ft)	84.43	81.04	82.00	80.31	79.00	78.00	
Invert Level (ft)	73.43	72.04	71.26	68.15	66.38	65.30	74.13
Q10 HGL (ft)	80.050	79.172	79.003	78.269	77.852	77.596	76.918
Q100 HGL (ft)	83.888	82.026	81.712	80.441	79.733	79.242	77.686

1/1/2004

F-12-1 Profile

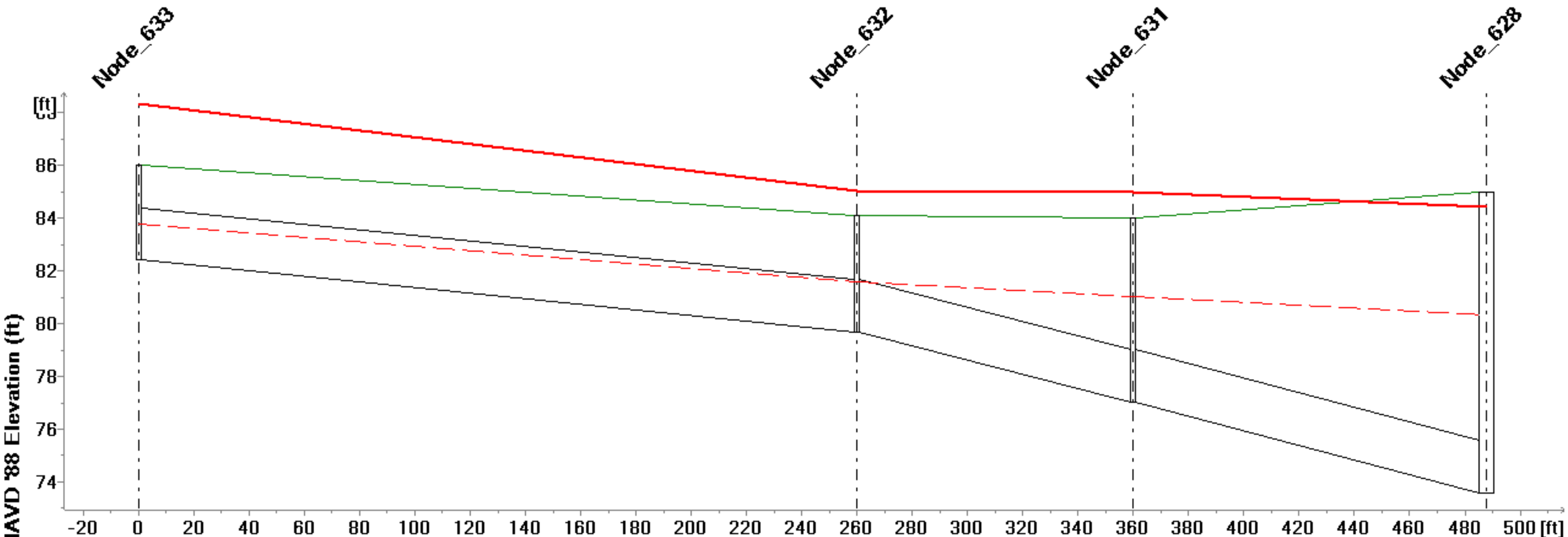


Link ID	Link_120	Link_121	Link_129		Link_135
Q10 (cfs)	9.720	9.717	9.714	9.713	9.710
Q100 (cfs)	16.801		15.718	15.640	15.597
Length (ft)	106.677	58.879	272.919		38.072
Diameter (ft)	2.0000				

MUID	Node_996	Node_995	Node_994	Node_993	....
Ground Level (ft)	84.00	81.99	81.38	83.04	82.00
Invert Level (ft)	76.30	75.85	75.60	74.46	71.26
Q10 HGL (ft)	79.650	79.496	79.411	79.049	79.003
Q100 HGL (ft)	82.519	82.039	81.926	81.710	81.712

1/1/2004

F-12-2 Profile



Link ID	Link_280		Link_276	Link_275
Q10 (cfs)	18.746		18.903	18.908
Q100 (cfs)	33.824		23.870	21.844
Length (ft)	259.810		100.137	127.706
Diameter (ft)	2.0000			
MUID	Node_633	Node_632	Node_631	Node_628
Ground Level (ft)	86.00	84.08	84.00	85.00
Invert Level (ft)	82.40	79.68	77.01	73.60
Q10 HGL (ft)	83.765	81.571	81.024	80.330
Q100 HGL (ft)	88.350	85.031	85.000	84.443

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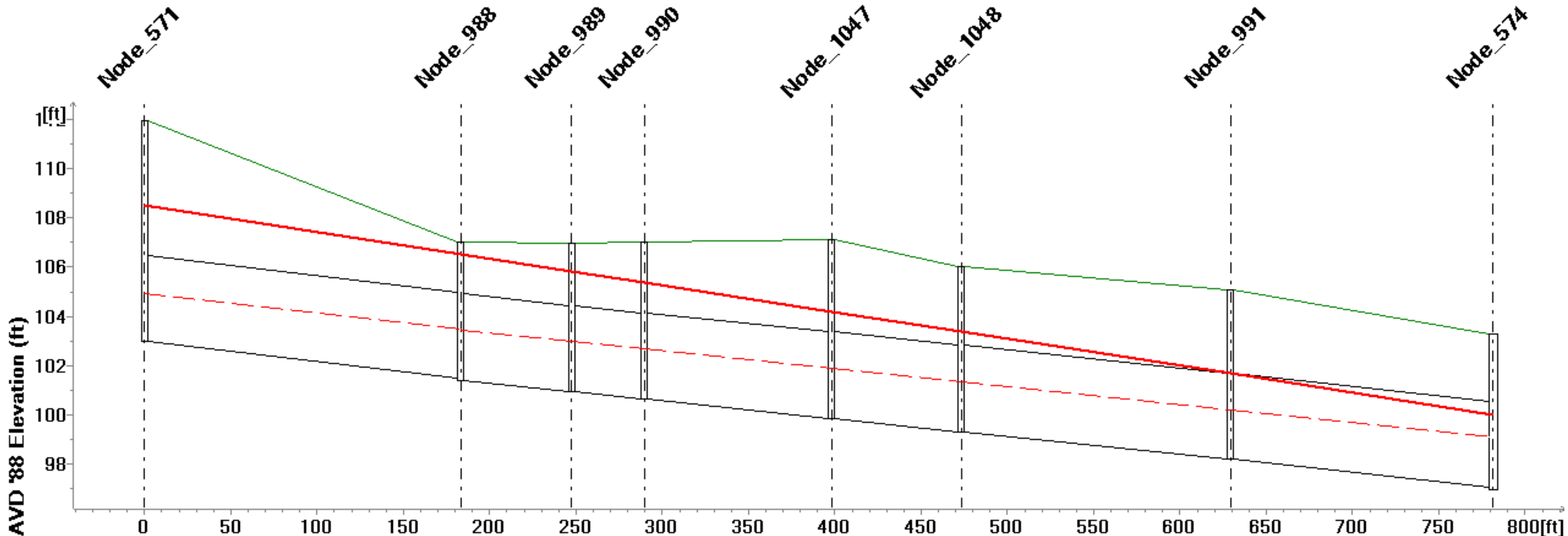
F-12-3 Profile

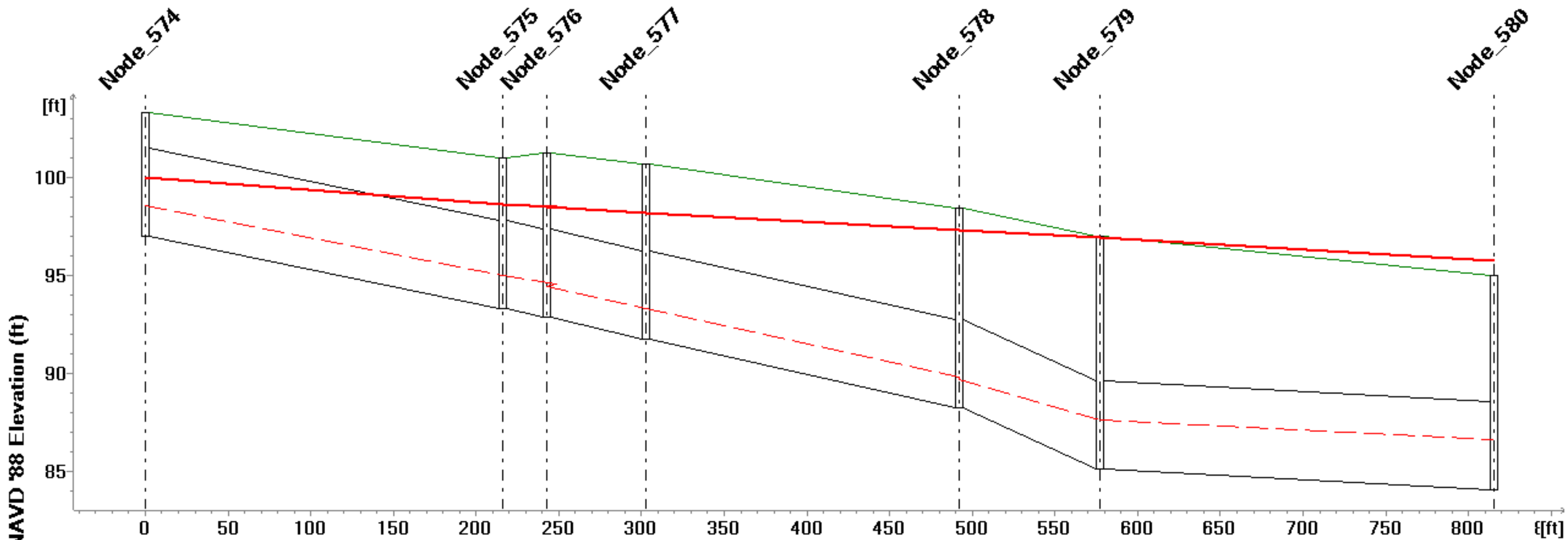


Link ID	Link_337	Link_487	Link_140	Link_488	Link_489	Link_490	Link_138
Q10 (cfs)	59.959	59.955	59.953	59.950	59.945	59.938	59.928
Q100 (cfs)	116.044	116.036	116.029	116.023	116.016	116.006	115.955
Length (ft)	183.310	64.254	42.190	108.405	75.175	155.852	152.384
Diameter (ft)	3.5000						

MUID	Node_571	Node_988	Node_989	Node_990	Node_1047	Node_1048	Node_991	Node_574
Ground Level (ft)	111.96	107.00	106.99	107.00	107.12	106.04	105.08	103.26
Invert Level (ft)	102.96	101.41	100.95	100.65	99.86	99.31	98.18	96.96
Q10 HGL (ft)	104.924	103.444	102.987	102.669	101.879	101.332	100.196	98.526
Q100 HGL (ft)	108.512	106.515	105.816	105.357	104.178	103.361	101.666	100.008

1/1/2004

F-12-3 Profile (cont.)



Link ID	Link_338	....	Link_342	Link_341	Link_339	Link_331
Q10 (cfs)	72.065	....	75.578	75.580		83.109
Q100 (cfs)	138.064	....	148.984	151.455	157.811	158.048
Length (ft)	215.903	....	59.517	189.967	84.650	238.096
Diameter (ft)	4.5000					

MUID	Node_574	Node_575	Node_576	Node_577	Node_578	Node_579	Node_580
Ground Level (ft)	103.26	101.00	101.25	100.64	98.43	97.02	95.01
Invert Level (ft)	96.96	93.31	92.85	91.75	88.23	85.12	84.03
Q10 HGL (ft)	98.526	94.985	94.405	93.301	89.670	87.615	86.632
Q100 HGL (ft)	100.008	98.620	98.467	98.186	97.274	96.901	95.726

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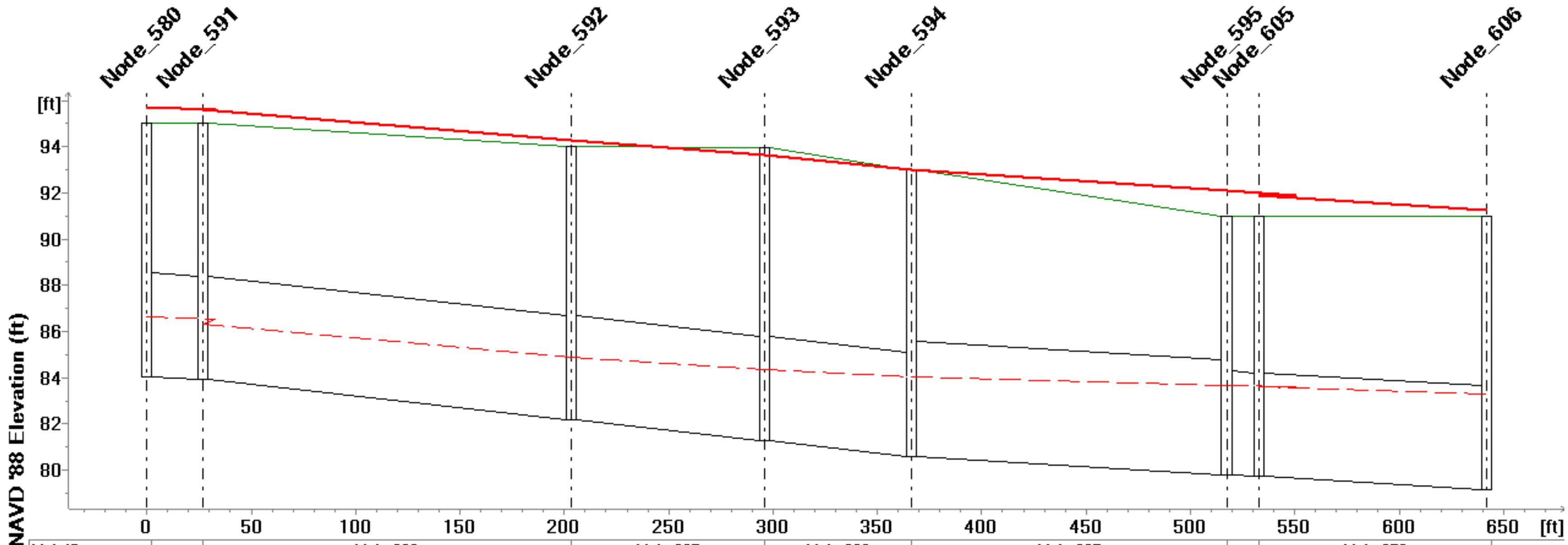
F-12-3 Profile (cont.)

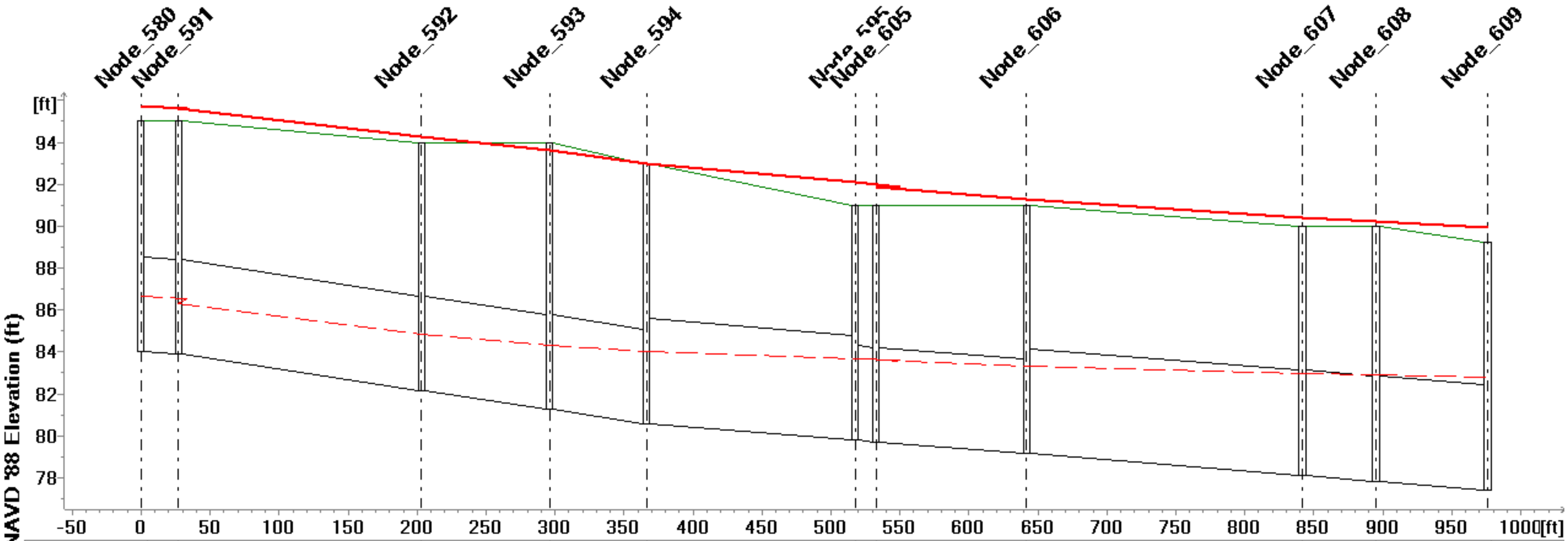


Link ID	....	Link_328	Link_327	Link_288	Link_325	......	Link_252
Q10 (cfs)	83.090	111.366	111.174	113.676	113.853	......	113.342
Q100 (cfs)	....	207.046	203.340	212.267	219.937	......	186.010
Length (ft)	26.878	176.329	92.821	70.179	151.165	......	108.943
Diameter (ft)	4.5000				5.0000	4.5000	

MUID	....	Node_591	Node_592	Node_593	Node_594	Node_595	Node_605	Node_606
Ground Level (ft)		95.01	94.00	93.96	93.00	91.00		90.99
Invert Level (ft)	....	83.91	82.18	81.28	80.60	79.80	79.72	79.16
Q10 HGL (ft)	....	86.321	84.869	84.333	84.040	83.691	83.602	83.307
Q100 HGL (ft)	....	95.631	94.284	93.640	92.982	92.103	91.869	91.255

1/1/2004

F-12-3 Profile (cont.)

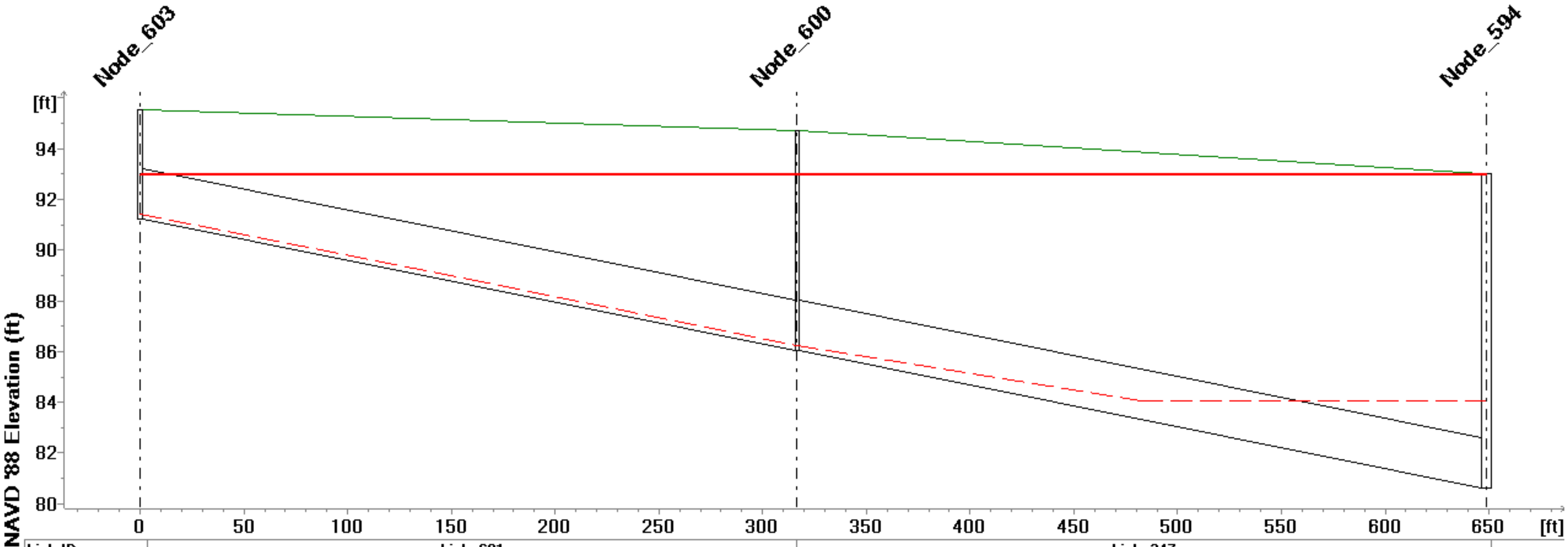


Link ID	......	Link_328	Link_327	Link_288	Link_325	....	Link_252	Link_256	Link_255	Link_245	
Q10 (cfs)	......	111.366	111.174	113.676	113.853	....	113.342	113.029	113.118	118.931	
Q100 (cfs)	......	207.046	203.340	212.267	219.937	....	186.010	195.770	191.338	207.025	
Length (ft)	......	176.329	92.821	70.179	151.165	....	108.943	200.065	53.206	80.907	
Diameter (ft)		4.5000			5.0000	4.5000		5.0000			

MUID	..	Node_591	Node_592	Node_593	Node_594	Node_595	Node_605	Node_606	Node_607	Node_608	....
Ground Level (ft)		95.01	94.00	93.96	93.00	91.00		90.99	89.99	90.00	89.22
Invert Level (ft)	..	83.91	82.18	81.28	80.60	79.80	79.72	79.16	78.12	77.84	77.42
Q10 HGL (ft)	..	86.321	84.869	84.333	84.040	83.691	83.602	83.307	82.998	82.916	82.778
Q100 HGL (ft)	..	95.631	94.284	93.640	92.982	92.103	91.869	91.255	90.416	90.213	89.947

1/1/2004

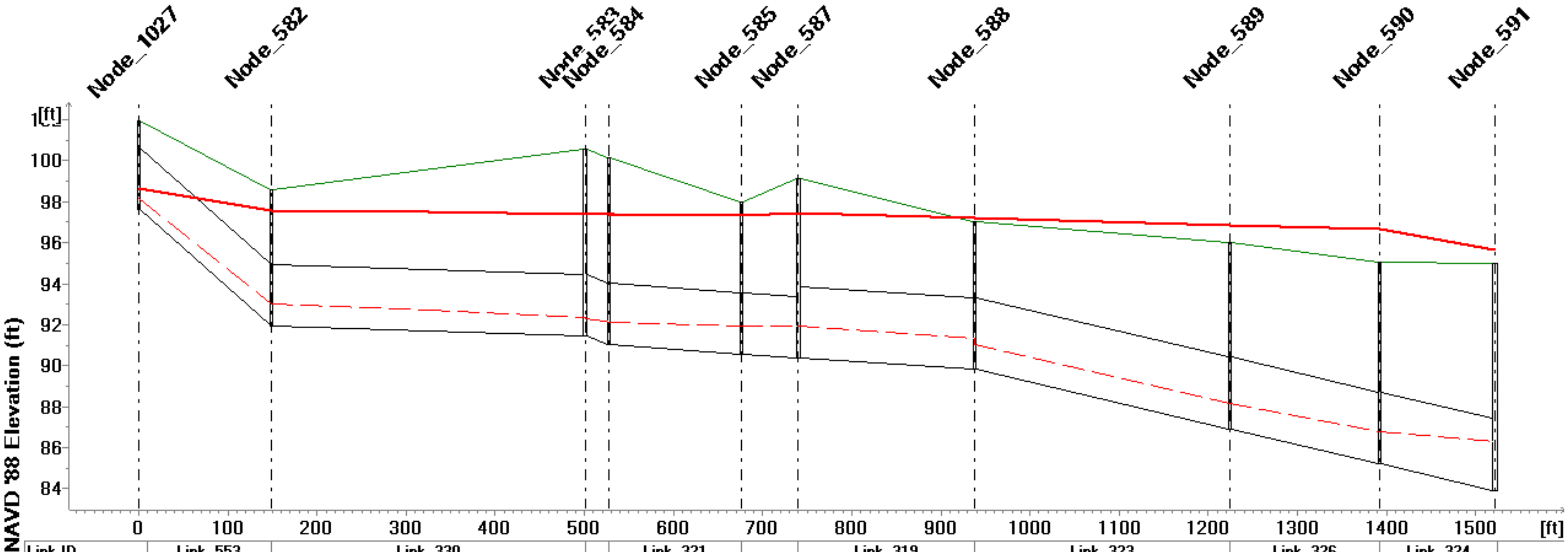
F-12-3-1 Profile



Link ID	Link_601		Link_247	
Q10 (cfs)	0.737		0.735	1.258
Q100 (cfs)	1.844	1.856	1.867	1.864
Length (ft)	316.650		332.070	
Diameter (ft)	2.0000			
MUID	Node_603	Node_600		Node_594
Ground Level (ft)	95.51	94.69		93.00
Invert Level (ft)	91.21	86.03		80.60
Q10 HGL (ft)	91.420	86.246		84.040
Q100 HGL (ft)	92.985	92.983		92.982

1/1/2004

F-12-3-2 Profile

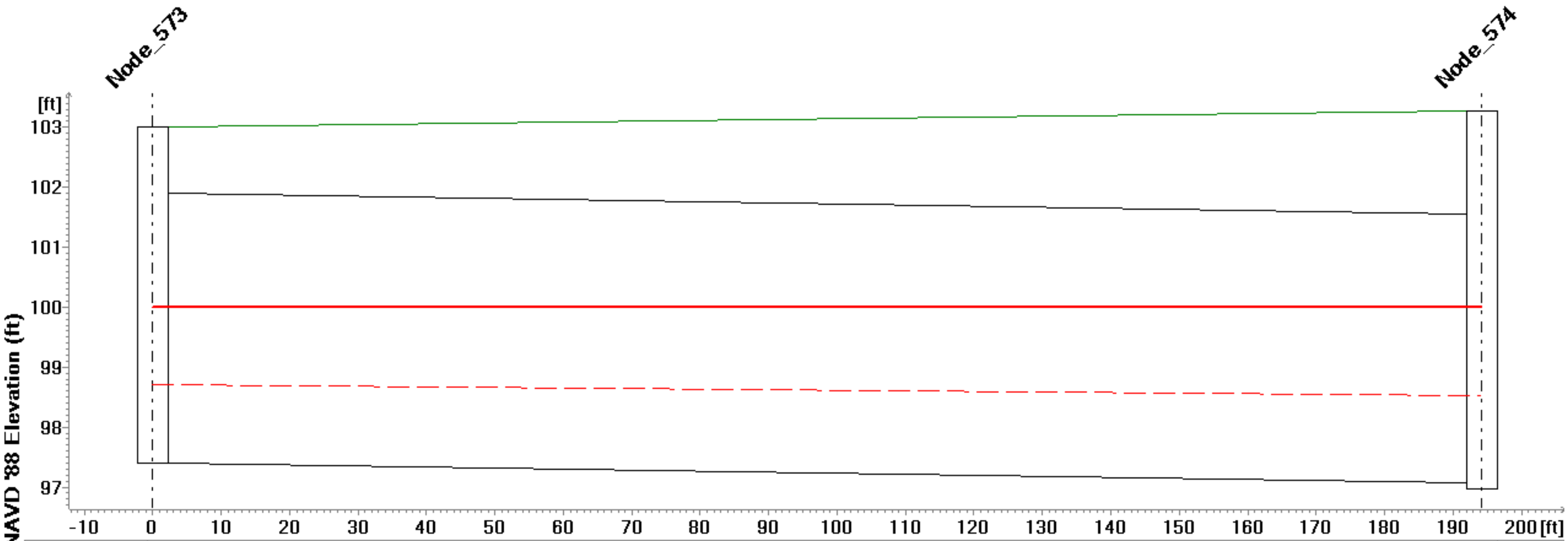


Link ID	Link_553	Link_330		....	Link_321	....	Link_319	Link_323	Link_326	Link_324
Q10 (cfs)	8.057	8.043	8.041	....	8.020	7.993	25.111	28.423	28.392	28.352
Q100 (cfs)	15.957	15.953	15.951	....	15.945	15.991	51.794	59.122	63.455	93.557
Length (ft)	148.177	352.380		....	149.003	63.370	197.828	286.700	167.569	129.537
Diameter (ft)	3.0000						3.5000			

MUID	....	Node_582	Node_583	Node_584	Node_585	Node_587	Node_588	Node_589	Node_590	....
Ground Level (ft)	101.95	98.61	100.54	100.12	97.98	99.11	97.00	96.02	95.07	95.01
Invert Level (ft)	97.65	91.91	91.44	91.02	90.57	90.38	89.81	86.91	85.22	83.91
Q10 HGL (ft)	98.143	92.998	92.276	92.139	91.938	91.945	91.020	88.179	86.798	86.321
Q100 HGL (ft)	98.670	97.555	97.395	97.381	97.311	97.470	97.219	96.857	96.677	95.631

1/1/2004

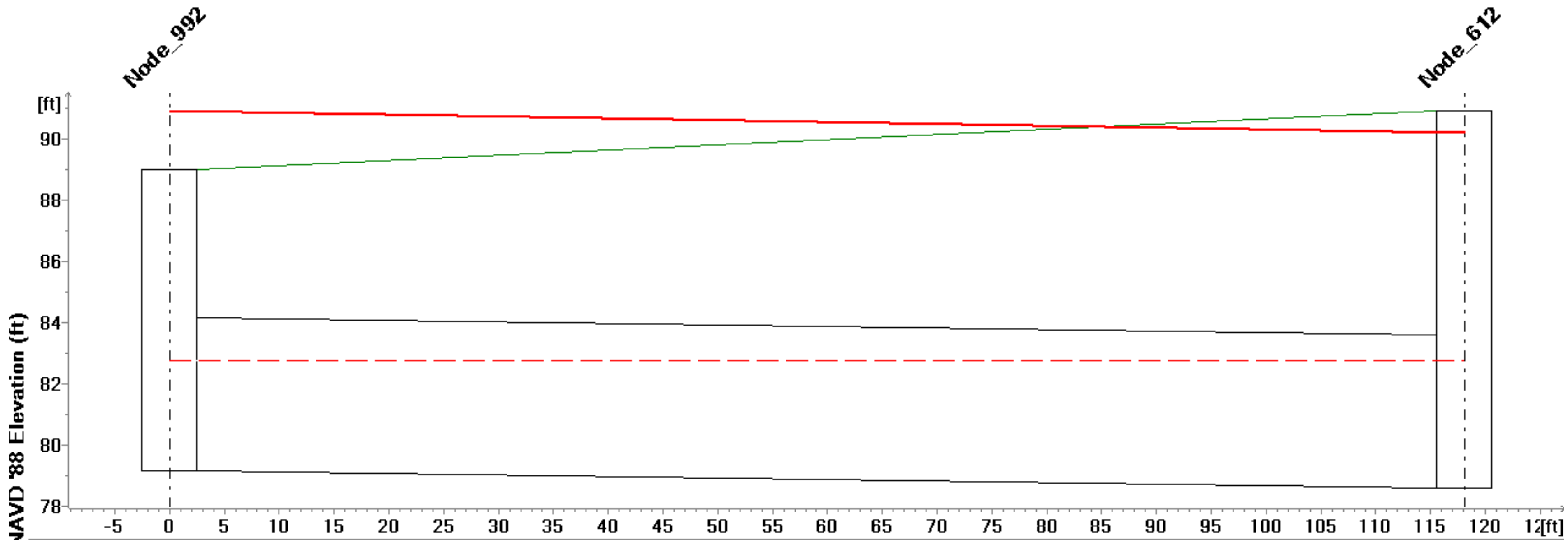
F-12-3-3 Profile



Link ID	Link_340	
Q10 (cfs)	12.164	
Q100 (cfs)	22.451	
Length (ft)	194.181	
Diameter (ft)	4.5000	
MUID	Node_573	Node_574
Ground Level (ft)	103.00	103.26
Invert Level (ft)	97.40	96.96
Q10 HGL (ft)	98.700	98.526
Q100 HGL (ft)	100.007	100.008

1/1/2004

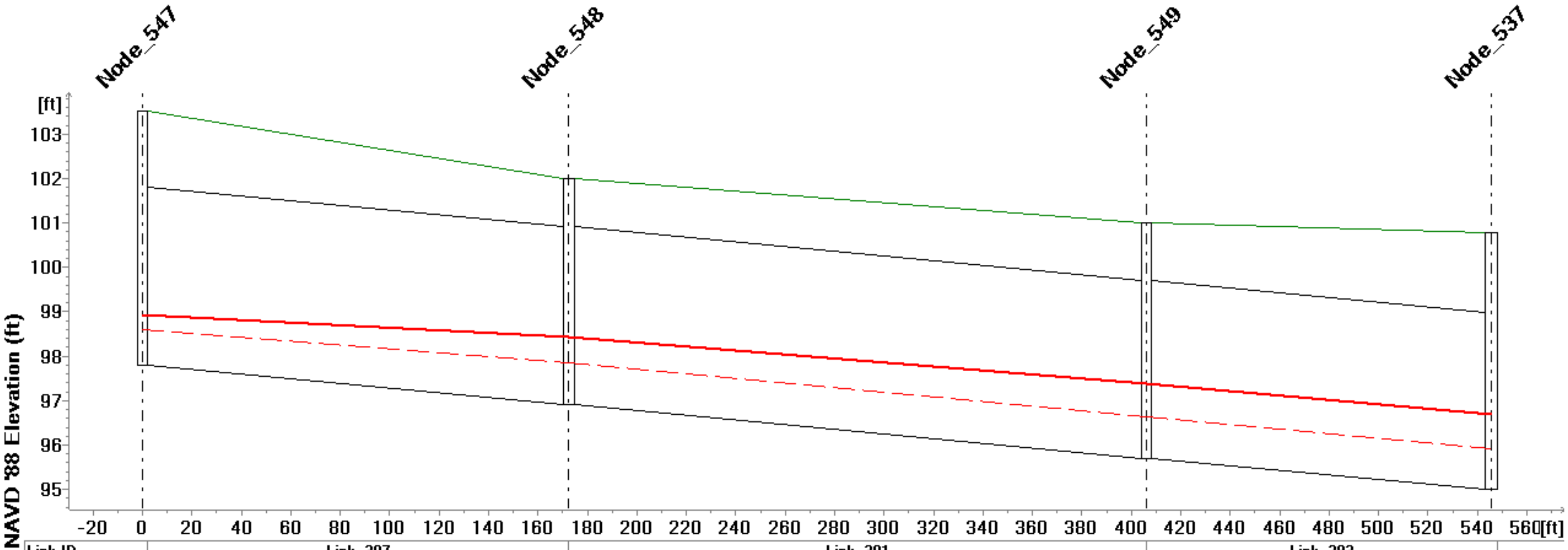
F-12-4 Profile



Link ID	Link_130	
Q10 (cfs)	9.516	
Q100 (cfs)	63.344	
Length (ft)	118.062	
Diameter (ft)	5.0000	
MUID	Node_992	Node_612
Ground Level (ft)	89.02	90.91
Invert Level (ft)	79.19	78.60
Q10 HGL (ft)	82.795	82.773
Q100 HGL (ft)	90.927	90.196

1/1/2004

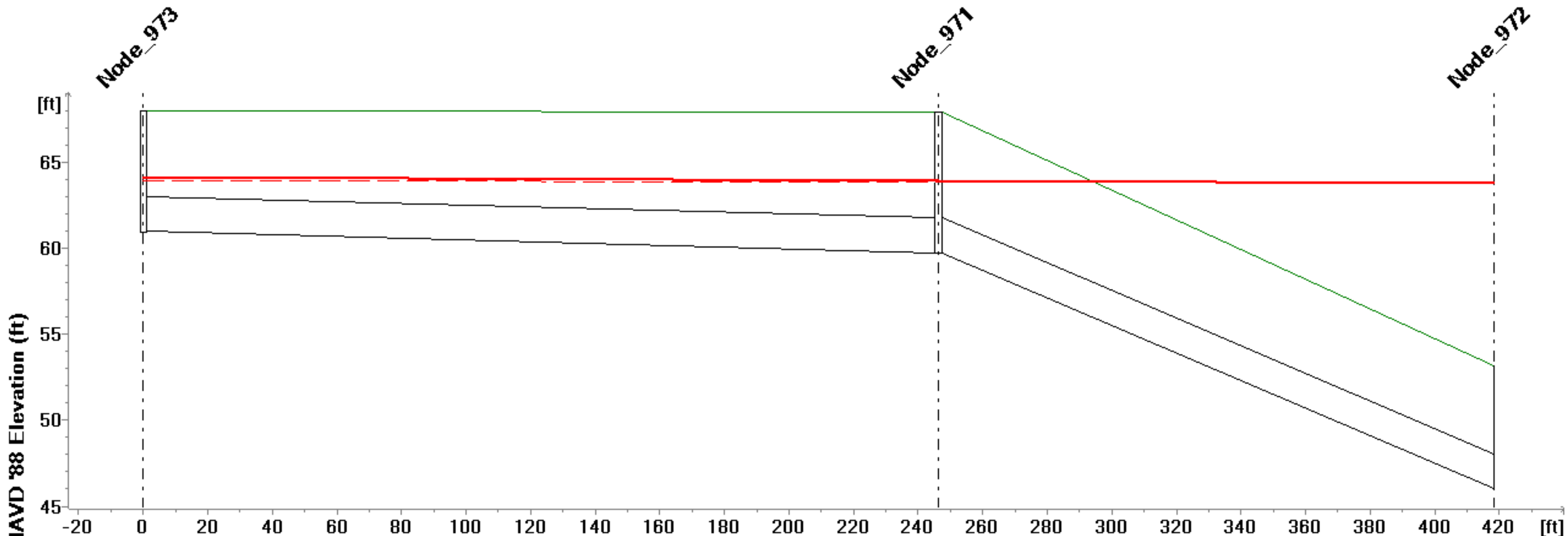
F-12-5 Profile



Link ID	Link_307		Link_301		Link_293
Q10 (cfs)	9.138		13.621		13.619
Q100 (cfs)	14.629		32.410		41.202
Length (ft)	172.527		233.757		139.106
Diameter (ft)	4.0000				
MUID	Node_547	Node_548		Node_549	Node_537
Ground Level (ft)	103.51	102.00		101.00	100.79
Invert Level (ft)	97.81	96.92		95.70	94.99
Q10 HGL (ft)	98.606	97.852		96.637	95.916
Q100 HGL (ft)	98.930	98.440		97.390	96.702

1/1/2004

SON-1 Profile

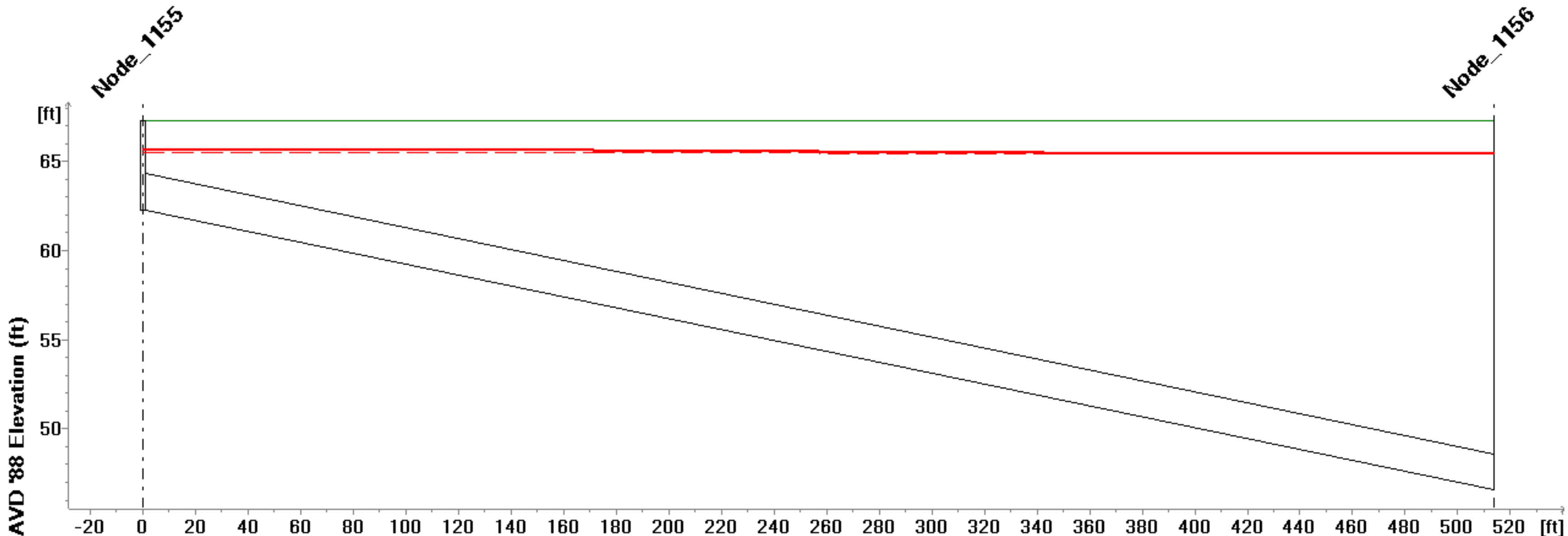


Link ID	Link_209	Link_211
Q10 (cfs)	4.224	
Q100 (cfs)	7.178	
Length (ft)	246.245	172.080
Diameter (ft)	2.0000	

MUID	Node_973	Node_971	Node_972
Ground Level (ft)	67.94	67.88	53.16
Invert Level (ft)	60.94	59.74	46.00
Q10 HGL (ft)	63.920	63.850	63.800
Q100 HGL (ft)	64.146	63.942	63.800

1/1/2004

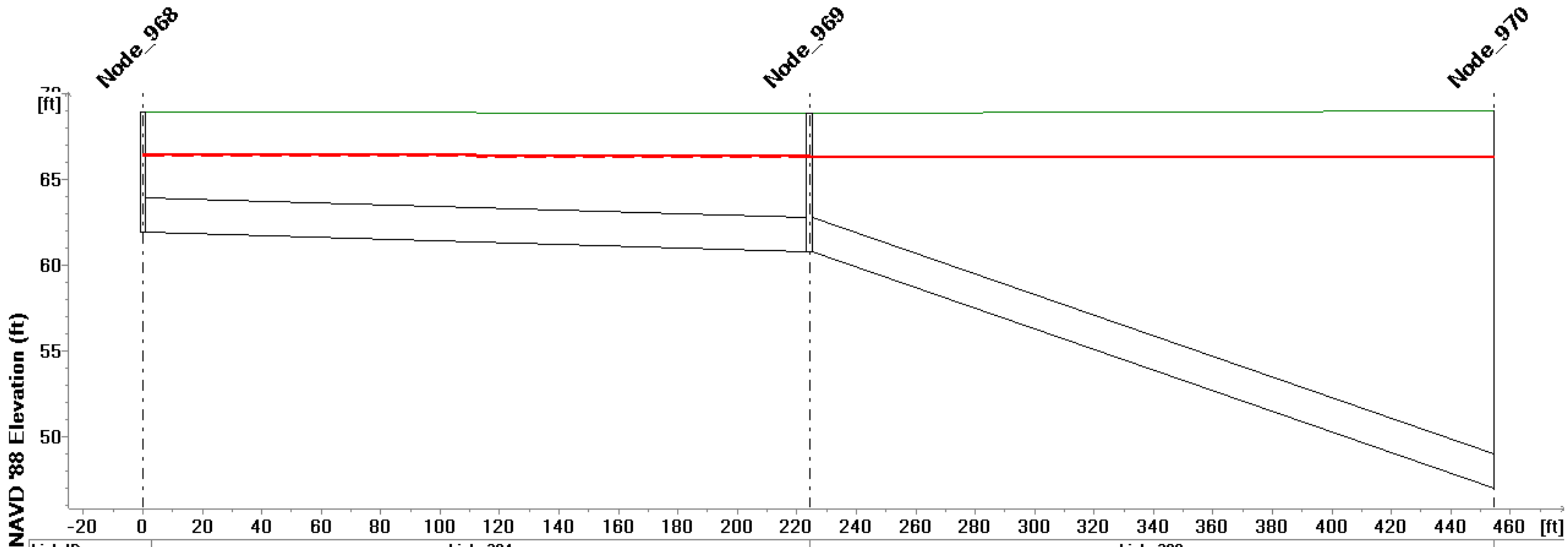
SON-2 Profile



Link ID	Link_604	
Q10 (cfs)	3.645	
Q100 (cfs)	6.137	
Length (ft)	513.720	
Diameter (ft)	2.0000	
MUID	Node_1155	Node_1156
Ground Level (ft)	67.30	
Invert Level (ft)	62.30	46.60
Q10 HGL (ft)	65.510	65.400
Q100 HGL (ft)	65.710	65.400

1/1/2004

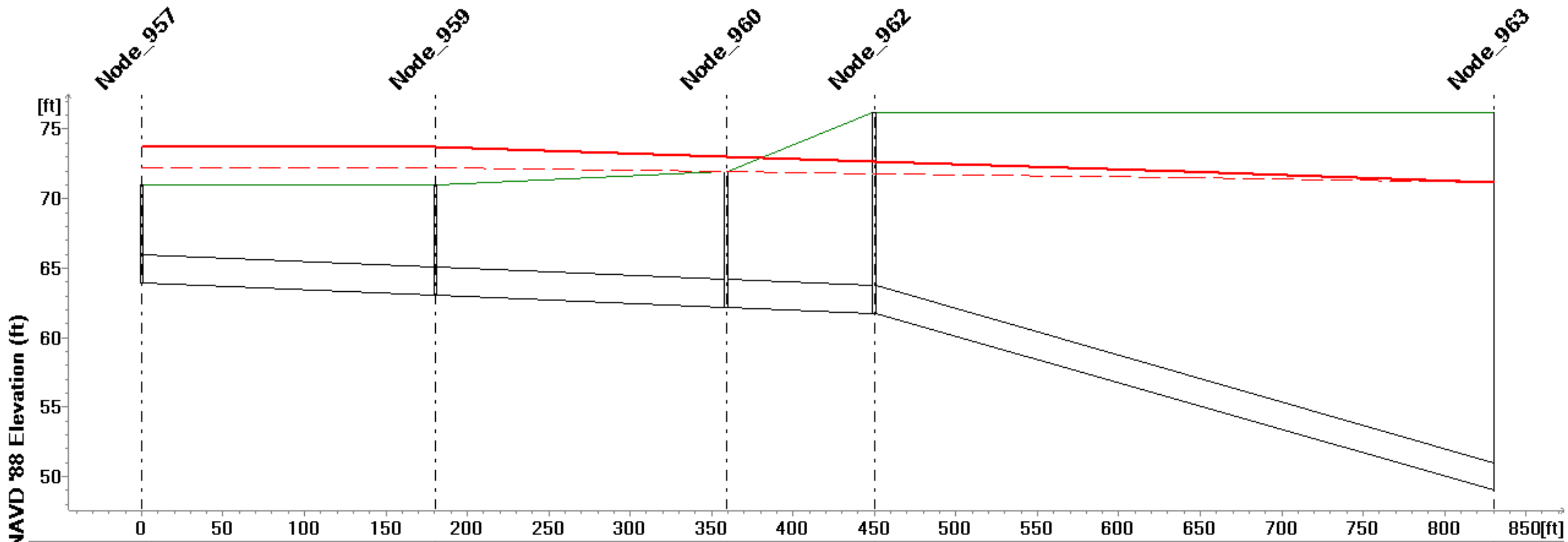
SON-3 Profile



Link ID	Link_204	Link_208	
Q10 (cfs)	3.364		
Q100 (cfs)	5.642		
Length (ft)	224.195	230.323	
Diameter (ft)	2.0000		
MUID	Node_968	Node_969	Node_970
Ground Level (ft)	68.97	68.91	69.00
Invert Level (ft)	61.97	60.85	47.00
Q10 HGL (ft)	66.383	66.342	66.300
Q100 HGL (ft)	66.532	66.418	66.300

1/1/2004

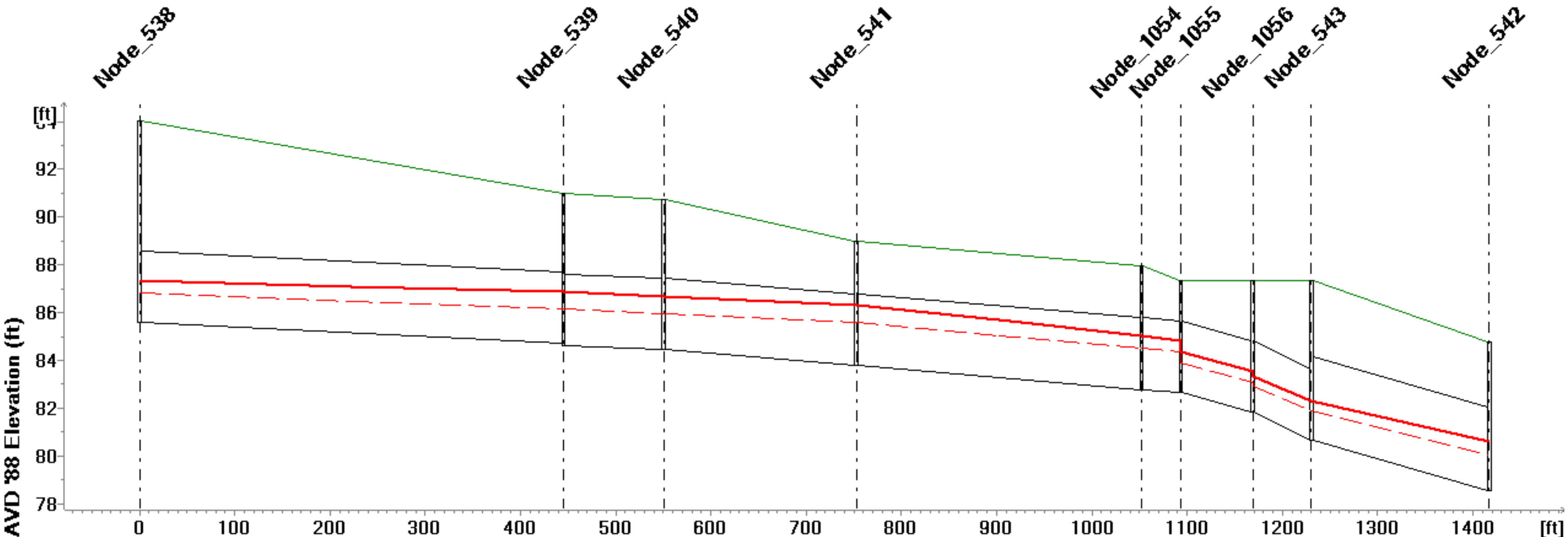
SON-4 Profile



Link ID	Link_216	Link_221	Link_215	Link_207	
Q10 (cfs)	0.098	9.917			
Q100 (cfs)	1.329	15.656			
Length (ft)	180.365	178.711	90.920	380.319	
Diameter (ft)	2.0000				
MUID	Node_957	Node_959	Node_960	Node_962	Node_963
Ground Level (ft)	70.98	71.01	72.00	76.15	
Invert Level (ft)	63.98	63.08	62.18	61.73	49.00
Q10 HGL (ft)	72.224	71.942	71.799	71.200	
Q100 HGL (ft)	73.753	73.750	73.049	72.692	71.200

1/1/2004

SON-5 Profile

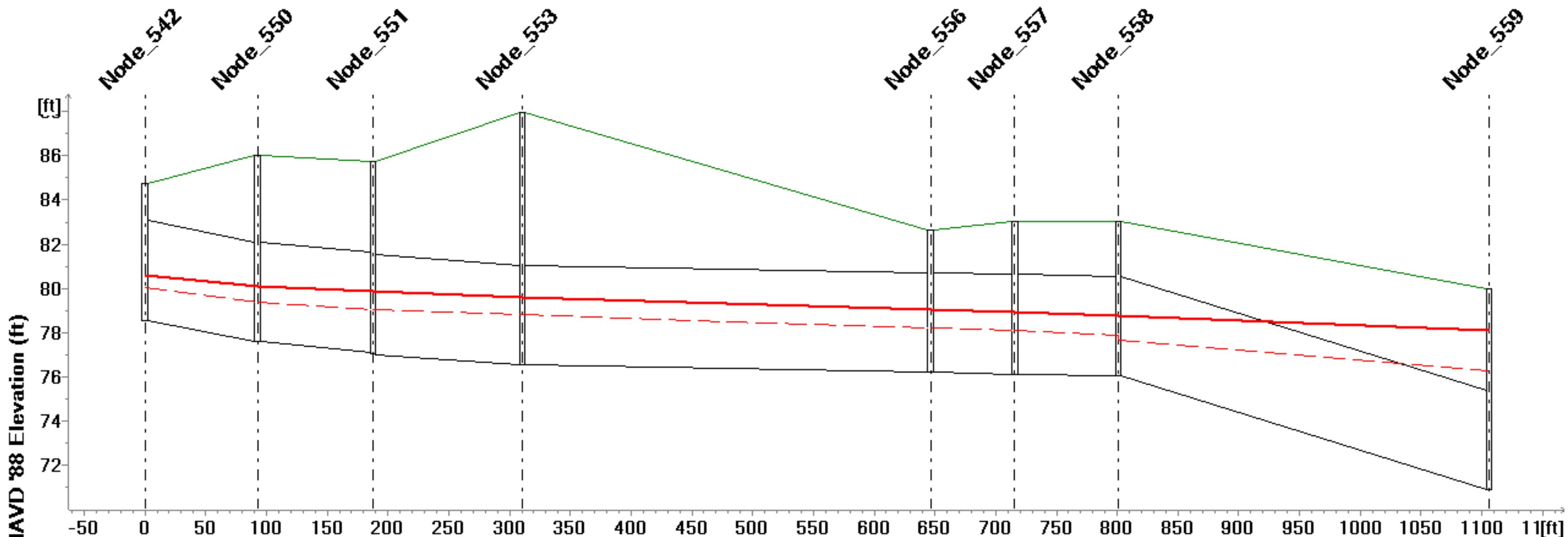


Link ID	Link_311		Link_309	Link_313	Link_497		....	Link_499	....	Link_312
Q10 (cfs)	10.944	10.935	17.036	16.993	28.609	28.599	....	28.614	28.618	28.619
Q100 (cfs)	17.944	17.928	28.054	28.085	47.476	47.480	....	47.470	47.467	47.472
Length (ft)	445.335		104.875	202.430	299.380		....	74.970	61.710	186.839
Diameter (ft)	3.0000									3.5000

MUID	Node_538	Node_539	Node_540	Node_541	Node_1054	....	....	Node_543	Node_542
Ground Level (ft)	94.03	91.00	90.74	89.00	87.94	87.35	87.36		84.76
Invert Level (ft)	85.60	84.60	84.44	83.80	82.78	82.64	81.83	80.66	78.56
Q10 HGL (ft)	86.818	86.169	85.974	85.573	84.507	83.910	82.946	81.874	80.019
Q100 HGL (ft)	87.330	86.872	86.693	86.340	85.045	84.350	83.329	82.303	80.611

1/1/2004

SON-5 Profile (cont.)

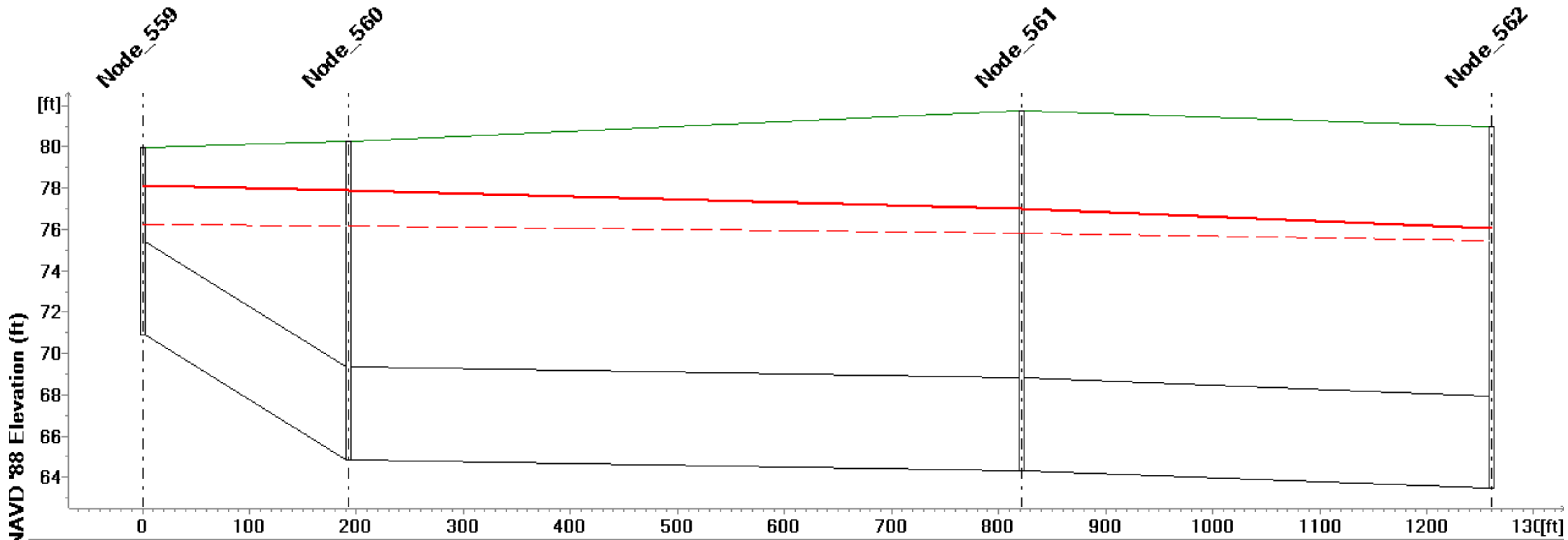


Link ID	Link_292	Link_291	Link_289	Link_290		Link_295	Link_299	Link_298
Q10 (cfs)	41.273	41.264	41.261		41.255	41.250	41.246	41.348
Q100 (cfs)	67.992	67.982	67.969	67.951	67.962	68.001	68.075	68.499
Length (ft)	92.518	95.177	122.890	335.840		69.142	85.126	305.135
Diameter (ft)	4.5000							

MUID	....	Node_550	Node_551	Node_553	Node_556	Node_557	Node_558	Node_559
Ground Level (ft)	84.76	86.00	85.76	87.93	82.62	83.02	83.05	79.98
Invert Level (ft)	78.56	77.60	77.03	76.53	76.20	76.13	76.05	70.88
Q10 HGL (ft)	80.019	79.373	79.053	78.802	78.237	78.097	77.672	76.260
Q100 HGL (ft)	80.611	80.112	79.853	79.623	79.059	78.932	78.767	78.121

1/1/2004

SON-5 Profile (cont.)

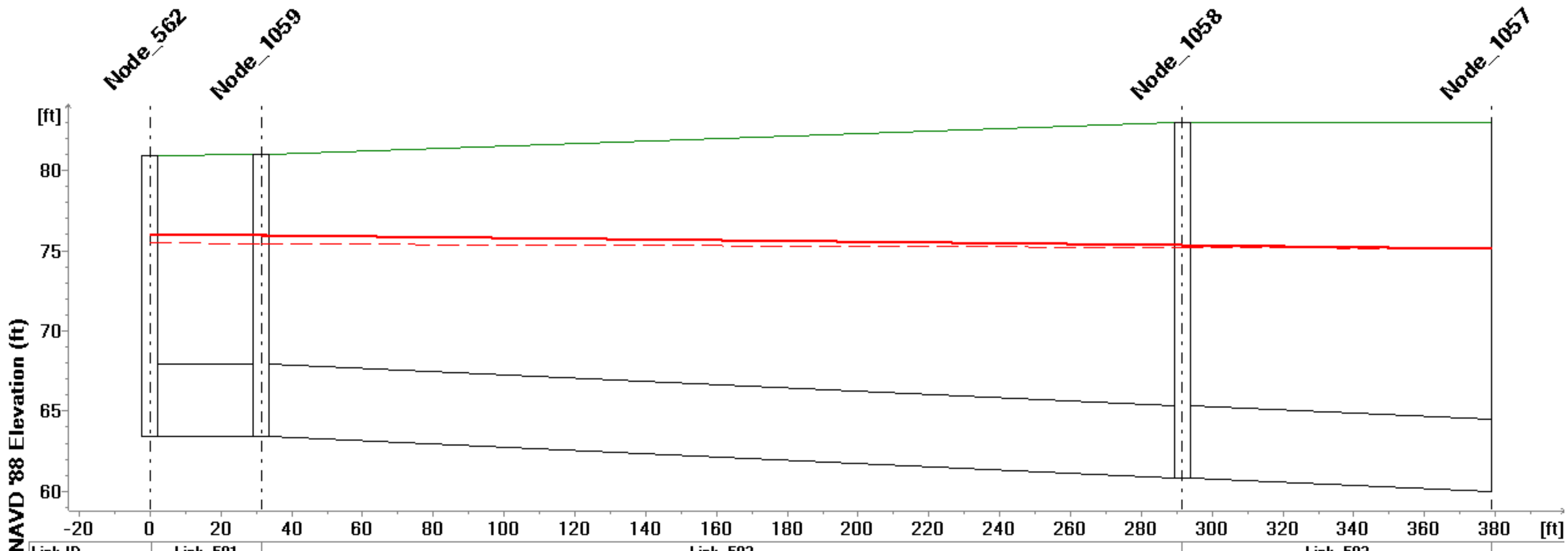


Link ID	Link_296	Link_300			Link_314
Q10 (cfs)	45.908	50.720	50.725	50.729	61.964
Q100 (cfs)	75.376	81.882	81.886	81.890	100.052
Length (ft)	192.984	628.559			438.992
Diameter (ft)	4.5000				

MUID	Node_559	Node_560	Node_561	Node_562
Ground Level (ft)	79.98	80.25	81.72	80.96
Invert Level (ft)	70.88	64.85	64.32	63.46
Q10 HGL (ft)	76.260	76.174	75.830	75.472
Q100 HGL (ft)	78.121	77.890	76.999	76.068

1/1/2004

SON-5 Profile (cont.)

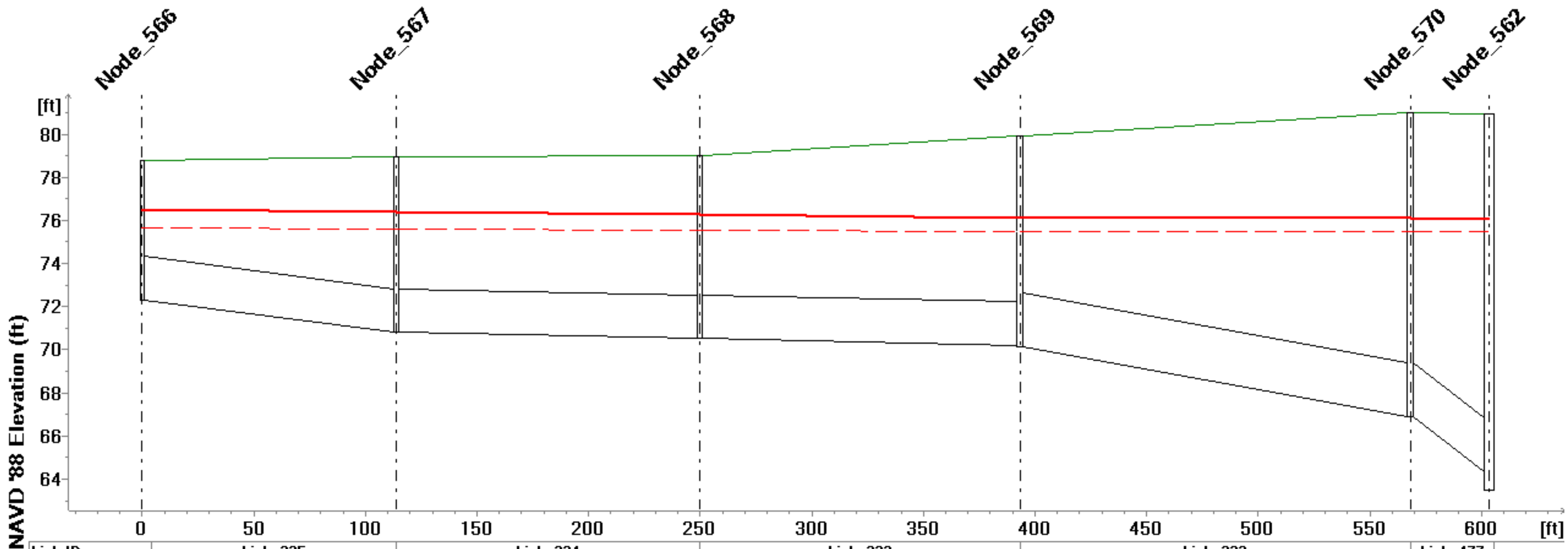


Link ID	Link_501	Link_502	Link_503
Q10 (cfs)	67.794	67.793	
Q100 (cfs)	109.594	109.593	
Length (ft)	31.330	260.260	87.370
Diameter (ft)	4.5000		

MUID	....	Node_1059	Node_1058	Node_1057
Ground Level (ft)	80.96	81.00	83.00	
Invert Level (ft)	63.46	63.40	60.85	60.00
Q10 HGL (ft)	75.472	75.440	75.185	75.100
Q100 HGL (ft)	76.068	75.984	75.322	75.100

1/1/2004

SON-5-1 Profile

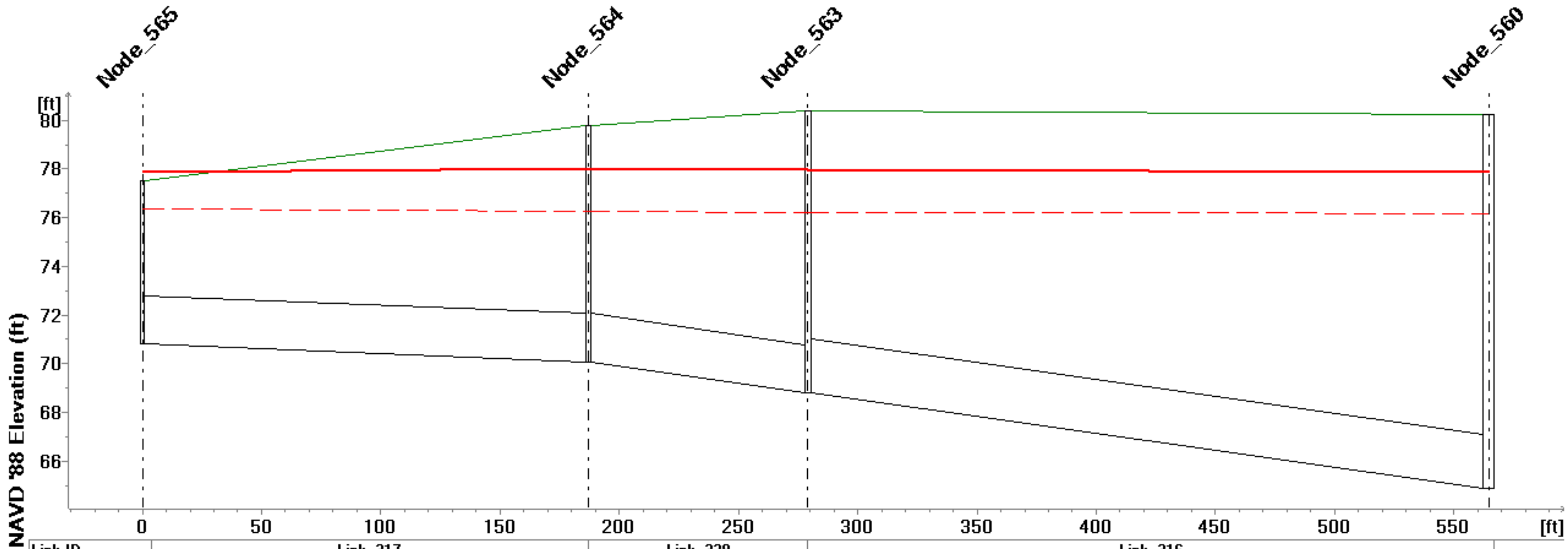


Link ID	Link_335	Link_334	Link_332	Link_333	Link_477
Q10 (cfs)	4.655		4.654		5.830
Q100 (cfs)	7.618				9.542
Length (ft)	113.991	135.934	143.370	174.912	35.149
Diameter (ft)	2.0000			2.5000	

MUID	Node_566	Node_567	Node_568	Node_569	Node_570	....
Ground Level (ft)	78.78	78.93	79.00	79.92	80.97	80.96
Invert Level (ft)	72.32	70.83	70.53	70.12	66.87	63.46
Q10 HGL (ft)	75.633	75.593	75.546	75.496	75.478	....
Q100 HGL (ft)	76.499	76.393	76.266	76.133	76.083	....

1/1/2004

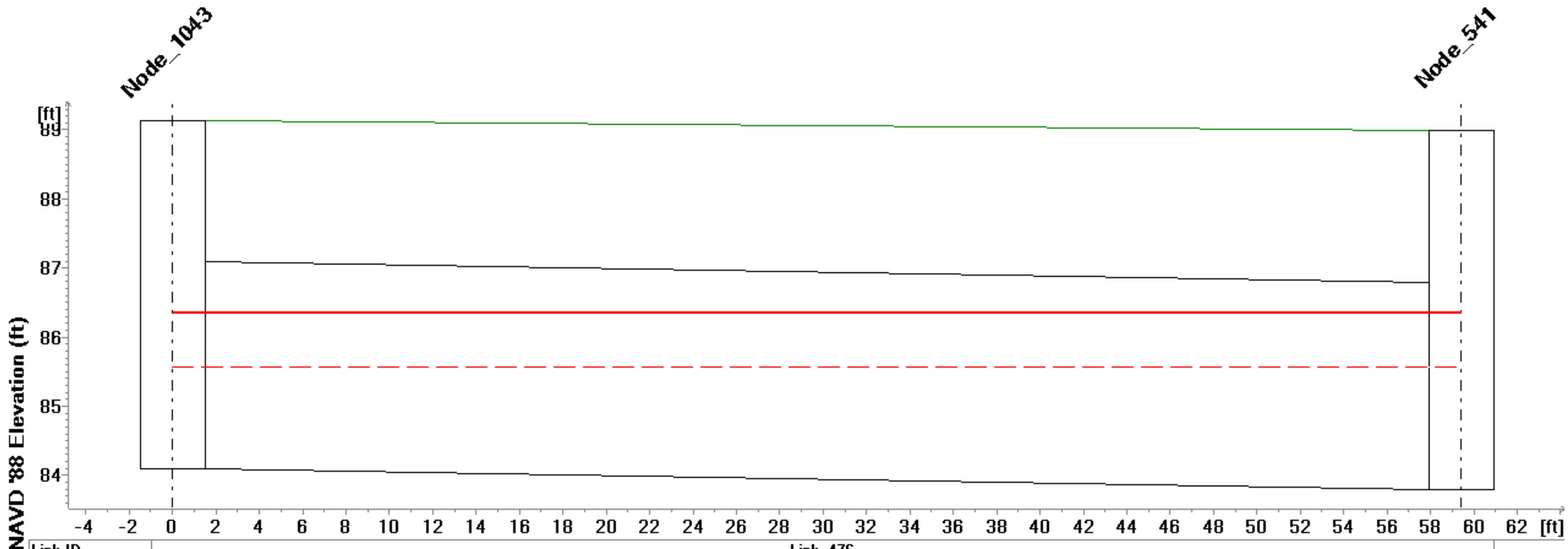
SON-5-2 Profile



Link ID	Link_317	Link_329	Link_316	
Q10 (cfs)	4.932			4.931
Q100 (cfs)	7.585	7.576	7.566	7.572
Length (ft)	186.963	92.183	285.375	
Diameter (ft)	2.0000		2.2500	
MUID	Node_565	Node_564	Node_563	Node_560
Ground Level (ft)	77.51	79.77	80.37	80.25
Invert Level (ft)	70.81	70.07	68.79	64.85
Q10 HGL (ft)	76.342	76.269	76.233	76.174
Q100 HGL (ft)	77.878	78.017	77.991	77.890

1/1/2004

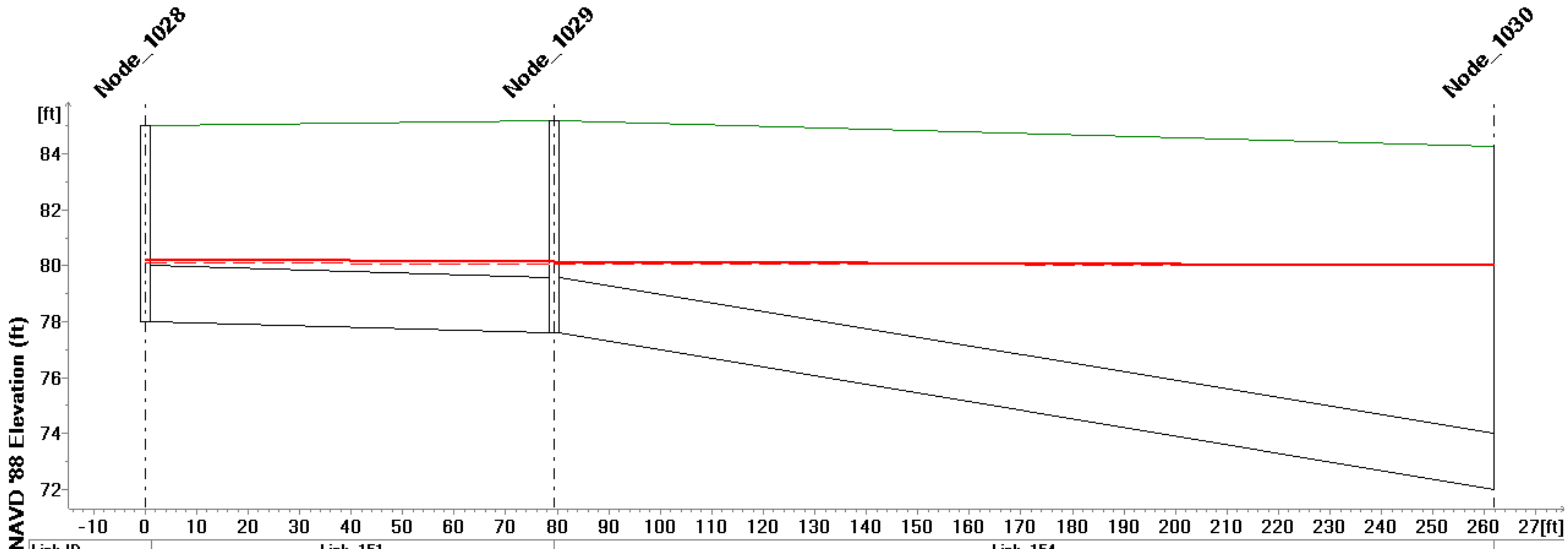
SON-5-3 Profile



Link ID	Link_476	
Q10 (cfs)	12.034	
Q100 (cfs)	19.703	
Length (ft)	59.428	
Diameter (ft)	3.0000	
MUID	Node_1043	Node_541
Ground Level (ft)	89.13	89.00
Invert Level (ft)	84.09	83.80
Q10 HGL (ft)	85.568	85.573
Q100 HGL (ft)	86.340	

1/1/2004

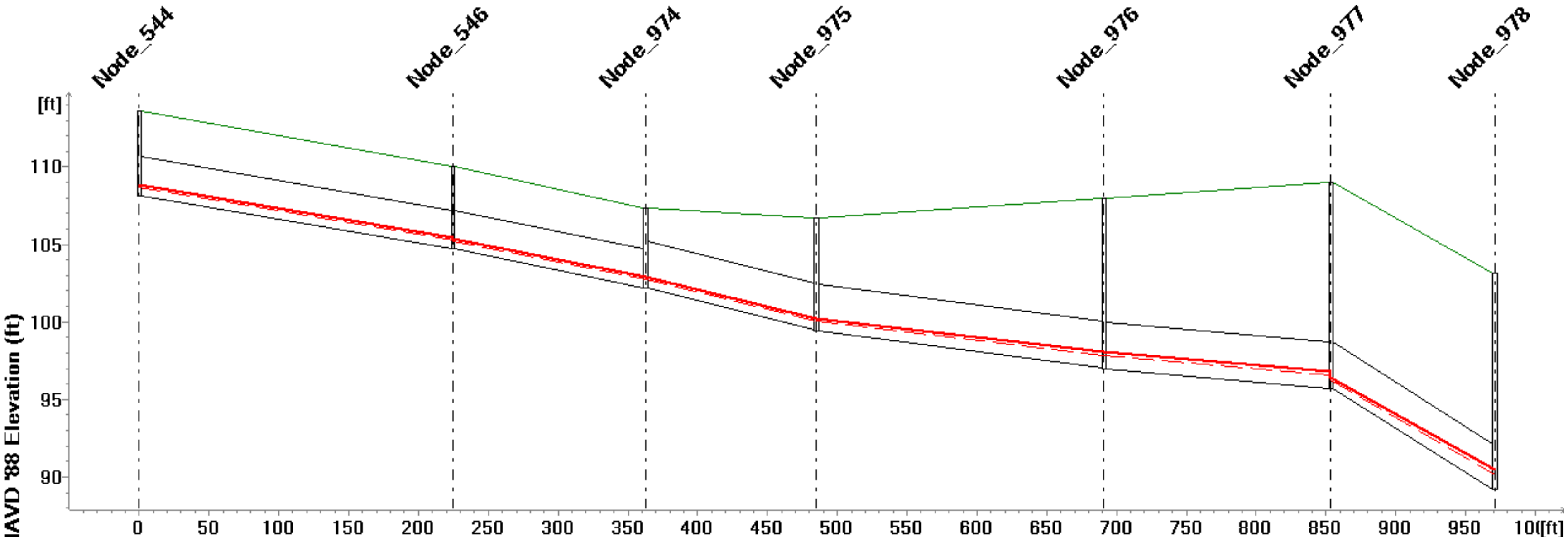
SON-6 Profile



Link ID	Link_151		Link_154	
Q10 (cfs)	4.729			
Q100 (cfs)	7.615			
Length (ft)	79.374		182.421	
Diameter (ft)	2.0000			
MUID	Node_1028	Node_1029		Node_1030
Ground Level (ft)	85.00	85.20		84.26
Invert Level (ft)	78.00	77.60		72.00
Q10 HGL (ft)	80.094	80.065		80.000
Q100 HGL (ft)	80.243	80.169		80.000

1/1/2004

SON-7 Profile

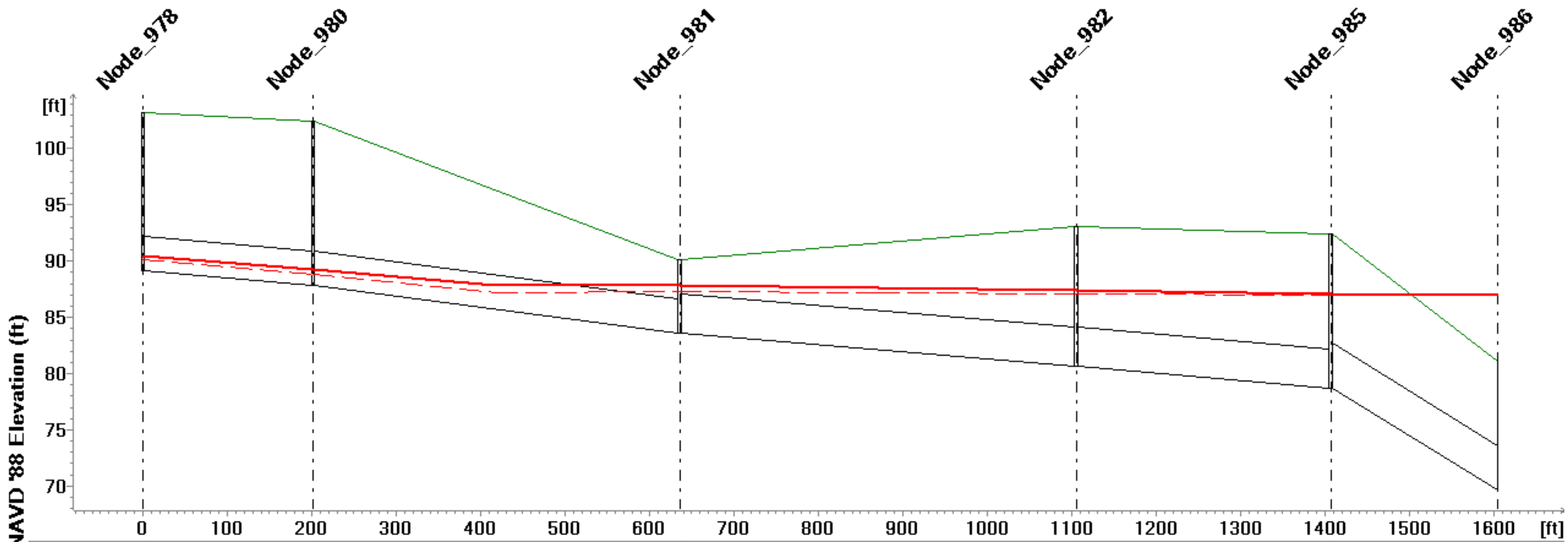


Link ID	Link_554	Link_213	Link_173	Link_212	Link_210	Link_200
Q10 (cfs)	6.178	6.176	7.354	7.352	11.402	11.399
Q100 (cfs)	10.126	10.125	12.013	12.011	19.125	19.122
Length (ft)	224.722	138.097	122.165	205.825	162.639	117.469
Diameter (ft)	2.5000		3.0000			

MUID	Node_544	Node_546	Node_974	Node_975	Node_976	Node_977	Node_978
Ground Level (ft)	113.56	110.00	107.32	106.74	107.98	109.00	103.17
Invert Level (ft)	108.16	104.70	102.22	99.44	96.98	95.70	89.17
Q10 HGL (ft)	108.720	105.238	102.748	100.064	97.827	96.230	90.162
Q100 HGL (ft)	108.878	105.391	102.895	100.246	98.091	96.389	90.492

1/1/2004

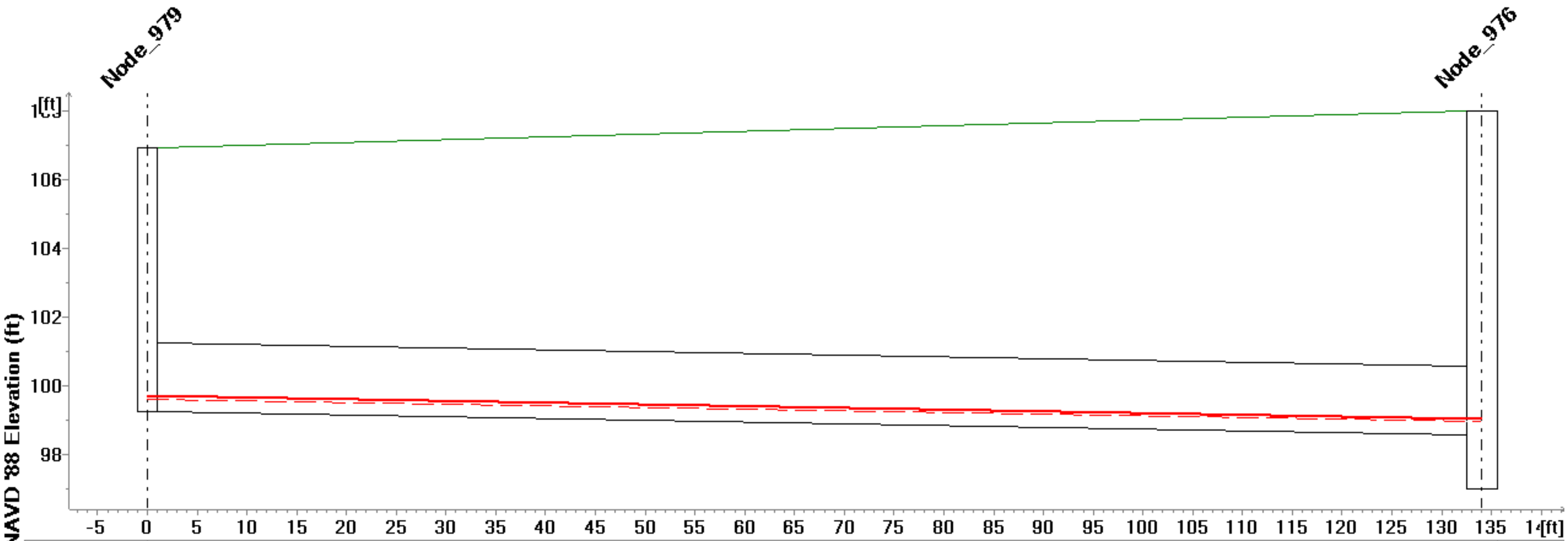
SON-7 Profile (cont.)



Link ID	Link_143		Link_134		Link_133		Link_136		Link_139		
Q10 (cfs)	14.014		14.619	14.712	19.424						
Q100 (cfs)	23.572		24.542	24.741	34.572	34.573	34.574				
Length (ft)	200.968		434.670		469.655		301.449		197.181		
Diameter (ft)	3.0000				3.5000				4.0000		
MUID	Node_978	Node_980		Node_981		Node_982		Node_985		Node_986	
Ground Level (ft)	103.17	102.48		90.15		93.06		92.44		81.04	
Invert Level (ft)	89.17	87.88		83.60		80.62		78.70		69.60	
Q10 HGL (ft)	90.162	88.859		87.268		87.123		87.030		87.000	
Q100 HGL (ft)	90.492	89.228		87.842		87.386		87.094		87.000	

1/1/2004

SON-7-1 Profile



Link ID	Link_172	
Q10 (cfs)	1.285	
Q100 (cfs)	2.058	
Length (ft)	134.060	
Diameter (ft)	2.0000	
MUID	Node_979	Node_976
Ground Level (ft)	106.93	107.98
Invert Level (ft)	99.24	96.98
Q10 HGL (ft)	99.606	97.827
Q100 HGL (ft)	99.702	98.091

1/1/2004

Appendix F
MIKE 11 Peak Q and HGL Tables

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 12799.17	5.837	1/1/2004 10:41
NATHANSON_CREEK 13006.50	599.746	1/1/2004 9:16
NATHANSON_CREEK 13315.00	576.053	1/1/2004 9:17
NATHANSON_CREEK 13722.50	575.977	1/1/2004 9:18
NATHANSON_CREEK 13969.60	682.1	1/1/2004 9:22
NATHANSON_CREEK 14080.00	708.887	1/1/2004 9:21
NATHANSON_CREEK 14404.50	715.415	1/1/2004 9:22
NATHANSON_CREEK 14742.00	715.355	1/1/2004 9:23
NATHANSON_CREEK 14813.00	715.347	1/1/2004 9:23
NATHANSON_CREEK 14929.00	715.342	1/1/2004 9:23
NATHANSON_CREEK 15039.50	717.939	1/1/2004 9:23
NATHANSON_CREEK 15358.00	719.183	1/1/2004 9:18
NATHANSON_CREEK 15614.80	721.735	1/1/2004 9:18
NATHANSON_CREEK 15706.50	721.424	1/1/2004 9:18
NATHANSON_CREEK 15860.50	721.201	1/1/2004 9:18
NATHANSON_CREEK 16224.50	720.743	1/1/2004 9:25
NATHANSON_CREEK 16500.90	720.721	1/1/2004 9:26
NATHANSON_CREEK 16723.50	724.104	1/1/2004 9:26
NATHANSON_CREEK 17077.00	724.068	1/1/2004 9:27
NATHANSON_CREEK 17267.80	703.788	1/1/2004 9:21
NATHANSON_CREEK 17441.50	694.797	1/1/2004 9:21
NATHANSON_CREEK 17699.10	699.494	1/1/2004 9:30
NATHANSON_CREEK 17839.70	699.49	1/1/2004 9:30
NATHANSON_CREEK 17854.10	699.49	1/1/2004 9:30
NATHANSON_CREEK 17898.60	699.489	1/1/2004 9:30
NATHANSON_CREEK 18055.00	699.486	1/1/2004 9:31
NATHANSON_CREEK 18453.70	699.501	1/1/2004 9:31
NATHANSON_CREEK 18816.00	700.147	1/1/2004 9:33
NATHANSON_CREEK 18908.50	711.792	1/1/2004 9:30
NATHANSON_CREEK 18969.05	741.547	1/1/2004 9:29
NATHANSON_CREEK 19271.55	742.098	1/1/2004 9:30
NATHANSON_CREEK 19688.45	729.323	1/1/2004 9:30
NATHANSON_CREEK 20053.95	732.521	1/1/2004 9:31
NATHANSON_CREEK 20362.50	732.376	1/1/2004 9:32
NATHANSON_CREEK 20642.85	745.265	1/1/2004 9:35
NATHANSON_CREEK 21002.85	745.208	1/1/2004 9:36
NATHANSON_CREEK 21242.45	751.043	1/1/2004 9:40
NATHANSON_CREEK 21563.50	751.034	1/1/2004 9:41
NATHANSON_CREEK 21946.85	751.014	1/1/2004 9:41
NATHANSON_CREEK 22387.70	750.958	1/1/2004 9:42
NATHANSON_CREEK 22703.20	753.581	1/1/2004 9:43
NATHANSON_CREEK 22859.51	753.57	1/1/2004 9:43

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 23158.91	753.536	1/1/2004 9:44
NATHANSON_CREEK 24411.36	753.476	1/1/2004 9:46
FRYER_CREEK 34.80	242.734	1/1/2004 8:05
FRYER_CREEK 313.50	239.481	1/1/2004 8:06
FRYER_CREEK 805.50	253.738	1/1/2004 8:05
FRYER_CREEK 1048.50	282.085	1/1/2004 7:31
FRYER_CREEK 1332.50	258.53	1/1/2004 8:11
FRYER_CREEK 1616.50	258.225	1/1/2004 8:12
FRYER_CREEK 1778.00	258.164	1/1/2004 8:12
FRYER_CREEK 2099.50	248.78	1/1/2004 8:12
FRYER_CREEK 2339.00	260.324	1/1/2004 8:23
FRYER_CREEK 2380.00	260.4	1/1/2004 8:23
FRYER_CREEK 2462.00	260.745	1/1/2004 8:23
FRYER_CREEK 2594.34	261.142	1/1/2004 8:23
FRYER_CREEK 2713.84	451.018	1/1/2004 8:14
FRYER_CREEK 2784.00	450.986	1/1/2004 8:14
FRYER_CREEK 2827.00	450.984	1/1/2004 8:14
FRYER_CREEK 2876.00	454.027	1/1/2004 8:14
FRYER_CREEK 3301.50	453.829	1/1/2004 8:15
FRYER_CREEK 3924.96	461.722	1/1/2004 8:17
FRYER_CREEK 4149.46	488.868	1/1/2004 8:18
FRYER_CREEK 4638.50	493.272	1/1/2004 8:19
FRYER_CREEK 5397.50	488.561	1/1/2004 8:25
FRYER_CREEK 5688.50	486.901	1/1/2004 8:27
FRYER_CREEK 5710.00	486.877	1/1/2004 8:27
FRYER_CREEK 5881.50	486.355	1/1/2004 8:29
FRYER_CREEK 6167.90	491.842	1/1/2004 8:31
FRYER_CREEK 6301.00	493.163	1/1/2004 8:31
FRYER_CREEK 6559.00	493.107	1/1/2004 8:32
FRYER_CREEK 7024.00	493.04	1/1/2004 8:32
FRYER_CREEK 7587.75	493.035	1/1/2004 8:34
FRYER_WEST_FORK 83.50	20.355	1/1/2004 8:01
FRYER_WEST_FORK 203.00	20.347	1/1/2004 8:02
FRYER_WEST_FORK 268.00	20.369	1/1/2004 8:03
FRYER_WEST_FORK 359.00	25.152	1/1/2004 8:02
FRYER_WEST_FORK 558.00	25.129	1/1/2004 8:02
FRYER_WEST_FORK 720.36	25.088	1/1/2004 8:03
FRYER_WEST_FORK 879.95	25.05	1/1/2004 8:04
FRYER_WEST_FORK 1055.59	28.446	1/1/2004 8:02
FRYER_WEST_FORK 1173.00	28.452	1/1/2004 8:02
FRYER_WEST_FORK 1360.00	27.597	1/1/2004 8:03
FRYER_WEST_FORK 1522.00	27.408	1/1/2004 8:01

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
FRYER_WEST_FORK 1639.91	25.176	1/1/2004 8:01
FRYER_WEST_FORK 1748.37	22.794	1/1/2004 8:01
FRYER_WEST_FORK 1852.46	22.792	1/1/2004 8:02
FRYER_WEST_FORK 1976.50	22.813	1/1/2004 8:04
FRYER_WEST_FORK 2138.40	26.944	1/1/2004 8:00
FRYER_WEST_FORK 2271.84	26.565	1/1/2004 8:01
FRYER_WEST_FORK 2361.93	28.124	1/1/2004 8:01
FRYER_WEST_FORK 2424.00	27.767	1/1/2004 8:01
FRYER_WEST_FORK 2440.05	27.676	1/1/2004 8:02
FRYER_EAST_FORK 19.50	215.686	1/1/2004 8:04
FRYER_EAST_FORK 107.00	214.087	1/1/2004 8:03
FRYER_EAST_FORK 232.50	212.756	1/1/2004 8:04
FRYER_EAST_FORK 357.00	211.437	1/1/2004 8:04
FRYER_EAST_FORK 501.00	207.631	1/1/2004 8:05
FRYER_EAST_FORK 665.50	203.458	1/1/2004 8:06
FRYER_EAST_FORK 800.93	200.28	1/1/2004 8:07
FRYER_EAST_FORK 861.92	198.825	1/1/2004 8:08
FRYER_EAST_FORK 915.99	198.049	1/1/2004 8:09

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 12660.33	101.59	1/1/2004 9:17
NATHANSON_CREEK 12938.00	100.863	1/1/2004 9:18
NATHANSON_CREEK 13075.00	100.613	1/1/2004 9:18
NATHANSON_CREEK 13555.00	97.844	1/1/2004 9:19
NATHANSON_CREEK 13890.00	95.163	1/1/2004 9:22
NATHANSON_CREEK 14003.00	93.841	1/1/2004 9:21
NATHANSON_CREEK 14157.00	92.144	1/1/2004 9:22
NATHANSON_CREEK 14652.00	89.423	1/1/2004 9:22
NATHANSON_CREEK 14792.00	87.388	1/1/2004 9:23
NATHANSON_CREEK 14834.00	86.873	1/1/2004 9:18
NATHANSON_CREEK 14947.00	86.508	1/1/2004 9:17
NATHANSON_CREEK 15132.00	86.098	1/1/2004 9:49
NATHANSON_CREEK 15584.00	83.707	1/1/2004 9:18
NATHANSON_CREEK 15691.00	83.643	1/1/2004 9:25
NATHANSON_CREEK 15722.00	83.511	1/1/2004 9:25
NATHANSON_CREEK 15999.00	82.573	1/1/2004 9:25
NATHANSON_CREEK 16450.00	81.028	1/1/2004 9:26
NATHANSON_CREEK 16527.00	79.58	1/1/2004 9:26
NATHANSON_CREEK 16920.00	78.497	1/1/2004 9:27
NATHANSON_CREEK 17234.00	77.671	1/1/2004 9:28
NATHANSON_CREEK 17317.00	76.885	1/1/2004 9:30
NATHANSON_CREEK 17566.00	75.723	1/1/2004 9:30
NATHANSON_CREEK 17832.20	74.462	1/1/2004 9:30
NATHANSON_CREEK 17847.20	74.677	1/1/2004 9:30
NATHANSON_CREEK 17861.00	74.793	1/1/2004 9:30
NATHANSON_CREEK 17950.00	73.419	1/1/2004 9:30
NATHANSON_CREEK 18160.00	72.107	1/1/2004 9:31
NATHANSON_CREEK 18747.40	69.606	1/1/2004 9:29
NATHANSON_CREEK 18869.00	69.184	1/1/2004 9:28
NATHANSON_CREEK 18948.00	68.497	1/1/2004 9:29
NATHANSON_CREEK 18990.10	68.711	1/1/2004 9:29
NATHANSON_CREEK 19553.00	65.789	1/1/2004 9:31
NATHANSON_CREEK 19823.90	64.153	1/1/2004 9:31
NATHANSON_CREEK 20284.00	62.715	1/1/2004 9:33
NATHANSON_CREEK 20441.00	61.679	1/1/2004 9:35
NATHANSON_CREEK 20844.70	60.009	1/1/2004 9:36
NATHANSON_CREEK 21161.00	58.291	1/1/2004 9:40
NATHANSON_CREEK 21323.90	56.885	1/1/2004 9:41
NATHANSON_CREEK 21803.10	54.376	1/1/2004 9:42
NATHANSON_CREEK 22090.60	53.056	1/1/2004 9:43
NATHANSON_CREEK 22684.80	51.472	1/1/2004 9:43
NATHANSON_CREEK 22723.20	51.339	1/1/2004 9:43

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 22995.82	50.498	1/1/2004 9:44
NATHANSON_CREEK 23322.00	49.436	1/1/2004 9:45
NATHANSON_CREEK 25500.72	43.09	1/1/2004 0:00
FRYER_CREEK 13.60	76.918	1/1/2004 8:05
FRYER_CREEK 56.00	75.903	1/1/2004 8:05
FRYER_CREEK 571.00	72.551	1/1/2004 8:05
FRYER_CREEK 1040.00	69.466	1/1/2004 8:12
FRYER_CREEK 1057.00	69.471	1/1/2004 8:12
FRYER_CREEK 1608.00	68.717	1/1/2004 8:13
FRYER_CREEK 1625.00	68.652	1/1/2004 8:13
FRYER_CREEK 1931.00	68.532	1/1/2004 8:22
FRYER_CREEK 2268.00	67.947	1/1/2004 8:14
FRYER_CREEK 2365.00	67.741	1/1/2004 8:14
FRYER_CREEK 2395.00	67.755	1/1/2004 8:14
FRYER_CREEK 2529.00	67.747	1/1/2004 8:14
FRYER_CREEK 2659.68	67.734	1/1/2004 8:14
FRYER_CREEK 2659.68	67.734	1/1/2004 8:14
FRYER_CREEK 2768.00	67.691	1/1/2004 8:14
FRYER_CREEK 2800.00	67.493	1/1/2004 8:14
FRYER_CREEK 2854.00	64.843	1/1/2004 8:15
FRYER_CREEK 2898.00	63.793	1/1/2004 8:16
FRYER_CREEK 3705.00	62.198	1/1/2004 8:17
FRYER_CREEK 4144.91	61.132	1/1/2004 8:24
FRYER_CREEK 4144.91	61.132	1/1/2004 8:24
FRYER_CREEK 4154.00	61.094	1/1/2004 8:24
FRYER_CREEK 5123.00	58.818	1/1/2004 8:28
FRYER_CREEK 5672.00	57.563	1/1/2004 8:31
FRYER_CREEK 5705.00	57.665	1/1/2004 8:31
FRYER_CREEK 5718.00	57.399	1/1/2004 8:31
FRYER_CREEK 6045.00	57.068	1/1/2004 8:31
FRYER_CREEK 6268.00	56.431	1/1/2004 8:31
FRYER_CREEK 6334.00	56.111	1/1/2004 8:32
FRYER_CREEK 6784.00	54.35	1/1/2004 8:32
FRYER_CREEK 7264.00	52.854	1/1/2004 7:34
FRYER_CREEK 7911.50	49.8	1/1/2004 0:00
FRYER_WEST_FORK 0.00	68.718	1/1/2004 8:02
FRYER_WEST_FORK 167.00	68.551	1/1/2004 8:02
FRYER_WEST_FORK 239.00	68.527	1/1/2004 8:02
FRYER_WEST_FORK 297.00	68.445	1/1/2004 8:02
FRYER_WEST_FORK 421.00	68.038	1/1/2004 8:02
FRYER_WEST_FORK 695.00	66.552	1/1/2004 8:04
FRYER_WEST_FORK 745.72	66.475	1/1/2004 8:04

BASELINE CONDITIONS - 10 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
FRYER_WEST_FORK 1014.18	65.226	1/1/2004 8:01
FRYER_WEST_FORK 1097.00	65.213	1/1/2004 8:01
FRYER_WEST_FORK 1249.00	65.201	1/1/2004 8:01
FRYER_WEST_FORK 1471.00	65.167	1/1/2004 8:01
FRYER_WEST_FORK 1573.00	65.163	1/1/2004 8:01
FRYER_WEST_FORK 1706.81	65.159	1/1/2004 8:01
FRYER_WEST_FORK 1789.92	62.928	1/1/2004 8:02
FRYER_WEST_FORK 1915.00	62.519	1/1/2004 8:01
FRYER_WEST_FORK 2038.00	61.927	1/1/2004 8:02
FRYER_WEST_FORK 2238.81	61.458	1/1/2004 8:26
FRYER_WEST_FORK 2304.86	61.207	1/1/2004 8:24
FRYER_WEST_FORK 2419.00	61.178	1/1/2004 8:23
FRYER_WEST_FORK 2429.00	61.144	1/1/2004 8:23
FRYER_WEST_FORK 2451.11	61.132	1/1/2004 8:24
FRYER_EAST_FORK 0.00	68.27	1/1/2004 8:08
FRYER_EAST_FORK 39.00	68.1	1/1/2004 8:11
FRYER_EAST_FORK 175.00	67.991	1/1/2004 8:12
FRYER_EAST_FORK 290.00	67.84	1/1/2004 8:14
FRYER_EAST_FORK 424.00	67.804	1/1/2004 8:14
FRYER_EAST_FORK 578.00	67.785	1/1/2004 8:14
FRYER_EAST_FORK 753.00	67.777	1/1/2004 8:14
FRYER_EAST_FORK 848.86	67.774	1/1/2004 8:14
FRYER_EAST_FORK 874.98	67.737	1/1/2004 8:14
FRYER_EAST_FORK 957.00	67.734	1/1/2004 8:14

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 12799.17	5.449	1/1/2004 12:33
NATHANSON_CREEK 13006.50	789.226	1/1/2004 9:12
NATHANSON_CREEK 13315.00	750.92	1/1/2004 9:14
NATHANSON_CREEK 13722.50	751.746	1/1/2004 9:14
NATHANSON_CREEK 13969.60	806.406	1/1/2004 9:17
NATHANSON_CREEK 14080.00	856.896	1/1/2004 9:16
NATHANSON_CREEK 14404.50	865.254	1/1/2004 9:16
NATHANSON_CREEK 14742.00	891.805	1/1/2004 9:26
NATHANSON_CREEK 14813.00	926.377	1/1/2004 9:26
NATHANSON_CREEK 14929.00	922.655	1/1/2004 9:26
NATHANSON_CREEK 15039.50	894.52	1/1/2004 9:26
NATHANSON_CREEK 15358.00	905.881	1/1/2004 9:25
NATHANSON_CREEK 15614.80	915.881	1/1/2004 9:25
NATHANSON_CREEK 15706.50	863.887	1/1/2004 9:37
NATHANSON_CREEK 15860.50	854.886	1/1/2004 9:01
NATHANSON_CREEK 16224.50	859.897	1/1/2004 9:01
NATHANSON_CREEK 16500.90	852.964	1/1/2004 9:47
NATHANSON_CREEK 16723.50	857.107	1/1/2004 9:44
NATHANSON_CREEK 17077.00	856.836	1/1/2004 9:44
NATHANSON_CREEK 17267.80	757.682	1/1/2004 9:53
NATHANSON_CREEK 17441.50	717.152	1/1/2004 9:53
NATHANSON_CREEK 17699.10	724.241	1/1/2004 9:54
NATHANSON_CREEK 17839.70	724.232	1/1/2004 9:54
NATHANSON_CREEK 17854.10	724.23	1/1/2004 9:54
NATHANSON_CREEK 17898.60	724.227	1/1/2004 9:54
NATHANSON_CREEK 18055.00	724.21	1/1/2004 9:54
NATHANSON_CREEK 18453.70	754.476	1/1/2004 9:55
NATHANSON_CREEK 18816.00	823.918	1/1/2004 9:58
NATHANSON_CREEK 18908.50	837.923	1/1/2004 9:57
NATHANSON_CREEK 18969.05	876.339	1/1/2004 9:57
NATHANSON_CREEK 19271.55	877.135	1/1/2004 9:58
NATHANSON_CREEK 19688.45	895.186	1/1/2004 9:59
NATHANSON_CREEK 20053.95	898.523	1/1/2004 9:59
NATHANSON_CREEK 20362.50	898.503	1/1/2004 10:00
NATHANSON_CREEK 20642.85	910.259	1/1/2004 10:00
NATHANSON_CREEK 21002.85	909.967	1/1/2004 10:01
NATHANSON_CREEK 21242.45	915.071	1/1/2004 10:01
NATHANSON_CREEK 21563.50	915.057	1/1/2004 10:02
NATHANSON_CREEK 21946.85	915.034	1/1/2004 10:02
NATHANSON_CREEK 22387.70	914.973	1/1/2004 10:03
NATHANSON_CREEK 22703.20	917.069	1/1/2004 10:04
NATHANSON_CREEK 22859.51	917.058	1/1/2004 10:04

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 23158.91	917.019	1/1/2004 10:05
NATHANSON_CREEK 24411.36	916.982	1/1/2004 10:07
FRYER_CREEK 34.80	309.725	1/1/2004 8:03
FRYER_CREEK 313.50	296.008	1/1/2004 8:06
FRYER_CREEK 805.50	313.97	1/1/2004 8:04
FRYER_CREEK 1048.50	355.268	1/1/2004 7:20
FRYER_CREEK 1332.50	321.279	1/1/2004 8:10
FRYER_CREEK 1616.50	324.424	1/1/2004 8:10
FRYER_CREEK 1778.00	323.845	1/1/2004 8:10
FRYER_CREEK 2099.50	295.87	1/1/2004 8:10
FRYER_CREEK 2339.00	299.342	1/1/2004 8:09
FRYER_CREEK 2380.00	299.229	1/1/2004 8:09
FRYER_CREEK 2462.00	298.841	1/1/2004 8:09
FRYER_CREEK 2594.34	300.466	1/1/2004 8:50
FRYER_CREEK 2713.84	543.854	1/1/2004 8:18
FRYER_CREEK 2784.00	543.929	1/1/2004 8:20
FRYER_CREEK 2827.00	543.997	1/1/2004 8:20
FRYER_CREEK 2876.00	547.537	1/1/2004 8:20
FRYER_CREEK 3301.50	547.757	1/1/2004 8:22
FRYER_CREEK 3924.96	575.476	1/1/2004 8:42
FRYER_CREEK 4149.46	602.735	1/1/2004 8:43
FRYER_CREEK 4638.50	607.36	1/1/2004 8:44
FRYER_CREEK 5397.50	595.627	1/1/2004 8:46
FRYER_CREEK 5688.50	588.293	1/1/2004 8:45
FRYER_CREEK 5710.00	588.276	1/1/2004 8:45
FRYER_CREEK 5881.50	587.876	1/1/2004 8:47
FRYER_CREEK 6167.90	588.347	1/1/2004 8:45
FRYER_CREEK 6301.00	595.908	1/1/2004 8:50
FRYER_CREEK 6559.00	599.693	1/1/2004 8:53
FRYER_CREEK 7024.00	603.763	1/1/2004 8:54
FRYER_CREEK 7587.75	603.765	1/1/2004 8:55
FRYER_WEST_FORK 83.50	24.789	1/1/2004 8:01
FRYER_WEST_FORK 203.00	24.769	1/1/2004 8:02
FRYER_WEST_FORK 268.00	24.788	1/1/2004 8:02
FRYER_WEST_FORK 359.00	31.028	1/1/2004 8:01
FRYER_WEST_FORK 558.00	30.999	1/1/2004 8:02
FRYER_WEST_FORK 720.36	30.942	1/1/2004 8:02
FRYER_WEST_FORK 879.95	30.896	1/1/2004 8:04
FRYER_WEST_FORK 1055.59	35.203	1/1/2004 8:01
FRYER_WEST_FORK 1173.00	35.209	1/1/2004 8:01
FRYER_WEST_FORK 1360.00	33.525	1/1/2004 8:03
FRYER_WEST_FORK 1522.00	32.334	1/1/2004 8:32

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
FRYER_WEST_FORK 1639.91	29.587	1/1/2004 8:32
FRYER_WEST_FORK 1748.37	23.752	1/1/2004 9:05
FRYER_WEST_FORK 1852.46	23.738	1/1/2004 9:07
FRYER_WEST_FORK 1976.50	23.772	1/1/2004 9:06
FRYER_WEST_FORK 2138.40	28.305	1/1/2004 7:56
FRYER_WEST_FORK 2271.84	28.569	1/1/2004 7:55
FRYER_WEST_FORK 2361.93	30.762	1/1/2004 7:55
FRYER_WEST_FORK 2424.00	30.284	1/1/2004 7:55
FRYER_WEST_FORK 2440.05	30.207	1/1/2004 7:55
FRYER_EAST_FORK 19.50	288.372	1/1/2004 8:04
FRYER_EAST_FORK 107.00	287.447	1/1/2004 8:05
FRYER_EAST_FORK 232.50	286.261	1/1/2004 8:05
FRYER_EAST_FORK 357.00	284.93	1/1/2004 8:05
FRYER_EAST_FORK 501.00	282.528	1/1/2004 8:07
FRYER_EAST_FORK 665.50	281.092	1/1/2004 8:07
FRYER_EAST_FORK 800.93	279.248	1/1/2004 8:08
FRYER_EAST_FORK 861.92	273.971	1/1/2004 7:57
FRYER_EAST_FORK 915.99	273.295	1/1/2004 7:57

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 12660.33	102.408	1/1/2004 9:13
NATHANSON_CREEK 12938.00	101.524	1/1/2004 9:13
NATHANSON_CREEK 13075.00	101.324	1/1/2004 9:14
NATHANSON_CREEK 13555.00	98.574	1/1/2004 9:14
NATHANSON_CREEK 13890.00	95.887	1/1/2004 9:17
NATHANSON_CREEK 14003.00	94.329	1/1/2004 9:20
NATHANSON_CREEK 14157.00	92.679	1/1/2004 9:24
NATHANSON_CREEK 14652.00	90.337	1/1/2004 9:26
NATHANSON_CREEK 14792.00	88.892	1/1/2004 9:26
NATHANSON_CREEK 14834.00	88.932	1/1/2004 9:26
NATHANSON_CREEK 14947.00	87.318	1/1/2004 9:43
NATHANSON_CREEK 15132.00	87.018	1/1/2004 9:43
NATHANSON_CREEK 15584.00	84.535	1/1/2004 9:44
NATHANSON_CREEK 15691.00	84.391	1/1/2004 9:44
NATHANSON_CREEK 15722.00	84.235	1/1/2004 9:44
NATHANSON_CREEK 15999.00	83.497	1/1/2004 9:44
NATHANSON_CREEK 16450.00	82.521	1/1/2004 9:47
NATHANSON_CREEK 16527.00	79.963	1/1/2004 9:48
NATHANSON_CREEK 16920.00	78.771	1/1/2004 9:53
NATHANSON_CREEK 17234.00	77.867	1/1/2004 9:53
NATHANSON_CREEK 17317.00	76.968	1/1/2004 9:54
NATHANSON_CREEK 17566.00	75.866	1/1/2004 9:54
NATHANSON_CREEK 17832.20	74.615	1/1/2004 9:54
NATHANSON_CREEK 17847.20	74.836	1/1/2004 9:54
NATHANSON_CREEK 17861.00	74.954	1/1/2004 9:54
NATHANSON_CREEK 17950.00	73.61	1/1/2004 9:55
NATHANSON_CREEK 18160.00	72.437	1/1/2004 9:57
NATHANSON_CREEK 18747.40	70.186	1/1/2004 9:58
NATHANSON_CREEK 18869.00	69.675	1/1/2004 9:58
NATHANSON_CREEK 18948.00	68.937	1/1/2004 9:58
NATHANSON_CREEK 18990.10	69.18	1/1/2004 9:58
NATHANSON_CREEK 19553.00	66.298	1/1/2004 9:58
NATHANSON_CREEK 19823.90	64.662	1/1/2004 9:59
NATHANSON_CREEK 20284.00	63.247	1/1/2004 10:00
NATHANSON_CREEK 20441.00	62.182	1/1/2004 10:00
NATHANSON_CREEK 20844.70	60.511	1/1/2004 10:01
NATHANSON_CREEK 21161.00	58.779	1/1/2004 10:01
NATHANSON_CREEK 21323.90	57.484	1/1/2004 10:02
NATHANSON_CREEK 21803.10	54.923	1/1/2004 10:02
NATHANSON_CREEK 22090.60	53.61	1/1/2004 10:03
NATHANSON_CREEK 22684.80	51.935	1/1/2004 10:05
NATHANSON_CREEK 22723.20	51.872	1/1/2004 10:05

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 22995.82	51.03	1/1/2004 10:05
NATHANSON_CREEK 23322.00	49.916	1/1/2004 10:06
NATHANSON_CREEK 25500.72	43.09	1/1/2004 0:00
FRYER_CREEK 13.60	77.354	1/1/2004 8:04
FRYER_CREEK 56.00	76.317	1/1/2004 8:04
FRYER_CREEK 571.00	72.943	1/1/2004 8:04
FRYER_CREEK 1040.00	70.608	1/1/2004 8:13
FRYER_CREEK 1057.00	70.611	1/1/2004 8:13
FRYER_CREEK 1608.00	69.417	1/1/2004 8:20
FRYER_CREEK 1625.00	69.352	1/1/2004 8:25
FRYER_CREEK 1931.00	69.249	1/1/2004 8:24
FRYER_CREEK 2268.00	68.81	1/1/2004 8:21
FRYER_CREEK 2365.00	68.514	1/1/2004 8:21
FRYER_CREEK 2395.00	68.528	1/1/2004 8:21
FRYER_CREEK 2529.00	68.52	1/1/2004 8:20
FRYER_CREEK 2659.68	68.508	1/1/2004 8:20
FRYER_CREEK 2659.68	68.508	1/1/2004 8:20
FRYER_CREEK 2768.00	68.465	1/1/2004 8:20
FRYER_CREEK 2800.00	68.272	1/1/2004 8:20
FRYER_CREEK 2854.00	65.234	1/1/2004 8:38
FRYER_CREEK 2898.00	64.313	1/1/2004 8:41
FRYER_CREEK 3705.00	62.715	1/1/2004 8:43
FRYER_CREEK 4144.91	61.604	1/1/2004 8:44
FRYER_CREEK 4144.91	61.604	1/1/2004 8:44
FRYER_CREEK 4154.00	61.567	1/1/2004 8:44
FRYER_CREEK 5123.00	59.365	1/1/2004 8:46
FRYER_CREEK 5672.00	58.25	1/1/2004 8:52
FRYER_CREEK 5705.00	58.351	1/1/2004 8:51
FRYER_CREEK 5718.00	58.153	1/1/2004 8:51
FRYER_CREEK 6045.00	57.883	1/1/2004 8:52
FRYER_CREEK 6268.00	56.966	1/1/2004 8:53
FRYER_CREEK 6334.00	56.641	1/1/2004 8:53
FRYER_CREEK 6784.00	54.871	1/1/2004 8:54
FRYER_CREEK 7264.00	52.871	1/1/2004 7:20
FRYER_CREEK 7911.50	49.8	1/1/2004 0:00
FRYER_WEST_FORK 0.00	68.945	1/1/2004 8:01
FRYER_WEST_FORK 167.00	68.774	1/1/2004 8:02
FRYER_WEST_FORK 239.00	68.751	1/1/2004 8:02
FRYER_WEST_FORK 297.00	68.616	1/1/2004 8:02
FRYER_WEST_FORK 421.00	68.222	1/1/2004 8:02
FRYER_WEST_FORK 695.00	66.864	1/1/2004 8:03
FRYER_WEST_FORK 745.72	66.816	1/1/2004 8:04

BASELINE CONDITIONS - 25 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
FRYER_WEST_FORK 1014.18	65.393	1/1/2004 9:04
FRYER_WEST_FORK 1097.00	65.387	1/1/2004 9:05
FRYER_WEST_FORK 1249.00	65.382	1/1/2004 9:04
FRYER_WEST_FORK 1471.00	65.365	1/1/2004 9:05
FRYER_WEST_FORK 1573.00	65.362	1/1/2004 9:05
FRYER_WEST_FORK 1706.81	65.359	1/1/2004 9:05
FRYER_WEST_FORK 1789.92	62.953	1/1/2004 9:08
FRYER_WEST_FORK 1915.00	62.559	1/1/2004 8:52
FRYER_WEST_FORK 2038.00	62.111	1/1/2004 8:48
FRYER_WEST_FORK 2238.81	61.895	1/1/2004 8:47
FRYER_WEST_FORK 2304.86	61.658	1/1/2004 8:44
FRYER_WEST_FORK 2419.00	61.641	1/1/2004 8:45
FRYER_WEST_FORK 2429.00	61.61	1/1/2004 8:45
FRYER_WEST_FORK 2451.11	61.604	1/1/2004 8:44
FRYER_EAST_FORK 0.00	68.958	1/1/2004 8:16
FRYER_EAST_FORK 39.00	68.805	1/1/2004 8:16
FRYER_EAST_FORK 175.00	68.712	1/1/2004 8:17
FRYER_EAST_FORK 290.00	68.592	1/1/2004 8:20
FRYER_EAST_FORK 424.00	68.572	1/1/2004 8:20
FRYER_EAST_FORK 578.00	68.556	1/1/2004 8:20
FRYER_EAST_FORK 753.00	68.549	1/1/2004 8:20
FRYER_EAST_FORK 848.86	68.546	1/1/2004 8:20
FRYER_EAST_FORK 874.98	68.512	1/1/2004 8:20
FRYER_EAST_FORK 957.00	68.508	1/1/2004 8:20

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 12799.17	11.956	1/1/2004 12:51
NATHANSON_CREEK 13006.50	1085.992	1/1/2004 9:10
NATHANSON_CREEK 13315.00	1032.709	1/1/2004 9:10
NATHANSON_CREEK 13722.50	868.802	1/1/2004 9:15
NATHANSON_CREEK 13969.60	835.305	1/1/2004 9:17
NATHANSON_CREEK 14080.00	906.005	1/1/2004 9:16
NATHANSON_CREEK 14404.50	918.393	1/1/2004 9:04
NATHANSON_CREEK 14742.00	1123.473	1/1/2004 9:22
NATHANSON_CREEK 14813.00	1136.727	1/1/2004 9:33
NATHANSON_CREEK 14929.00	1111.586	1/1/2004 9:34
NATHANSON_CREEK 15039.50	1050.689	1/1/2004 9:35
NATHANSON_CREEK 15358.00	1106.806	1/1/2004 9:35
NATHANSON_CREEK 15614.80	1095.932	1/1/2004 9:36
NATHANSON_CREEK 15706.50	1132.041	1/1/2004 9:36
NATHANSON_CREEK 15860.50	1092.148	1/1/2004 9:36
NATHANSON_CREEK 16224.50	1068.511	1/1/2004 9:37
NATHANSON_CREEK 16500.90	979.037	1/1/2004 9:38
NATHANSON_CREEK 16723.50	985.285	1/1/2004 9:38
NATHANSON_CREEK 17077.00	985.218	1/1/2004 9:39
NATHANSON_CREEK 17267.80	882.818	1/1/2004 9:39
NATHANSON_CREEK 17441.50	798.597	1/1/2004 9:40
NATHANSON_CREEK 17699.10	781.119	1/1/2004 9:40
NATHANSON_CREEK 17839.70	781.116	1/1/2004 9:41
NATHANSON_CREEK 17854.10	781.116	1/1/2004 9:41
NATHANSON_CREEK 17898.60	781.115	1/1/2004 9:41
NATHANSON_CREEK 18055.00	779.881	1/1/2004 9:41
NATHANSON_CREEK 18453.70	819.407	1/1/2004 9:41
NATHANSON_CREEK 18816.00	940.297	1/1/2004 9:46
NATHANSON_CREEK 18908.50	959.666	1/1/2004 9:46
NATHANSON_CREEK 18969.05	1000.66	1/1/2004 9:46
NATHANSON_CREEK 19271.55	1002.285	1/1/2004 9:45
NATHANSON_CREEK 19688.45	1039.264	1/1/2004 9:46
NATHANSON_CREEK 20053.95	1043.998	1/1/2004 9:46
NATHANSON_CREEK 20362.50	1035.797	1/1/2004 9:51
NATHANSON_CREEK 20642.85	1054.794	1/1/2004 9:47
NATHANSON_CREEK 21002.85	1024.108	1/1/2004 9:47
NATHANSON_CREEK 21242.45	1006.808	1/1/2004 9:44
NATHANSON_CREEK 21563.50	1006.795	1/1/2004 9:44
NATHANSON_CREEK 21946.85	1006.781	1/1/2004 9:45
NATHANSON_CREEK 22387.70	1006.851	1/1/2004 9:46
NATHANSON_CREEK 22703.20	1011.622	1/1/2004 9:44
NATHANSON_CREEK 22859.51	1011.569	1/1/2004 9:44

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
NATHANSON_CREEK 23158.91	1011.456	1/1/2004 9:45
NATHANSON_CREEK 24411.36	1011.379	1/1/2004 9:47
FRYER_CREEK 34.80	356.575	1/1/2004 8:34
FRYER_CREEK 313.50	346.538	1/1/2004 8:36
FRYER_CREEK 805.50	365.294	1/1/2004 8:32
FRYER_CREEK 1048.50	376.322	1/1/2004 8:22
FRYER_CREEK 1332.50	368.836	1/1/2004 8:34
FRYER_CREEK 1616.50	352.37	1/1/2004 8:54
FRYER_CREEK 1778.00	352.485	1/1/2004 8:55
FRYER_CREEK 2099.50	332.258	1/1/2004 8:57
FRYER_CREEK 2339.00	323.31	1/1/2004 9:19
FRYER_CREEK 2380.00	324.199	1/1/2004 9:19
FRYER_CREEK 2462.00	324.898	1/1/2004 9:18
FRYER_CREEK 2594.34	328.858	1/1/2004 9:18
FRYER_CREEK 2713.84	594.02	1/1/2004 8:08
FRYER_CREEK 2784.00	594.653	1/1/2004 8:09
FRYER_CREEK 2827.00	595.477	1/1/2004 8:35
FRYER_CREEK 2876.00	600.868	1/1/2004 8:09
FRYER_CREEK 3301.50	643.247	1/1/2004 8:39
FRYER_CREEK 3924.96	760.9	1/1/2004 8:40
FRYER_CREEK 4149.46	799.174	1/1/2004 8:40
FRYER_CREEK 4638.50	824.688	1/1/2004 8:40
FRYER_CREEK 5397.50	780.991	1/1/2004 8:50
FRYER_CREEK 5688.50	768.508	1/1/2004 8:50
FRYER_CREEK 5710.00	768.46	1/1/2004 8:50
FRYER_CREEK 5881.50	768.064	1/1/2004 8:51
FRYER_CREEK 6167.90	722.31	1/1/2004 8:51
FRYER_CREEK 6301.00	736.341	1/1/2004 8:54
FRYER_CREEK 6559.00	757.425	1/1/2004 8:55
FRYER_CREEK 7024.00	799.586	1/1/2004 8:57
FRYER_CREEK 7587.75	797.804	1/1/2004 8:58
FRYER_WEST_FORK 83.50	31.374	1/1/2004 8:01
FRYER_WEST_FORK 203.00	31.343	1/1/2004 8:01
FRYER_WEST_FORK 268.00	31.358	1/1/2004 8:02
FRYER_WEST_FORK 359.00	39.787	1/1/2004 8:01
FRYER_WEST_FORK 558.00	39.76	1/1/2004 8:02
FRYER_WEST_FORK 720.36	39.668	1/1/2004 8:02
FRYER_WEST_FORK 879.95	39.606	1/1/2004 8:03
FRYER_WEST_FORK 1055.59	44.5	1/1/2004 7:54
FRYER_WEST_FORK 1173.00	44.339	1/1/2004 7:54
FRYER_WEST_FORK 1360.00	43.34	1/1/2004 7:53
FRYER_WEST_FORK 1522.00	51.031	1/1/2004 7:53

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX FLOWS

Creek and Stationing	Maximum Flow (cfs)	Maximum Time
FRYER_WEST_FORK 1639.91	43.13	1/1/2004 7:53
FRYER_WEST_FORK 1748.37	26.078	1/1/2004 8:30
FRYER_WEST_FORK 1852.46	26.701	1/1/2004 8:36
FRYER_WEST_FORK 1976.50	28.417	1/1/2004 8:37
FRYER_WEST_FORK 2138.40	35.907	1/1/2004 8:33
FRYER_WEST_FORK 2271.84	36.308	1/1/2004 8:38
FRYER_WEST_FORK 2361.93	38.168	1/1/2004 8:34
FRYER_WEST_FORK 2424.00	38.036	1/1/2004 8:41
FRYER_WEST_FORK 2440.05	38.07	1/1/2004 8:41
FRYER_EAST_FORK 19.50	381.175	1/1/2004 7:58
FRYER_EAST_FORK 107.00	380.17	1/1/2004 8:02
FRYER_EAST_FORK 232.50	392.756	1/1/2004 8:04
FRYER_EAST_FORK 357.00	395.532	1/1/2004 8:04
FRYER_EAST_FORK 501.00	394.077	1/1/2004 8:04
FRYER_EAST_FORK 665.50	392.692	1/1/2004 8:05
FRYER_EAST_FORK 800.93	378.28	1/1/2004 8:05
FRYER_EAST_FORK 861.92	347.289	1/1/2004 8:05
FRYER_EAST_FORK 915.99	342.15	1/1/2004 8:05

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 12660.33	103.31	1/1/2004 9:10
NATHANSON_CREEK 12938.00	102.167	1/1/2004 9:10
NATHANSON_CREEK 13075.00	101.946	1/1/2004 9:10
NATHANSON_CREEK 13555.00	99.013	1/1/2004 9:14
NATHANSON_CREEK 13890.00	96.077	1/1/2004 9:17
NATHANSON_CREEK 14003.00	94.58	1/1/2004 9:16
NATHANSON_CREEK 14157.00	93.161	1/1/2004 9:20
NATHANSON_CREEK 14652.00	91.419	1/1/2004 9:33
NATHANSON_CREEK 14792.00	89.774	1/1/2004 9:34
NATHANSON_CREEK 14834.00	89.882	1/1/2004 9:34
NATHANSON_CREEK 14947.00	87.992	1/1/2004 9:35
NATHANSON_CREEK 15132.00	87.725	1/1/2004 9:32
NATHANSON_CREEK 15584.00	85.293	1/1/2004 9:36
NATHANSON_CREEK 15691.00	85.09	1/1/2004 9:36
NATHANSON_CREEK 15722.00	84.869	1/1/2004 9:36
NATHANSON_CREEK 15999.00	84.033	1/1/2004 9:37
NATHANSON_CREEK 16450.00	82.994	1/1/2004 9:37
NATHANSON_CREEK 16527.00	80.417	1/1/2004 9:38
NATHANSON_CREEK 16920.00	79.275	1/1/2004 9:39
NATHANSON_CREEK 17234.00	78.356	1/1/2004 9:39
NATHANSON_CREEK 17317.00	77.199	1/1/2004 9:40
NATHANSON_CREEK 17566.00	76.129	1/1/2004 9:40
NATHANSON_CREEK 17832.20	74.903	1/1/2004 9:41
NATHANSON_CREEK 17847.20	75.137	1/1/2004 9:41
NATHANSON_CREEK 17861.00	75.264	1/1/2004 9:41
NATHANSON_CREEK 17950.00	73.864	1/1/2004 9:41
NATHANSON_CREEK 18160.00	72.744	1/1/2004 9:43
NATHANSON_CREEK 18747.40	70.674	1/1/2004 9:45
NATHANSON_CREEK 18869.00	70.067	1/1/2004 9:45
NATHANSON_CREEK 18948.00	69.288	1/1/2004 9:45
NATHANSON_CREEK 18990.10	69.554	1/1/2004 9:45
NATHANSON_CREEK 19553.00	66.69	1/1/2004 9:46
NATHANSON_CREEK 19823.90	65.041	1/1/2004 9:46
NATHANSON_CREEK 20284.00	63.619	1/1/2004 9:47
NATHANSON_CREEK 20441.00	62.526	1/1/2004 9:47
NATHANSON_CREEK 20844.70	60.785	1/1/2004 9:46
NATHANSON_CREEK 21161.00	59.034	1/1/2004 9:44
NATHANSON_CREEK 21323.90	57.787	1/1/2004 9:44
NATHANSON_CREEK 21803.10	55.21	1/1/2004 9:45
NATHANSON_CREEK 22090.60	53.92	1/1/2004 9:45
NATHANSON_CREEK 22684.80	52.242	1/1/2004 9:44
NATHANSON_CREEK 22723.20	52.146	1/1/2004 9:44

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
NATHANSON_CREEK 22995.82	51.317	1/1/2004 9:46
NATHANSON_CREEK 23322.00	50.169	1/1/2004 9:46
NATHANSON_CREEK 25500.72	43.09	1/1/2004 0:00
FRYER_CREEK 13.60	77.685	1/1/2004 8:34
FRYER_CREEK 56.00	76.653	1/1/2004 8:33
FRYER_CREEK 571.00	73.329	1/1/2004 8:32
FRYER_CREEK 1040.00	71.454	1/1/2004 8:34
FRYER_CREEK 1057.00	71.457	1/1/2004 8:34
FRYER_CREEK 1608.00	69.821	1/1/2004 8:40
FRYER_CREEK 1625.00	69.759	1/1/2004 8:40
FRYER_CREEK 1931.00	69.664	1/1/2004 8:39
FRYER_CREEK 2268.00	69.264	1/1/2004 8:38
FRYER_CREEK 2365.00	68.924	1/1/2004 8:36
FRYER_CREEK 2395.00	68.936	1/1/2004 8:36
FRYER_CREEK 2529.00	68.928	1/1/2004 8:36
FRYER_CREEK 2659.68	68.917	1/1/2004 8:36
FRYER_CREEK 2659.68	68.917	1/1/2004 8:36
FRYER_CREEK 2768.00	68.875	1/1/2004 8:35
FRYER_CREEK 2800.00	68.685	1/1/2004 8:35
FRYER_CREEK 2854.00	65.567	1/1/2004 8:38
FRYER_CREEK 2898.00	64.975	1/1/2004 8:39
FRYER_CREEK 3705.00	63.501	1/1/2004 8:40
FRYER_CREEK 4144.91	62.378	1/1/2004 8:45
FRYER_CREEK 4144.91	62.378	1/1/2004 8:45
FRYER_CREEK 4154.00	62.302	1/1/2004 8:45
FRYER_CREEK 5123.00	60.058	1/1/2004 8:50
FRYER_CREEK 5672.00	58.907	1/1/2004 8:53
FRYER_CREEK 5705.00	59.025	1/1/2004 8:53
FRYER_CREEK 5718.00	58.868	1/1/2004 8:53
FRYER_CREEK 6045.00	58.617	1/1/2004 8:54
FRYER_CREEK 6268.00	57.527	1/1/2004 8:55
FRYER_CREEK 6334.00	57.212	1/1/2004 8:56
FRYER_CREEK 6784.00	55.528	1/1/2004 8:56
FRYER_CREEK 7264.00	53.263	1/1/2004 8:57
FRYER_CREEK 7911.50	49.8	1/1/2004 0:00
FRYER_WEST_FORK 0.00	69.265	1/1/2004 8:01
FRYER_WEST_FORK 167.00	69.098	1/1/2004 8:01
FRYER_WEST_FORK 239.00	69.077	1/1/2004 8:01
FRYER_WEST_FORK 297.00	68.846	1/1/2004 8:01
FRYER_WEST_FORK 421.00	68.455	1/1/2004 8:02
FRYER_WEST_FORK 695.00	67.33	1/1/2004 8:03
FRYER_WEST_FORK 745.72	67.306	1/1/2004 8:03

BASELINE CONDITIONS - 100 YEAR, 24 HOUR MAX WATER SURFACE ELEVATIONS

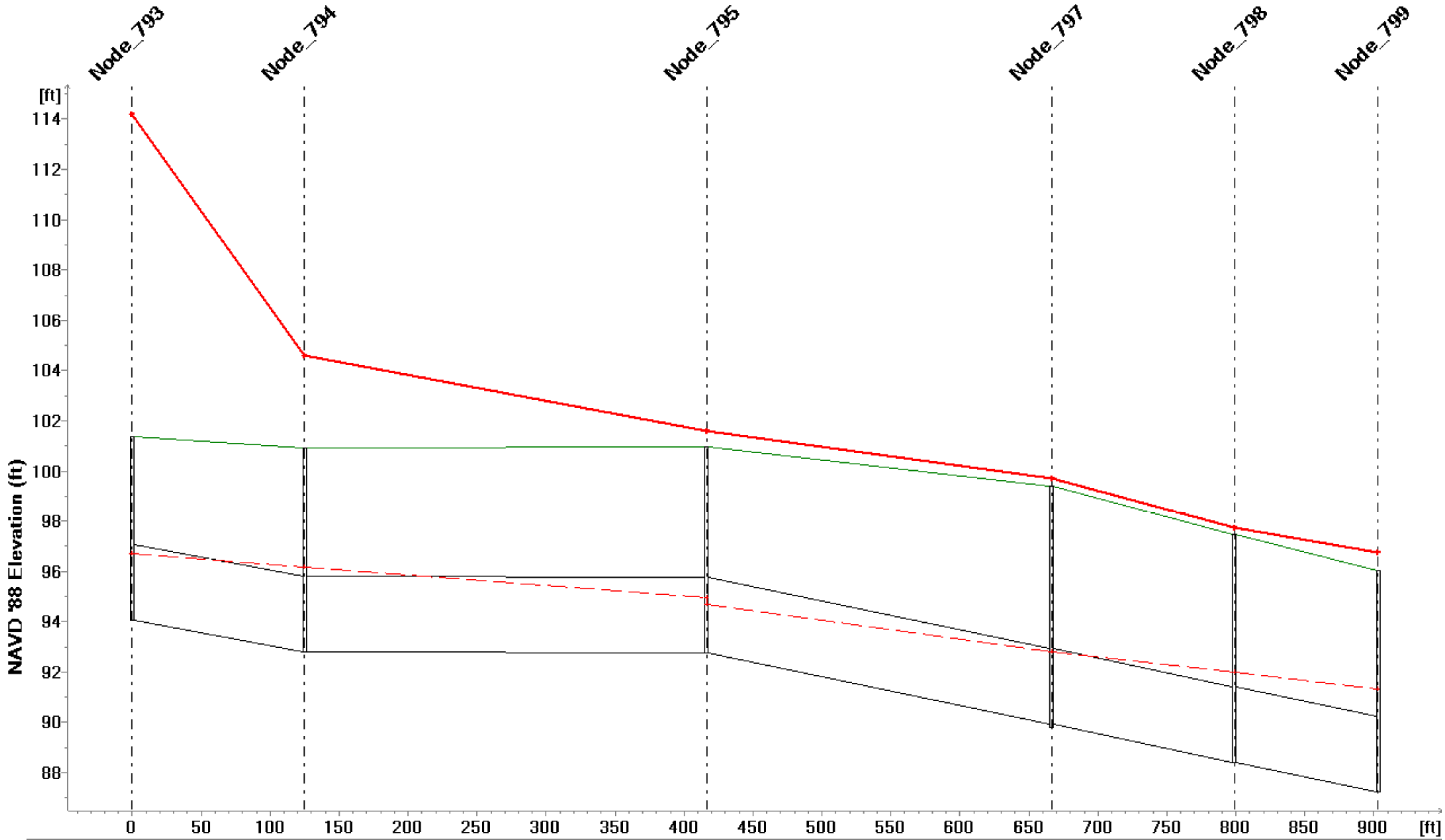
Creek and Stationing	Maximum Water Surface Elevation (ft)	Maximum Time
FRYER_WEST_FORK 1014.18	65.9	1/1/2004 8:29
FRYER_WEST_FORK 1097.00	65.893	1/1/2004 8:29
FRYER_WEST_FORK 1249.00	65.887	1/1/2004 8:28
FRYER_WEST_FORK 1471.00	65.86	1/1/2004 8:30
FRYER_WEST_FORK 1573.00	65.857	1/1/2004 8:30
FRYER_WEST_FORK 1706.81	65.855	1/1/2004 8:30
FRYER_WEST_FORK 1789.92	63.231	1/1/2004 8:41
FRYER_WEST_FORK 1915.00	63.099	1/1/2004 8:42
FRYER_WEST_FORK 2038.00	63.001	1/1/2004 8:43
FRYER_WEST_FORK 2238.81	62.954	1/1/2004 8:43
FRYER_WEST_FORK 2304.86	62.43	1/1/2004 8:45
FRYER_WEST_FORK 2419.00	62.423	1/1/2004 8:45
FRYER_WEST_FORK 2429.00	62.382	1/1/2004 8:45
FRYER_WEST_FORK 2451.11	62.378	1/1/2004 8:45
FRYER_EAST_FORK 0.00	69.552	1/1/2004 8:05
FRYER_EAST_FORK 39.00	69.351	1/1/2004 8:06
FRYER_EAST_FORK 175.00	69.222	1/1/2004 8:08
FRYER_EAST_FORK 290.00	69.049	1/1/2004 8:08
FRYER_EAST_FORK 424.00	69.019	1/1/2004 8:08
FRYER_EAST_FORK 578.00	68.993	1/1/2004 8:09
FRYER_EAST_FORK 753.00	68.982	1/1/2004 8:09
FRYER_EAST_FORK 848.86	68.981	1/1/2004 8:09
FRYER_EAST_FORK 874.98	68.921	1/1/2004 8:36
FRYER_EAST_FORK 957.00	68.917	1/1/2004 8:36

Appendix G
MIKE URBAN Storm Drain Profile Figures with CIP Projects

Legend for Storm Drain System Profiles with CIP Projects Implemented

(green line)	Ground Level
(black line)	Crown/Invert Level of Pipe
(red dashed line)	Q10 HGL
(red thick line)	Q100 HGL

Line S-1 with CIP Project

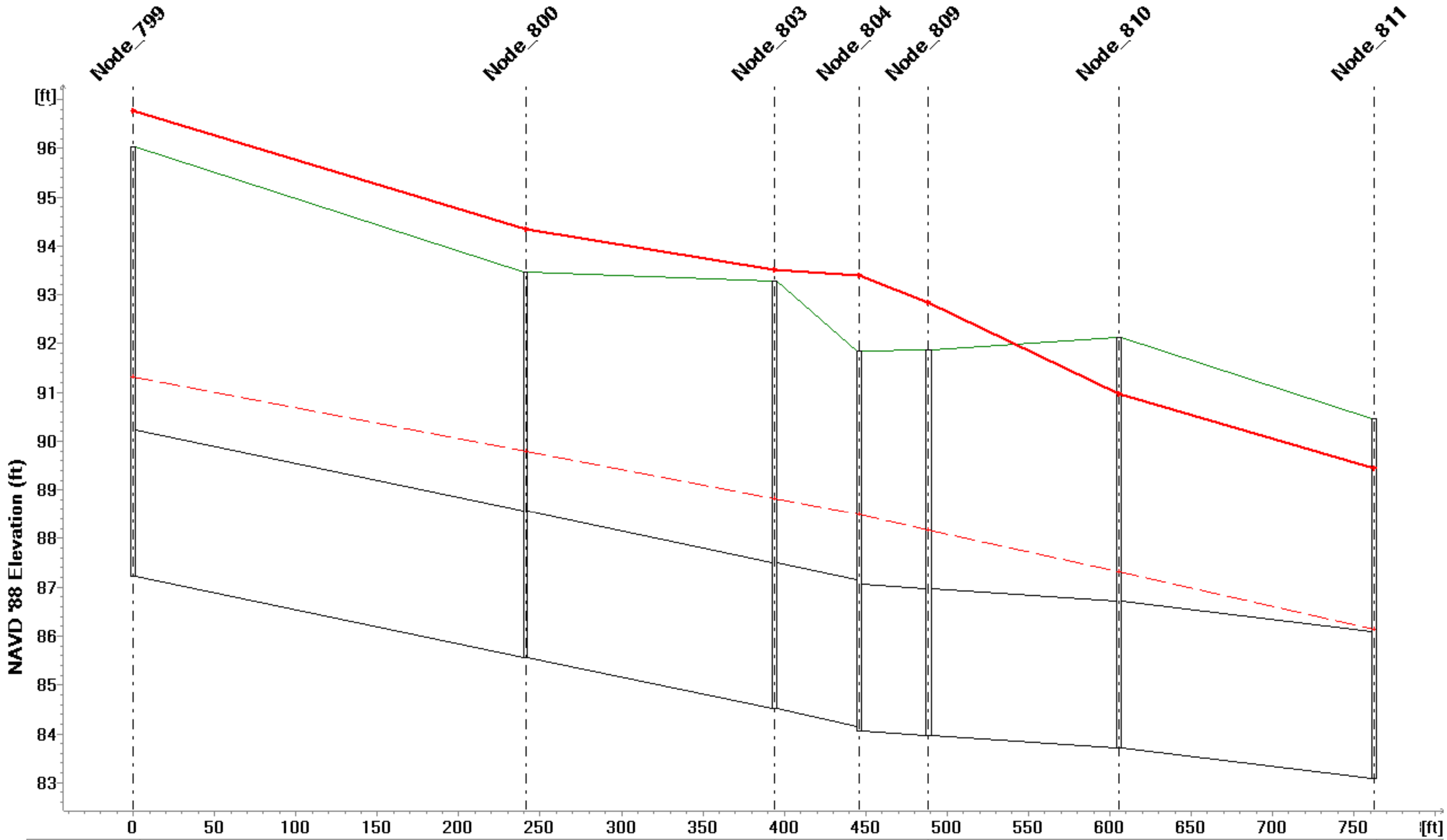


Link ID	Link_386	Link_385	Link_383	Link_231	Link_344
Q10 (cfs)	47.641	47.640	47.642	58.748	58.745
Q100 (cfs)	116.155	94.624	67.466	95.118	78.555
Length (ft)	124.782	291.395	250.402	132.288	104.135
Diameter (ft)	3.0000				

Shaft ID	Node_793	Node_794	Node_795	Node_797	Node_798	Node_799
Ground Level (ft)	101.37	100.92	100.96	99.41	97.48	96.03
Invert Level (ft)	94.07	92.82	92.76	89.82	88.41	87.23
Q10 HGL (ft)	96.705	96.184	94.695	92.822	91.983	91.323
Q100 HGL (ft)	114.222	104.623	101.589	99.701	97.726	96.770

1/1/2004

Line S-1 with CIP Project (cont.)

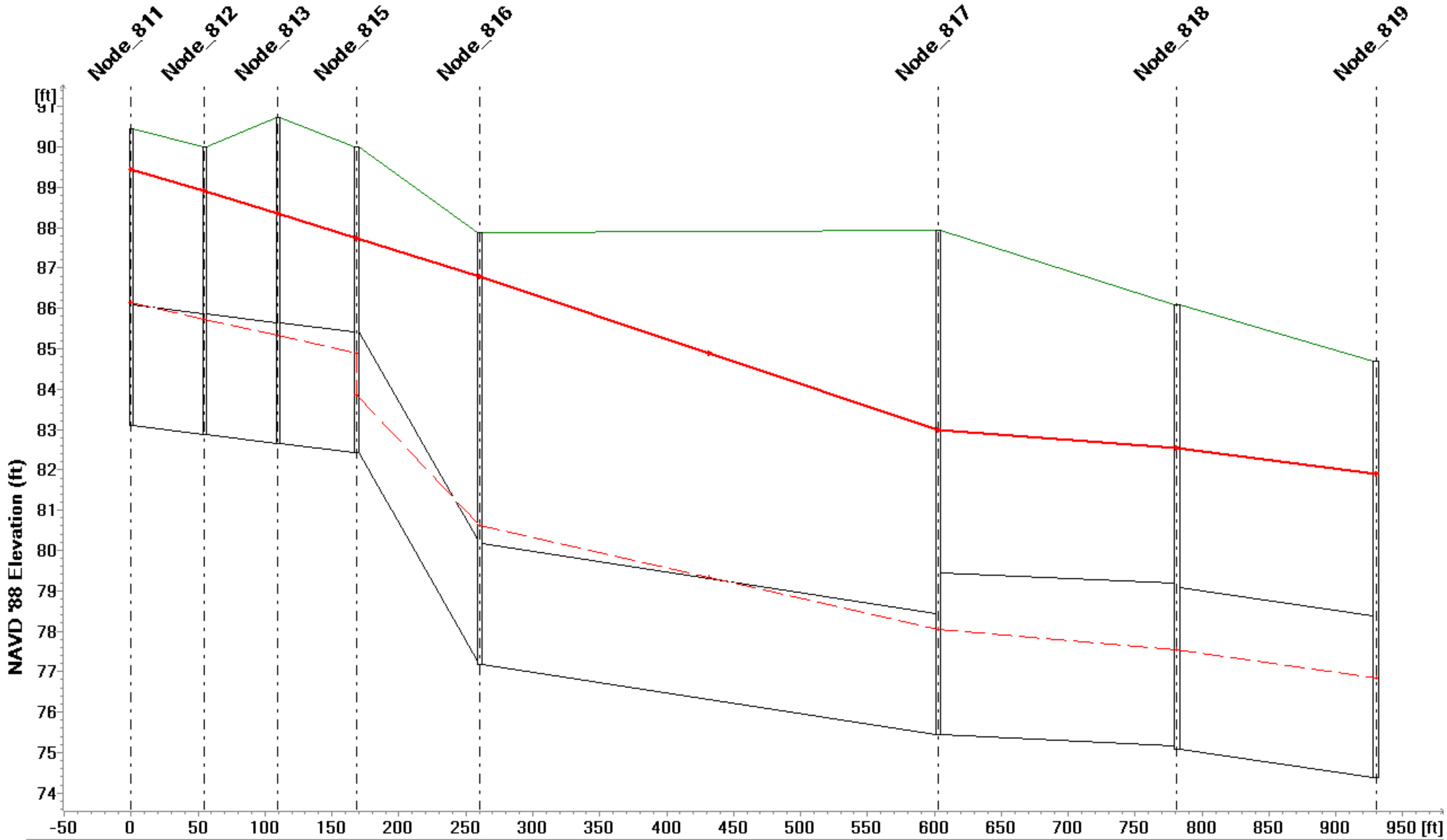


Link ID	Link_230	Link_114	Link_76	Link_482	Link_483	Link_484
Q10 (cfs)	58.742	58.741	58.740	63.663		
Q100 (cfs)	75.812	74.189	75.298	93.425	95.000	88.059
Length (ft)	241.112	152.803	52.103	42.584	117.228	156.575
Diameter (ft)	3.0000					

Shaft ID	Node_799	Node_800	Node_803	Node_804	Node_809	Node_810	Node_811
Ground Level (ft)	96.03	93.46	93.27	91.85	91.86	92.12	90.46
Invert Level (ft)	87.23	85.56	84.51	84.05	83.96	83.71	83.09
Q10 HGL (ft)	91.323	89.796	88.830	88.502	88.184	87.309	86.141
Q100 HGL (ft)	96.770	94.335	93.514	93.390	92.832	90.979	89.445

1/1/2004

Line S-1 with CIP Project (cont.)

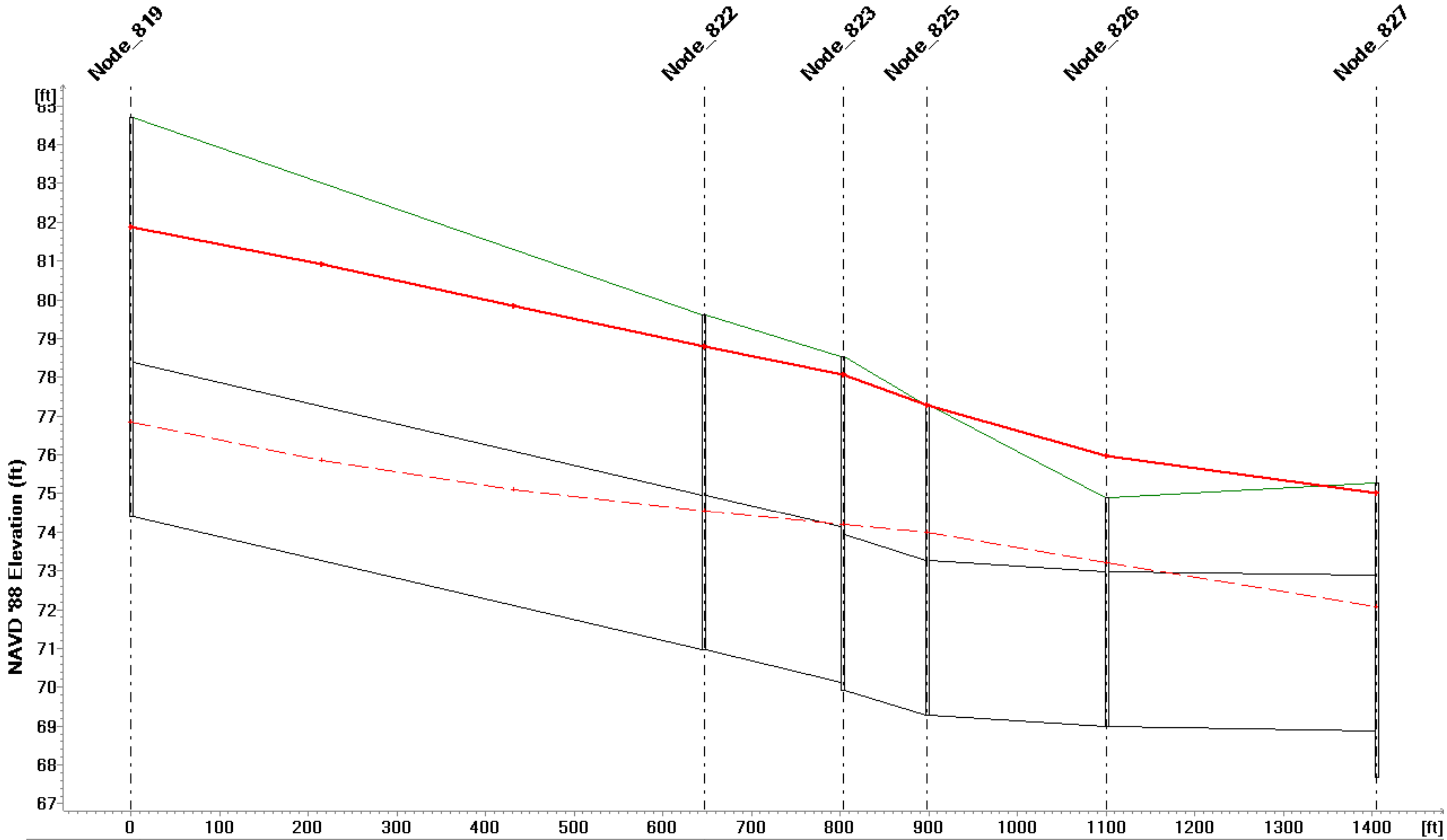


Link ID	Link_485	Link_486	Link_77	Link_71	Link_63		Link_62	Link_61
Q10 (cfs)	63.663					63.662	63.661	74.583
Q100 (cfs)	85.795	84.718	84.104	83.751	83.702	83.683	83.621	105.709
Length (ft)	54.837	54.925	58.882	91.763	342.381		178.406	148.659
Diameter (ft)	3.0000						4.0000	

Shaft ID	......	Node_812	Node_813	Node_815	Node_816	Node_817	Node_818	Node_819
Ground Level (ft)	......	90.00	90.72	89.99	87.87	87.94	86.08	84.69
Invert Level (ft)	......	82.87	82.65	82.42	77.17	75.44	75.08	74.39
Q10 HGL (ft)	......	85.731	85.322	83.848	80.604	78.049	77.527	76.842
Q100 HGL (ft)	......	88.908	88.348	87.748	86.777	82.988	82.530	81.885

1/1/2004

Line S-1 with CIP Project (cont.)

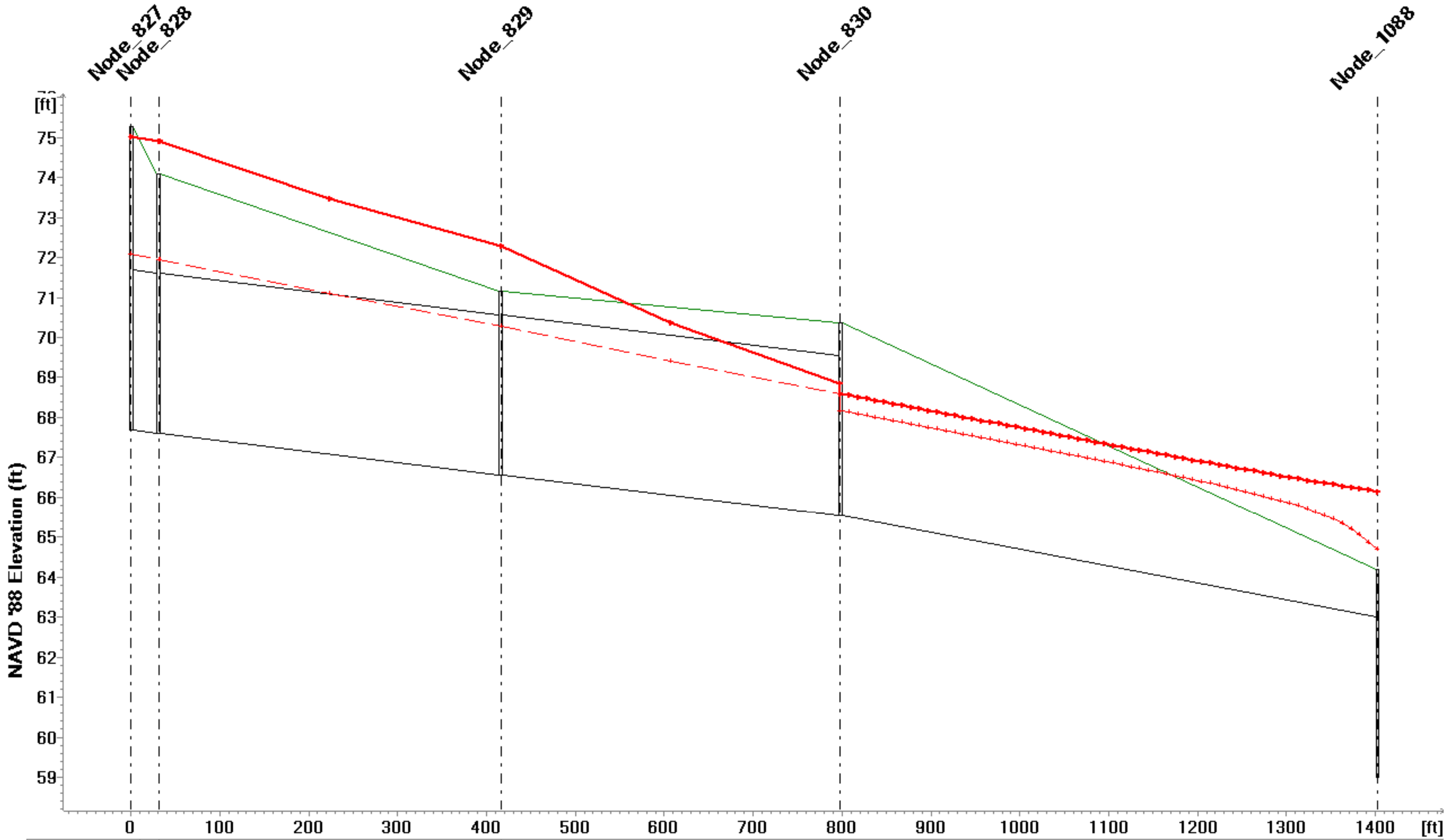


Link ID	Link_59			Link_67	Link_69	Link_68	Link_66
Q10 (cfs)	74.583	74.587	74.632	74.698	74.717	97.134	97.121
Q100 (cfs)	109.843	110.082	110.861	113.746	151.494	134.434	122.116
Length (ft)	646.730			156.394	95.156	202.655	304.602
Diameter (ft)	4.0000						

Shaft ID	Node_819	Node_822	Node_823	Node_825	Node_826	Node_827
Ground Level (ft)	84.69	79.62	78.53	77.28	74.89	75.28
Invert Level (ft)	74.39	70.96	69.93	69.28	68.99	67.69
Q10 HGL (ft)	76.842	74.535	74.190	73.980	73.222	72.082
Q100 HGL (ft)	81.885	78.789	78.064	77.295	75.975	75.021

1/1/2004

Line S-1 with CIP Project (cont.)

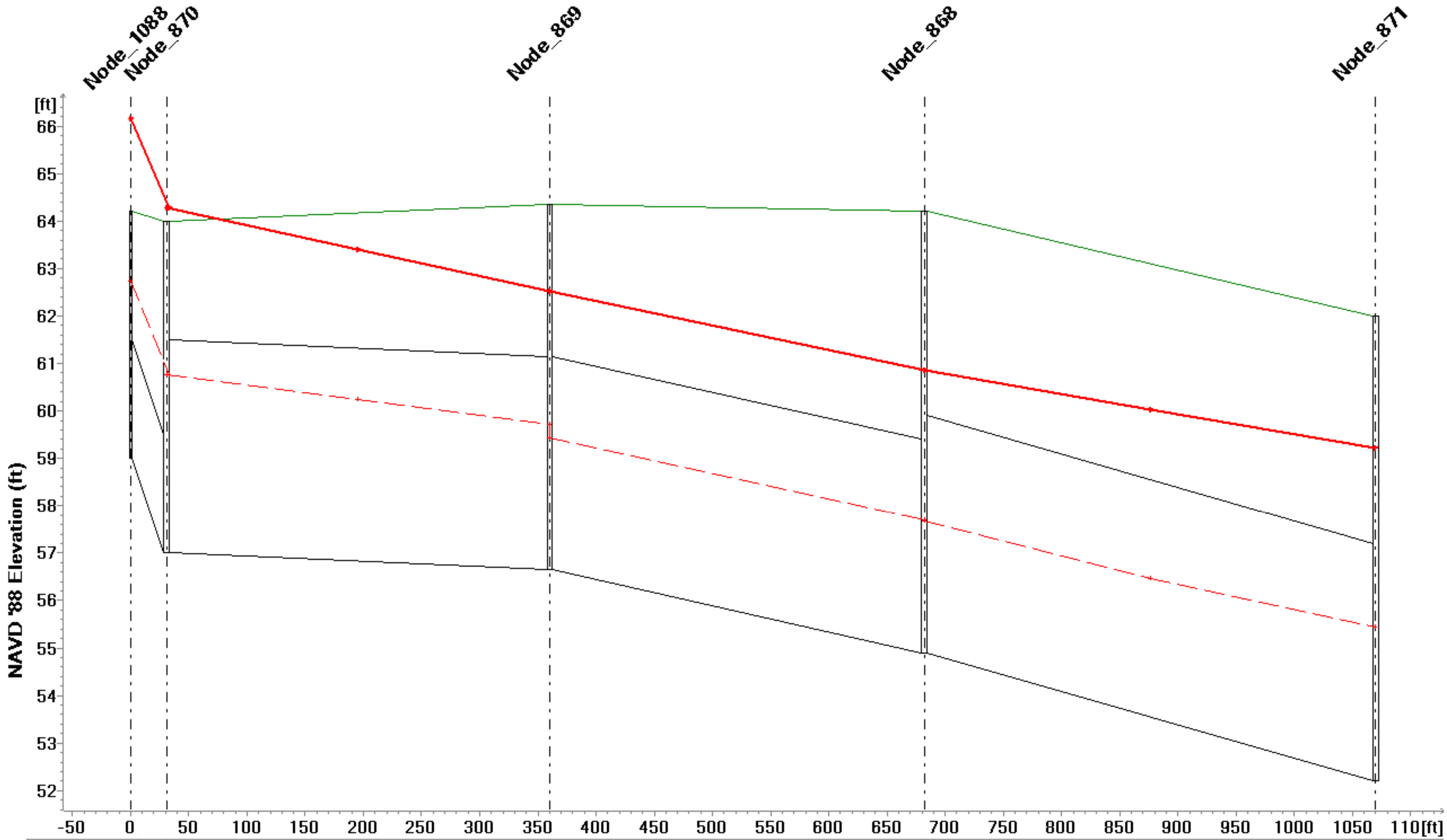


Link ID	....	Link_84		Link_541		Link_542	
Q10 (cfs)	....	104.120	104.119	104.116	104.115	110.818	110.811
Q100 (cfs)	....	136.799	134.978	144.920	142.130		
Length (ft)	....	384.977		381.700		604.310	
Diameter (ft)		4.0000					

Shaft ID	Node_828	Node_829	Node_830	Node_1088
Ground Level (ft)	74.09	71.16	70.35	64.20
Invert Level (ft)	67.60	66.55	65.55	59.00
Q10 HGL (ft)	71.940	70.284	68.172	62.725
Q100 HGL (ft)	74.903	72.296	68.595	66.149

1/1/2004

Line S-1 with CIP Project (cont.)

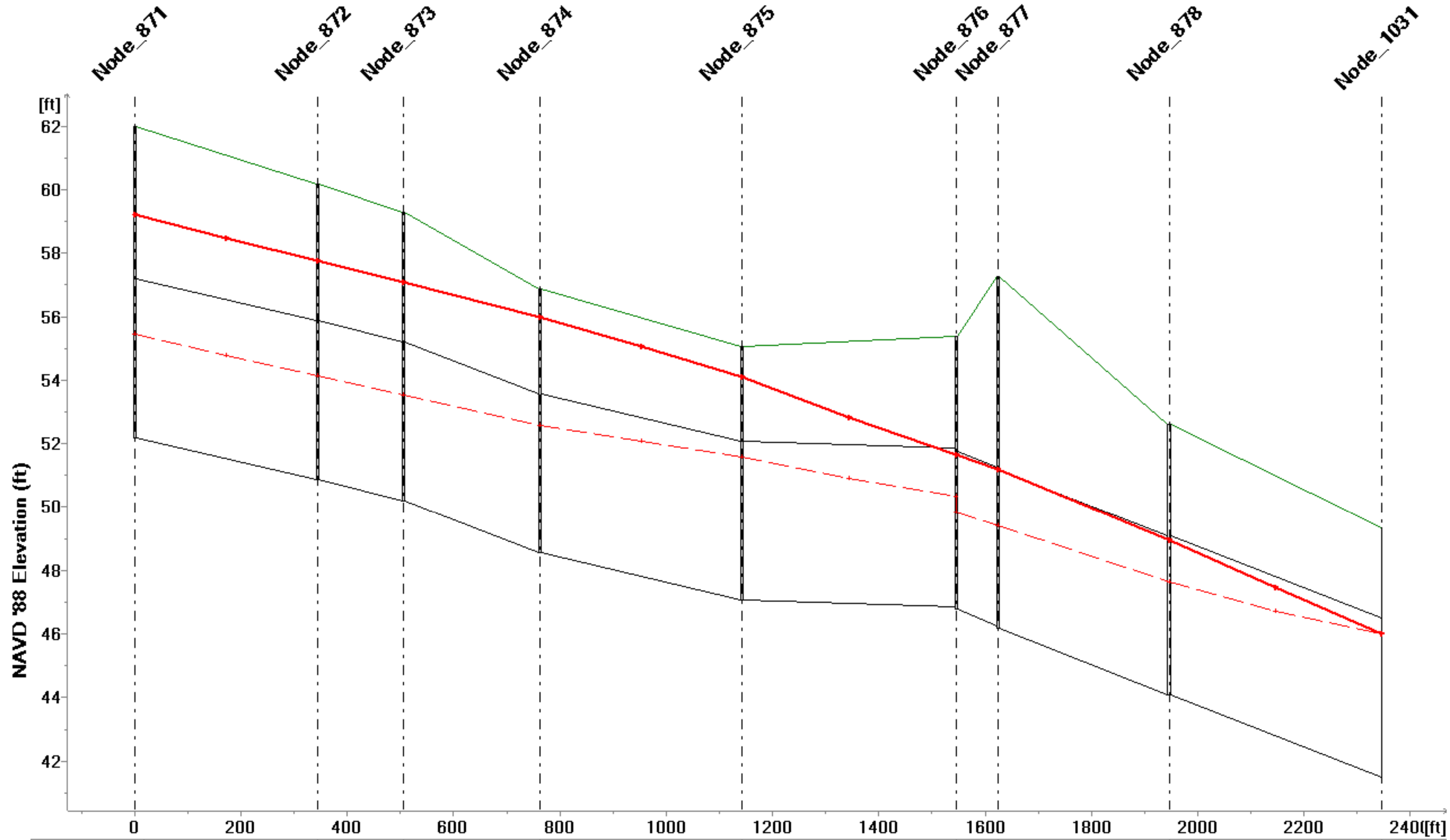


Link ID	......	Link_17		Link_16		Link_21		
Q10 (cfs)	......	113.184	113.183			133.714	133.669	
Q100 (cfs)	......	163.563	163.565	163.575		189.529	189.531	
Length (ft)	......	329.548		321.773		387.903		
Diameter (ft)	......	4.5000				5.0000		

Shaft ID	..	Node_870	Node_869	Node_868	Node_871	
Ground Level (ft)	..	64.00	64.34	64.20	62.00	
Invert Level (ft)	..	57.00	56.64	54.90	52.20	
Q10 HGL (ft)	..	60.764	59.440	57.663	55.437	
Q100 HGL (ft)	..	64.283	62.528	60.852	59.215	

1/1/2004

Line S-1 with CIP Project (cont.)

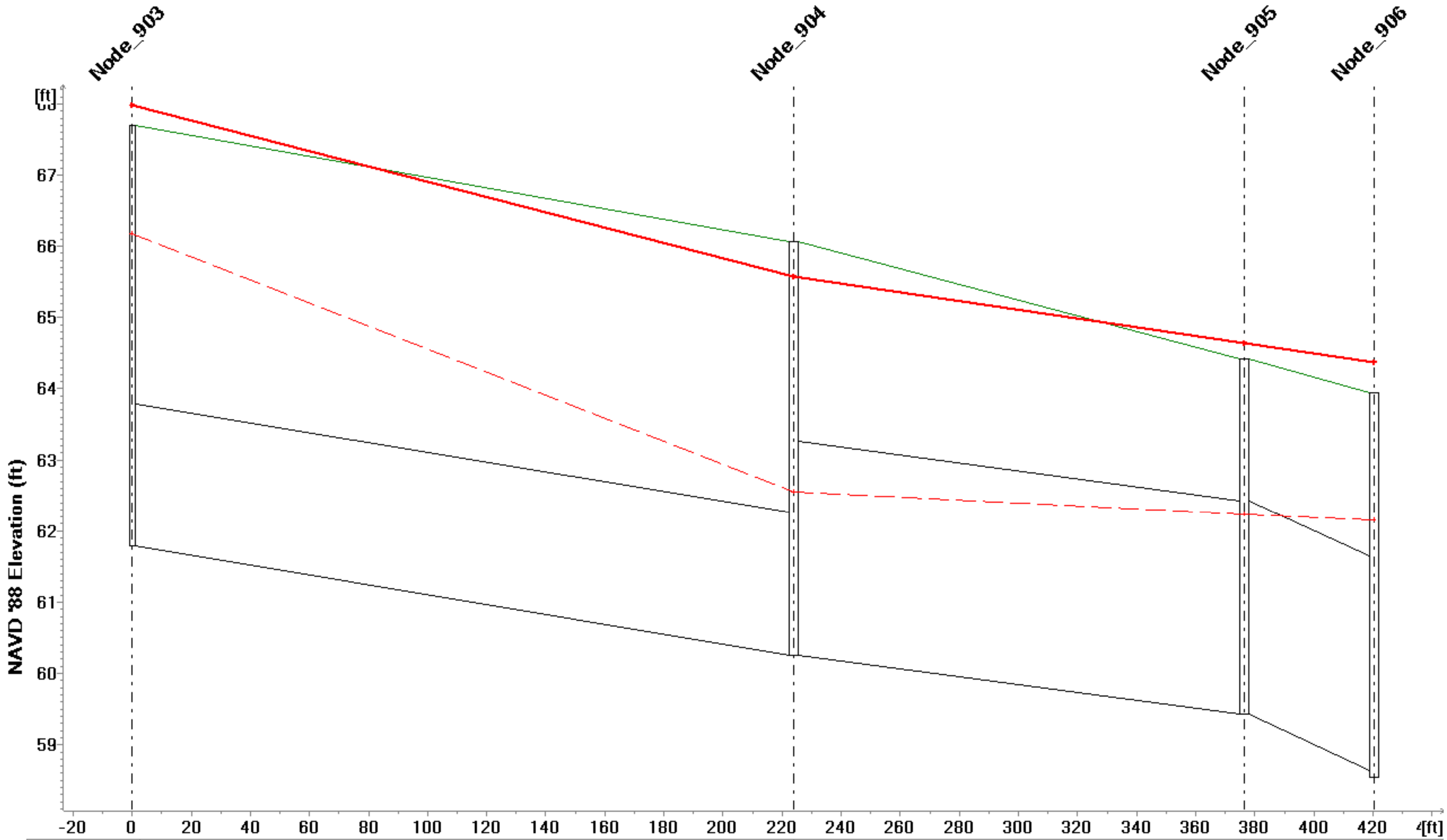


Link ID	Link_24		Link_22	Link_26	Link_25		Link_23		....	Link_20	Link_152	
Q10 (cfs)	133.586	133.522	133.502	139.726	150.721	150.665	150.616	150.612	....	160.005	165.876	165.869
Q100 (cfs)	189.538		189.539	198.693	217.843	217.842	219.383	219.107	....	240.908	246.927	246.930
Length (ft)	344.154		161.809	256.988	379.677		402.957		....	321.649	399.904	
Diameter (ft)	5.0000											

Shaft ID	Node_871	Node_872	Node_873	Node_874	Node_875	Node_876	Node_877	Node_878	Node_1031
Ground Level (ft)	62.00	60.16	59.30	56.87	55.07	55.37	57.26	52.62	49.34
Invert Level (ft)	52.20	50.86	50.20	48.57	47.07	46.77	46.16	44.08	41.49
Q10 HGL (ft)	55.437	54.137	53.541	52.562	51.574	49.842	49.397	47.632	46.000
Q100 HGL (ft)	59.215	57.763	57.097	55.969	54.087	51.654	51.198	48.944	46.000

1/1/2004

Line N-3 with CIP Project

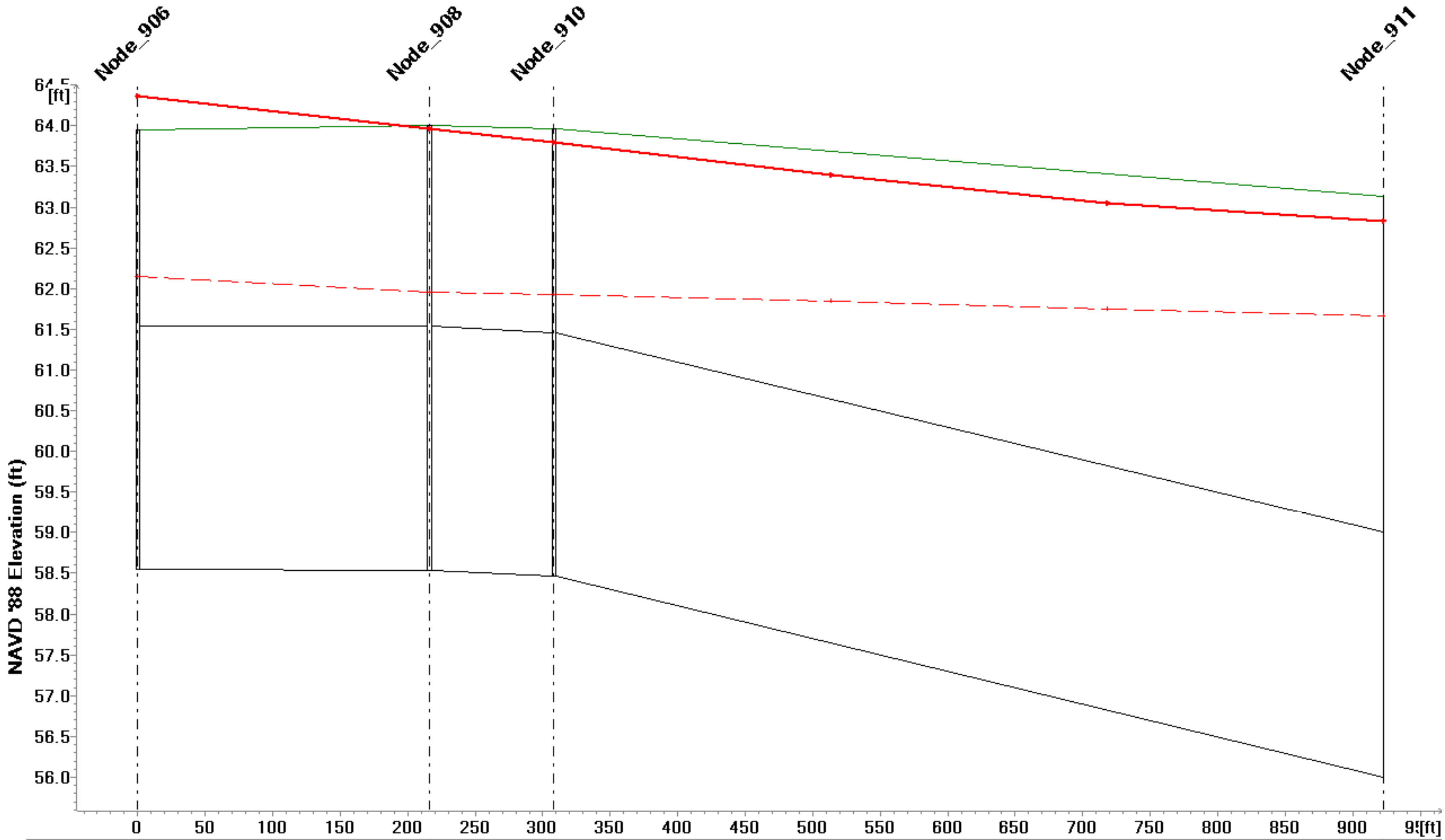


Link ID	Link_46	Link_50	Link_53
Q10 (cfs)	31.863	31.781	31.684
Q100 (cfs)	41.149	36.076	57.647
Length (ft)	224.037	152.347	43.987
Diameter (ft)	2.0000	3.0000	

Shaft ID	Node_903	Node_904	Node_905	Node_906
Ground Level (ft)	67.69	66.06	64.43	63.94
Invert Level (ft)	61.79	60.26	59.43	58.54
Q10 HGL (ft)	66.175	62.556	62.233	62.152
Q100 HGL (ft)	67.976	65.571	64.644	64.368

1/1/2004

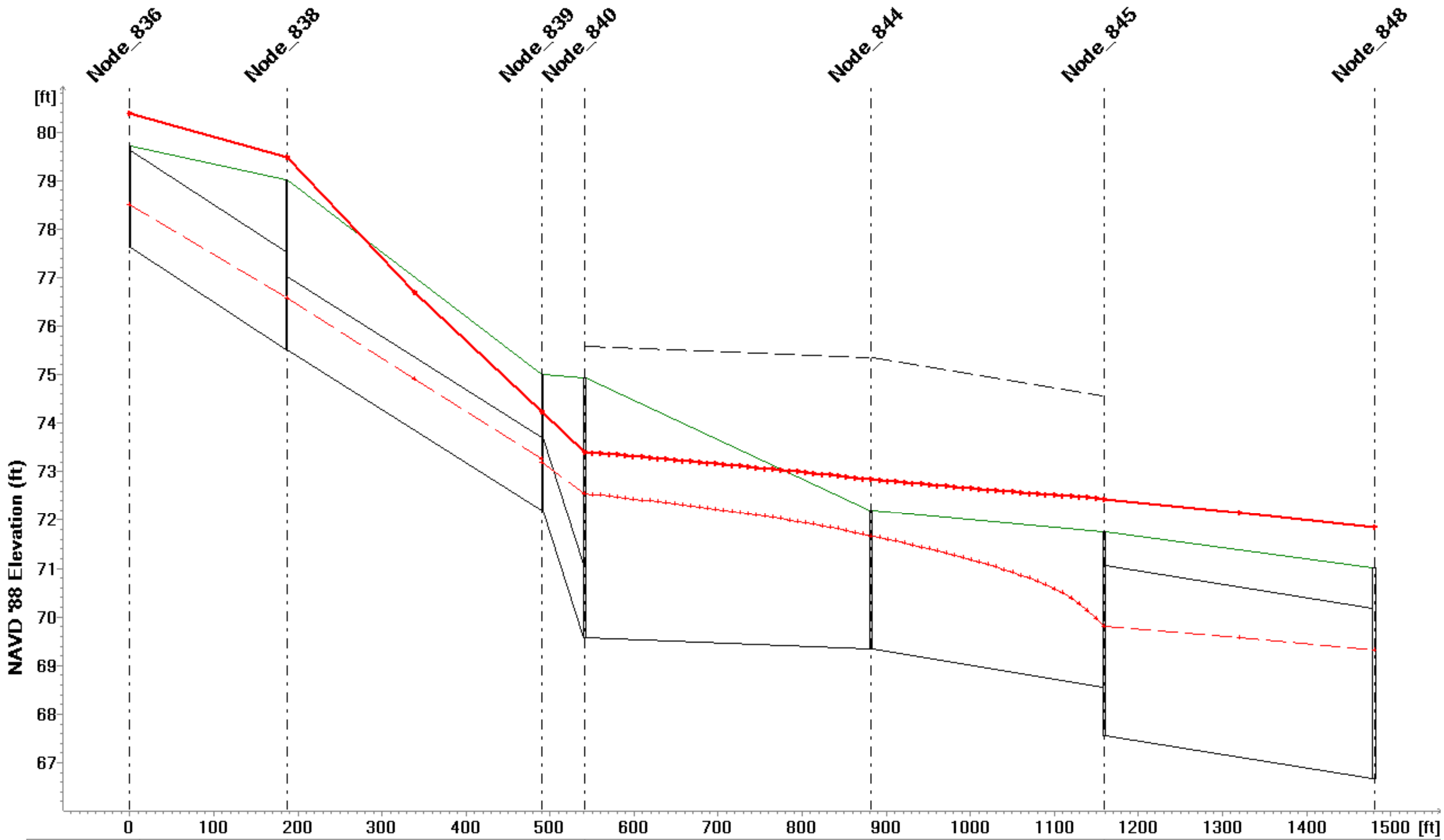
Line N-3 with CIP Project (cont.)



Link ID	Link_55		Link_52		Link_44			
Q10 (cfs)	31.676		31.649		31.628	31.622		31.619
Q100 (cfs)	36.380		37.770		41.389	41.496		
Length (ft)	215.861		92.433		614.470			
Diameter (ft)	3.0000							
Shaft ID	Node_906	Node_908		Node_910			Node_911	
Ground Level (ft)	63.94	64.00		63.96			63.13	
Invert Level (ft)	58.54			58.46			56.00	
Q10 HGL (ft)	62.152	61.962		61.925			61.665	
Q100 HGL (ft)	64.368	63.960		63.801			62.830	

1/1/2004

Line N-5 with CIP Project

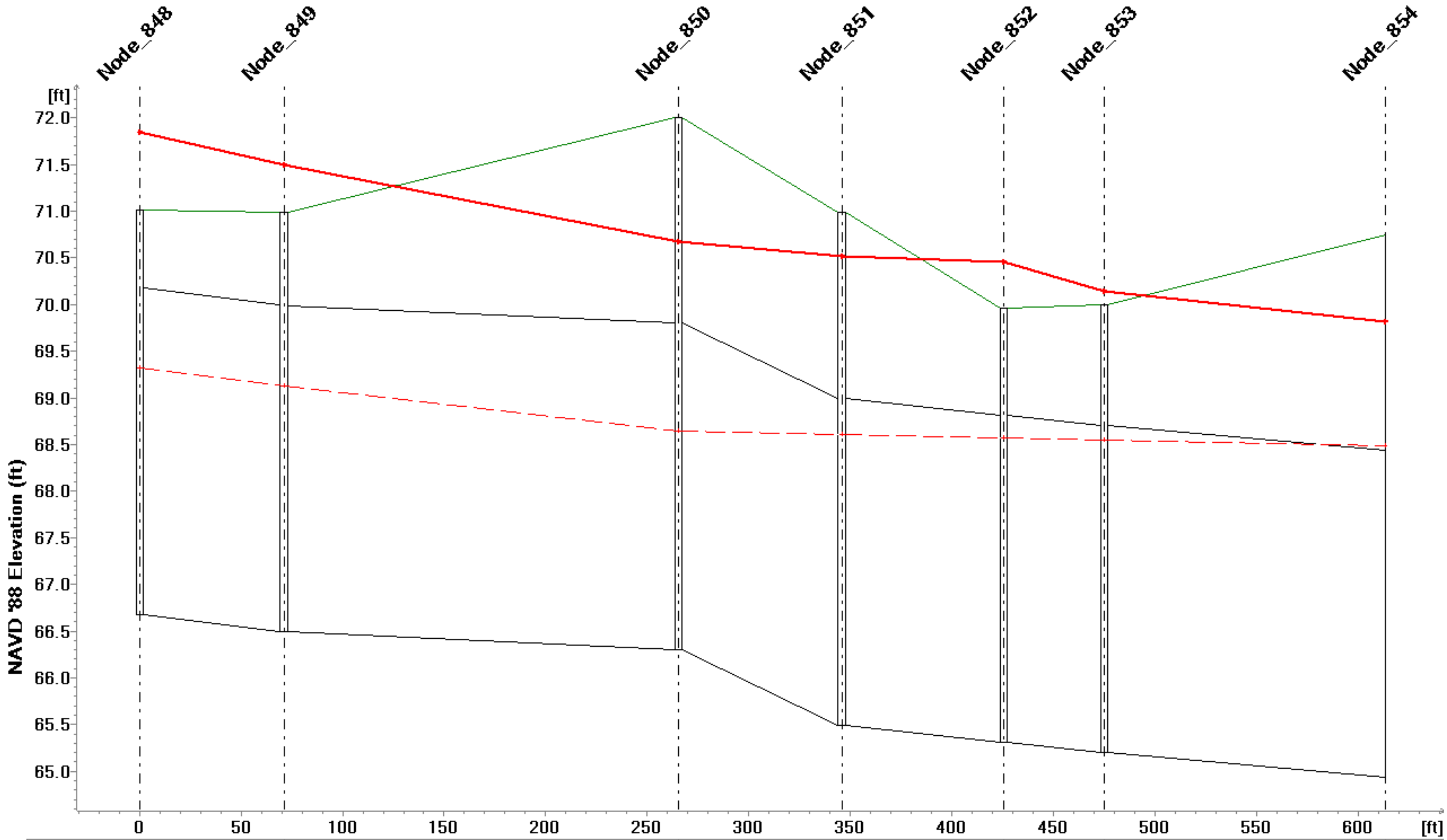


Link ID	Link_102	Link_107			Link_109	Link_101	Link_106	
Q10 (cfs)	10.320	10.310	10.312	....	36.876		36.844	36.841
Q100 (cfs)	18.327	15.746	15.735	....			47.861	47.866
Length (ft)	186.672	304.156		....	341.294	277.297	321.190	
Diameter (ft)	2.0000	1.5000			2.5000		3.5000	

Shaft ID	Node_836	Node_838	Node_839	Node_840	Node_844	Node_845	Node_848
Ground Level (ft)	79.72	79.02	74.99	74.94	72.21	71.75	71.01
Invert Level (ft)	77.62	75.52	72.19	69.58	69.34	67.56	66.68
Q10 HGL (ft)	78.504	76.581	73.190	72.547	71.671	69.804	69.326
Q100 HGL (ft)	80.387	79.486	74.237	73.401	72.838	72.439	71.845

1/1/2004

Line N-5 with CIP Project (cont.)

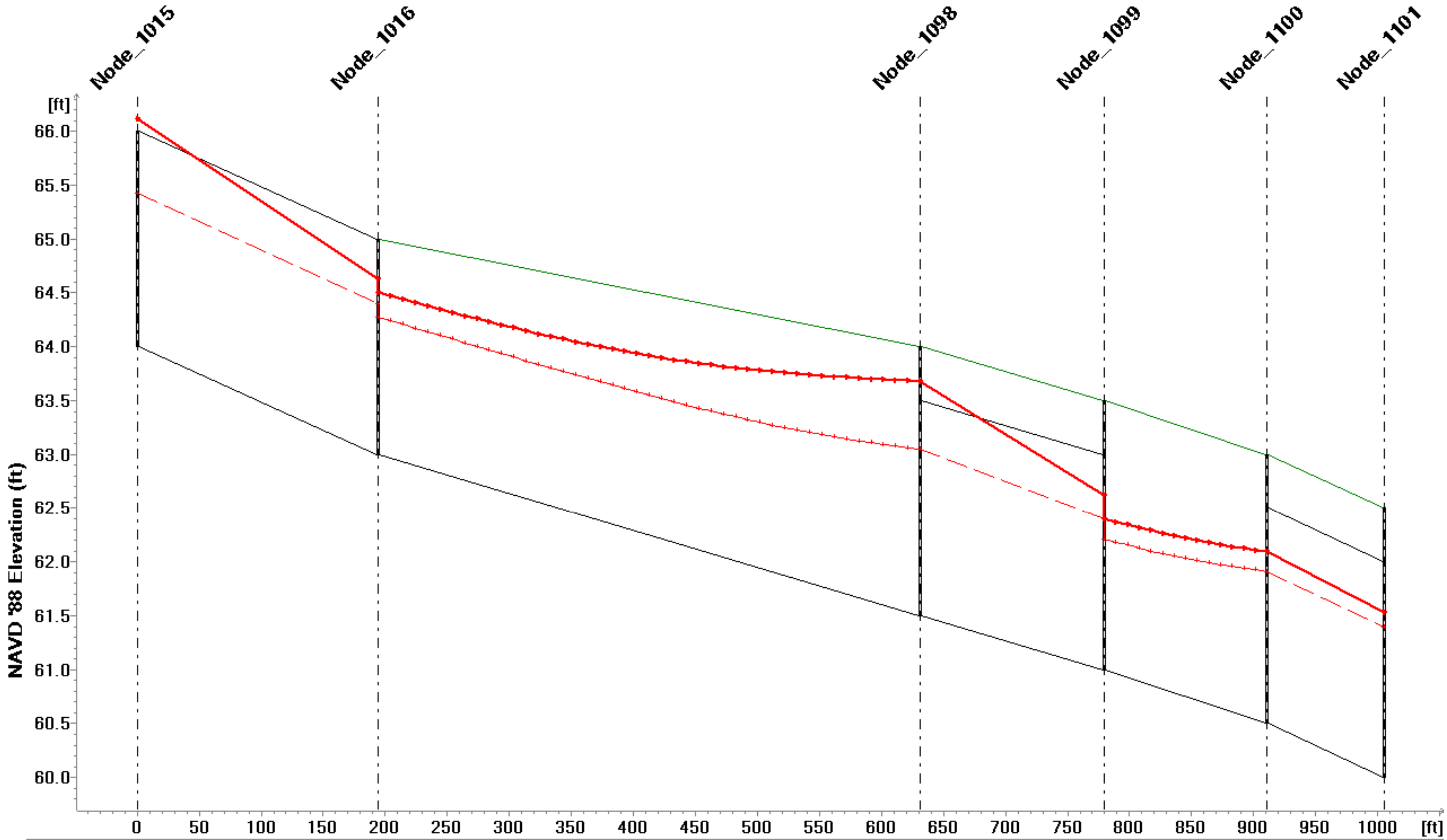


Link ID	Link_91	Link_90	Link_88	Link_89	Link_93	Link_96
Q10 (cfs)	54.496	54.491	54.483	54.476	54.470	54.475
Q100 (cfs)	78.672	78.667	78.661	78.657	78.653	78.647
Length (ft)	71.128	194.385	80.267	79.935	49.319	138.440
Diameter (ft)	3.5000					

Shaft ID	Node_848	Node_849	Node_850	Node_851	Node_852	Node_853	Node_854
Ground Level (ft)	71.01	70.99	72.00	70.99	69.96	70.00	70.75
Invert Level (ft)	66.68	66.49	66.30	65.49	65.31	65.20	64.94
Q10 HGL (ft)	69.326	69.124	68.641	68.606	68.572	68.549	68.484
Q100 HGL (ft)	71.845	71.491	70.668	70.517	70.460	70.144	69.818

1/1/2004

Line F-1 with CIP Project

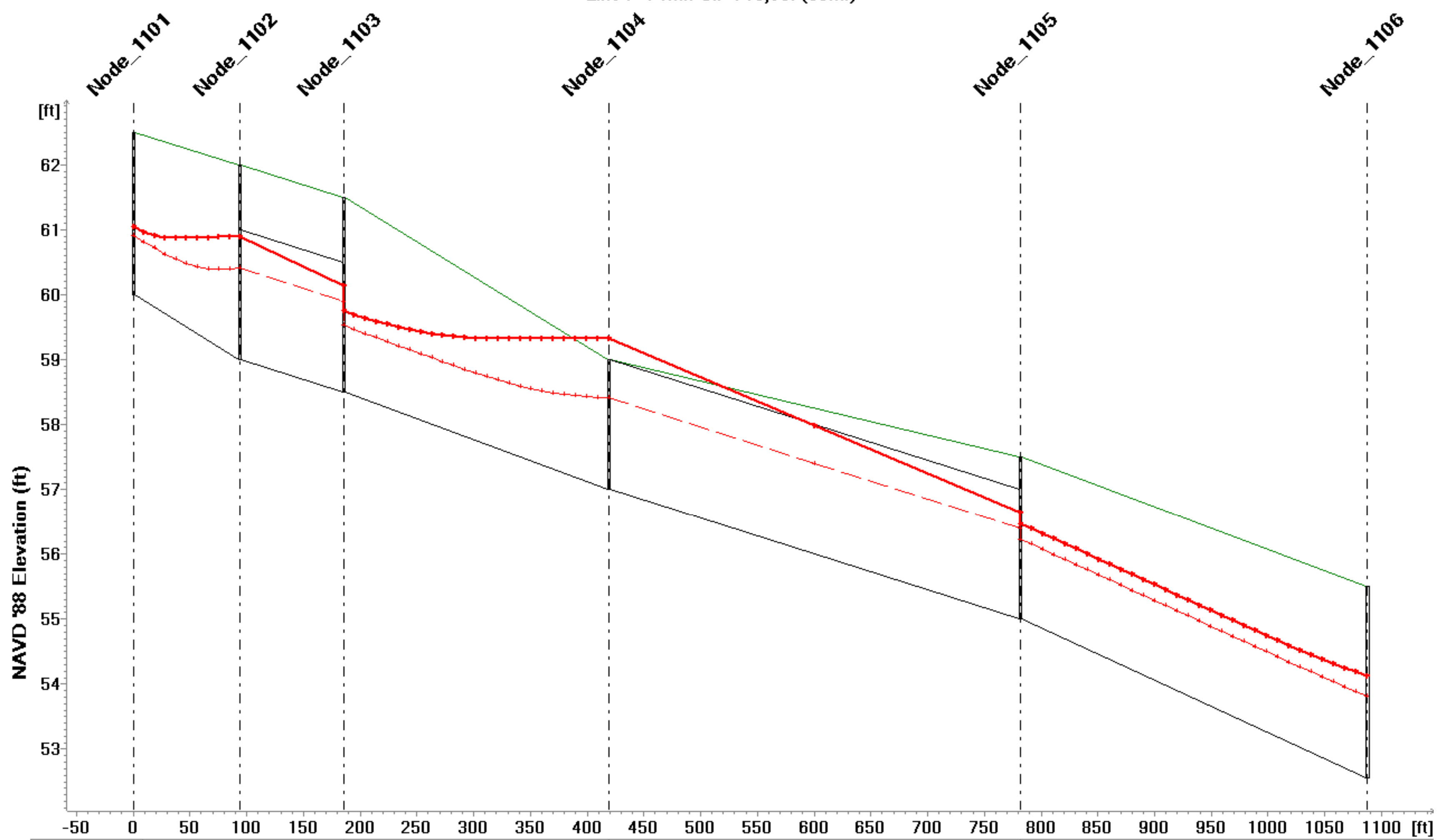


Link ID	Link_165	Link_570	Link_571	Link_572	Link_573
Q10 (cfs)	15.669	15.668 15.667 15.666 15.661 15.654	15.653	15.649	15.648
Q100 (cfs)	21.940	21.222	21.112	21.113	18.797
Length (ft)	194.460	436.890	148.190	131.480	94.190
Diameter (ft)	2.0000		2.0000		2.0000

Shaft ID	Node_1015	Node_1016	Node_1098	Node_1099	Node_1100	....
Ground Level (ft)	66.00	65.00	64.00	63.50	63.00	62.50
Invert Level (ft)	64.00	63.00	61.50	61.00	60.50	60.00
Q10 HGL (ft)	65.430	64.274	63.049	62.211	61.913	60.908
Q100 HGL (ft)	66.114	64.505	63.681	62.401	62.094	61.052

1/1/2004

Line F-1 with CIP Project (cont.)

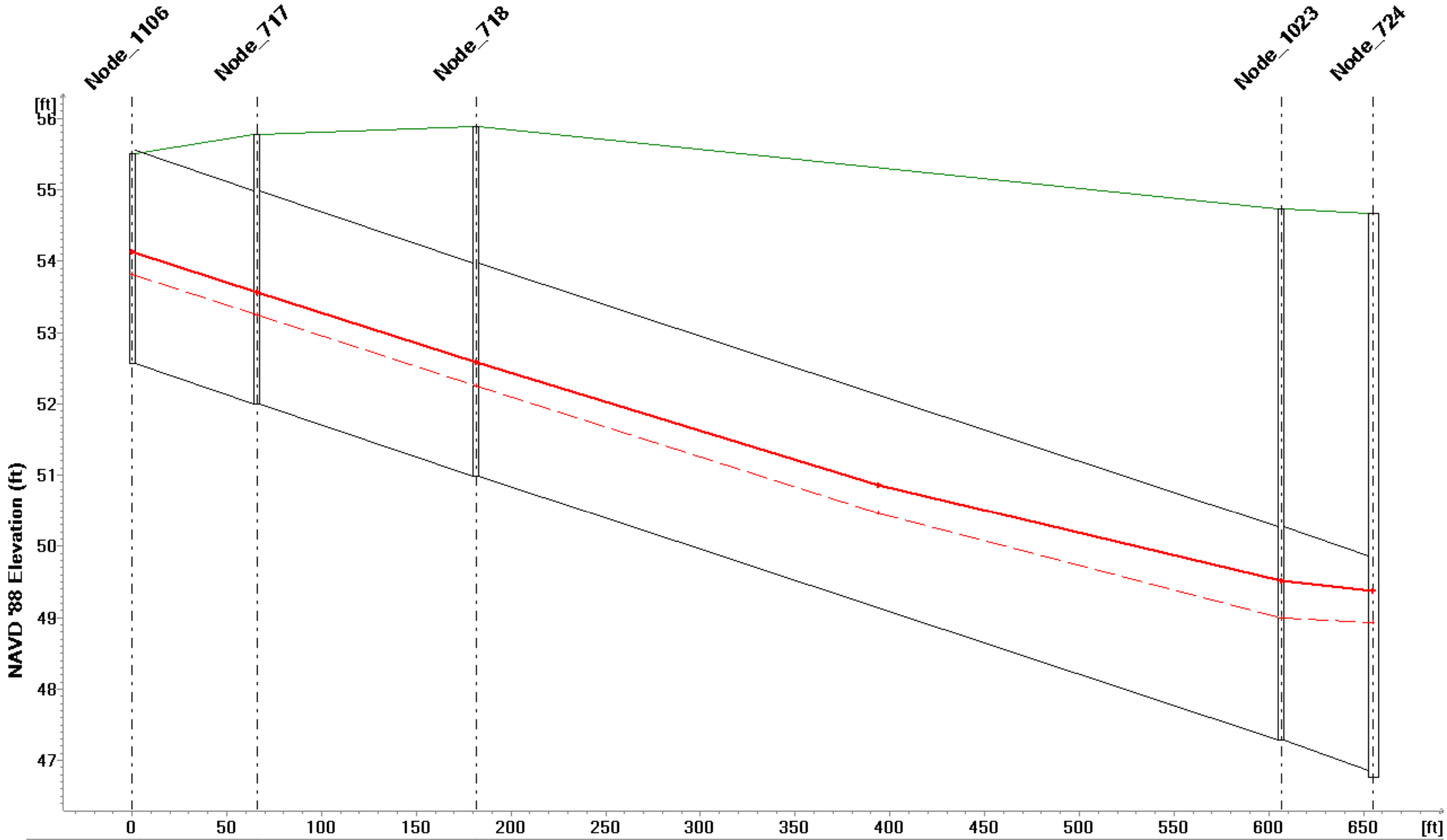


Link ID	Link_574	Link_575	Link_576	Link_577	Link_578								
Q10 (cfs)	.....	15.647	15.646	15.645	15.644	....	15.640	..	25.224	....	25.222	25.223	25.222
Q100 (cfs)	....	22.628	22.627	....	21.502	21.503	....	36.880	36.879	36.878	36.879		
Length (ft)	94.190	91.030	233.510	363.250	305.660								
Diameter (ft)		2.0000		2.0000									

Shaft ID	....	Node_1102	Node_1103	Node_1104	Node_1105	Node_1106
Ground Level (ft)	62.50	62.00	61.50	59.00	57.50	55.50
Invert Level (ft)	60.00	59.00	58.50	57.00	55.00	52.56
Q10 HGL (ft)	60.908	60.404	59.526	58.407	56.229	53.821
Q100 HGL (ft)	61.052	60.887	59.750	59.328	56.476	54.130

1/1/2004

Line F-1 with CIP Project (cont.)

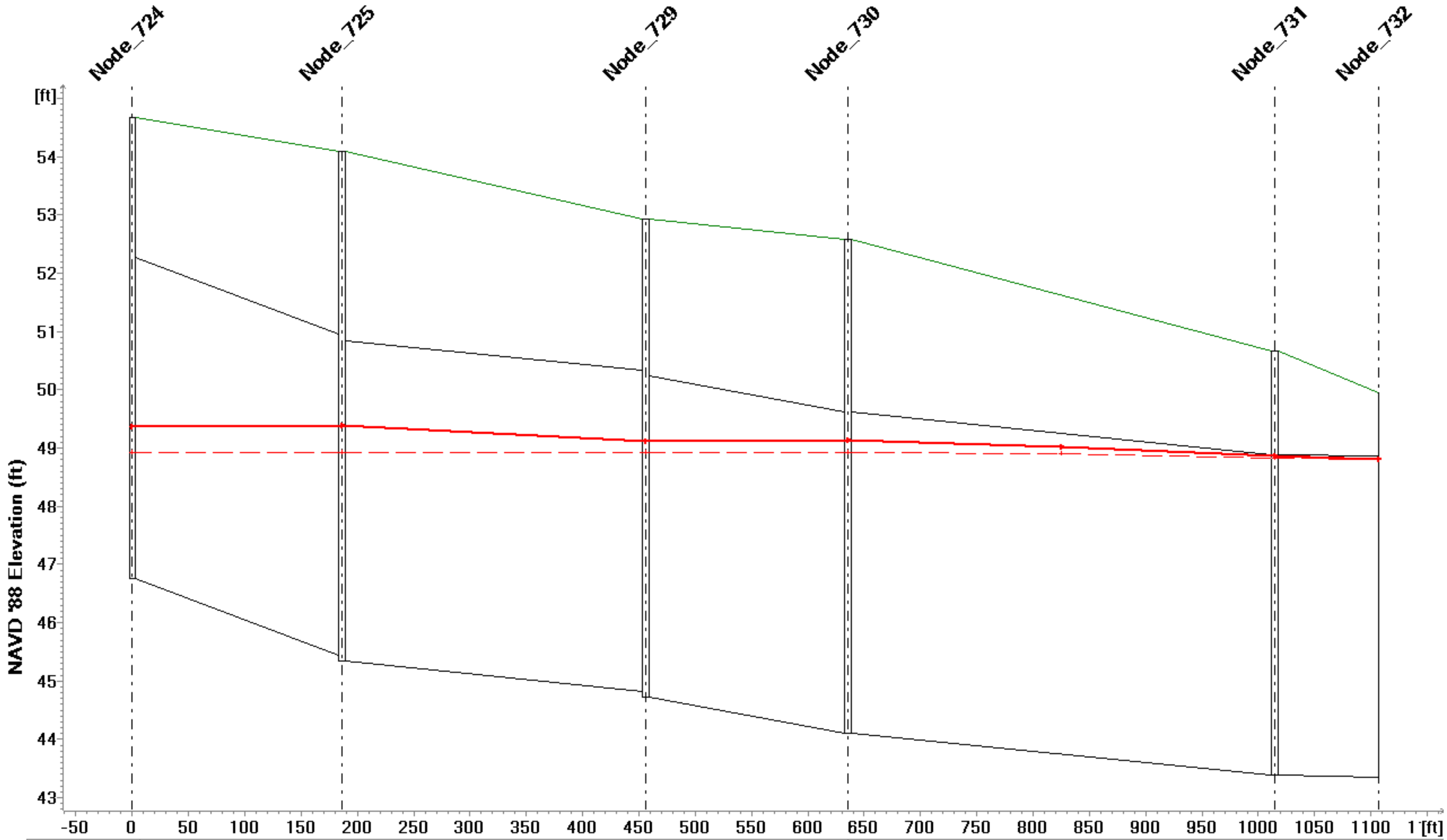


Link ID	Link_167	Link_436	Link_164		Link_159
Q10 (cfs)	25.222	25.221	25.223	25.240	25.284
Q100 (cfs)	36.879	36.881	36.889	36.939	37.049
Length (ft)	65.947	115.580	424.890		48.747
Diameter (ft)	3.0000				

Shaft ID	....	Node_717	Node_718	Node_1023	....
Ground Level (ft)	55.50	55.77	55.89	54.74	54.66
Invert Level (ft)	52.56	51.99	50.98	47.28	46.76
Q10 HGL (ft)	53.821	53.249	52.249	48.998	48.925
Q100 HGL (ft)	54.130	53.563	52.576	49.516	49.369

1/1/2004

Line F-1 with CIP Project (cont.)

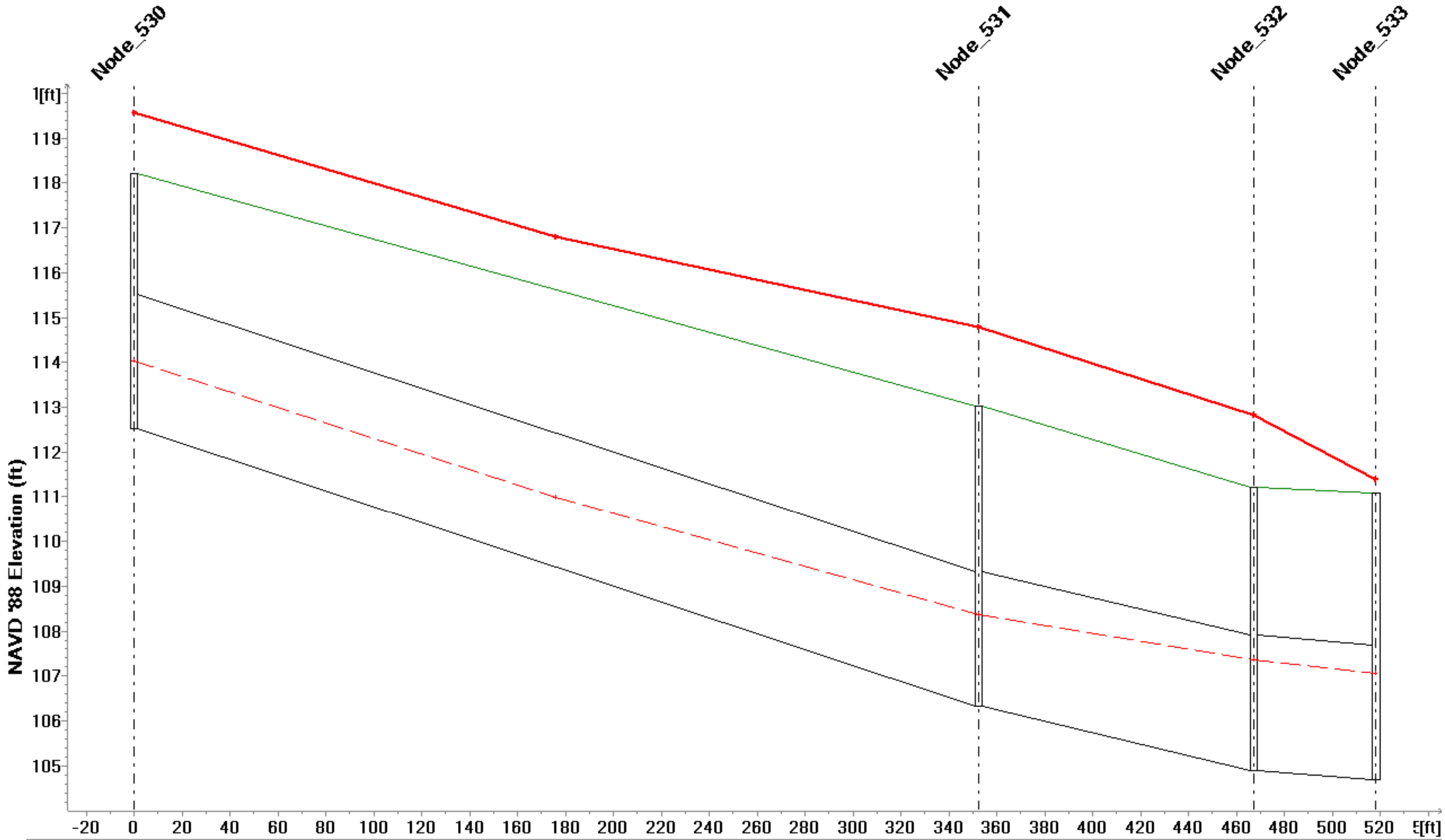


Link ID	Link_441	Link_439	Link_403	Link_363		Link_430
Q10 (cfs)	64.129	64.169	64.195	64.205	64.203	64.202
Q100 (cfs)	102.872	102.891	102.908	102.916		
Length (ft)	186.251	269.850	179.388	378.970		92.304
Diameter (ft)	5.5000					

Shaft ID	Node_724	Node_725	Node_729	Node_730	Node_731	....
Ground Level (ft)	54.66	54.10	52.93	52.57	50.66	49.96
Invert Level (ft)	46.76	45.35	44.73	44.11	43.38	43.36
Q10 HGL (ft)	48.925	48.924	48.916	48.922	48.833	48.800
Q100 HGL (ft)	49.369	49.382	49.122	49.134	48.871	48.800

1/1/2004

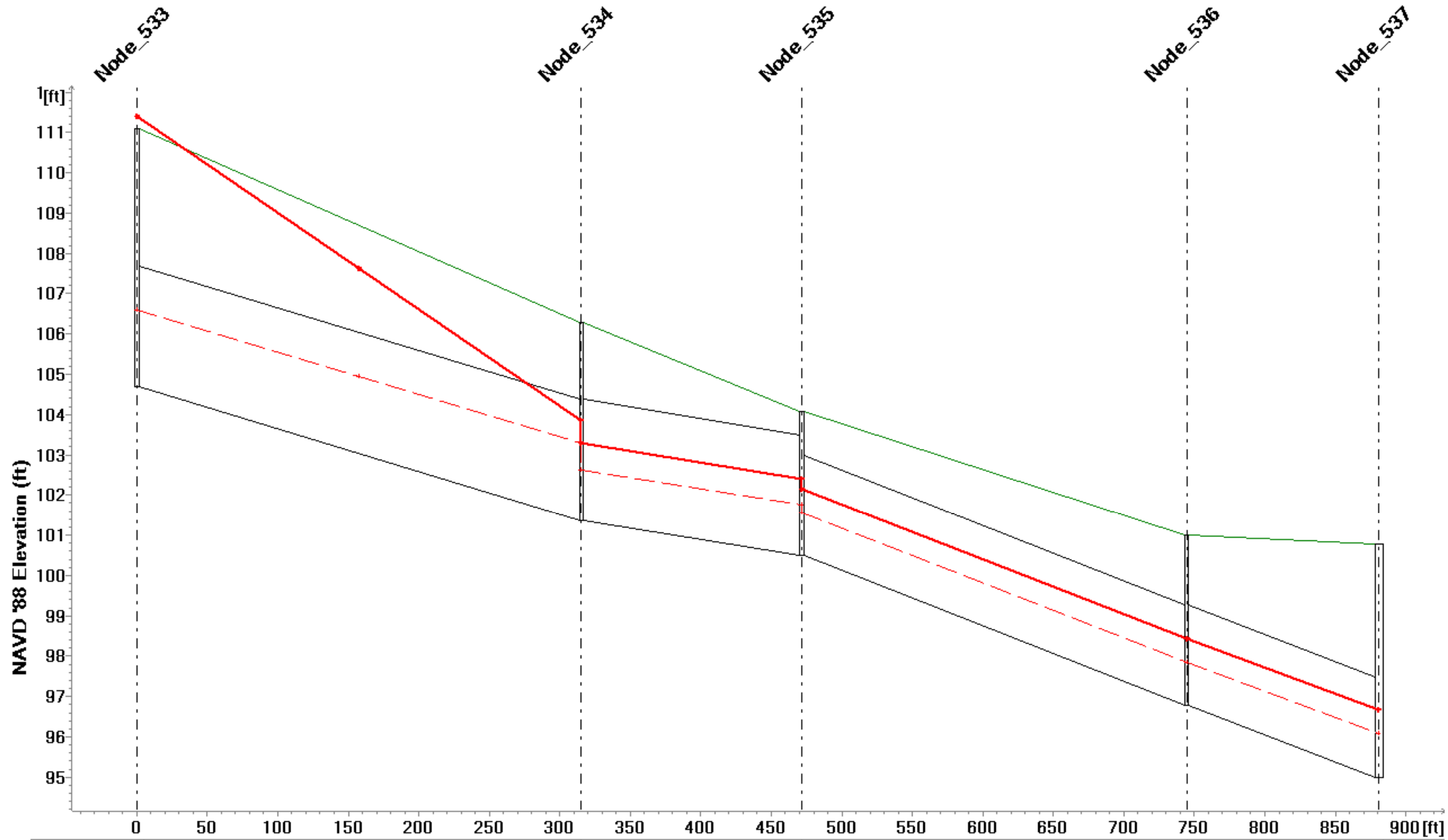
Line F-12 with CIP Project



Link ID	Link_478		Link_306	Link_305
Q10 (cfs)	49.023	49.030	55.457	55.452
Q100 (cfs)	96.760	93.964	116.908	124.235
Length (ft)	352.366		114.754	51.153
Diameter (ft)	3.0000			
Shaft ID	Node_530	Node_531	Node_532	....
Ground Level (ft)	118.21	113.02	111.20	111.09
Invert Level (ft)	112.51	106.32	104.90	104.69
Q10 HGL (ft)	114.025	108.363	107.359	106.600
Q100 HGL (ft)	119.576	114.800	112.831	111.389

1/1/2004

Line F-12 with CIP Project (cont.)

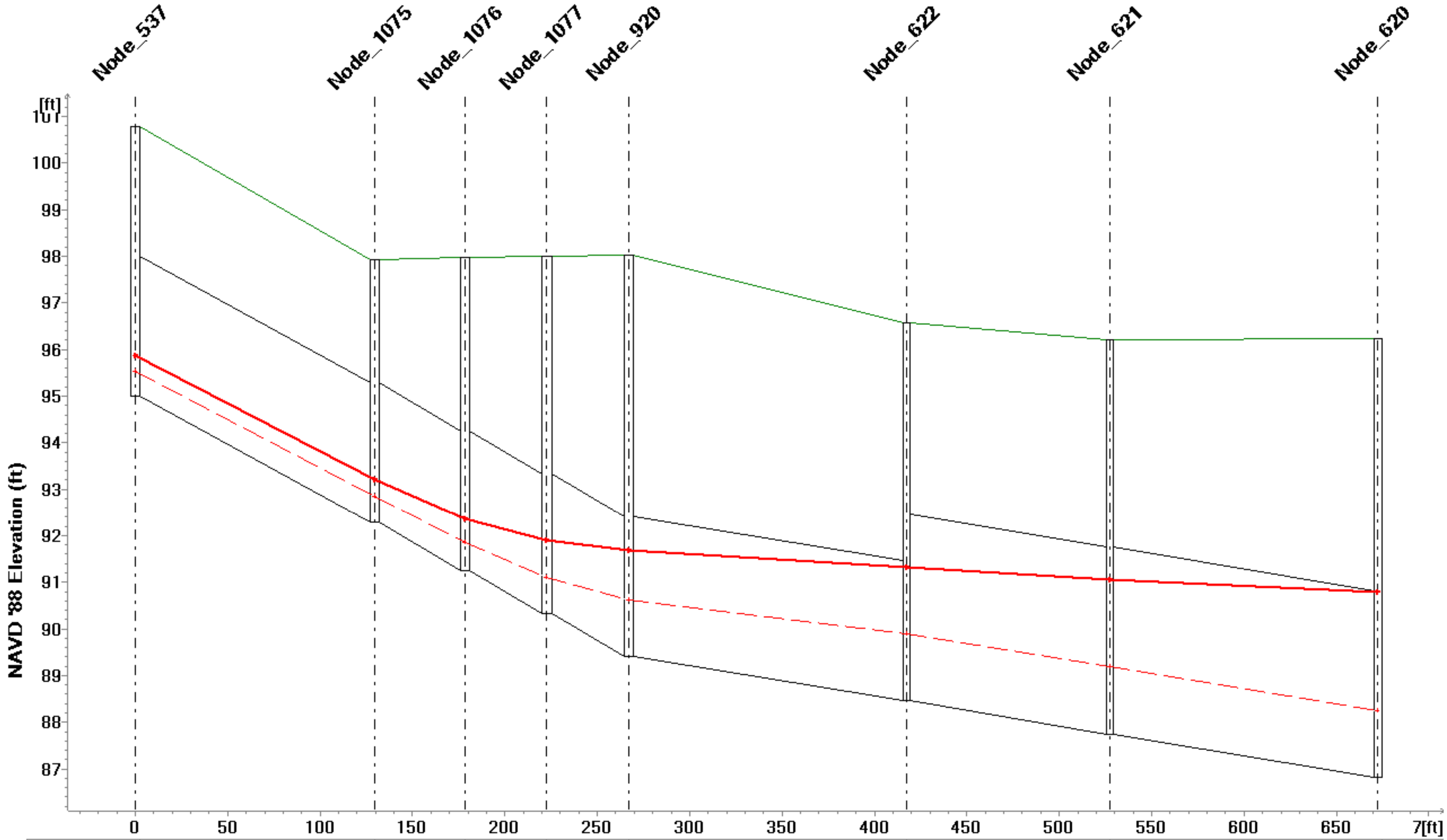


Link ID	Link_303		Link_561	Link_304	Link_308
Q10 (cfs)	55.445	55.430	20.126	20.130	20.128
Q100 (cfs)	117.920	115.882	40.651	40.639	
Length (ft)	315.316		156.400	272.820	136.556
Diameter (ft)	3.0000			2.5000	

Shaft ID	Node_533	Node_534	Node_535	Node_536	Node_537
Ground Level (ft)	111.09	106.28	104.08	101.01	100.79
Invert Level (ft)	104.69	101.38	100.50	96.77	94.99
Q10 HGL (ft)	106.600	102.632	101.569	97.853	95.542
Q100 HGL (ft)	111.389	103.296	102.145	98.440	95.868

1/1/2004

Line F-12 with CIP Project (cont.)

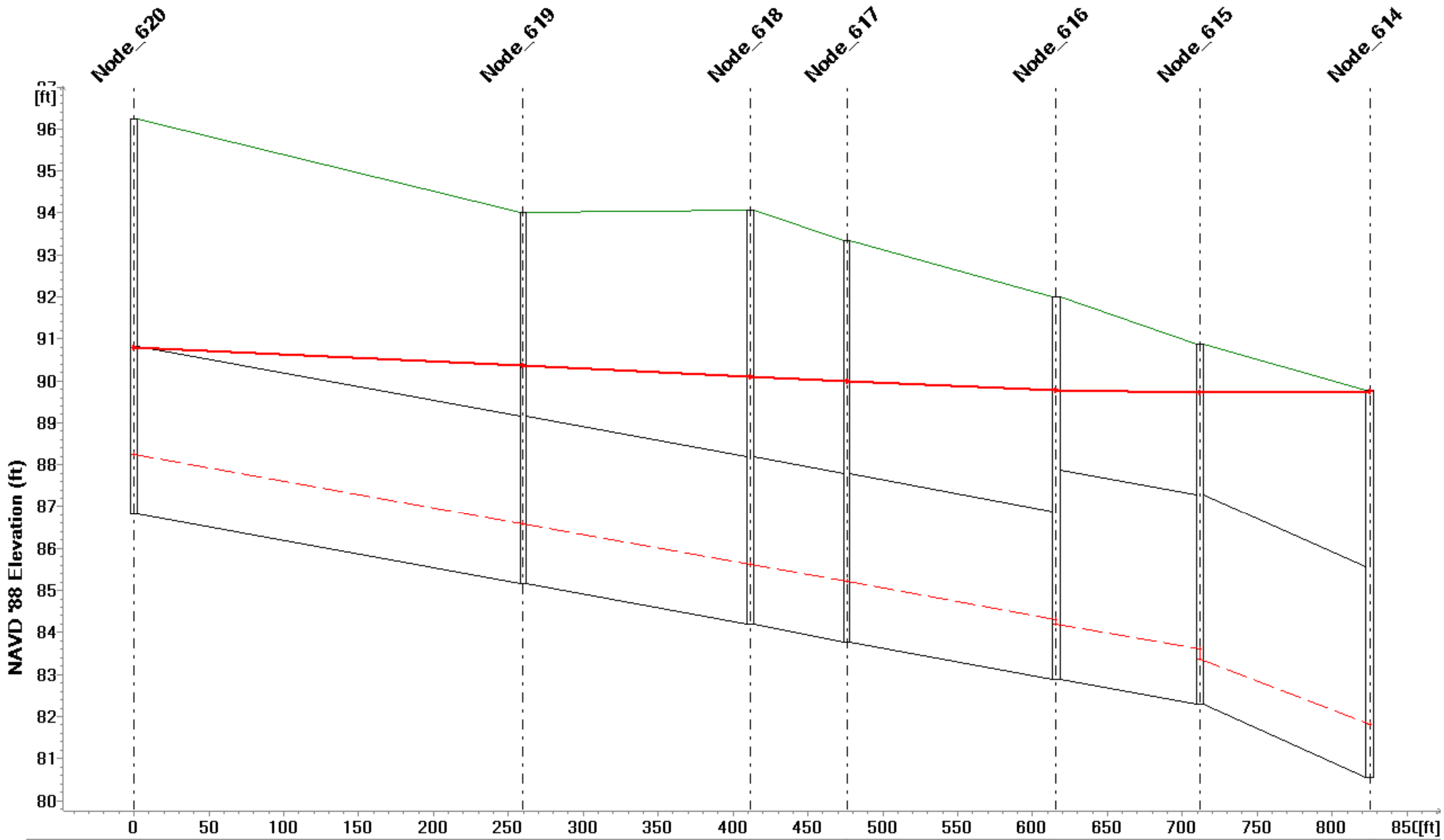


Link ID	Link_518	Link_519	Link_520	Link_521	Link_37/Link_527	Link_239	Link_241
Q10 (cfs)	29.656	29.652	29.651	34.914	17.448	34.900	
Q100 (cfs)	59.562	59.573	59.572	67.143	33.466	66.877	66.900
Length (ft)	129.670	48.960	44.090	44.080	150.574/150.574	110.074	144.967
Diameter (ft)	3.0000				3.0000/3.0000	4.0000	

Shaft ID	Node_537	Node_1075	Node_1076	Node_1077	Node_920	Node_622	Node_621	Node_620
Ground Level (ft)	100.79	97.93	97.98	98.00	98.02	96.58	96.22	96.23
Invert Level (ft)	94.99	92.28	91.26	90.34	89.42	88.46	87.75	86.82
Q10 HGL (ft)	95.542	92.838	91.850	91.101	90.624	89.891	89.183	88.254
Q100 HGL (ft)	95.868	93.208	92.358	91.892	91.676	91.311	91.051	90.800

1/1/2004

Line F-12 with CIP Project (cont.)

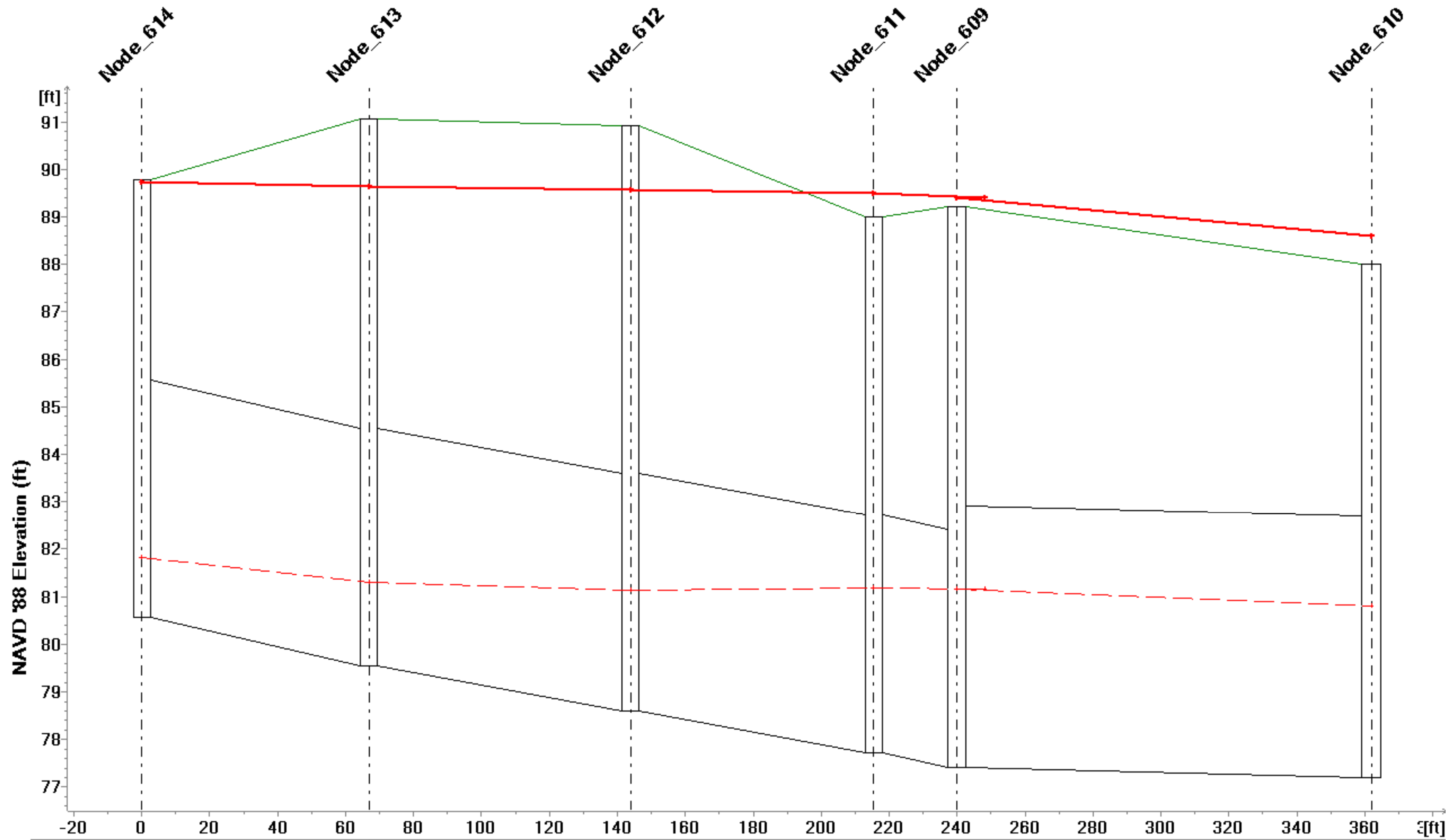


Link ID	Link_242	Link_238	Link_240	Link_237	Link_232	Link_234
Q10 (cfs)	34.893	34.877		34.879	34.881	34.879
Q100 (cfs)	66.946	66.957	66.967	66.976	66.992	66.997
Length (ft)	259.827	151.752	64.352	139.715	96.226	113.412
Diameter (ft)	4.0000				5.0000	

Shaft ID	Node_620	Node_619	Node_618	Node_617	Node_616	Node_615	Node_614
Ground Level (ft)	96.23	94.00	94.07	93.33	92.00	90.88	89.78
Invert Level (ft)	86.82	85.16	84.19	83.78	82.88	82.28	80.56
Q10 HGL (ft)	88.254	86.594	85.625	85.211	84.206	83.369	81.815
Q100 HGL (ft)	90.800	90.354	90.104	90.000	89.773	89.729	89.736

1/1/2004

Line F-12 with CIP Project (cont.)



Link ID	Link_235	Link_472	Link_244	Link_250	Link_253
Q10 (cfs)	34.798	35.046	44.928	44.747	164.314
Q100 (cfs)	70.479	70.108	82.358	84.861	305.509
Length (ft)	66.980	76.966	71.519	24.438	122.014
Diameter (ft)	5.0000				5.5000

Shaft ID	Node_614	Node_613	Node_612	Node_611	Node_609	Node_610
Ground Level (ft)	89.78	91.05	90.91	89.00	89.22	88.01
Invert Level (ft)	80.56	79.55	78.60	77.72	77.42	77.21
Q10 HGL (ft)	81.815	81.303	81.142	81.176	81.168	80.802
Q100 HGL (ft)	89.736	89.633	89.579	89.505	89.414	88.592

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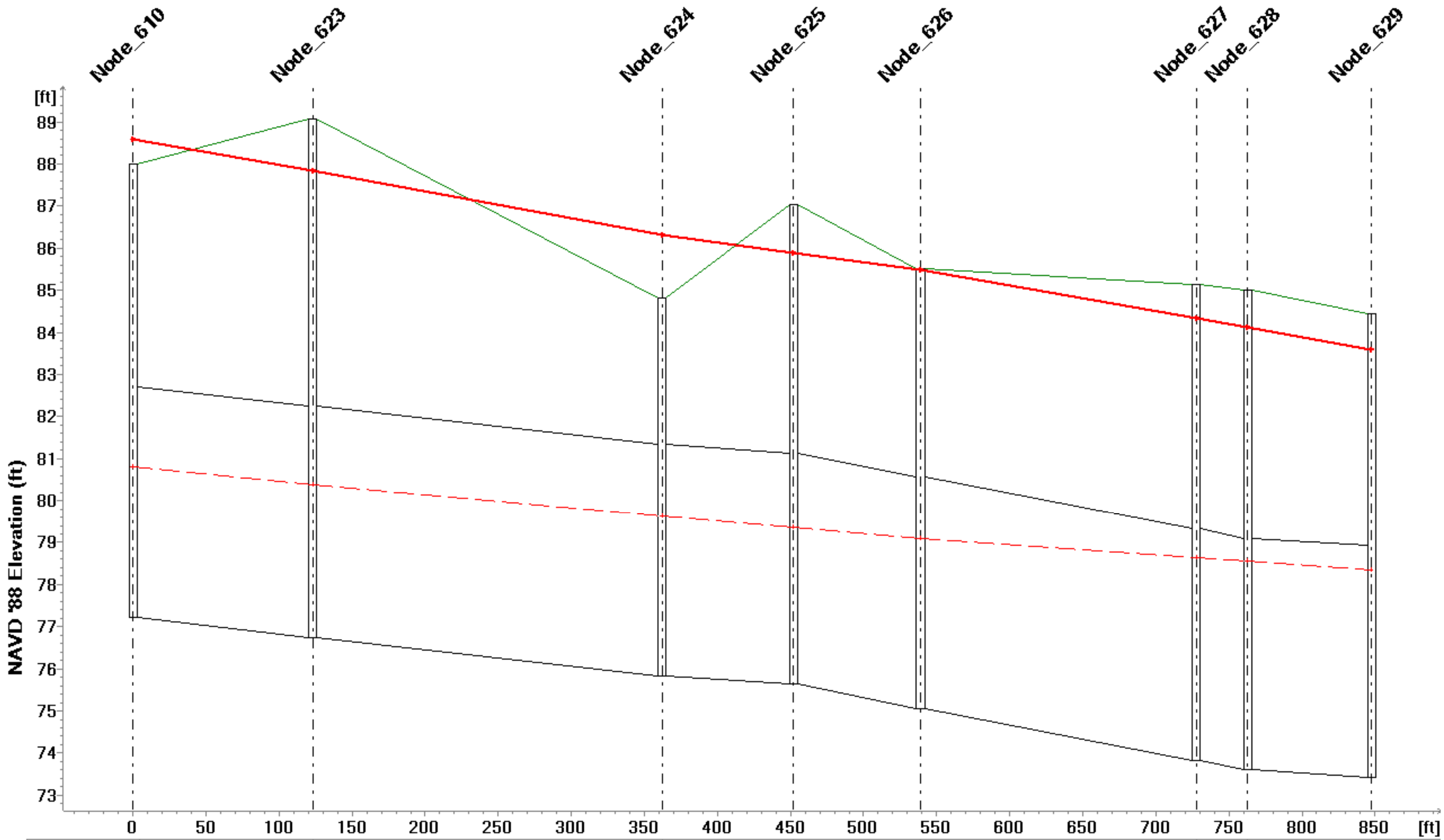
Line F-12 with CIP Project (cont.)



Link ID	Link_113	Link_243	Link_257	Link_259	Link_272	....	Link_278
Q10 (cfs)	164.162	163.856	163.695	163.680	163.656	....	182.019
Q100 (cfs)	297.711	297.521	272.722	271.567	290.124	....	298.193
Length (ft)	123.220	238.742	89.961	86.975	188.845	35.152	84.827
Diameter (ft)	5.5000						

Shaft ID	Node_610	Node_623	Node_624	Node_625	Node_626	Node_627	Node_628	Node_629
Ground Level (ft)	88.01	89.06	84.83	87.03	85.51	85.14	85.00	84.43
Invert Level (ft)	77.21	76.74	75.83	75.63	75.06	73.83	73.60	73.43
Q10 HGL (ft)	80.802	80.386	79.617	79.357	79.093	78.627	78.559	78.355
Q100 HGL (ft)	88.592	87.828	86.315	85.896	85.492	84.340	84.127	83.582

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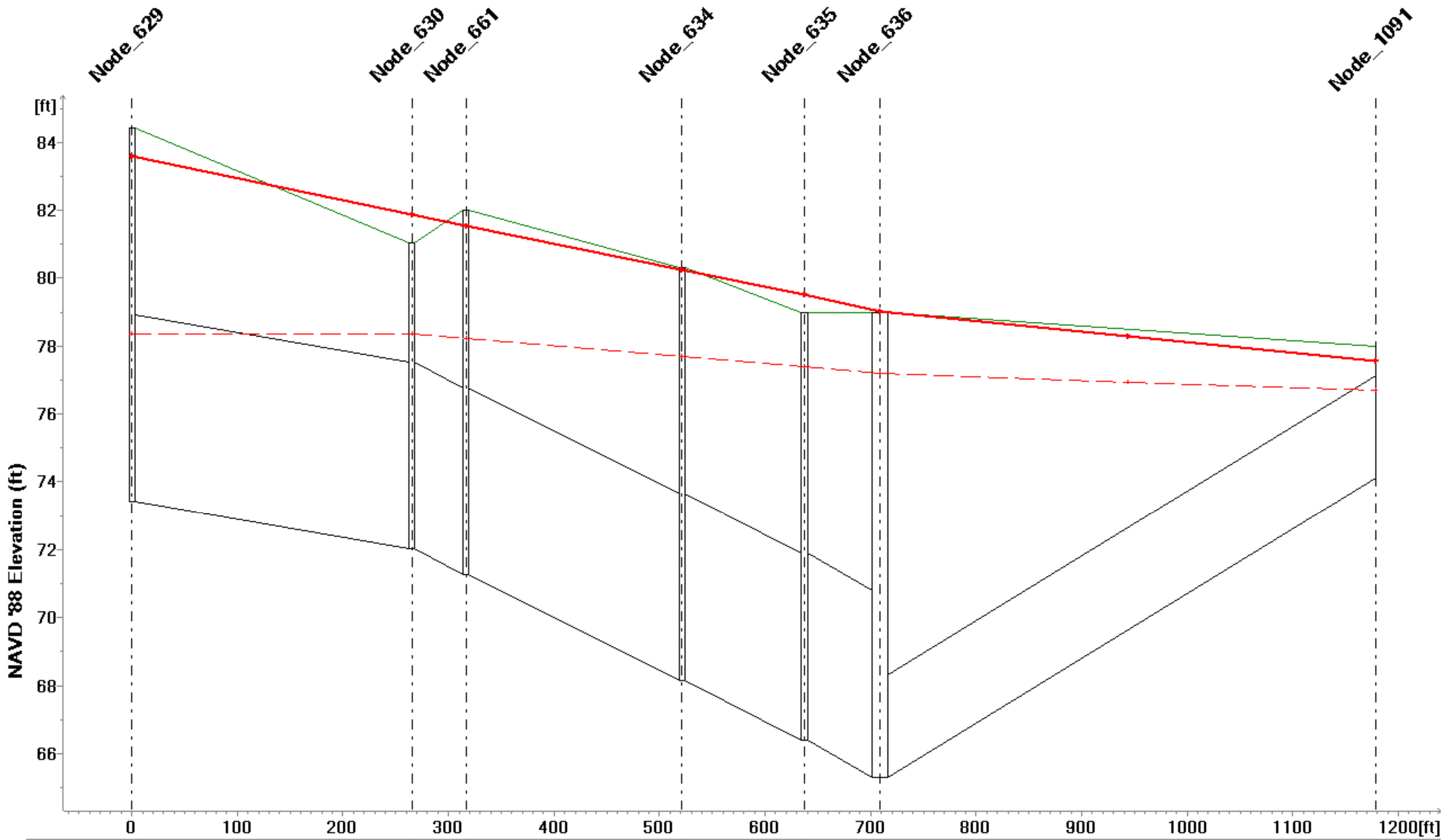
Line F-12 with CIP Project (cont.)



Link ID	Link_277	....	Link_343	Link_283	Link_281	Link_562	
Q10 (cfs)	182.097	182.111	191.031		191.032	203.405	203.404
Q100 (cfs)	299.180	297.672	302.133	298.801	317.643	339.556	339.426
Length (ft)	265.210	51.304	204.578	116.219	71.443	469.760	
Diameter (ft)	5.5000					3.0000	

Shaft ID	Node_629	Node_630	Node_661	Node_634	Node_635	Node_636	Node_1091
Ground Level (ft)	84.43	81.04	82.00	80.31	79.00		78.00
Invert Level (ft)	73.43	72.04	71.26	68.15	66.38	65.30	74.13
Q10 HGL (ft)	78.355	78.358	78.235	77.693	77.385	77.195	76.684
Q100 HGL (ft)	83.582	81.874	81.550	80.242	79.516	79.007	77.566

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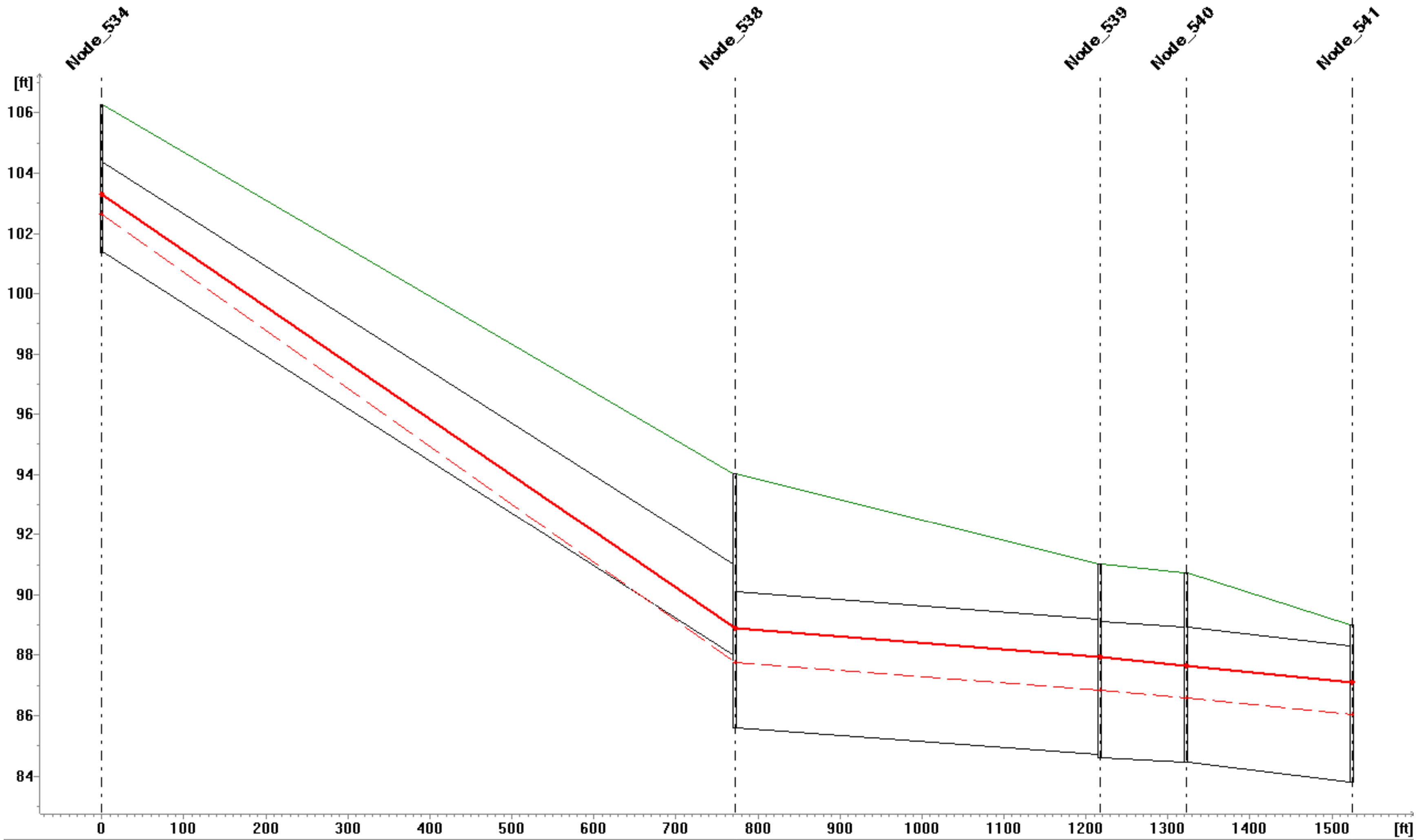
SON-5 Profile



Link ID	Link_607				Link_311		Link_309		Link_313	
Q10 (cfs)	35.300	35.305	35.306	35.303	45.925	45.904	51.919		51.916	
Q100 (cfs)	71.331	71.301		71.300	89.207	89.162	99.248		99.250	
Length (ft)	771.800				445.335		104.875		202.430	
Diameter (ft)	3.0000				4.5000					
MUID	Node_534		Node_538			Node_539		Node_540		Node_541
GroundLevel (ft)	106.28		94.03			91.00		90.74		89.00
InvertLevel (ft)	101.38		85.60			84.60		84.44		83.80
Q10 HGL (ft)	102.632		87.763			86.838		86.592		86.052
Q100 HGL (ft)	101.391		85.616			84.620		84.459		83.811

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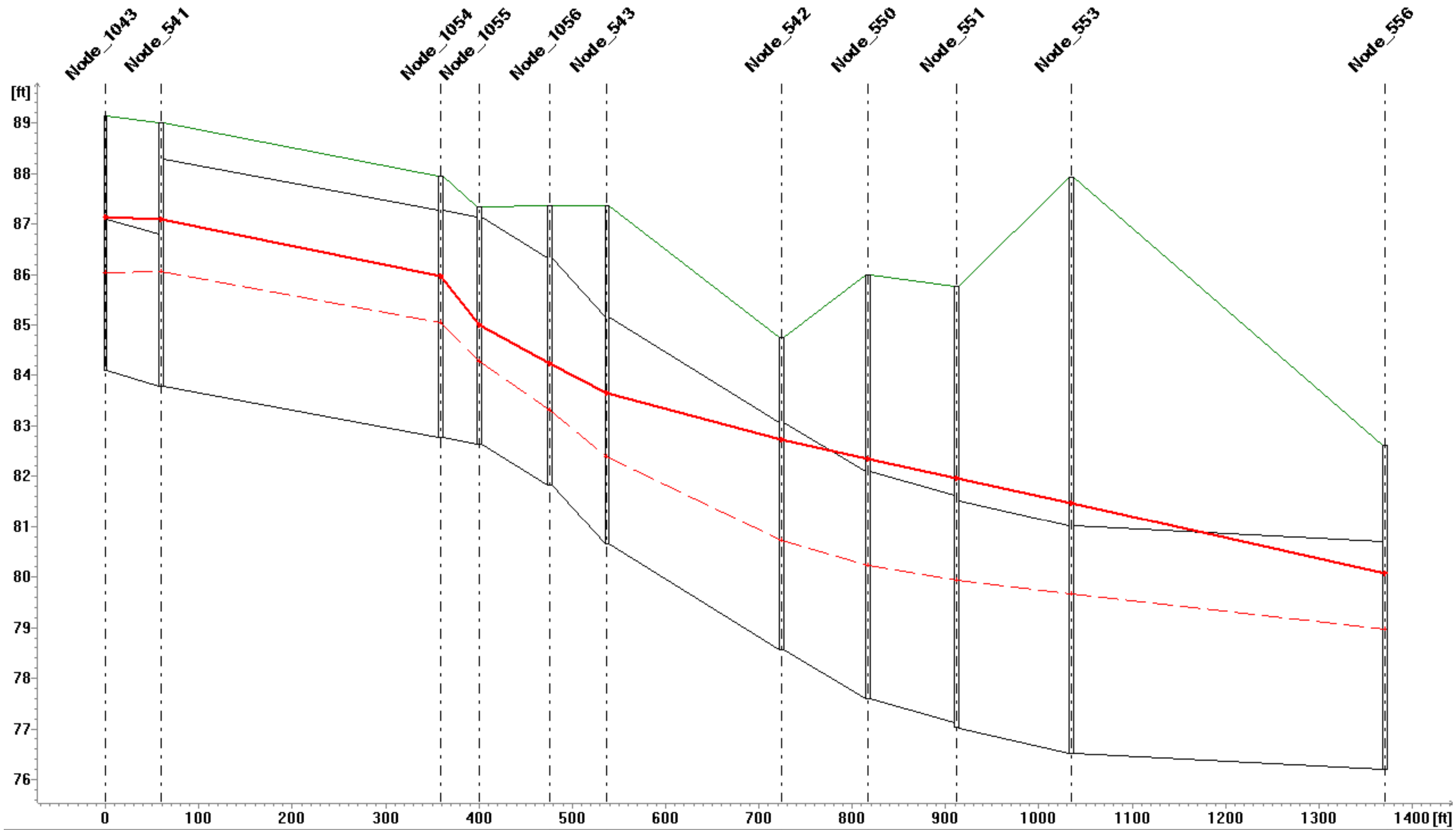
SON-5 Profile (cont.)



Link ID	....	Link_497	....	Link_499	....	Link_312	Link_292	Link_291	Link_289	Link_290	
Q10 (cfs)	11.604	63.379	....	63.331	63.325	63.342	75.900	75.874	75.842	75.837	75.835
Q100 (cfs)	19.474	118.626	....	118.640	118.626	118.586	138.977	138.970	138.965	138.960	138.939
Length (ft)	59.428	299.380	....	74.970	61.710	186.839	92.518	95.177	122.890	335.840	
Diameter (ft)	3.0000	4.5000									

MUID	......	Node_541	Node_1054	....	....	Node_543	Node_542	Node_550	Node_551	Node_553	Node_556
GroundLevel (ft)	......	89.00	87.94	87.35	87.36		84.76	86.00	85.76	87.93	82.62
InvertLevel (ft)	......	83.80	82.78	82.64	81.83	80.66	78.56	77.60	77.03	76.53	76.20
Q10 HGL (ft)	......	86.052	85.044	84.270	83.319	82.381	80.731	80.221	79.939	79.676	78.971
Q100 HGL (ft)	......	83.811	82.796	82.656	81.846	80.676	78.576	77.616	77.036	76.545	76.216

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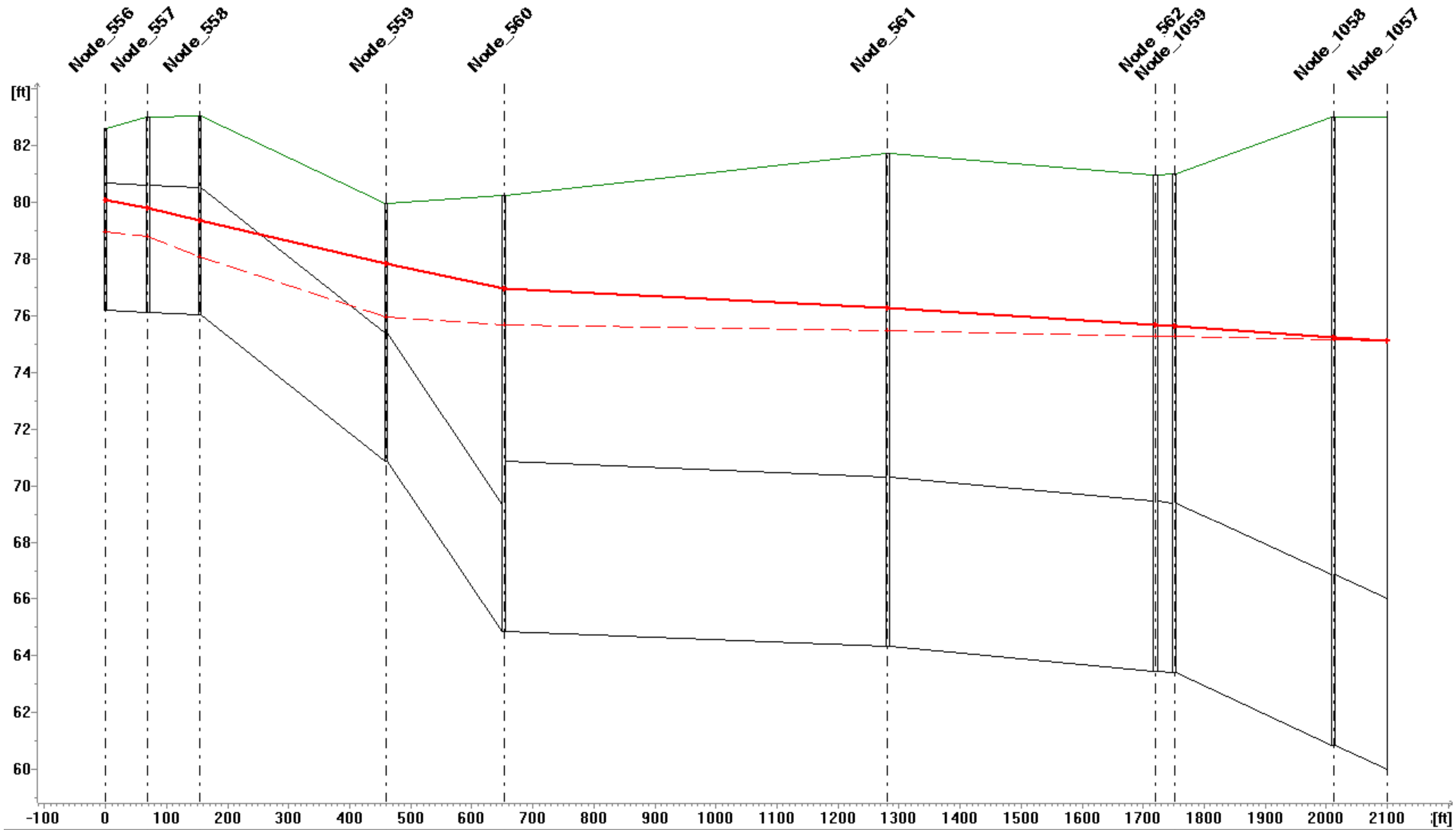
SON-5 Profile (cont.)



Link ID	....	....	Link_298	Link_296	Link_300	Link_314	.....	Link_502	....	
Q10 (cfs)	....	75.825	75.873	80.405	85.214	85.218	85.222	96.356	96.357	.....
										102.149
Q100 (cfs)	....	138.900	139.009	146.191	154.216	154.217	154.218	172.403	181.879	181.880
Length (ft)	....	85.126	305.135	192.984	628.559	438.992	.....	260.260	87.370	
Diameter (ft)	4.5000	6.0000								
MUID	....	....	Node_558	Node_559	Node_560	Node_561	Node_562	Node_1059	Node_1058	....
GroundLevel (ft)	....	83.02	83.05	79.98	80.25	81.72	80.96	81.00	83.00	
InvertLevel (ft)	....	76.13	76.05	70.88	64.85	64.32	63.46	63.40	60.85	....
Q10 HGL (ft)	....	78.798	78.073	75.945	75.684	75.473	75.284	75.268	75.142	....
Q100 HGL (ft)	....	76.146	76.064	75.100						

1/1/2004

Appendix H
10-Year Storm Drain Capital Improvement Program

	City of Sonoma											
	10-Year Storm Drain Capital Improvement Program - FY 2010 - 2020 (all costs shown in 2011 dollars)											May-10
CIP ID No.		**FY 10-11**	**FY 11-12**	**FY 12-13**	**FY 13-14**	**FY 14-15**	**FY 15-16**	**FY 16-17**	**FY 17-18**	**FY 18-19**	**FY 19-20**	**Totals**
	Recommended Capital Improvement Projects											
1	Fryer Creek culvert at West MacArthur St.		600,000	640,897								$ 1,240,897
2	Nathanson Creek – Patten St. Bridge			800,000	200,000	172,094						$ 1,172,094
3	Nathanson Creek Floodwalls					500,000	1,500,000	2,056,874				$ 4,056,874
4	Line F-12 – Increase Pipe Size	552,786										$ 552,786
5	Bypass – Connect Line F-12 to Line SON-5								1,000,000	1,000,000	941,092	$ 2,941,092
6	Line F-1 – Increase Pipe Size				316,807							$ 316,807
7	Line N-3 – Increase Pipe Size					242,228						$ 242,228
8	Line N-5 – Increase Pipe Size										703,056	$ 703,056
9	Line S-1 – Increase Pipe Size – Pipe 70 and 62-66				872,531	500,000						$ 1,372,531
10	Line S-1 – Increase Pipe Size upstream of Junction with Line S-1-6		915,559									$ 915,559
	TOTAL CIP	**552,786**	**1,515,559**	**1,440,897**	**1,389,338**	**1,414,322**	**1,500,000**	**2,056,874**	**1,000,000**	**1,000,000**	**1,644,148**	**$ 13,513,924**
		FY 10-11	**FY 11-12**	**FY 12-13**	**FY 13-14**	**FY 14-15**	**FY 15-16**	**FY 16-17**	**FY 17-18**	**FY 18-19**	**FY 19-20**	**Totals**