

City of St. Joseph, Missouri
Facilities Plan

Technical Memorandum No. TM-CSO-8
Diversion Structure Modifications



By



Work Order No. 09-001
B&V Project 163509

March 3, 2010

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Diversion Structure Modifications

1.0 Executive Summary

The purpose of this technical memorandum is to evaluate and summarize recommendations to modify and improve the existing combined sewer diversion structures. As part of the 2008 Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP), various diversion structure modifications were proposed including the installation of automated gates and increasing weir heights to better utilize the existing sewer system capacity. The main goal of the 2008 LTCP was to reduce average annual frequency of CSOs at each diversion structure for Phase I to 12 events and for Phase III to four events or less. Since completion of the 2008 LTCP, the Facilities Plan was initiated to refine the recommendation of the LTCP and detail other needed collection system and treatment facility improvements. As documented in TM-CSO-3a – Phase IA CSO Control Recommended Improvements Model, although reducing the CSO frequency is still important, the main focus of the CSO Facilities Plan is to increase the percent capture of the combined sewer system by conveying and treating wet weather flows at a higher rate. Therefore, the diversion structure modifications documented herein have been revised from the LTCP recommendations to focus on conveyance and treatment of combined sewage to increase the wet weather percent capture, which is the revised criteria for the CSO control program.

In order to increase the conveyance capacity of the diversion structures and eliminate hydraulic bottlenecks, it is recommended to enlarge the existing orifices and slide gates of the following diversion structures: Francis, Messanie, Patee, Olive, Duncan, Maple, and Hickory. It is also recommended that the Whitehead outfall be modified and enclosed so that a flap gate can be mounted to prevent Missouri River water from backing up and entering the combined sewer system (CSS) during periods of high river water levels. Lastly, the existing slide gate in the Blacksnake Diversion Structure no longer seals properly and leaks. This slide gate is recommended to be replaced. Automation of three manually cleaned bar screens at the Blacksnake, Whitehead, and Brown's Branch Diversion Structures was also investigated. Upon review of the costs,

the City elected not to move forward with those improvements. The project costs for the aforementioned modifications are presented in Table ES-1 and Table ES-2. Table ES-1 presents the opinion of probable costs for the diversion structure modifications that include the automation of the three manually cleaned bar screens. Table ES-2 presents the opinion of probable costs for the diversion structure modifications excluding the costs for automation of the three manually cleaned bar screens. City staff elected to move forward with the diversion structure modifications summarized in Table ES-2.

Table ES-1	
Summary of Opinion of Probable Project Costs	
Including Automation of Manually Cleaned Bar Screens ¹	
Item	Cost, \$
Diversion Structure Modifications	
Blacksnake Improvements	651,000
Whitehead Improvements	783,000
Brown's Branch Improvements	280,000
Miscellaneous Diversion Structure Improvements	210,000
Flood Protection/Fill (placeholder) ²	0
Site Remediation (placeholder) ²	75,000
<i>Subtotal</i>	<i>1,999,000</i>
Electrical, I&C, Sitework, Contractor General Requirements ³	839,000
<i>Subtotal</i>	<i>2,838,000</i>
Contingency ⁴	710,000
Land Acquisition (placeholder) ^{2,5}	0
Opinion of Probable Construction Cost	3,548,000
Engineering, Legal, and Administration ⁶	710,000
Opinion of Total Project Cost	4,258,000
<ol style="list-style-type: none"> 1. All costs presented in May 2009 dollars (ENR BCI = 4773). 2. Site related costs are placeholders and must be revised following final siting of the facilities. 3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs. 4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, and site remediation costs. 5. Land acquisition is not anticipated for the diversion structure modifications. 6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition. 	

Table ES-2	
Summary of Opinion of Probable Project Costs	
Excluding Automation of Manually Cleaned Bar Screens ¹	
Item	Cost, \$
Diversion Structure Modifications	
Blacksnake Improvements	32,000
Whitehead Improvements	179,000
Brown's Branch Improvements	0
Miscellaneous Diversion Structure Improvements	210,000
Flood Protection/Fill (placeholder) ²	0
Site Remediation (placeholder) ²	53,000
<i>Subtotal</i>	<i>474,000</i>
Electrical, I&C, Sitework, Contractor General Requirements ³	98,000
<i>Subtotal</i>	<i>572,000</i>
Contingency ⁴	143,000
Land Acquisition (placeholder) ^{2,5}	0
Opinion of Probable Construction Cost	715,000
Engineering, Legal, and Administration ⁶	143,000
Opinion of Total Project Cost	858,000
<ol style="list-style-type: none"> 1. All costs presented in May 2009 dollars (ENR BCI = 4773). 2. Site related costs are placeholders and must be revised following final siting of the facilities. 3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs. 4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, and site remediation costs. 5. Land acquisition is not anticipated for the diversion structure modifications. 6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition. 	

The diversion structure modifications are intended to supplement the CSO program by adding conveyance capacity to the diversion structures, preventing river water from entering the collection system during high river stages, and maximizing the first flush pollutant load into the diversion structures. In addition, automation of three manually cleaned bar screens at the Blacksnake, Whitehead, and Brown's Branch Diversion Structures was investigated. Upon review of the costs, the City elected not to move forward with those improvements. The diversion structure modifications are not required to meet the wet weather capture and treatment goals of the LTCP, however, the

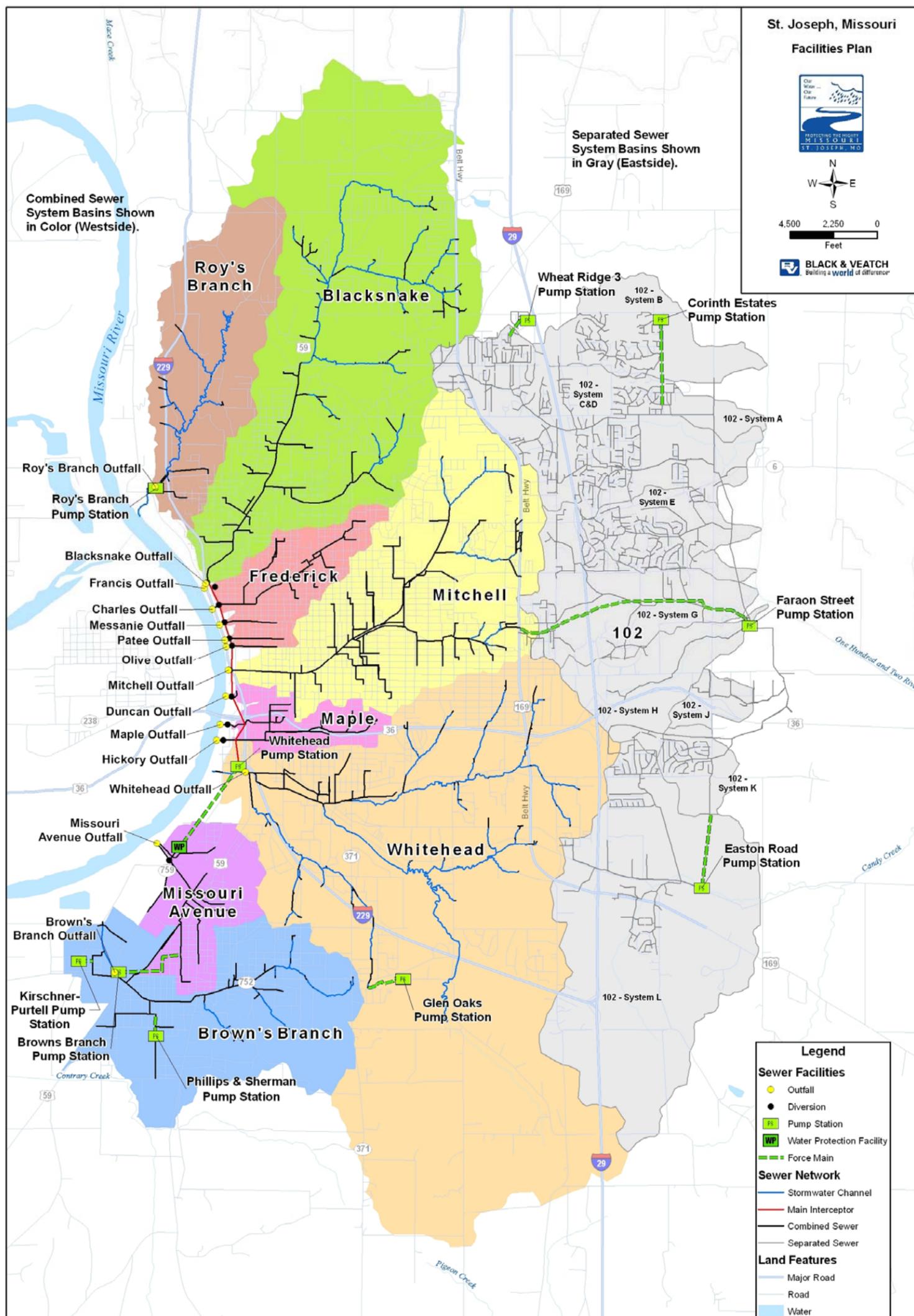
modifications are recommended enhancements that should be implemented to optimize the system's conveyance capacity and first flush capture.

2.0 Purpose of Technical Memorandum

The purpose of this technical memorandum is to evaluate and summarize recommendations to modify and improve the existing combined sewer diversion structures. As part of the 2008 CSO LTCP, various diversion structure modifications were proposed including the installation of automated gates and increasing weir heights to better utilize the existing sewer system capacity. Those recommendations will be reviewed herein and modified as necessary to correlate with the wet weather percent capture and treatment goals of the CSO LTCP established in the Facilities Plan. Conceptual layouts of the modifications along with project costs will be provided for the recommended modifications.

3.0 Introduction and Background

As part of the 2008 CSO LTCP, diversion structure modifications were proposed for eleven diversion structures. Motor operated gates were proposed at the Charles, Mitchell, Missouri Avenue, and Brown's Branch Diversion Structures. Additional fixed weir height was recommended at the following seven diversion structures to maximize flow to the Water Protection Facility (WPF) and reduce Phase I overflow frequency: Francis, Messanie, Patee, Olive, Duncan, Maple, and Hickory. Figure 1 shows the locations of the diversion structures.



St. Joseph Collection System

Figure 1

The main goal of the 2008 LTCP was to reduce average annual frequency of CSOs at each diversion structure for Phase I to 12 events and for Phase III to four events or less. Since completion of the 2008 LTCP, the Facilities Plan was initiated to refine the recommendation of the LTCP and detail other needed collection system and treatment facility improvements. As documented in TM-CSO-3a – Phase IA CSO Control Recommended Improvements Model, although reducing the CSO frequency is still important, the main focus of the CSO Facilities Plan is to increase the percent capture of the combined sewer system by conveying and treating wet weather flows at a higher rate. Therefore, the diversion structure modifications documented herein have been revised from the LTCP recommendations to focus on conveyance and treatment of combined sewage to increase the wet weather percent capture.

Technical memorandum TM-CSO-3a documents the Phase IA CSO improvements. The Phase IA improvements will allow the combined sewer system wet weather percent capture to be increased to 60 percent. The Phase IA projects will be recommended to be constructed over the next 20 years. The diversion structure modifications are supplemental projects to the Phase IA projects and are not required to achieve the wet weather capture goals of the LTCP program. However, these projects will help the City by maximizing the conveyance capacity of the existing diversion structures at a low cost and provide an additional factor of safety for the program. In addition, the diversion structure modifications address improvements to help the City automate existing manually cleaned bar screens and prevent Missouri River water from flowing into the CSS during high river stages.

4.0 Diversion Structure Modifications

The following sections describe the proposed modifications at each of the diversion structures. As-built drawings and schematics of the diversion structures showing existing configurations are provided in Appendix A. Project costs for the proposed modifications are presented in Section 5.0.

4.1 Blacksnake

The Blacksnake Diversion Structure is located at the far northern end of the Main Interceptor and intercepts all flows generated from the 5,250 acre Blacksnake Basin. The diversion structure passes dry weather flows, which include both sewage flows and Blacksnake Creek base flows, from the Blacksnake Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 36 inch Main Interceptor by a concrete diversion dam. When the 36 inch interceptor reaches capacity, (approximately 29 cubic feet per second (cfs)), the flow overtops the concrete dam and discharges, untreated, to the Missouri River as a CSO.

There are no alternatives to increase the diversion structure's wet weather capture besides upsizing the Main Interceptor. Upsizing the Main Interceptor would be an extensive and expensive improvement. A retrofit of this kind does not correlate with the goal of the diversion structure modifications to be relatively easy and inexpensive improvements focused to increase the wet weather capture. Therefore, diversion structure improvements are not recommended to increase the wet weather capture of the Blacksnake Diversion Structure.

City staff stated that the existing 36 inch by 36 inch slide gate in the Blacksnake Diversion Structure leaks and is in need of replacement. Therefore, the existing slide gate is proposed to be replaced, in kind, with a new slide gate.

In addition, there is an existing manually cleaned bar screen at the Blacksnake Diversion Structure, which frequently becomes plugged. Maintenance staff enter the Blacksnake sewer and clean the bar screen after every wet weather event. The cost of replacing the manually cleaned bar screen with an automated trash rake and bar screen facility was investigated. By automating the bar screen, manned entry into the Blacksnake sewer will be reduced. Furthermore, the reliability of the diversion structure will be improved. Costs for automating the screen as well as leaving the existing, manually cleaned bar screen in place are presented in Section 5.0.

Based upon a review of the costs, the City has elected not to replace the existing manually cleaned bar screen with an automated screen. The City can choose to automate

the trash rake and bar screen at any time if monies and priorities allow the suggested improvements to be constructed.

4.2 Francis Street

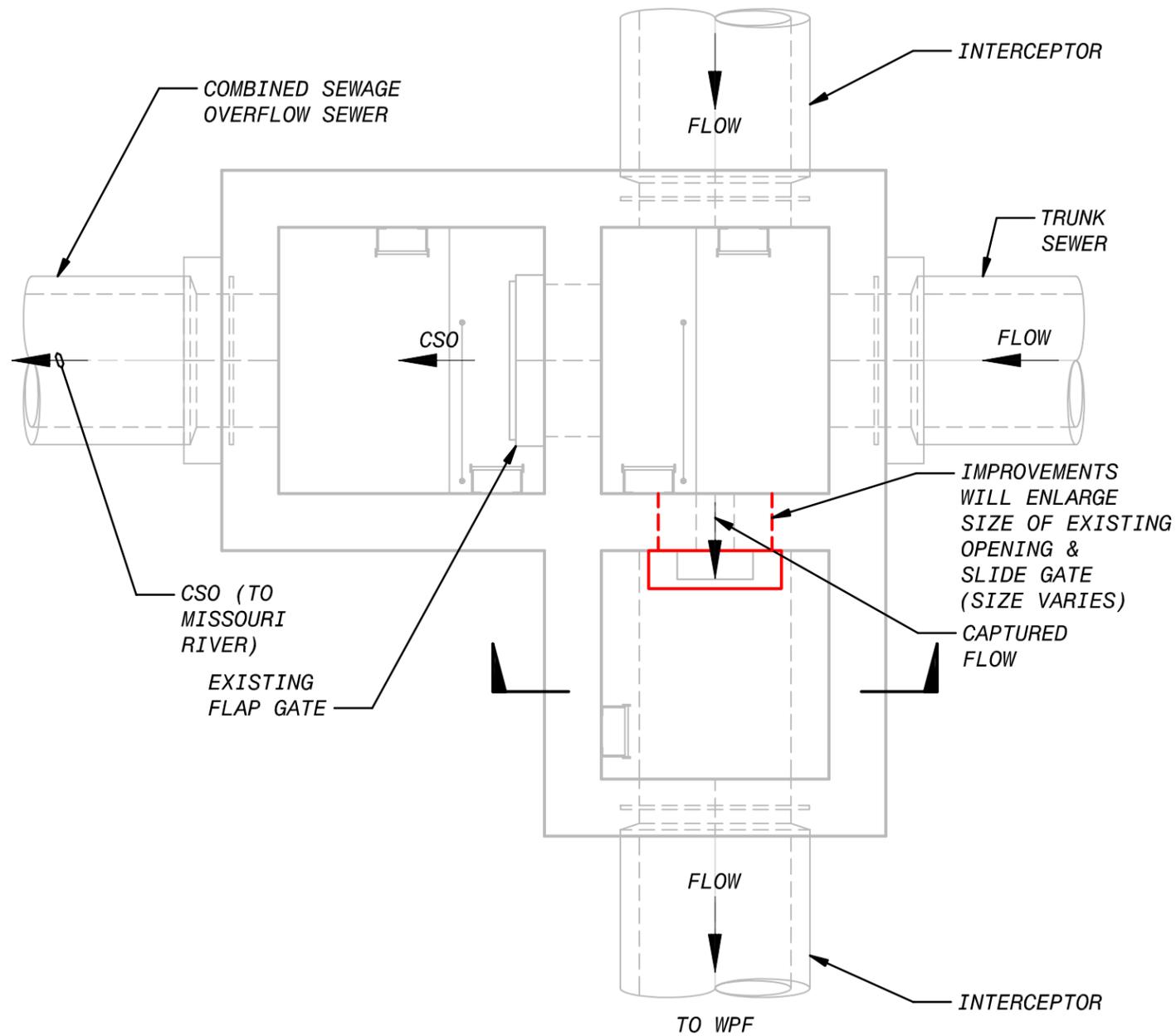
The Francis Street Diversion Structure is located at the northern end of the Main Interceptor, south of the Blacksnake Diversion Structure. The structure intercepts a portion of the flows generated by the 730 acre Frederick Basin. The diversion structure passes dry weather flows from the Francis Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 48 inch interceptor through a 12 inch by 12 inch low flow opening. At an inflow of approximately 2.3 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

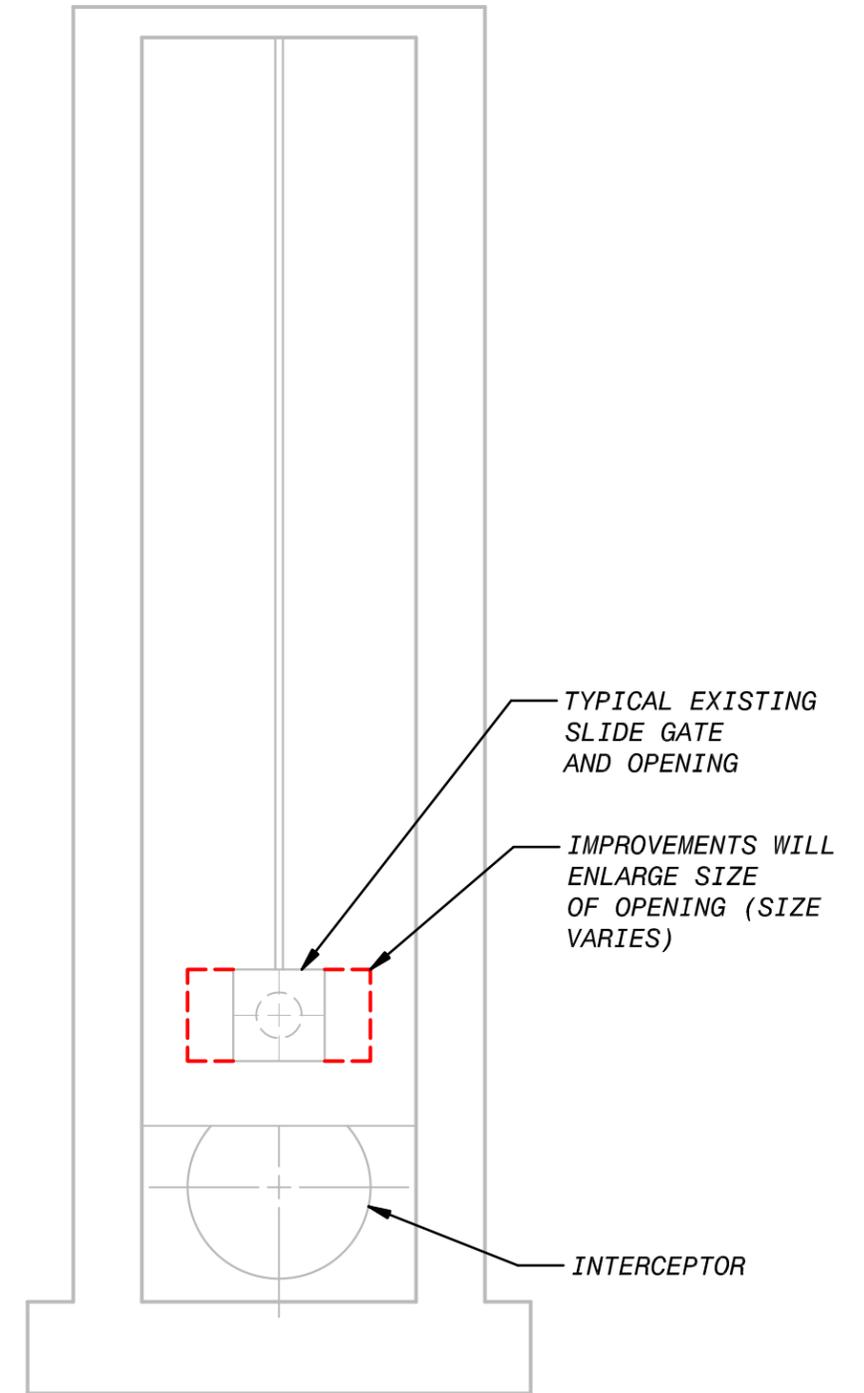
Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 12 inch by 12 inch low flow orifice is enlarged, it will be able to pass more flow to the interceptor before a CSO occurs. Figure 2 presents a typical example of how the diversion structures can be enlarged to increase their conveyance capacity. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 24 inch wide by 12 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 4.6 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF. In addition, by expanding the orifice, more of the first flush pollutant load will be captured.

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CYGNET ID: 163509-2000-WWTCN-C-N0001CX0J



TYPICAL SECTIONAL PLAN



TYPICAL SECTION

ST. JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509

TYPICAL DIVERSION STRUCTURE
PLAN & SECTION

March 2010

FIGURE 2

4.3 Charles Street

The Charles Street Diversion Structure is located at the northern end of the Main Interceptor, south of the Francis Street Diversion Structure. The structure intercepts a large portion of the flows generated by the 730 acre Frederick Basin. The diversion structure passes dry weather flows from the Charles Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 48 inch interceptor through a 24 inch by 24 inch low flow opening. At an inflow of approximately 6.5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 24 inch by 24 inch low flow orifice is enlarged, it will be able to pass more flows to the interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 13 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.4 Messanie Street

The Messanie Street Diversion Structure is located in the middle of the Main Interceptor, south of the Charles Street Diversion Structure. The structure intercepts a portion of the flows generated by the 730 acre Frederick Basin. The diversion structure passes dry weather flows from the Messanie Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 48 inch interceptor through a 24 inch by 24 inch low flow opening. At an inflow of approximately 5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 24 inch by 24 inch low flow orifice is enlarged, it will be able to pass more flows to the interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 10 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.5 Patee Street

The Patee Street Diversion Structure is located in the middle of the Main Interceptor, south of the Messanie Street Diversion Structure. The structure intercepts a portion of the flows generated by the 730 acre Frederick Basin. The diversion structure passes dry weather flows from the Patee Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 48 inch interceptor through a 24 inch by 24 inch low flow opening. At an inflow of approximately 2.5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 24 inch by 24 inch low flow orifice is enlarged, it will be able to pass more flows to the

interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 5 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.6 Olive Street

The Olive Street Diversion Structure is located in the middle of the Main Interceptor, south of the Patee Street Diversion Structure. The structure intercepts a portion of the flows generated by the 730 acre Frederick Basin. The diversion structure passes dry weather flows from the Olive Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 48 inch interceptor through a 24 inch by 24 inch low flow opening. At an inflow of approximately 5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 24 inch by 24 inch low flow orifice is enlarged, it will be able to pass more flows to the interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 10 cfs to pass from the collection system and into the interceptor before a CSO occurs.

Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.7 Mitchell Street

The Mitchell Street Diversion Structure is located in the middle of the Main Interceptor, south of the Patee Street Diversion Structure. The structure intercepts all flows generated by the 3,140 acre Mitchell Basin. The diversion structure passes dry weather flows from the Mitchell Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 54 inch interceptor through two 24 inch by 24 inch low flow openings. At an inflow of approximately 27.5 cfs, combined sewage backs up behind the openings and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout and capacity, there are no acceptable options to increase its wet weather percent capture. First, the diversion structure can already pass approximately 27.5 cfs to the interceptor. This equates to approximately 66 percent of the treatment capacity of the existing 27 million gallons per day (mgd) WPF headworks capacity. If the openings were expanded at Mitchell, it would further overload the interceptor capacity and prevent flow from entering the interceptor from the other smaller diversion structures which have been proposed to be upsized upstream from Mitchell. Furthermore, the existing openings cannot be enlarged easily as there is not enough room between them to enlarge the openings and keep them separate. To expand the conveyance of the Mitchell Diversion Structure to the main interceptor, the two existing low flow openings would need to be merged into one larger opening. This would require the use of a slide gate larger than 72 inches in width. A gate of this size would require the use of double operating stems to ensure that the gate does not jam during operation. A double stemmed, large gate would increase the cost of the retrofit. From both a cost perceptive and flow perspective, it is recommended that no modifications be made to the Mitchell Diversion Structure.

4.8 Duncan Street

The Duncan Street Diversion Structure is located in the middle of the Main Interceptor, south of the Mitchell Street Diversion Structure. The structure intercepts a small portion of the flows generated by the 430 acre Maple Basin. The diversion structure passes dry weather flows from the Duncan 24 inch Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 54 inch interceptor through a 12 inch by 12 inch low flow opening. At an inflow of approximately 2 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 12 inch by 12 inch low flow orifice is enlarged, it will be able to pass more flows to the interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 36 inch wide by 18 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 6 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.9 Maple Street

The Maple Street Diversion Structure is located near the southern end of the Main Interceptor, south of the Duncan Street Diversion Structure. The structure intercepts about half of the flows generated by the 430 acre Maple Basin. The diversion structure passes dry weather flows from the Maple 72 inch Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 54 inch interceptor through an 18 inch by 18 inch low flow opening. At an inflow of approximately 5.5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 18 inch by 18 inch low flow orifice is enlarged, it will be able to pass more flows to the interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 14.5 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.10 Hickory Street

The Hickory Street Diversion Structure is located near the southern end of the Main Interceptor, south of the Maple Street Diversion Structure. The structure intercepts about half of the flows generated by the 430 acre Maple Basin. The diversion structure passes dry weather flows from the 72 inch Hickory Trunk Sewer to the Main Interceptor. The diversion structure also passes some wet weather flows to the Main Interceptor.

Flow enters the diversion structure and is directed to the 54 inch interceptor through an 18 inch by 18 inch low flow opening. At an inflow of approximately 5 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.

Upon review of the diversion structure's layout, there is a relatively simple and inexpensive way to increase the diversion structure's wet weather capture. If the existing 18 inch by 18 inch low flow orifice is enlarged, it will be able to pass more flows to the

interceptor before a CSO occurs. Although the interceptor must have capacity to receive the increased inflows, there are small wet weather events that can cause an overflow from the diversion structure before the interceptor reaches capacity. The aforementioned modification will help to maximize the flow down the interceptor before CSOs occur.

The existing orifice is proposed to be enlarged to a 48 inch wide by 24 inch tall orifice and retrofitted with a new slide gate. This will allow approximately 13 cfs to pass from the collection system and into the interceptor before a CSO occurs. Correspondingly, this will increase the wet weather capture of the diversion structure and allow more combined sewage to be treated and disinfected at the WPF.

4.11 Whitehead

The Whitehead Diversion Structure is located at the south end of the Main Interceptor. The structure intercepts all of the flows generated by the 8,640 acre Whitehead Basin. The diversion structure passes dry weather flows from the 16 foot by 16 foot Whitehead Trunk Sewer to the Whitehead Interceptor. The Whitehead Interceptor conveys the captured flows to the Whitehead Pump Station. Directly upstream from the Whitehead Pump Station, the Whitehead Interceptor ties into the Main Interceptor. The diversion structure also passes some wet weather flows to the Whitehead Interceptor.

Flow exits the 16 foot by 16 foot Whitehead Trunk Sewer and passes into an open air concrete lined channel. At the downstream end of the concrete channel, a 2.3 foot tall concrete weir directs dry weather flows into the 48 inch Whitehead Interceptor. At an inflow of approximately 19 cfs, combined sewage backs up behind the opening and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO. A photograph of the diversion structure is presented in Figure 3.



Figure 3 – Whitehead Diversion Structure

Upon review of the diversion structure layout, there are no acceptable options to increase the diversion structure's wet weather capture besides upsizing the 1,500 foot long Whitehead Interceptor. Upsizing the Whitehead Interceptor would be an extensive and expensive improvement. A retrofit of this kind does not correlate with the goal of the diversion structure modifications being relatively easy and inexpensive improvements focused to increase the wet weather capture. Therefore, diversion structure modifications are not recommended at the Whitehead Diversion Structure to increase the percent capture. However, a flap gate and bar screening system are recommended for the diversion structure.

The Whitehead Diversion Structure should be retrofitted with a flap gate. Currently, the weir at the diversion structure is connected to the downstream open channel without a flap gate. Consequently, if the Missouri River water level is high, river water can pass backwards from the downstream open channel over the weir and into the Whitehead Interceptor. Ultimately, this can cause river water to be treated unnecessarily

at the WPF. Furthermore, in the future, a stormwater separation conduit (presented in detail in TM-CSO-5 –Stormwater Separation Conduits) will deliver Whitehead Creek flows into the open channel downstream of the diversion structure. This flow could also create additional backwater and allow creek flow to pass backwards and into the Whitehead Interceptor. Therefore, to prevent this backflow condition from occurring in the future, it is recommended that the existing diversion structure to be fitted with a flap gate. The proposed flap gate modifications are shown in Figure 4.

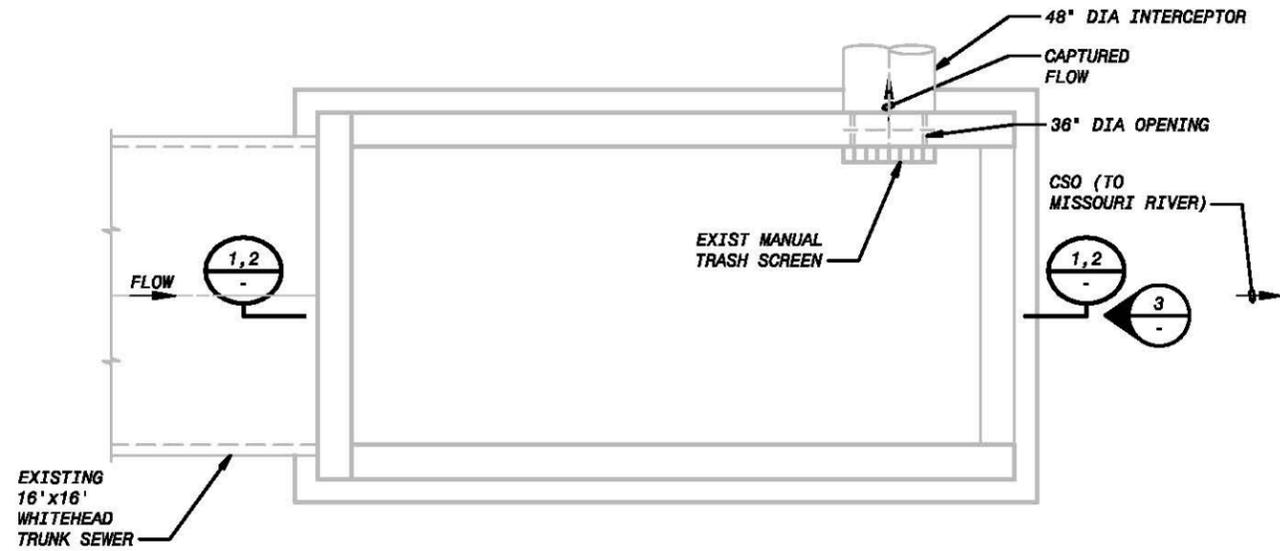
There is an existing manually cleaned bar screen on the diversion pipe at the Whitehead Diversion Structure. The cost of replacing the manually cleaned bar screen with an automated trash rake and bar screen facility was investigated. By automating the bar screen, the reliability of the diversion structure will be improved. Costs for automating the screen as well as leaving the existing, manually cleaned bar screen in place are presented in Section 5.0.

Based upon a review of the costs, the City has elected not to replace the existing manually cleaned bar screen with an automated screen. The City can choose to automate the trash rake and bar screen at any time if monies and priorities allow the suggested improvements to be constructed.

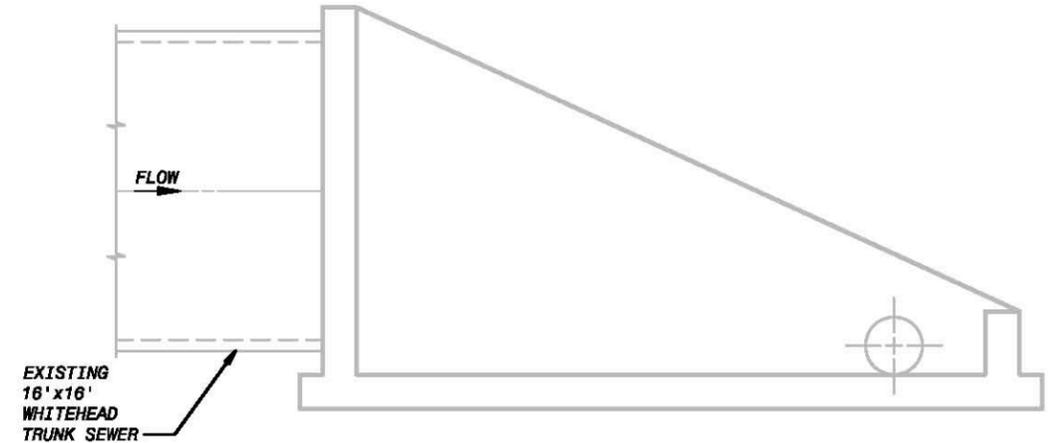
4.12 Missouri Avenue

The Missouri Avenue Diversion Structure is located directly adjacent to the WPF. The structure intercepts all of the flows generated by the 820 acre Missouri Avenue Basin. The diversion structure passes dry weather flows from the 96 inch Missouri Avenue Trunk Sewer to the WPF In-plant Influent Pump Station through a 30 inch pipe. The diversion structure also passes some wet weather flows to the In-plant Influent Pump Station.

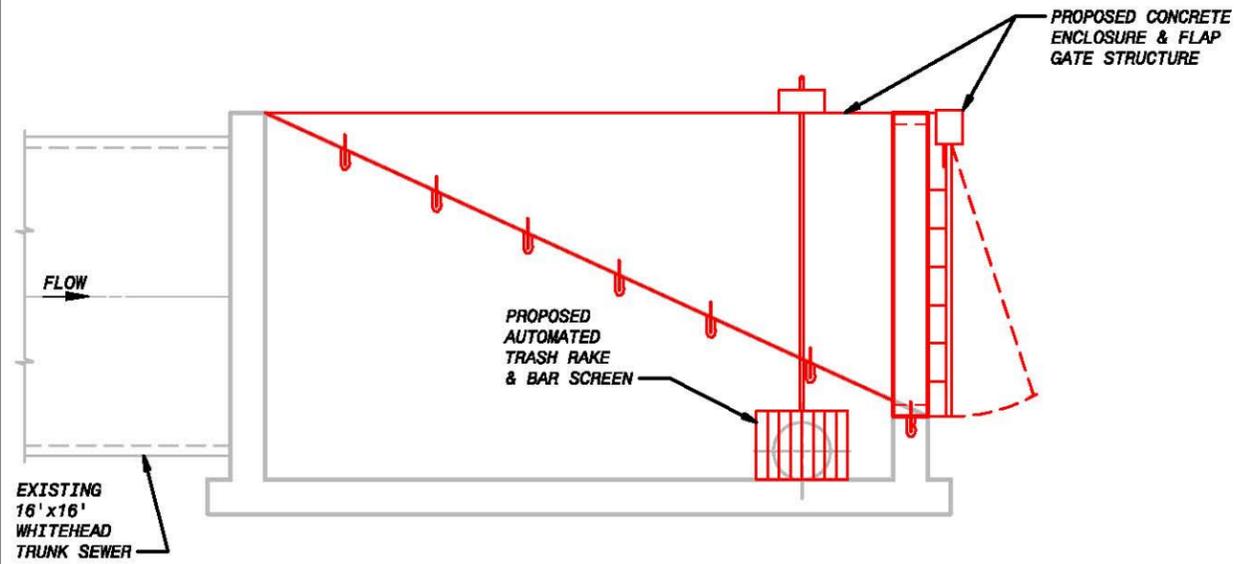
Diverted flow exits the 96 inch Missouri Avenue Trunk Sewer and passes into the low flow 30 inch pipe connected to the In-plant Influent Pump Station. At an inflow of approximately 12 cfs, combined sewage backs up behind the low flow pipe and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO.



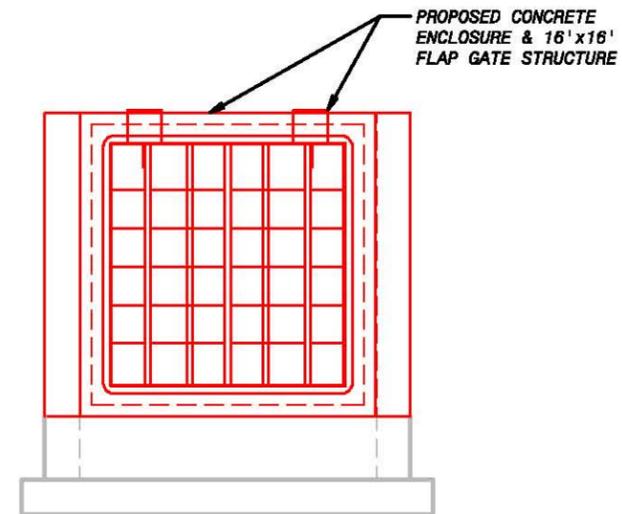
EXISTING TOP PLAN



EXISTING SECTION 1



PROPOSED SECTION 2



PROPOSED ELEVATION 3

**ST. JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509**

**WHITEHEAD COMBINED SEWER OUTFALL
PLAN, SECTIONS, & ELEVATION**

March 2010

FIGURE 4

BFIGBORD
 BFBFIGBORD
 CYGNET ID: 163509-2000-WWTCN-C-N0001CX0K

Upon review of the diversion structure's layout, there are no acceptable options to increase the diversion structure's wet weather capture. The existing 30 inch pipe, approximately 1,600 feet in length, would need to be upsized from the diversion structure to the In-plant Influent Pump Station. Upsizing this pipe would be an extensive and expensive improvement. A retrofit of this kind does not correlate with the goal of the diversion structure modifications being relatively easy and inexpensive improvements focused to increase the wet weather capture. Furthermore, the low flow pipe leads directly to the In-plant Influent Pump Station which has a firm capacity of approximately 10 mgd (15.5 cfs). If additional flows are captured at the Missouri Avenue Diversion Structure, the pump station would also need to be expanded creating an additional and significant expense. Therefore, no modifications are being recommended at the Missouri Avenue Diversion Structure.

4.13 Brown's Branch

The Brown's Branch Diversion Structure is located approximately 1.3 miles southwest of the WPF. The structure intercepts all of the flows generated by the 2,470 acre Brown's Branch Basin. The diversion structure passes dry weather flows from the double box 9 foot by 9 foot Brown's Branch Trunk Sewer to the Brown's Branch Pump Station through a 24 inch pipe. The diversion structure also passes some wet weather flows to the pump station.

Flow exits the double box trunk sewer and passes into the low flow 24 inch pipe connected to the pump station. At an inflow of approximately 9 cfs, combined sewage backs up behind the low flow pipe and overtops the diversion structure's weir allowing flow to discharge, untreated, to the Missouri River as a CSO. The Brown's Branch Pump Station pumps flow into the Missouri Avenue Basin where it flows by gravity to the Missouri Avenue Diversion Structure and to the WPF.

Upon review of the diversion structure's layout, there are no acceptable options to increase the diversion structure's wet weather capture. The existing 24 inch pipe would need to be upsized from the diversion structure to the Brown's Branch Pump Station, approximately 170 feet. Upsizing this pipe would be an extensive and expensive

improvement. Furthermore, the low flow pipe leads directly to the Brown's Branch Pump Station which has a capacity of approximately 6.7 mgd (10.3 cfs). If additional flows are captured at the Brown's Branch Diversion Structure, the pump station would also need to be expanded creating an additional and significant expense. Therefore, diversion structure modifications are not recommended at the Missouri Avenue Diversion Structure.

There is an existing manually cleaned bar screen on the diversion pipe at the Brown's Branch Diversion Structure. The cost of replacing the manually cleaned bar screen with an automated trash rake and bar screen facility was investigated. By automating the bar screen, the reliability of the diversion structure will be improved. Costs for automating the screen as well as leaving the existing, manually cleaned bar screen in place are presented in Section 5.0.

Based upon a review of the costs, the City has elected not to replace the existing manually cleaned bar screen with an automated screen. The City can choose to automate the trash rake and bar screen at any time if monies and priorities allow the suggested improvements to be constructed.

5.0 Diversion Structure Modification Costs

A conceptual cost estimating methodology was employed to develop capital project costs for the diversion structure modifications. Project costs are given in May 2009 dollars (Engineering News Record (ENR) Building Cost Index (BCI) equal to 4773).

Equipment costs for the slide gate and screening systems were based on quotations provided by vendors. Equipment installation was projected at 40 percent of the equipment cost for all screening and gate equipment. Table 1 provides a summary of the opinion of probable project costs for the diversion structure modifications including costs for automating the existing manually cleaned bar screens. Table 2 provides a summary of the opinion of probable project costs excluding the bar screen automation improvements. Upon review of the costs, City staff elected to move forward with the diversion structure modifications summarized in Table 2.

Additional construction costs were projected by applying a percentage to appropriate project costs as indicated in Footnotes 3 and 4 of Tables 1 and 2. The cost for electrical and instrumentation and controls (I&C) was projected at 25 percent of the cost of equipment. An allowance of 10 percent was applied for project sitework. Contractor general requirements were projected at 12 percent and contingency was set at 25 percent. Costs related to engineering, legal, and administration are reflected in a 20 percent multiplier applied to all construction costs.

Appendix B presents additional details of the development of the conceptual capital costs.

Table 1	
Summary of Opinion of Probable Project Costs Including Automation of Manually Cleaned Bar Screens ¹	
Item	Cost, \$
Diversion Structure Modifications	
Blacksnake Improvements	651,000
Whitehead Improvements	783,000
Brown's Branch Improvements	280,000
Miscellaneous Diversion Structure Improvements	210,000
Flood Protection/Fill (placeholder) ²	0
Site Remediation (placeholder) ²	75,000
<i>Subtotal</i>	<i>1,999,000</i>
Electrical, I&C, Sitework, Contractor General Requirements ³	839,000
<i>Subtotal</i>	<i>2,838,000</i>
Contingency ⁴	710,000
Land Acquisition (placeholder) ^{2,5}	0
Opinion of Probable Construction Cost	3,548,000
Engineering, Legal, and Administration ⁶	710,000
Opinion of Total Project Cost	4,258,000
<p>1. All costs presented in May 2009 dollars (ENR BCI = 4773).</p> <p>2. Site related costs are placeholders and must be revised following final siting of the facilities.</p> <p>3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs.</p> <p>4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, and site remediation costs.</p> <p>5. Land acquisition is not anticipated for the diversion structure modifications.</p> <p>6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.</p>	

Table 2	
Summary of Opinion of Probable Project Costs Excluding Automation of Manually Cleaned Bar Screens ¹	
Item	Cost, \$
Diversion Structure Modifications	
Blacksnake Improvements	32,000
Whitehead Improvements	179,000
Brown's Branch Improvements	0
Miscellaneous Diversion Structure Improvements	210,000
Flood Protection/Fill (placeholder) ²	0
Site Remediation (placeholder) ²	53,000
<i>Subtotal</i>	<i>474,000</i>
Electrical, I&C, Sitework, Contractor General Requirements ³	98,000
<i>Subtotal</i>	<i>572,000</i>
Contingency ⁴	143,000
Land Acquisition (placeholder) ^{2,5}	0
Opinion of Probable Construction Cost	715,000
Engineering, Legal, and Administration ⁶	143,000
Opinion of Total Project Cost	858,000
<ol style="list-style-type: none"> 1. All costs presented in May 2009 dollars (ENR BCI = 4773). 2. Site related costs are placeholders and must be revised following final siting of the facilities. 3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs. 4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, and site remediation costs. 5. Land acquisition is not anticipated for the diversion structure modifications. 6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition. 	

6.0 Conclusions

The main objective of the Phase IA improvements of the CSO LTCP is to increase the percent capture of the combined sewer system by conveying and treating wet weather flows at a higher rate. The diversion structure modifications are intended to supplement the CSO program by adding conveyance capacity to the diversion structures, preventing river water from entering the combined sewer system during high river stages, and maximizing the first flush pollutant load into the diversion structures. In addition,

automation of three manually cleaned bar screens at the Blacksnake, Whitehead, and Brown's Branch Diversion Structures was investigated. Upon review of the costs, the City elected not to move forward with those improvements. The diversion structure modifications are not required to meet the wet weather capture and treatment goals of the LTCP, however, the modifications are recommended enhancements that should be implemented to optimize the system's conveyance capacity and first flush capture.

7.0 References

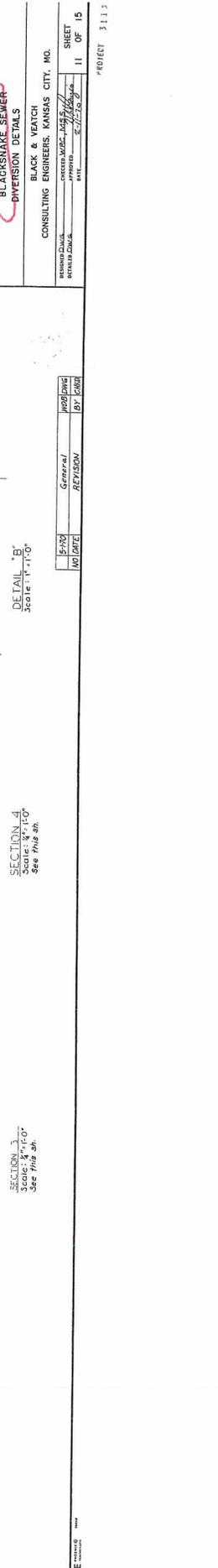
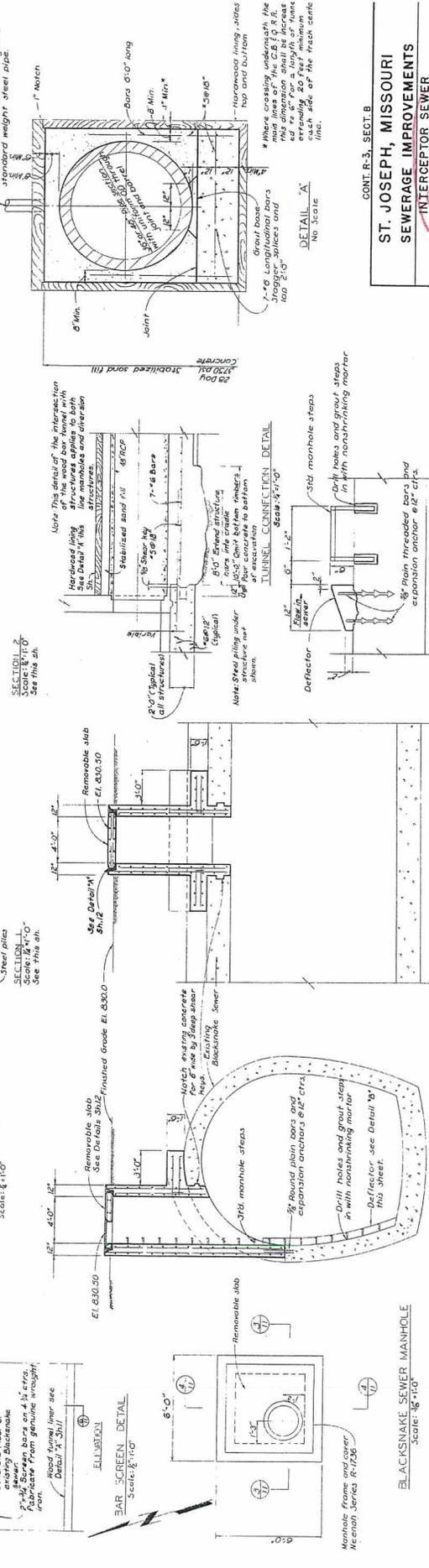
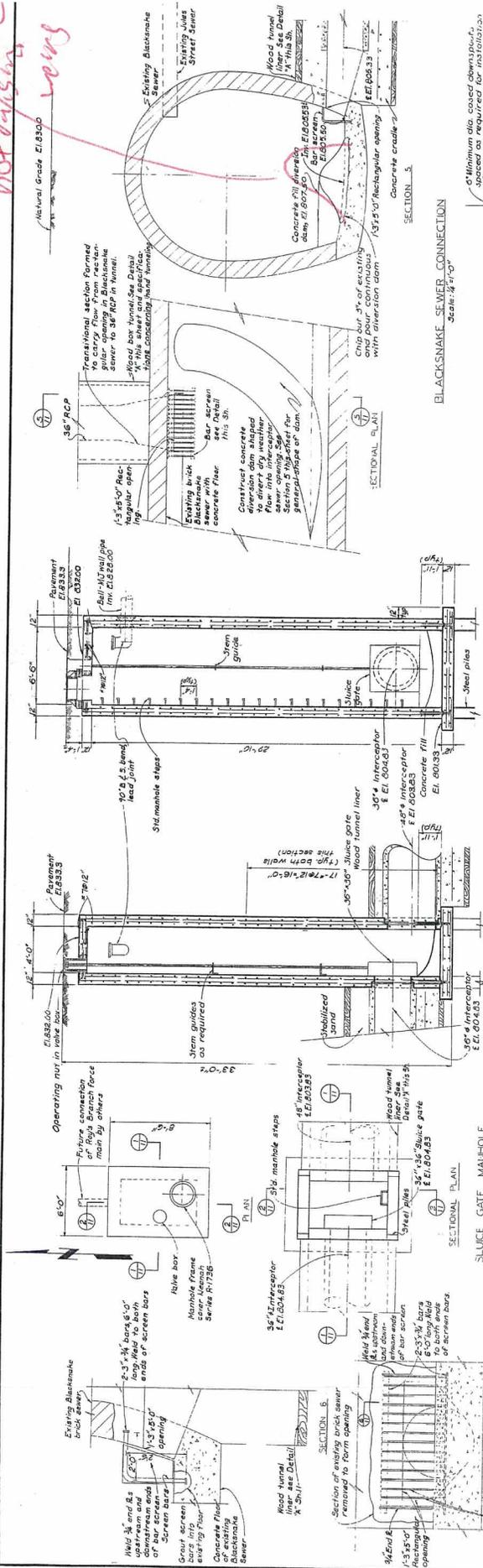
The following references were used in the preparation of this memorandum:

- TM-CSO-3a – Phase IA CSO Control Recommended Improvements Model (Black & Veatch, June 18, 2009).
- TM-CSO-5 – Stormwater Separation Conduits (Black & Veatch, November 12, 2009).
- St. Joseph, Missouri Sewerage Improvements, Contract R3, Section B (Black & Veatch, 1970).

Appendix A

Diversion Structure As-Built Drawings, Sketches, and Hydraulic Reviews

Leave alone not touching



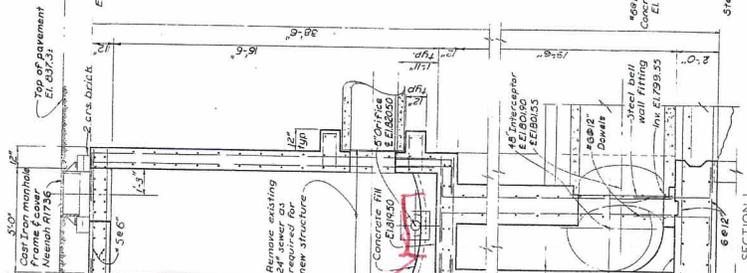
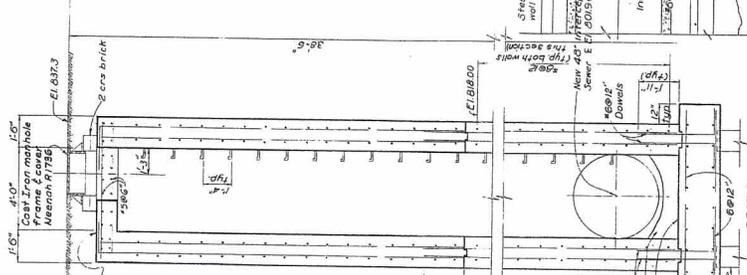
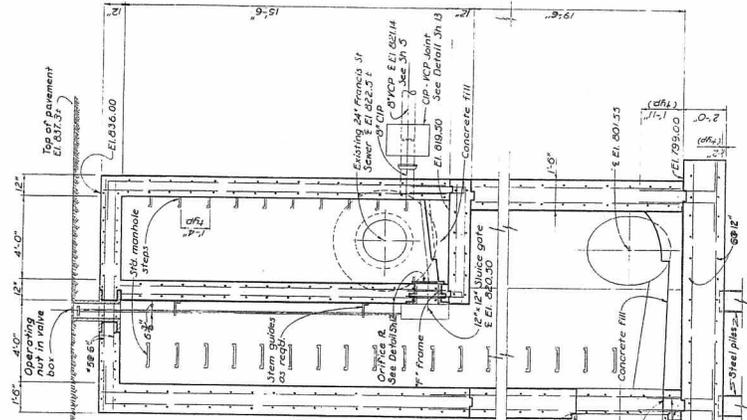
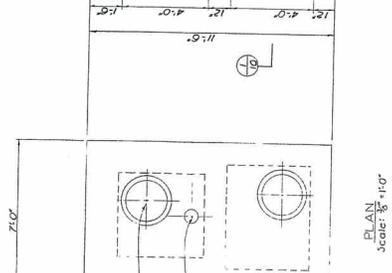
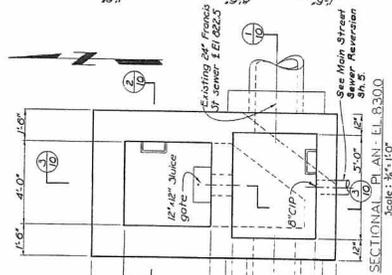
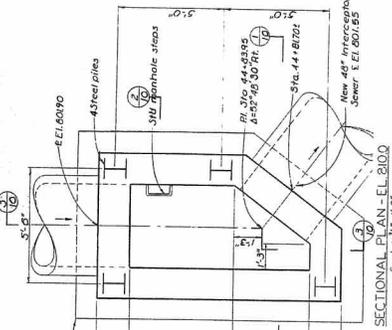
CONT. R-3, SECT. B
ST. JOSEPH, MISSOURI
SEWERAGE IMPROVEMENTS
INTERCEPTOR SEWER
BLACKSNAKE SEWER
DIVERSION DETAILS
 BLACK & VEATCH
 CONSULTING ENGINEERS, KANSAS CITY, MO.
 DRAWN BY: [Name]
 CHECKED BY: [Name]
 DATE: 2-17-26
 SHEET 11 OF 15
 PROJECT 3113

NO.	DATE	REVISION	BY	CHECK
1	NOV 1925	GENERAL	W. J. DAVIS	W. J. DAVIS
2	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
3	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
4	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
5	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
6	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
7	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
8	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
9	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS
10	MAY 1926	GENERAL	W. J. DAVIS	W. J. DAVIS

General Notes:
 - All dimensions are to be "as shown" unless otherwise noted.
 - New 48" Interceptor Sewer, manhole, and 36" manhole shall be constructed in accordance with Kansas R-3300-J.
 - Details shown on this sheet are cut on this sheet.

2.3 cbs

Causas Overflow



Double

CONT. R-3, SECT. B
ST. JOSEPH, MISSOURI
SEWERAGE IMPROVEMENTS
INTERCEPTOR SEWER
FRANCIS STREET SEWER
DIVERSION STRUCTURE
 BLACK & VEATCH
 CONSULTING ENGINEERS, KANSAS CITY, MO.
 SHEET NO. 15 OF 15
 PROJECT 3113

NO.	DATE	BY	CHKD.
1	5-78	REVISION	GENERAL

SECTION 3
 Scale: 3/8"=1'-0"

SECTION 2
 Scale: 3/8"=1'-0"

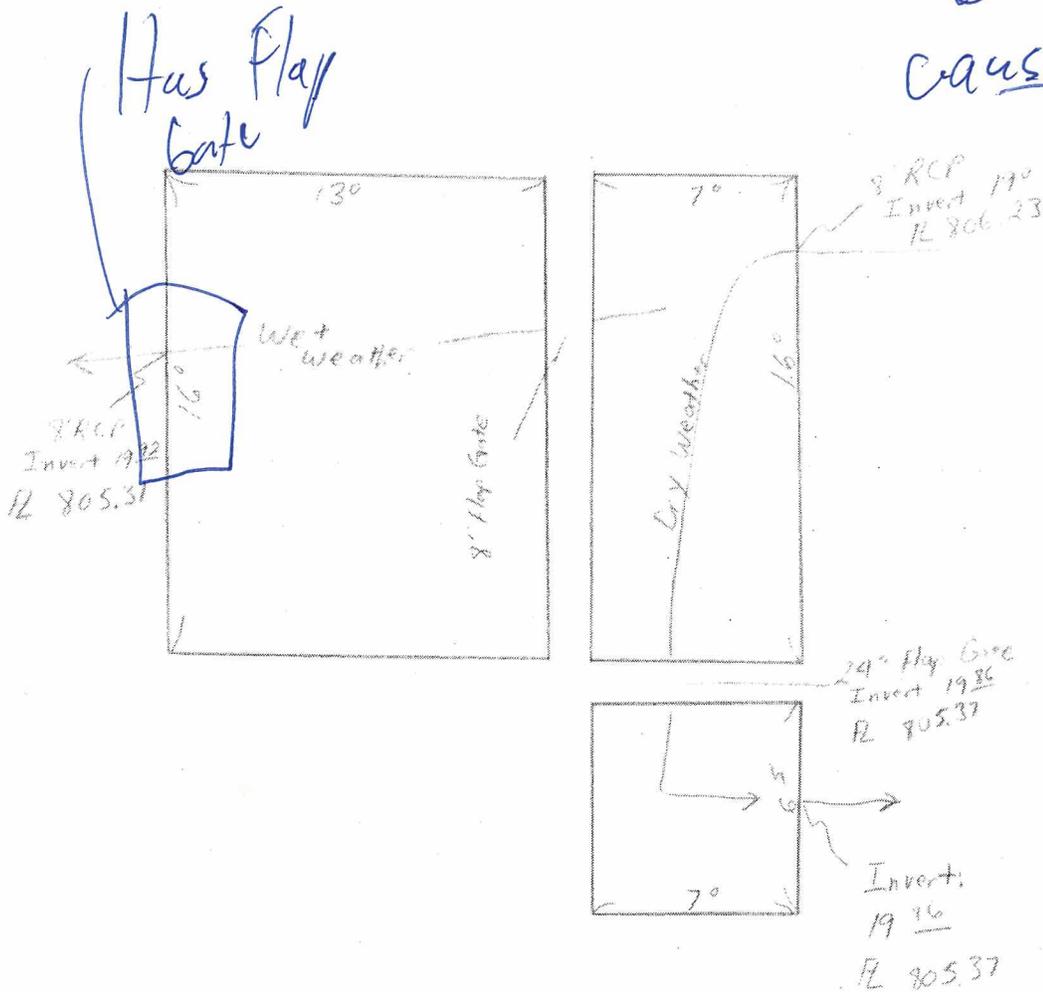
SECTION 1
 Scale: 3/8"=1'-0"

ME

Diversion Name: Charles

Picture Numbers: _____

6.5 cbs
causes a CSO

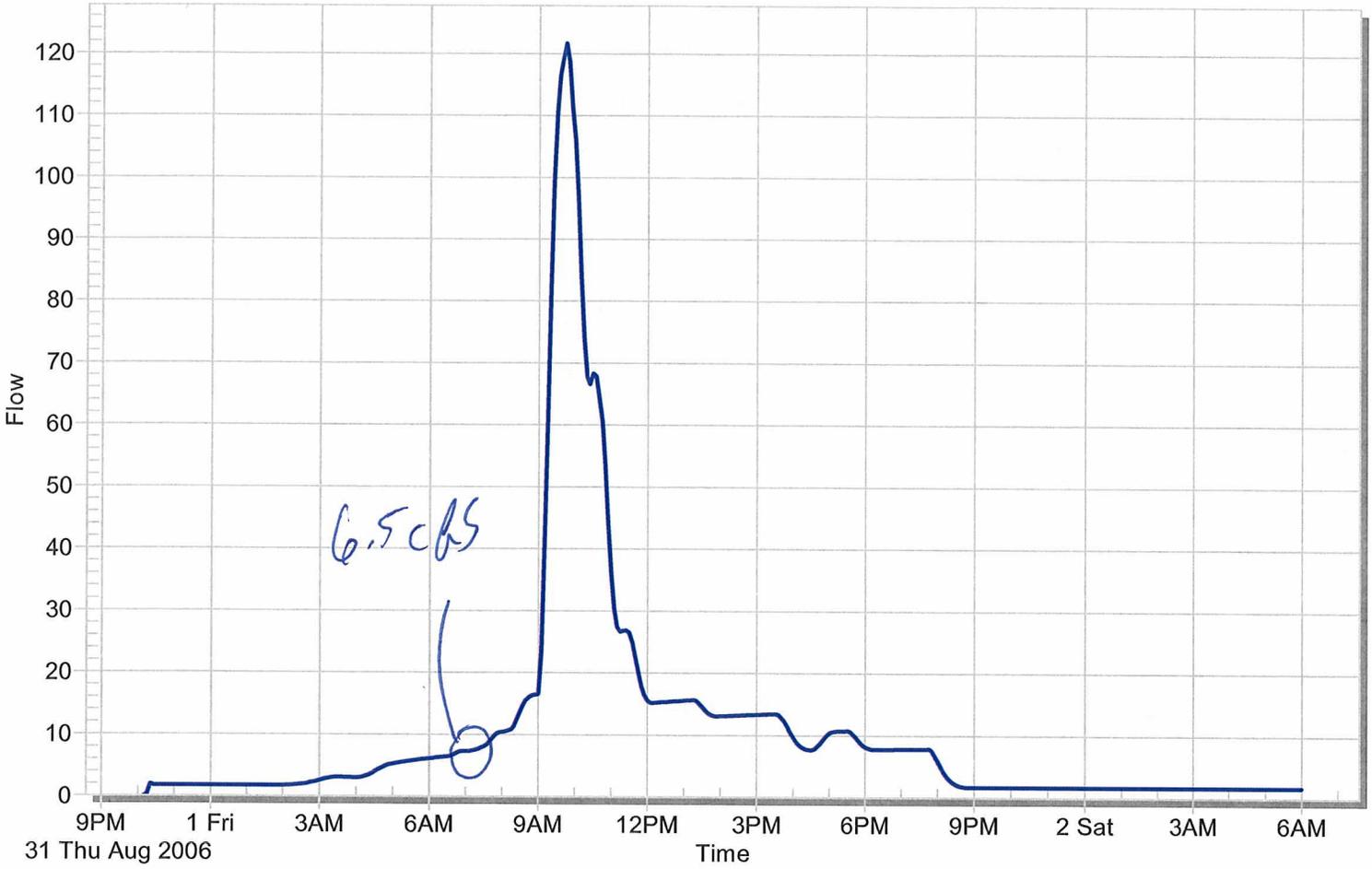


Francis : 2.3 cbs causes an overflow

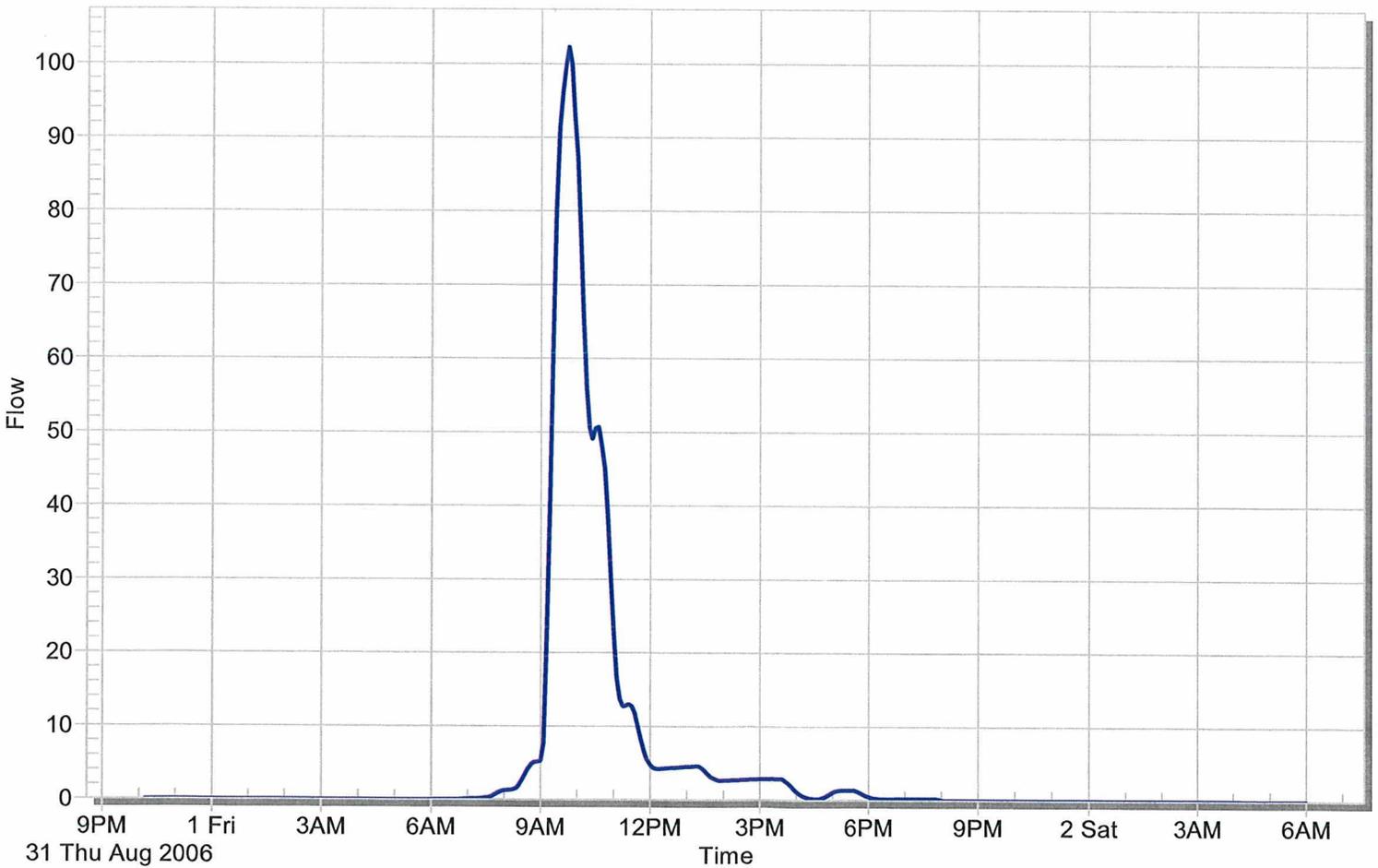
Black snake : 29 cbs causes CSO

Charles

Conduit 0300003C from SBS-31 to SBS-32

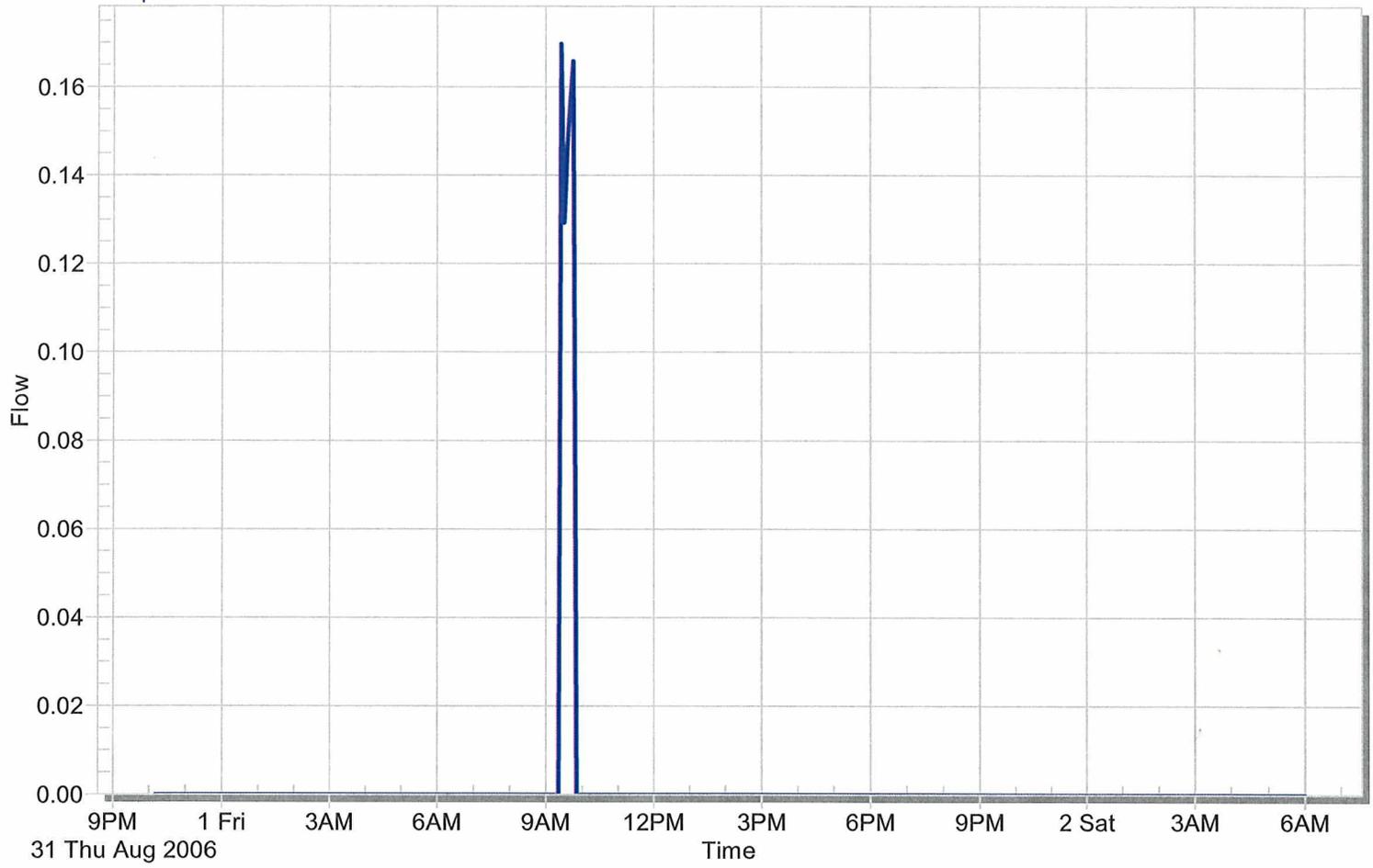


Conduit 0300000C.1 from SBS-34 to SBS-RIVER

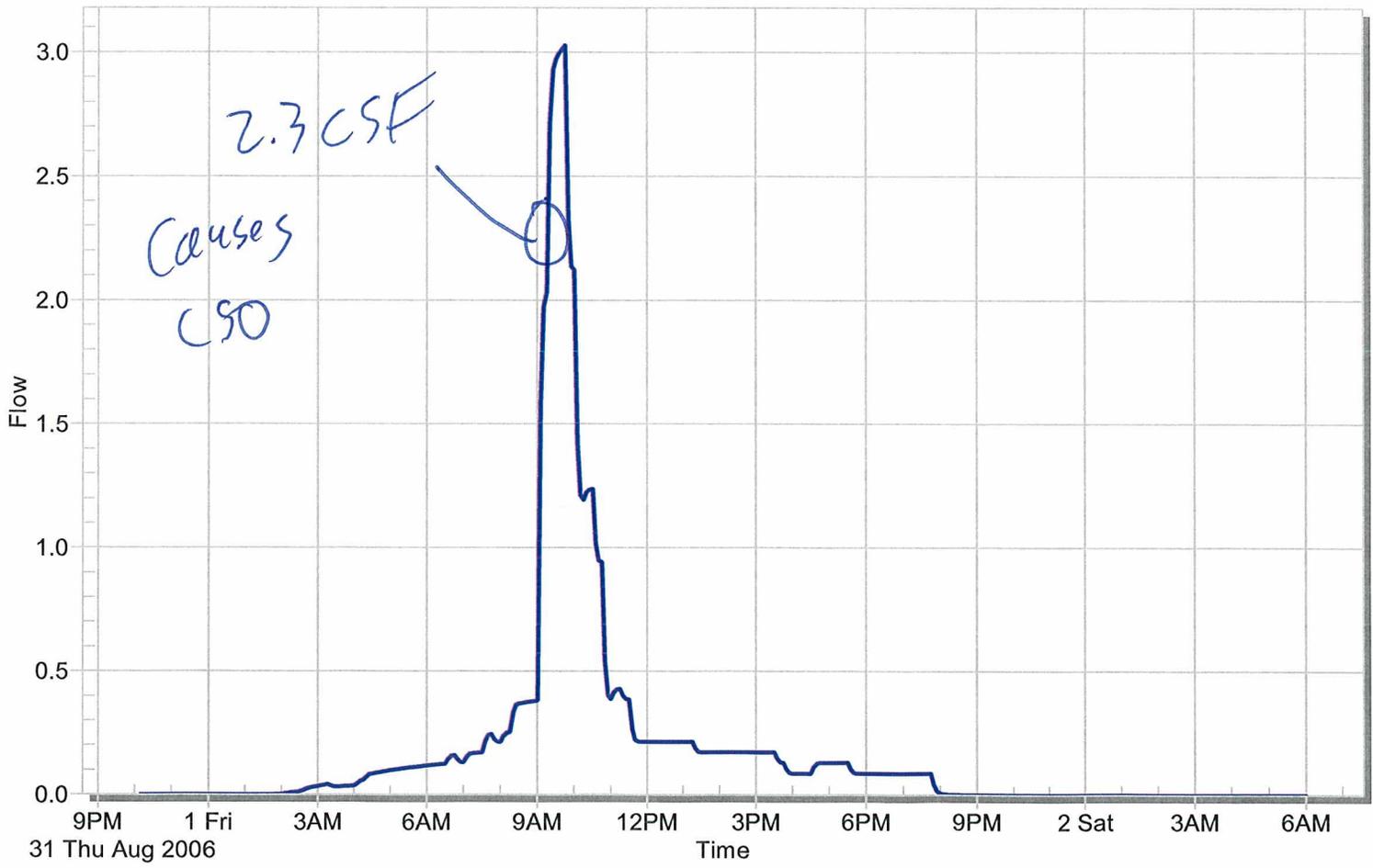


Francis

Conduit 03F0030C from 16-37 to 16-27

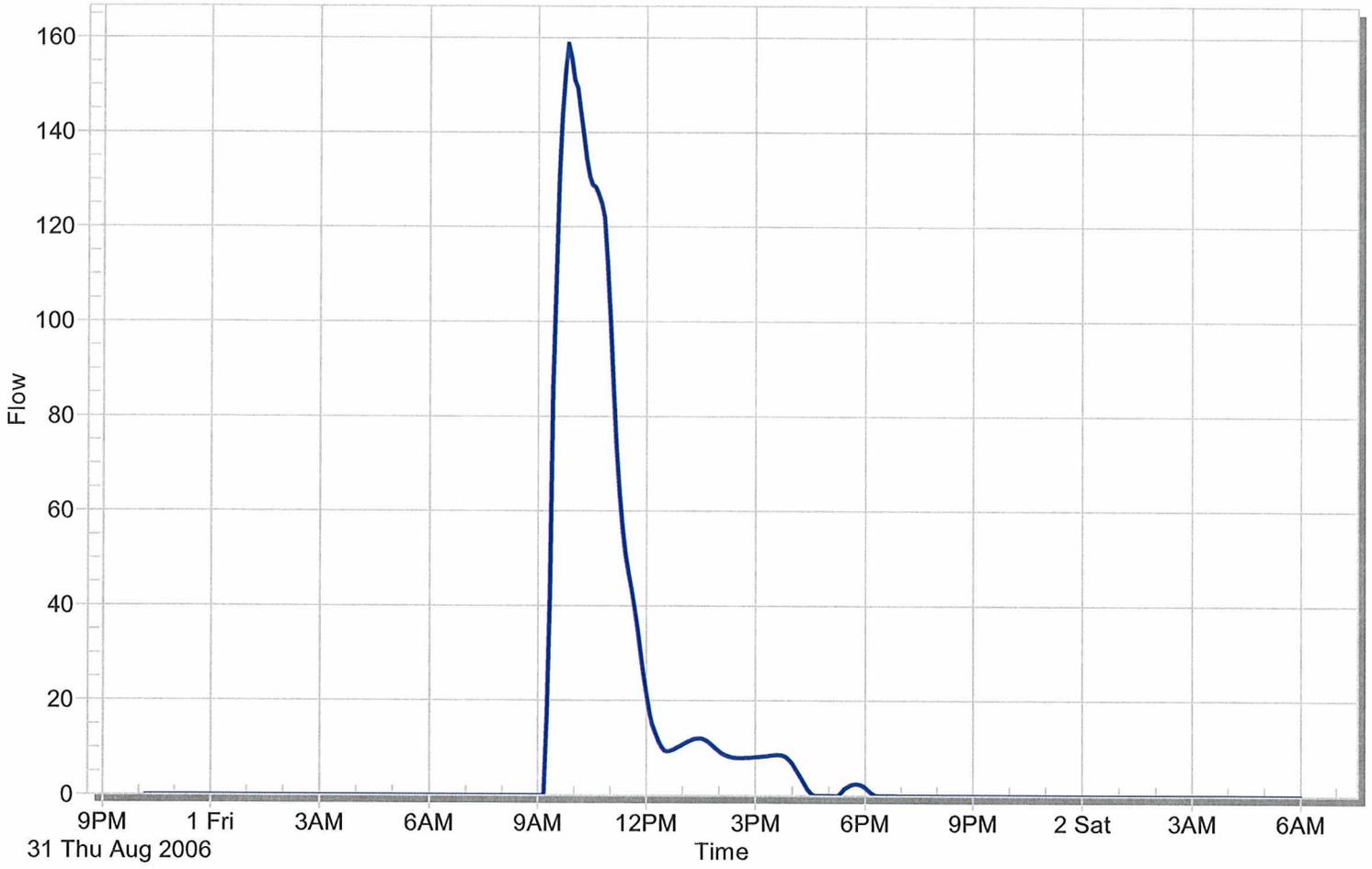


Conduit 03F0035C from 16-12 to 16-37

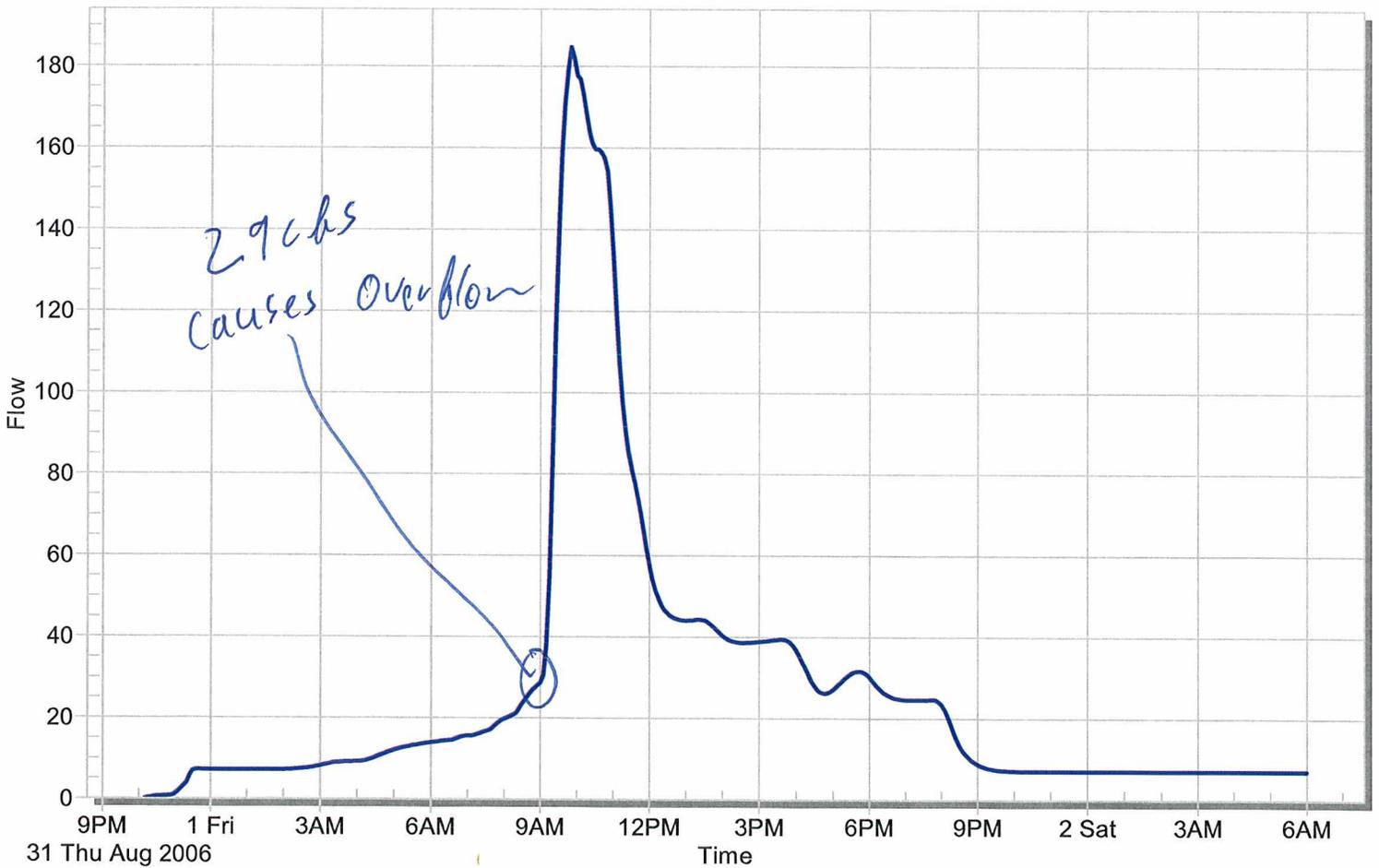


Black Snake

Conduit 0200000C from BSS-31 to BSS-RIVER

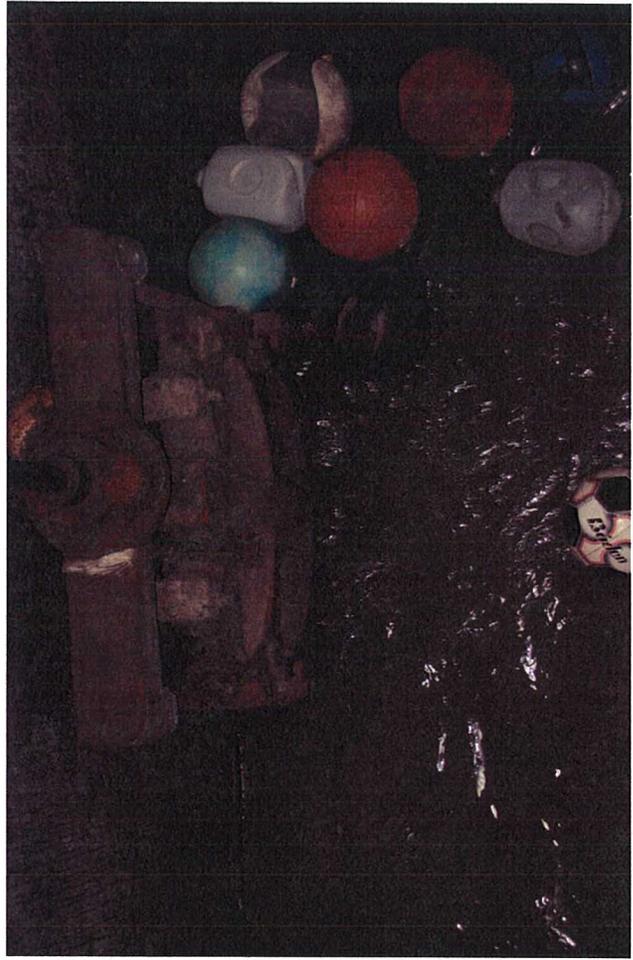


Conduit 0200005C from BSS-29 to BSS-30





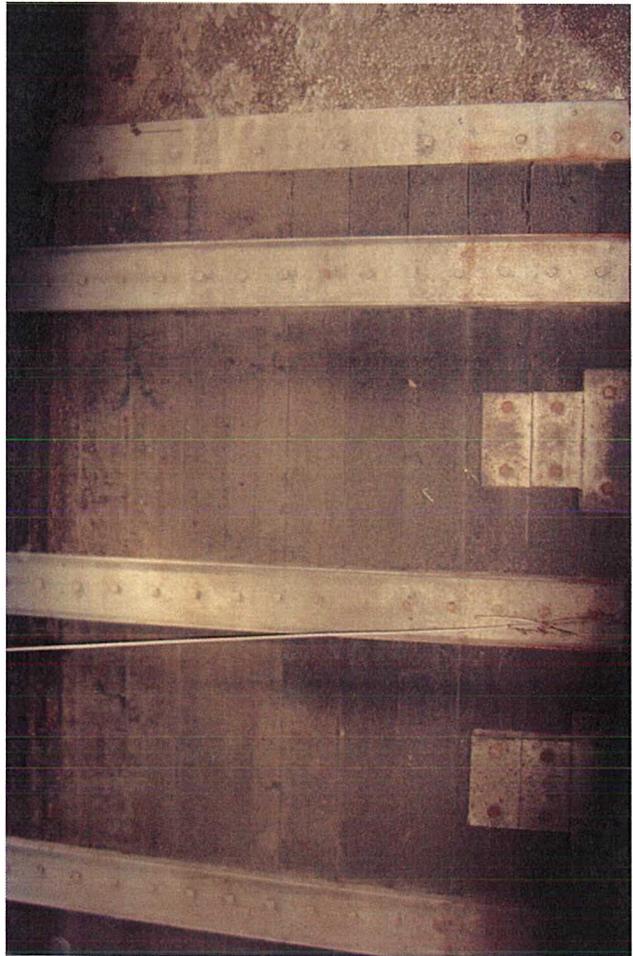
Charles



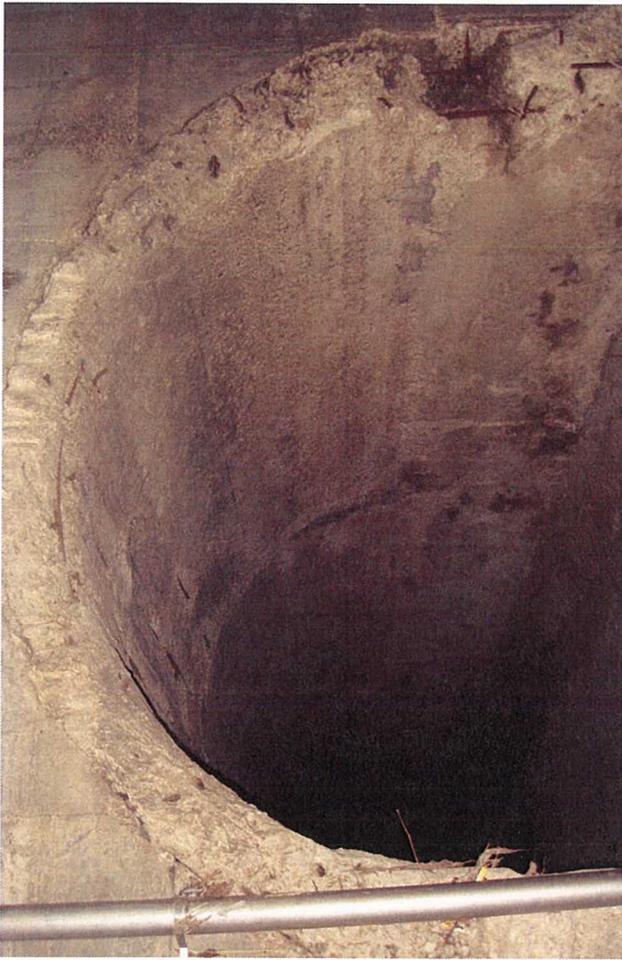
Charles_SluiceGate



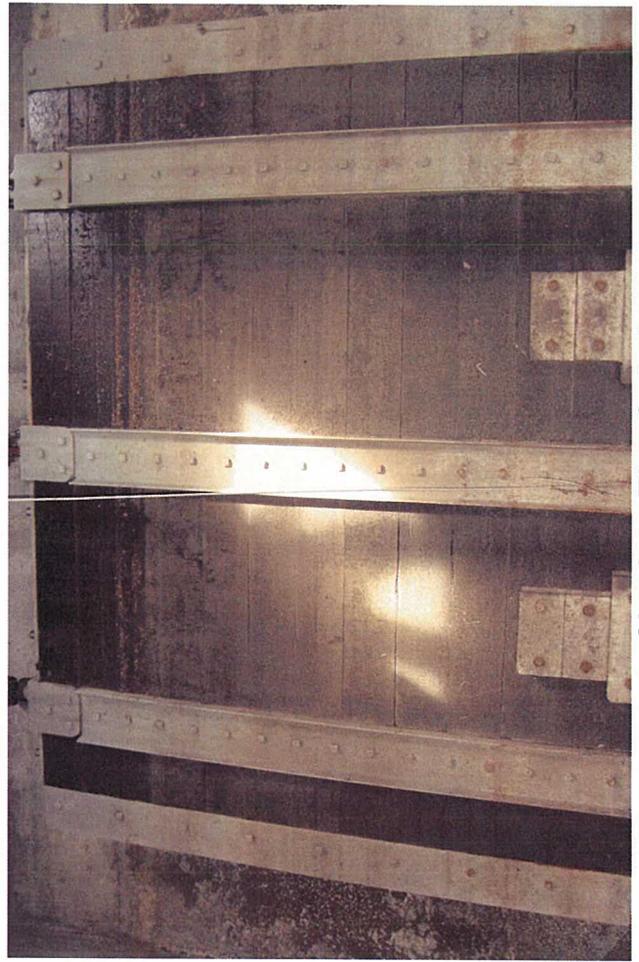
Charles_96In_toRiver



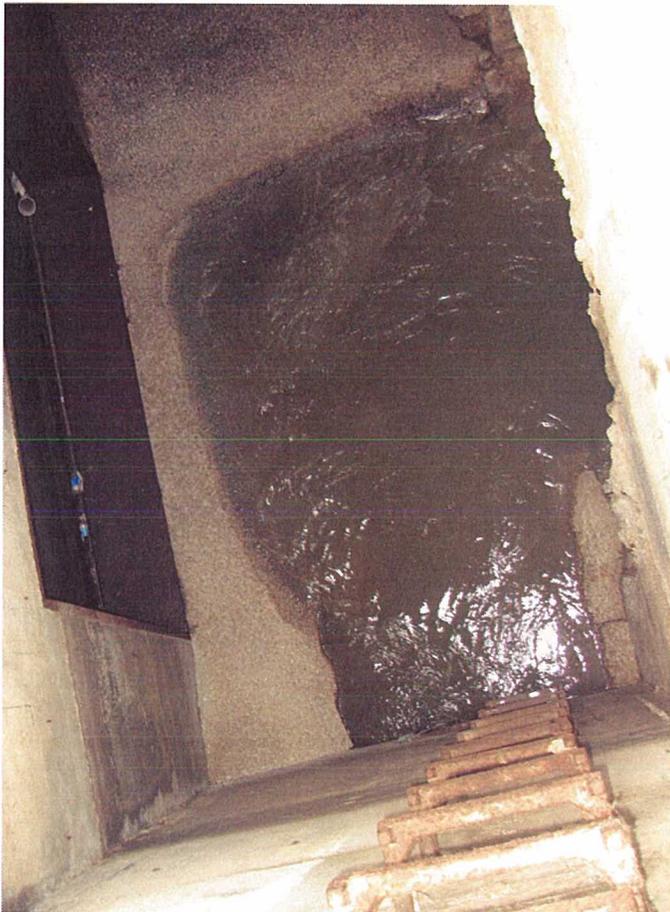
Charles_FlapGate



Charles_96In_toRiver1



Charles_FlapGate1



Charles_DryWeatherCell

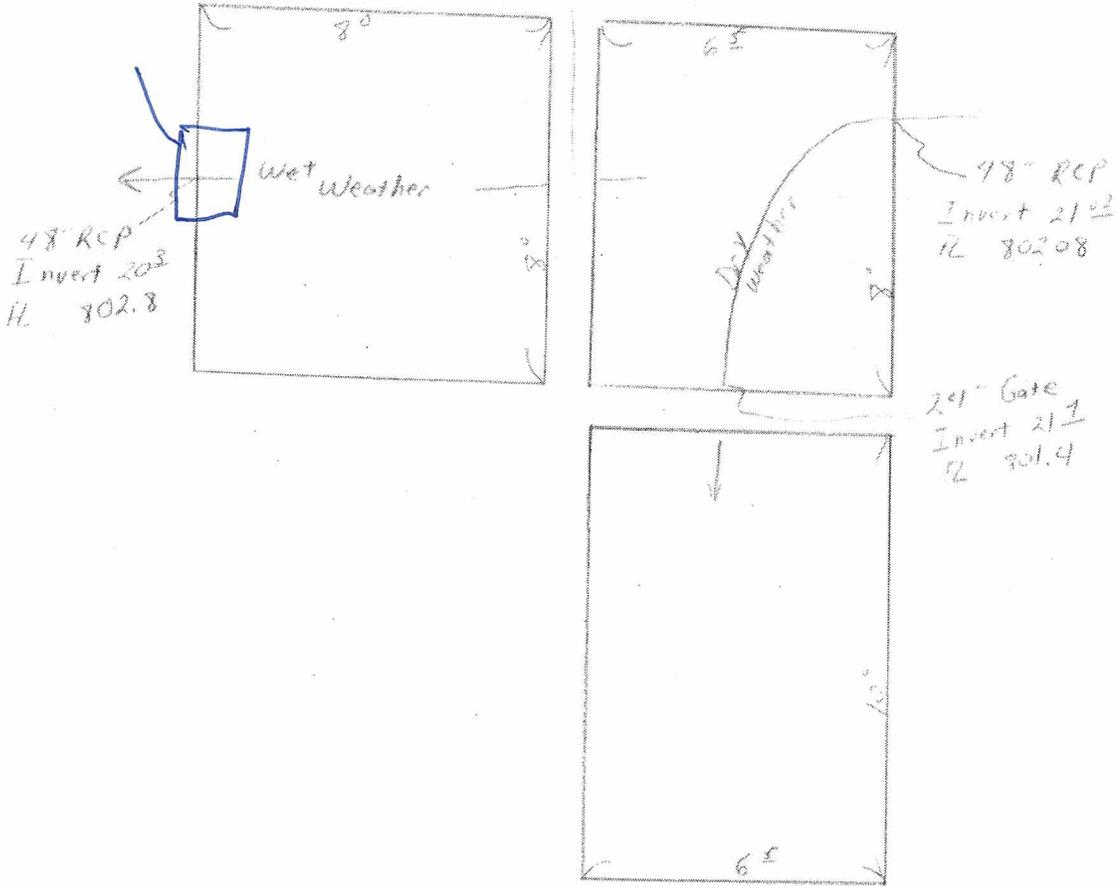
Diversion Name: Messanie

Picture Numbers: _____

Has Flap Gate

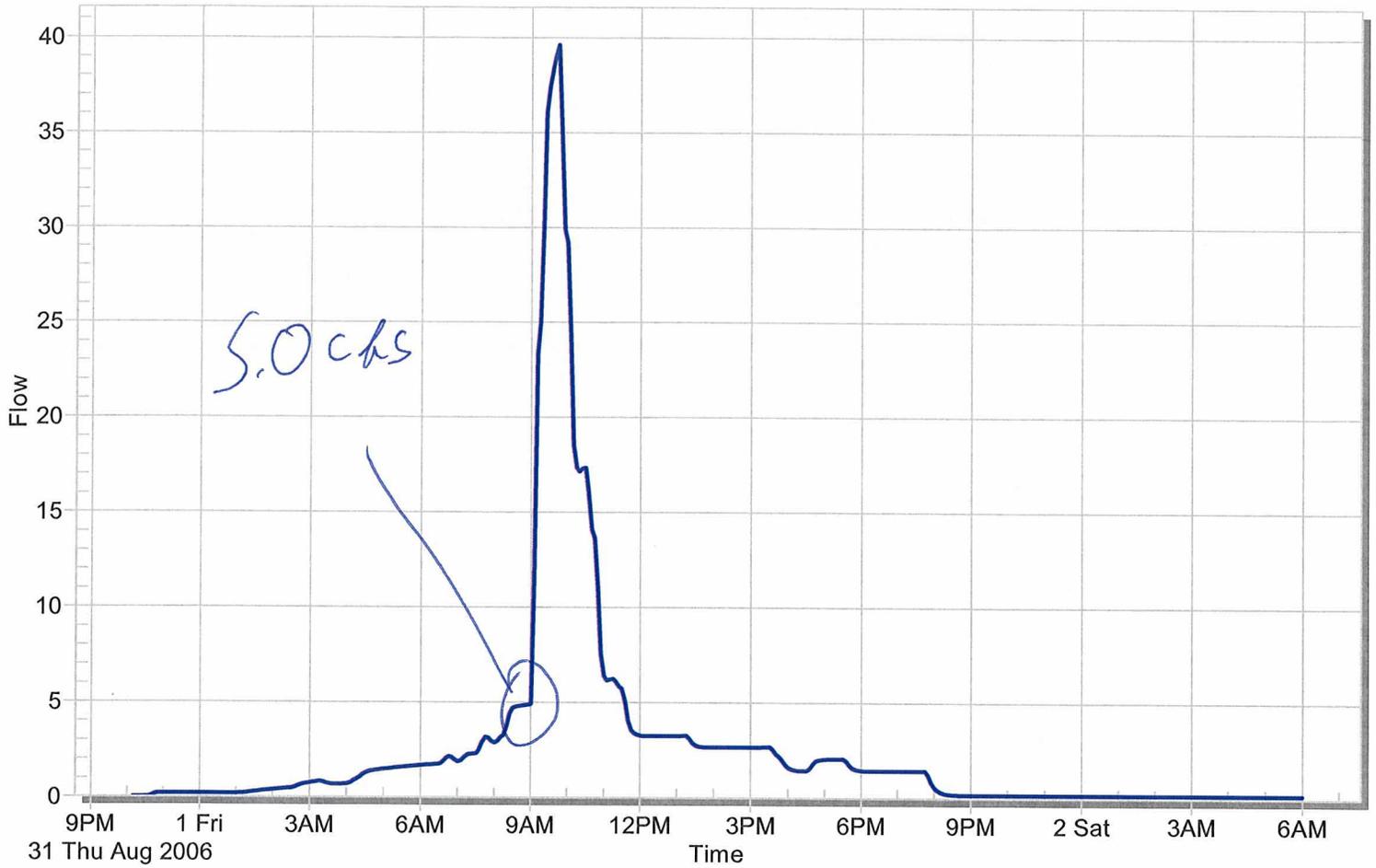
Socks
causes a CSO

4" Flap Gate
Invert 202.4
R 802.16

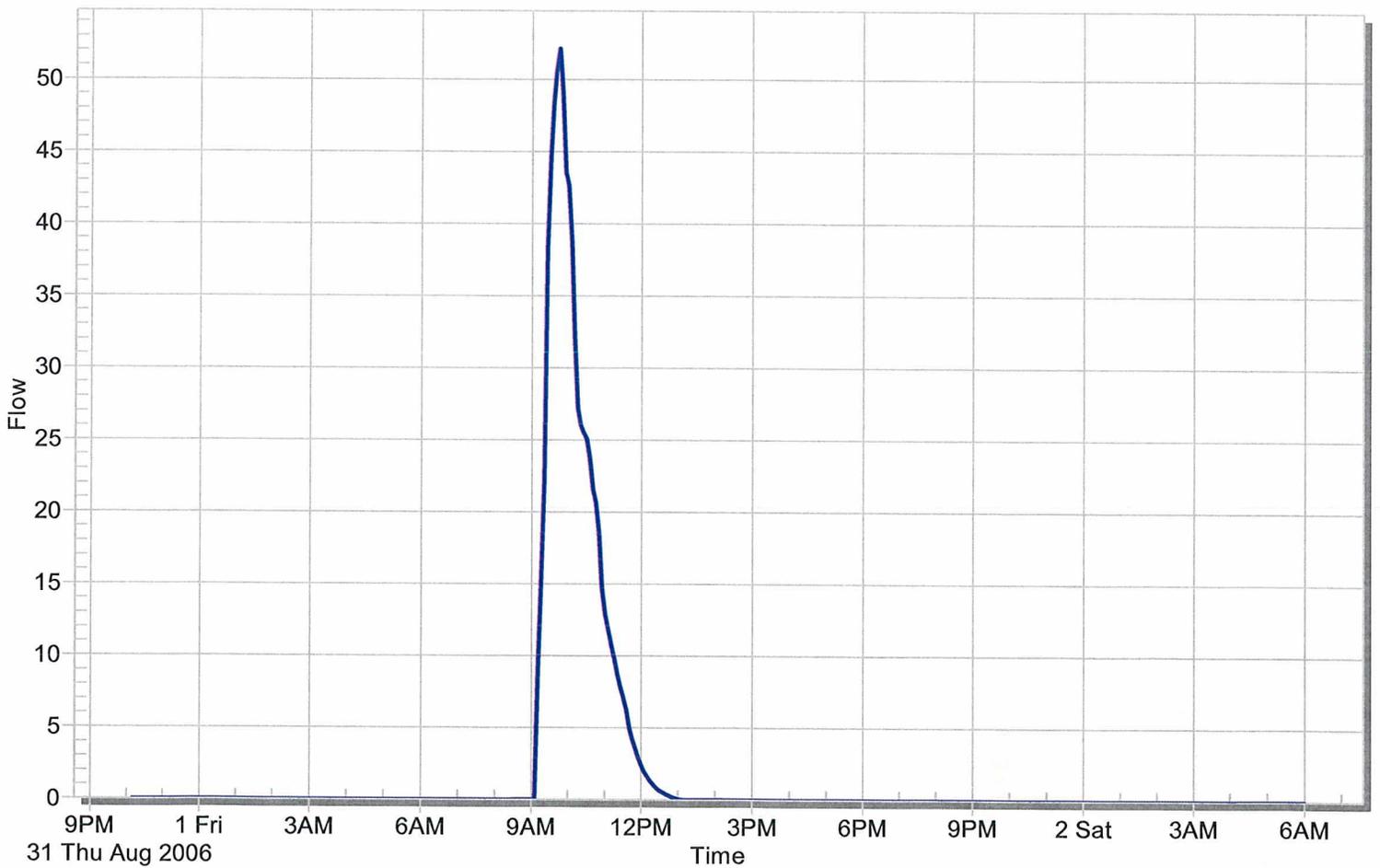


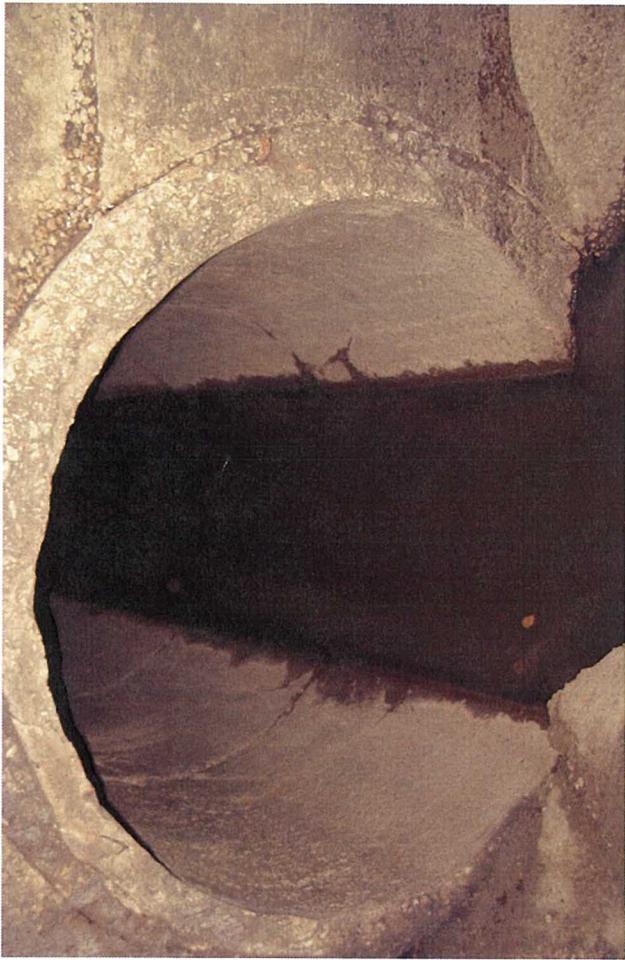
Messanie

Conduit 03M0010C from 12-16 to 9-75

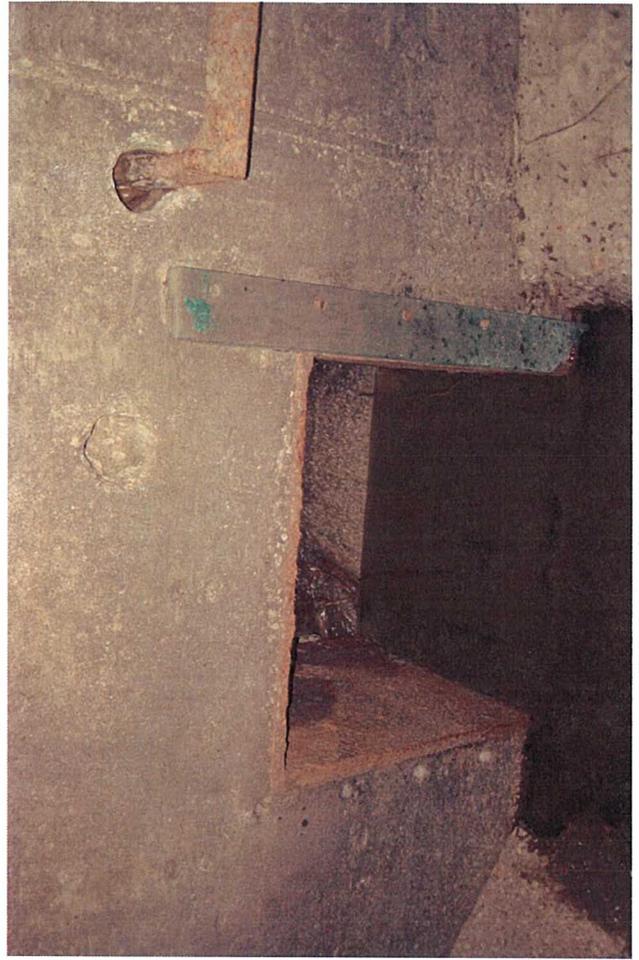


Conduit 03M0005C from 9-75-2 to 9-RIVER

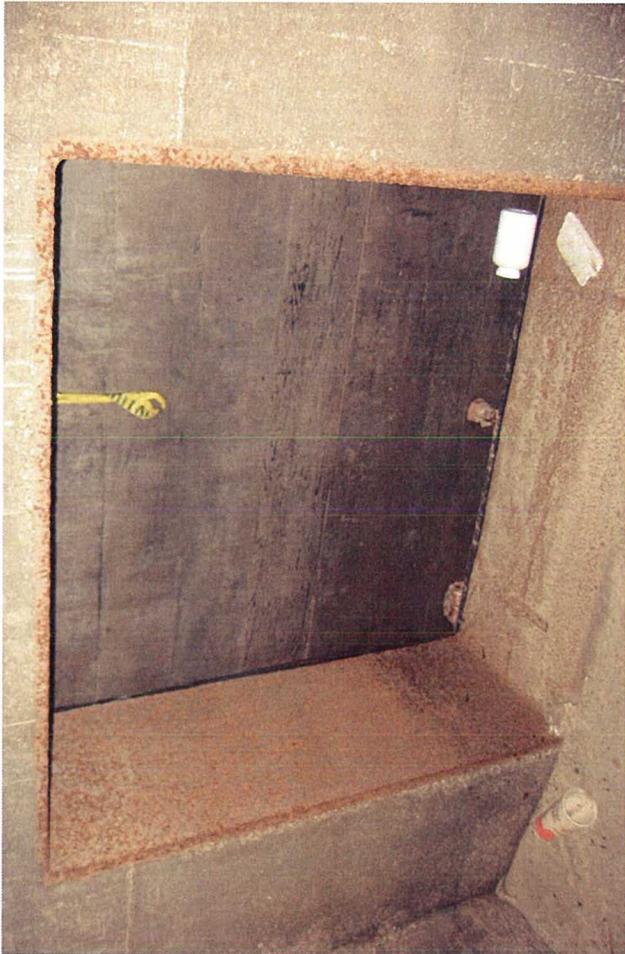




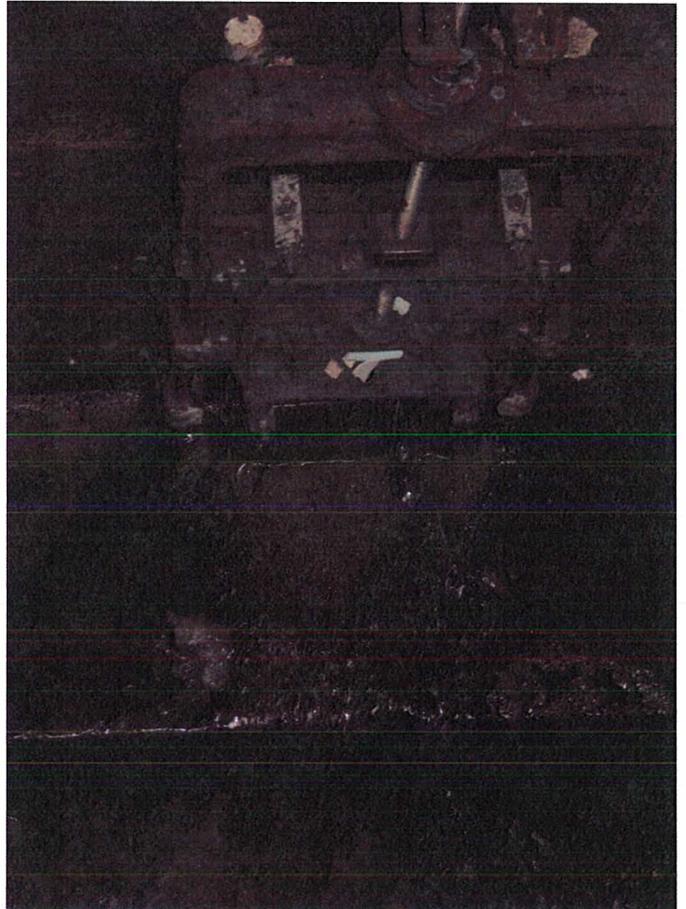
Messanie_48In_Inflow



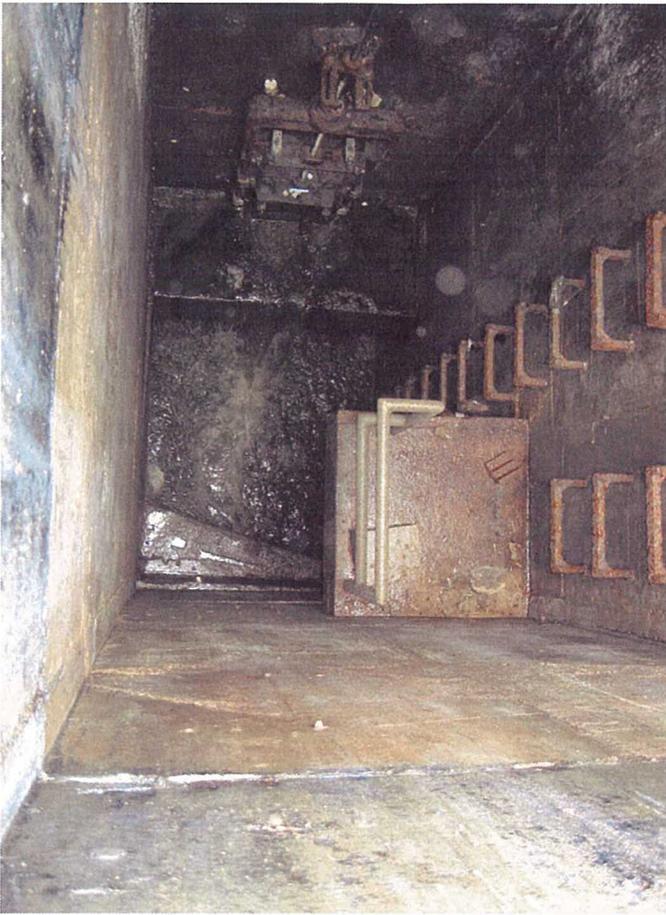
Messanie_SluiceGate1



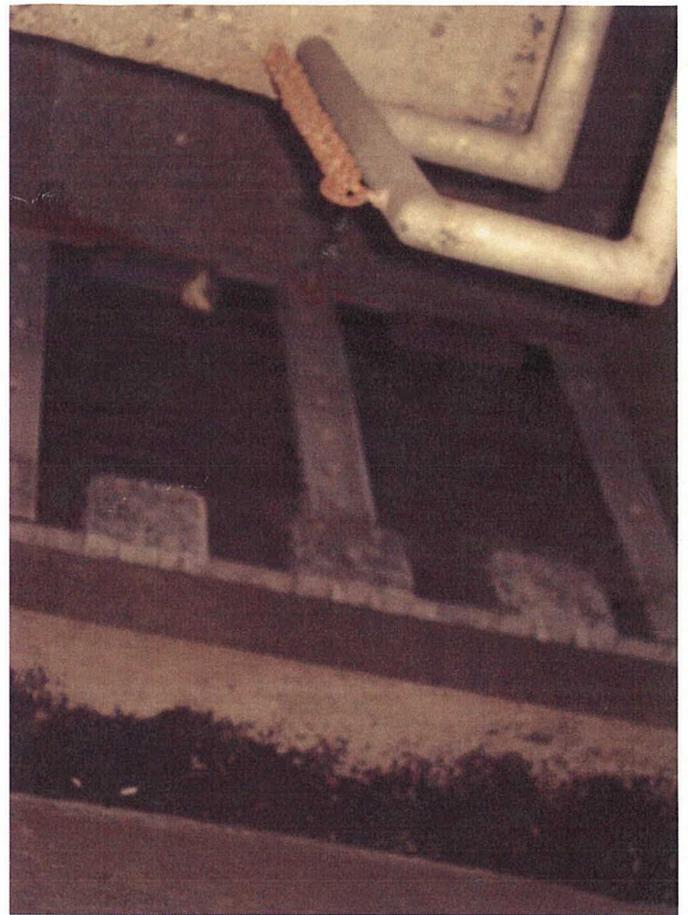
Messanie_FlapGate1



Messanie_SluiceGate



Messanie_OutFlow



Messanie_FlapGate



Messanie_WetWeatherCell

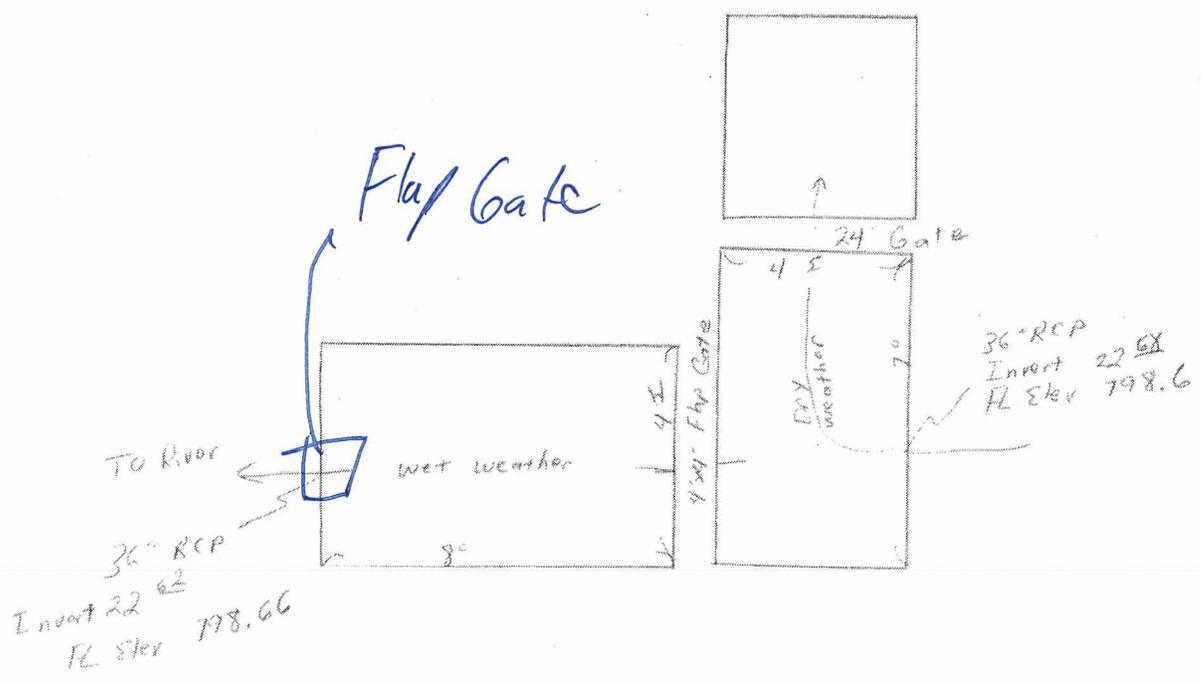


Messanie

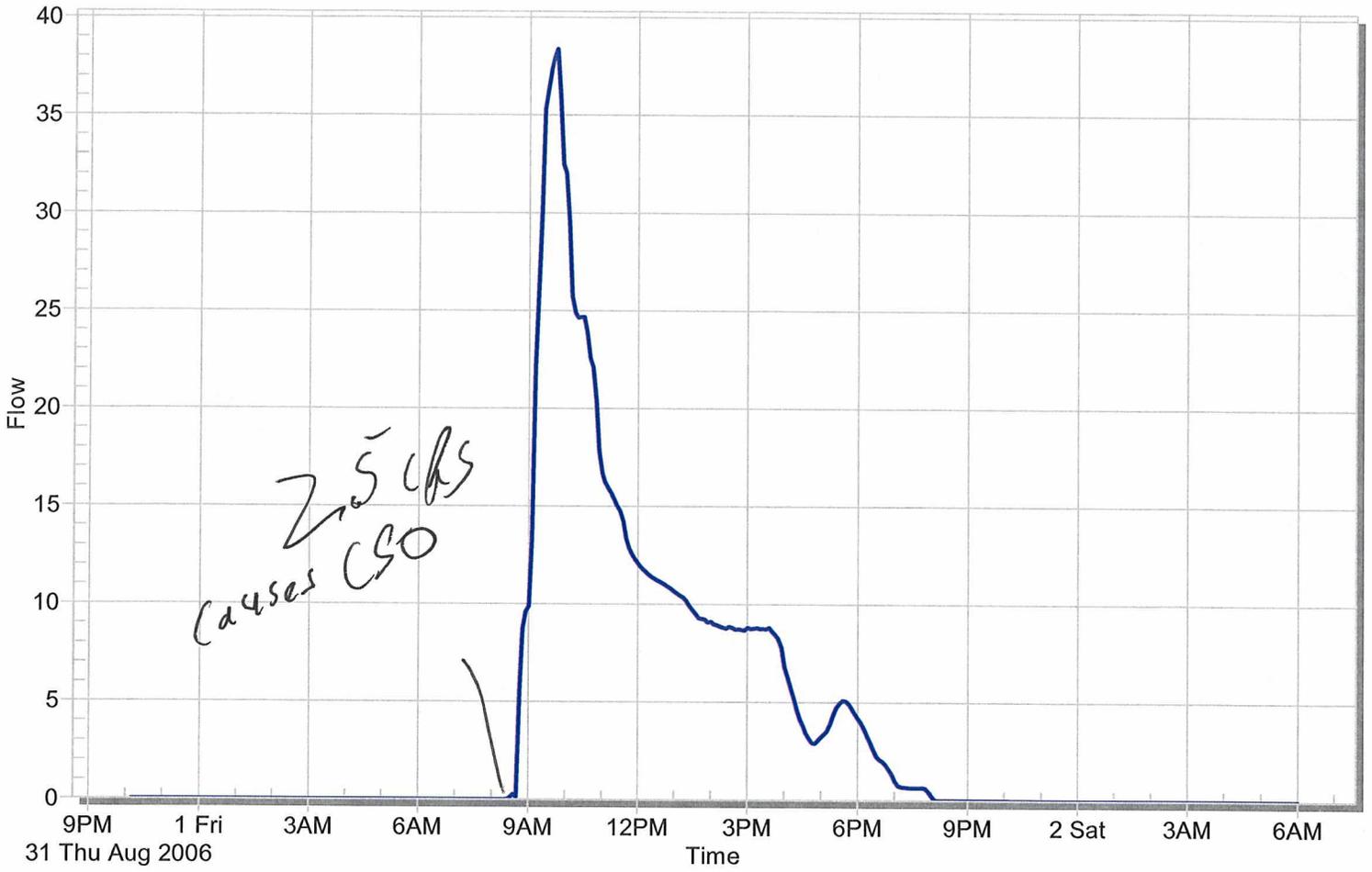
Diversion Name: Patee

Picture Numbers: _____

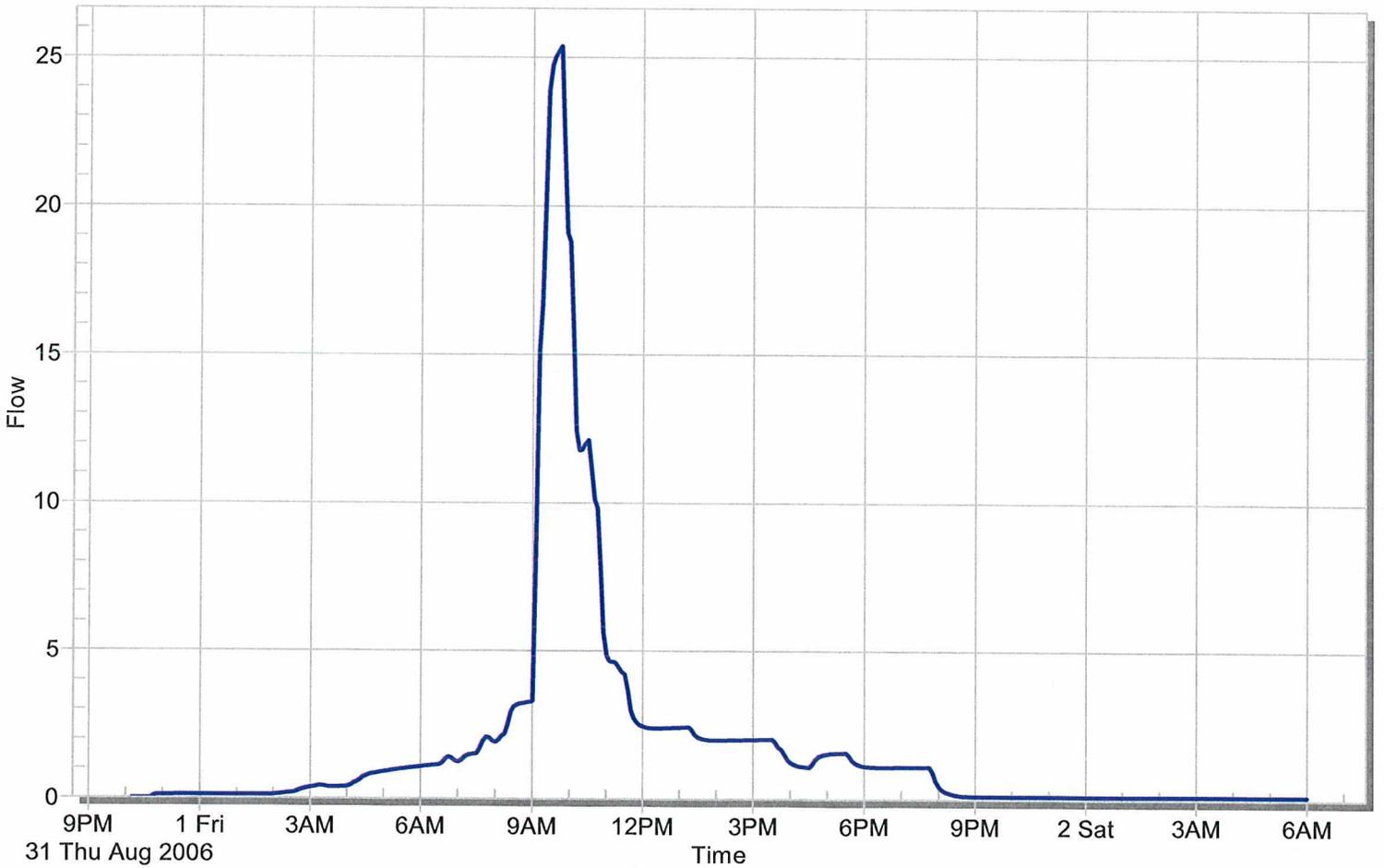
2.5 cfs
cause
overflow



Conduit 03P0005C from 9-76-2 to 9-R2



Conduit 03P0010C from 9-65 to 9-76





Patee_36In_Inflow



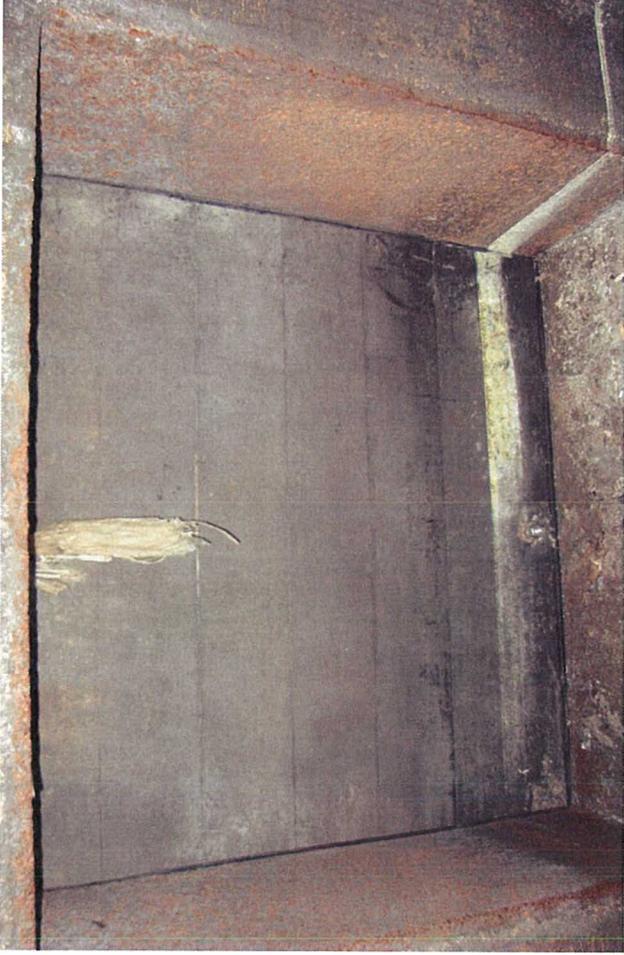
Patee_SluiceGate



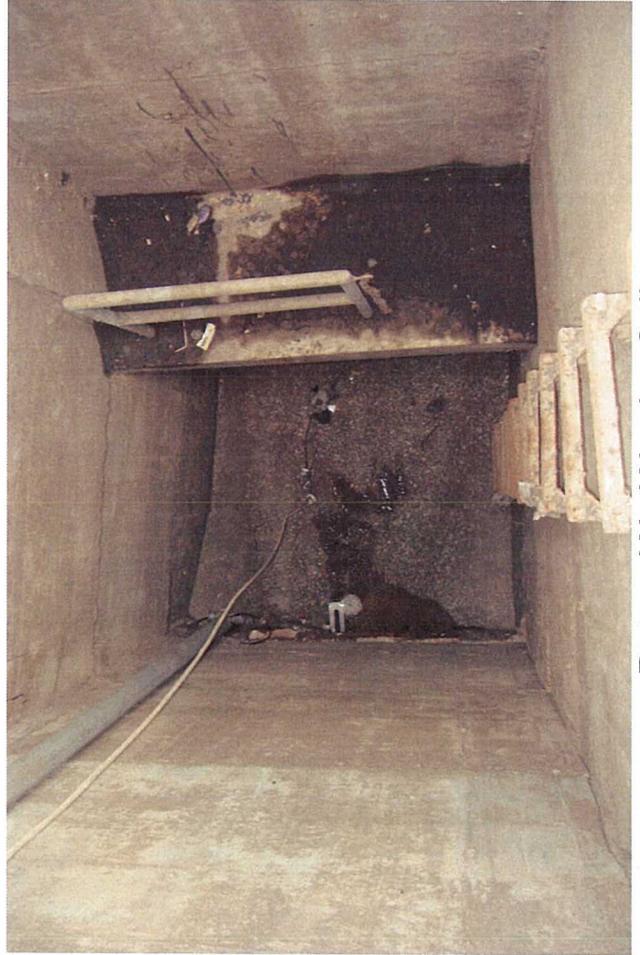
Patee_SluiceGate1



Patee_FlapGate



Patee_FlapGate1



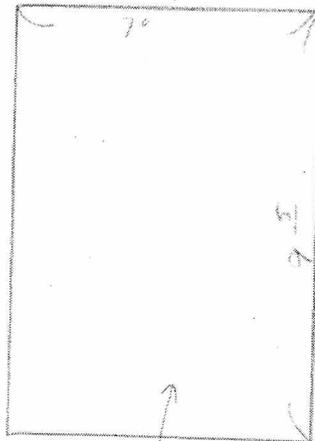
Patee_WetWeatherCell

Diversion Name: Olive

Picture Numbers: _____

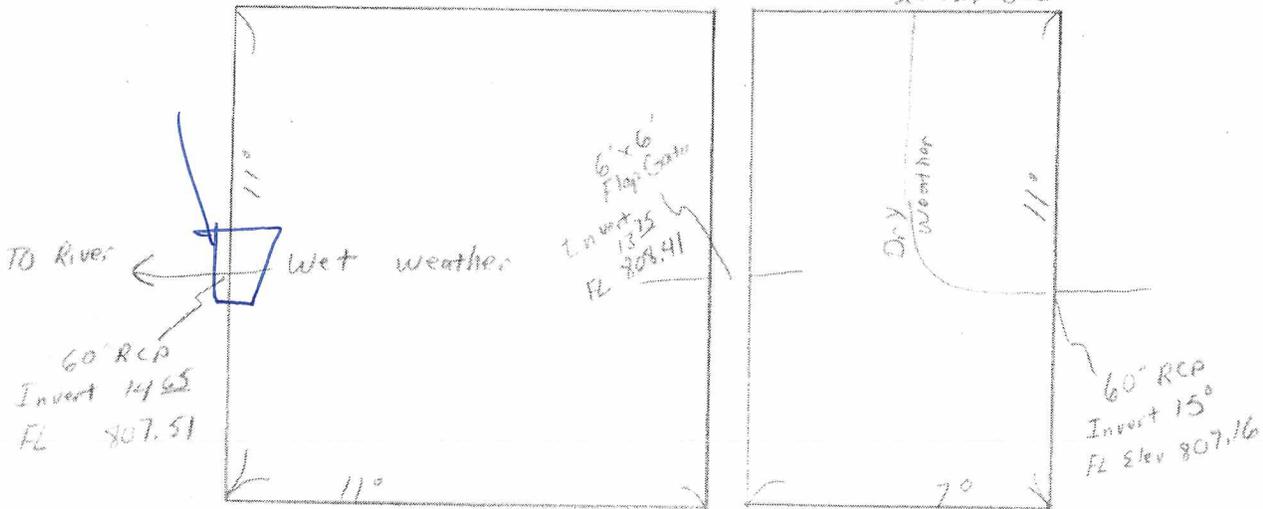
Scbs
Causes LSO

Interceptor
Main to South



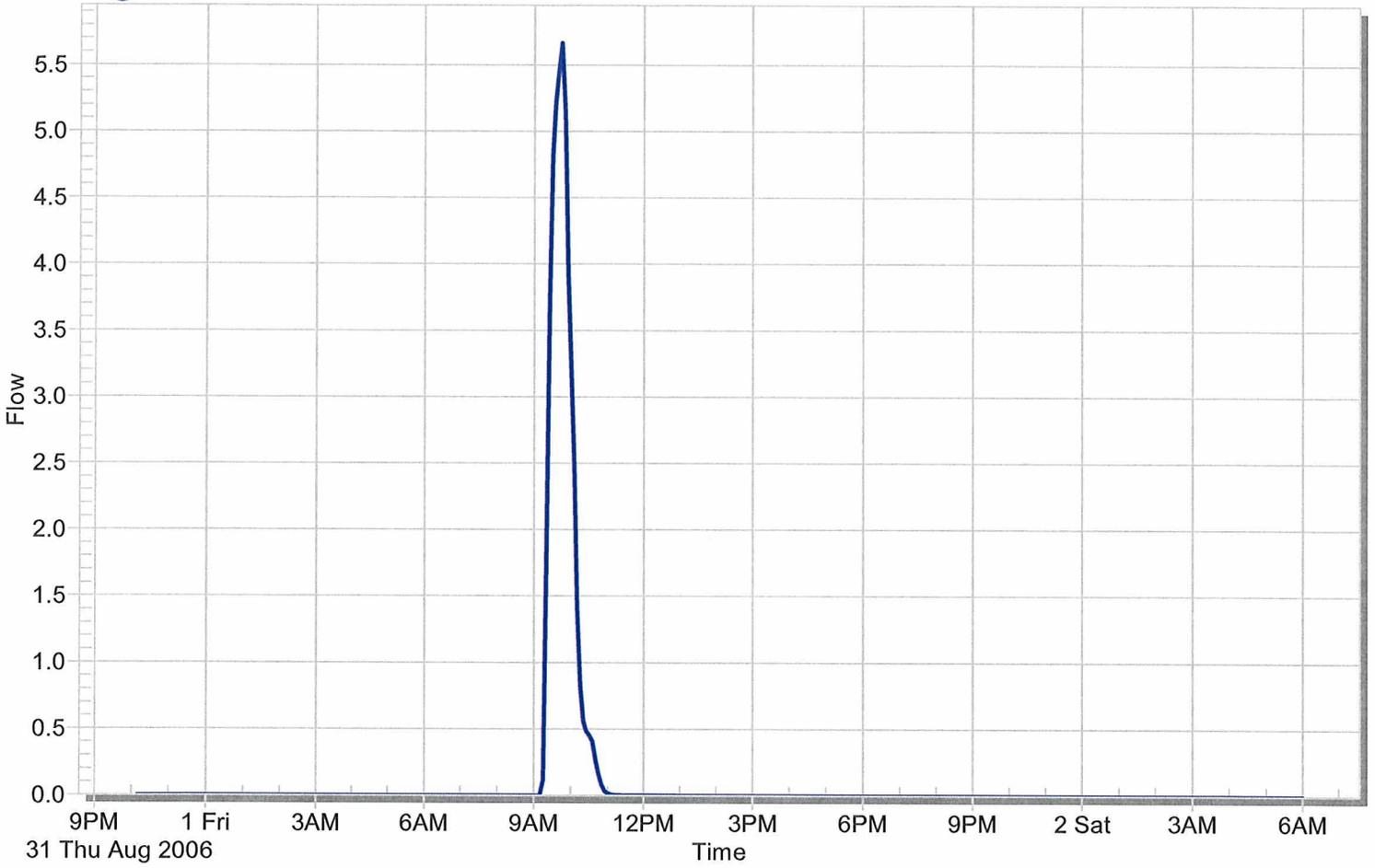
24' x 24' Gate

Flap Gate

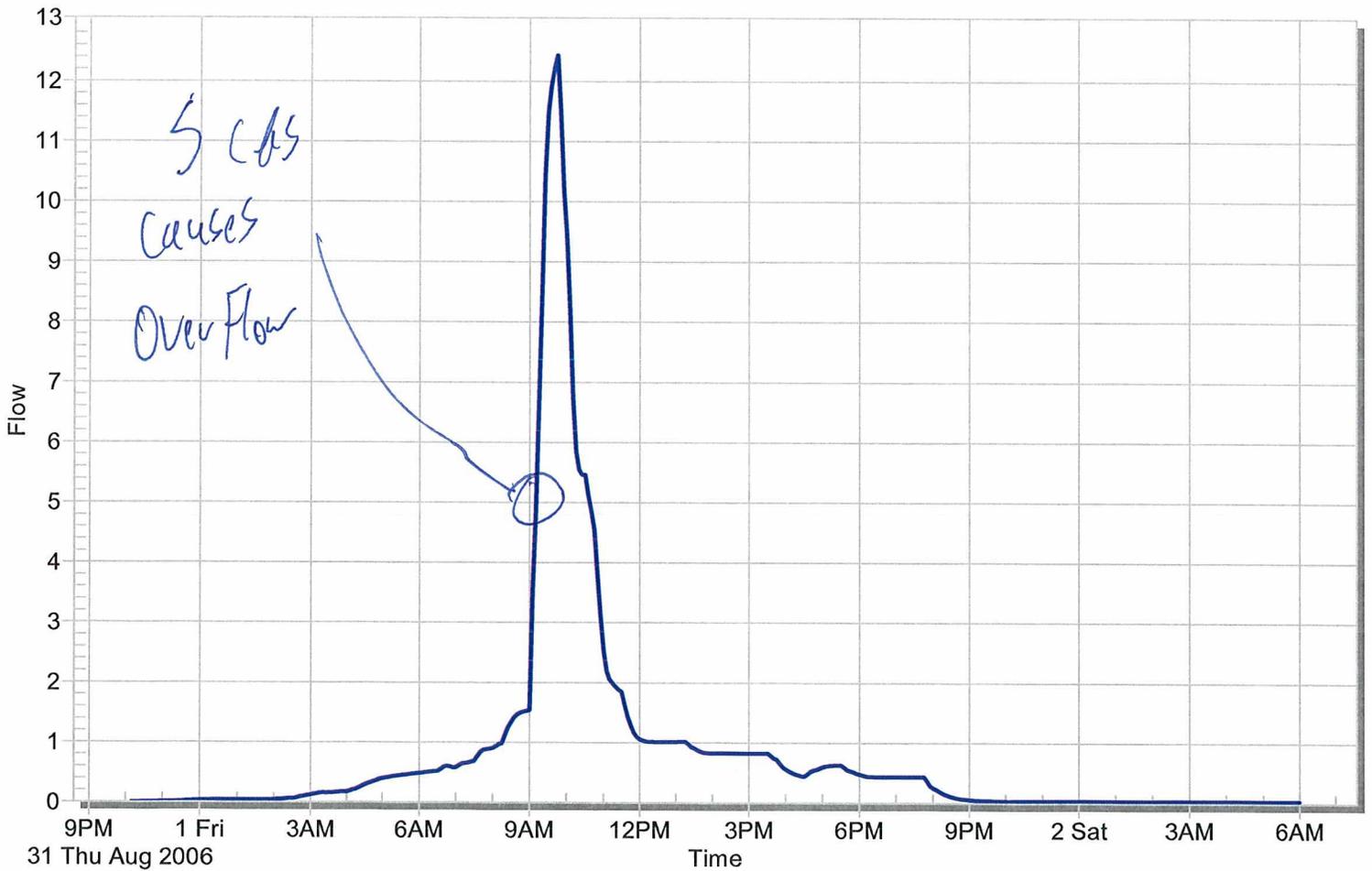


Olive

Conduit 03O0005C from 9-77-2 to 9-R3

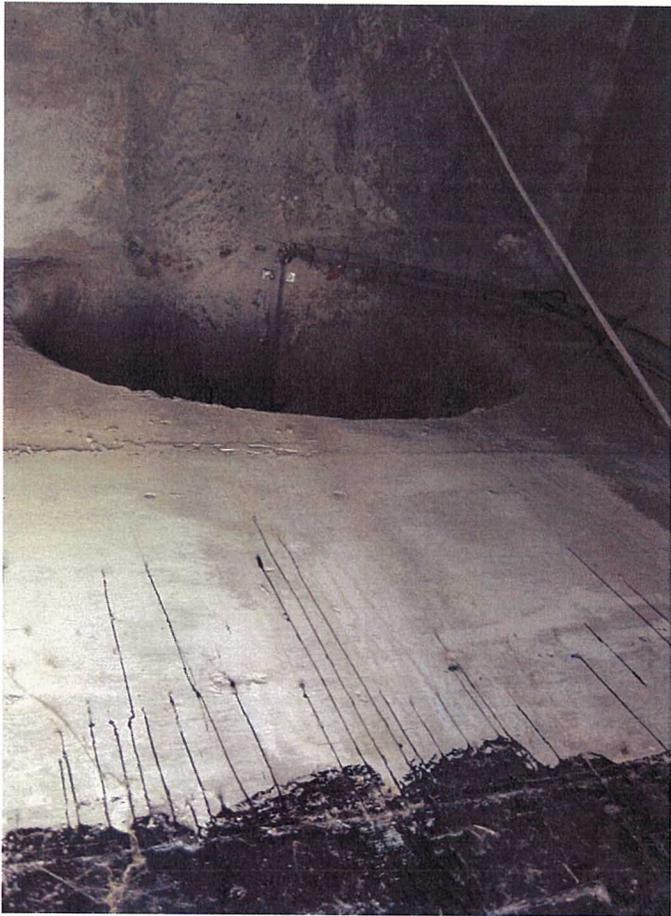


Conduit 03O0010C from 9-74 to 9-77





Olive_FlapGate1



Olive_60In_Outflow



Olive_SluiceGate1



Olive_SluiceGate2



Olive_FlapGate



Olive_60In_Inflow



Olive

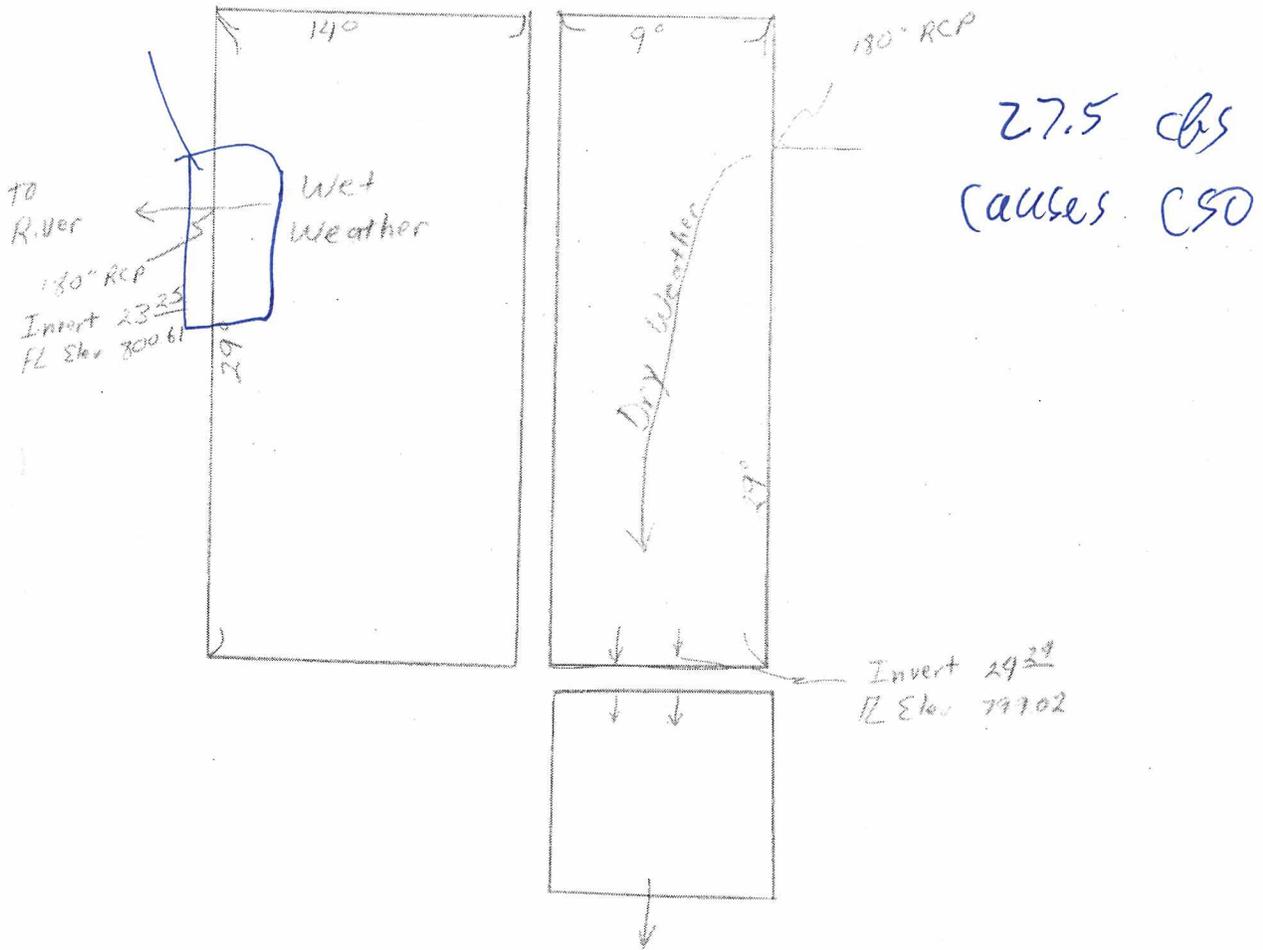


Olive_SluiceGate

Diversion Name: Mitchell

Picture Numbers: _____

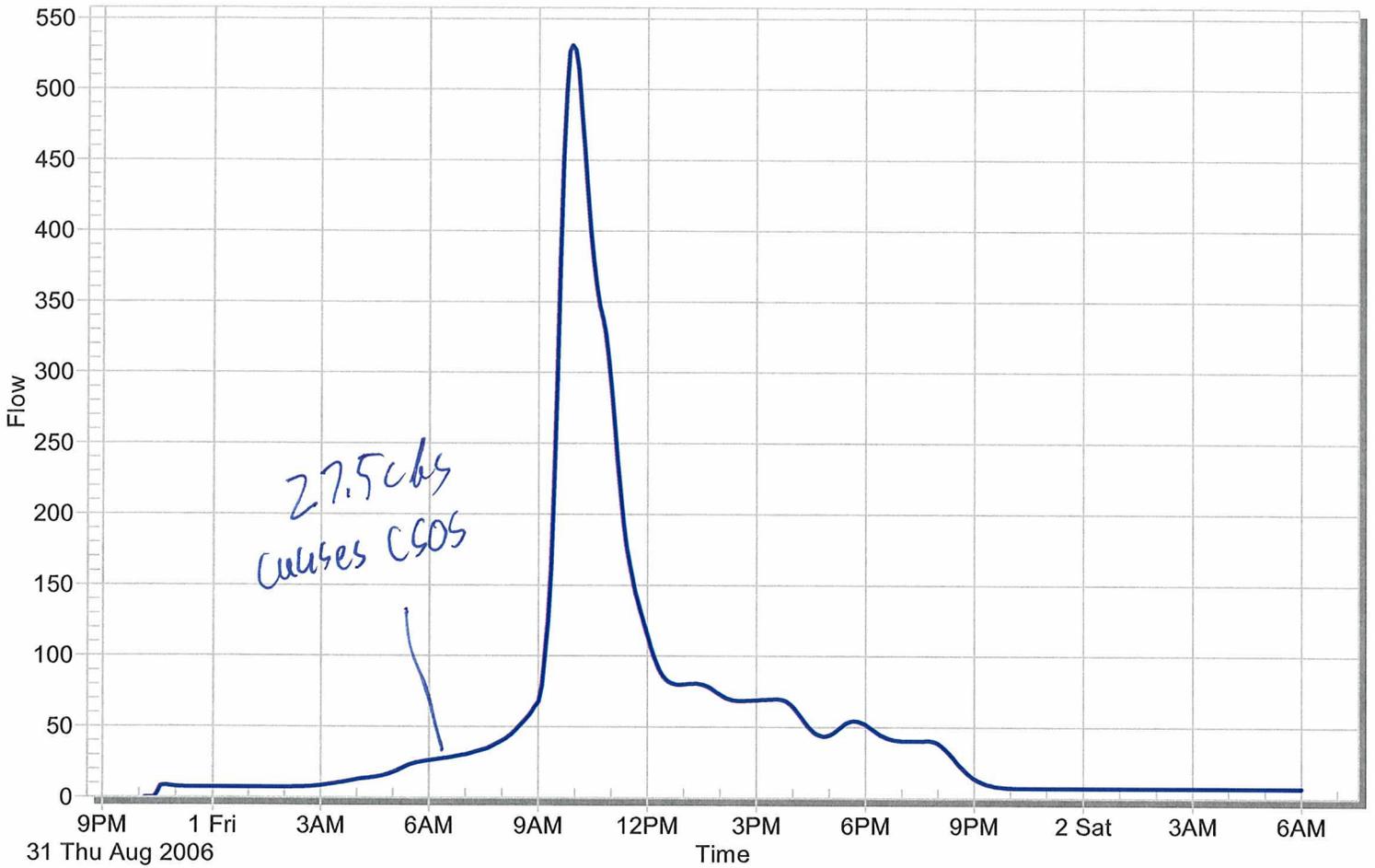
Double Flaps



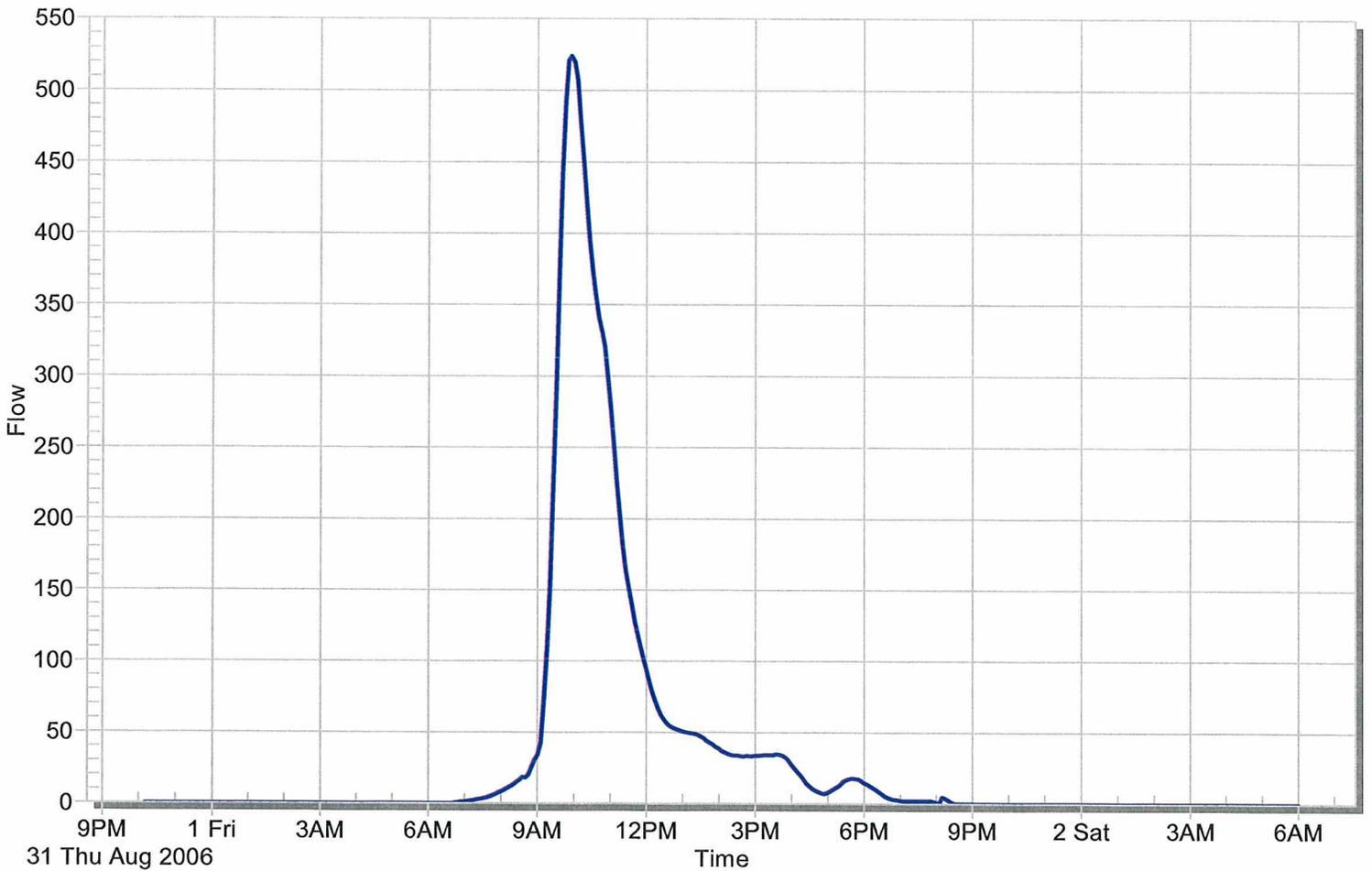
Unable to enter Dry Weather Cell

Mitchel

Conduit 0400004C from BDCS-37 to BDCS-38

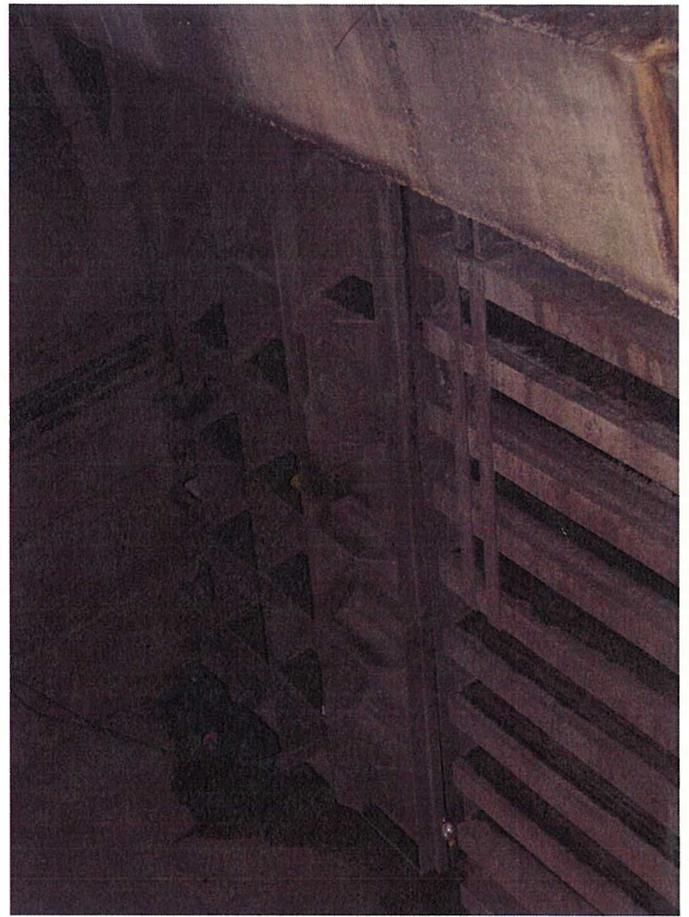


Conduit 0400002C.1 from BDCS-39 to BDCS-RIVER

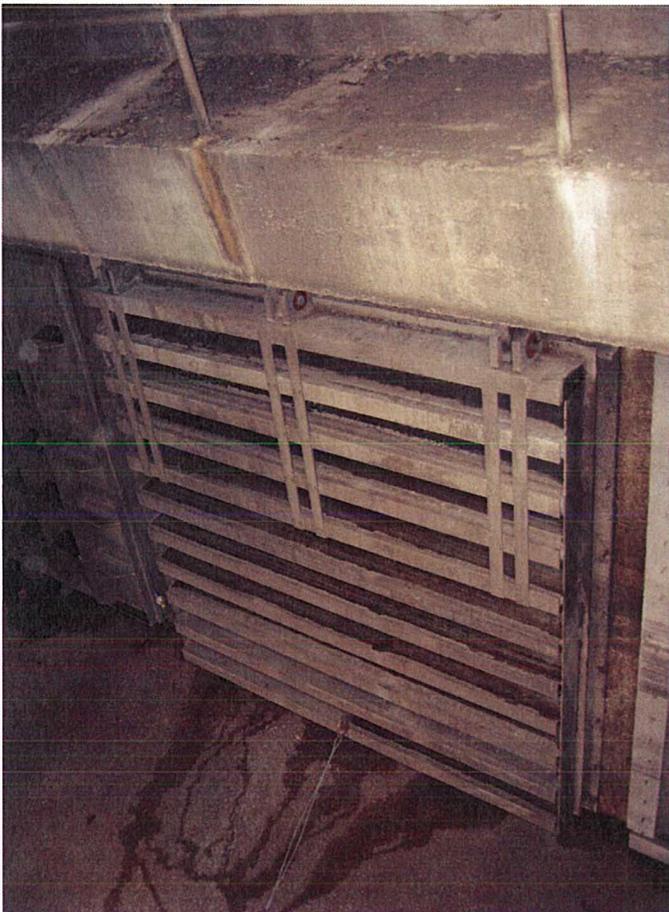




Mitchell_WetWeatherOutflow



Mitchell_NorthFlapGate



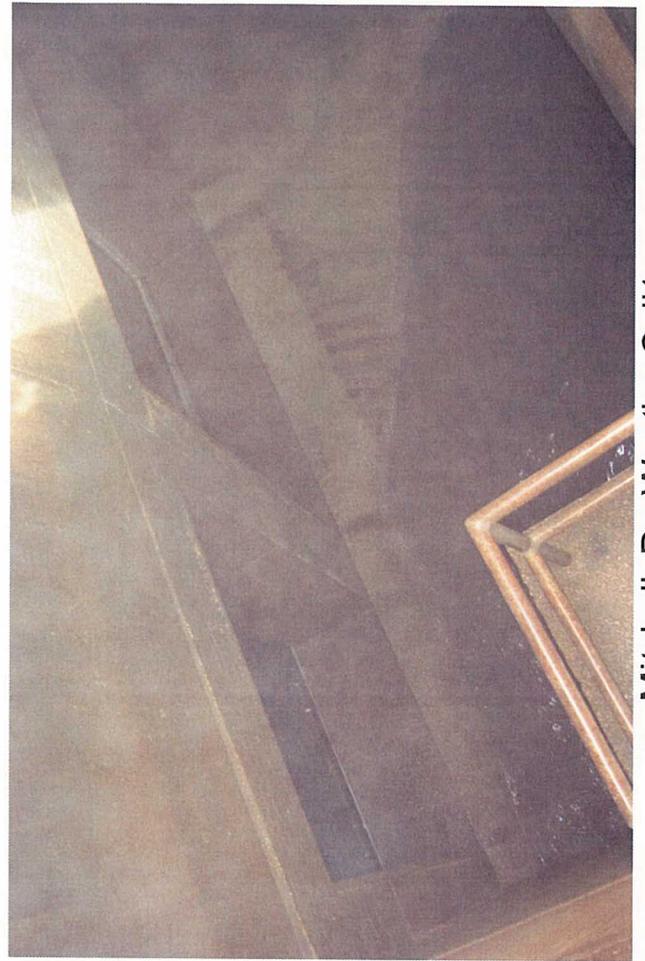
Mitchell_MiddleFlapGate



Mitchell_SouthFlapGate



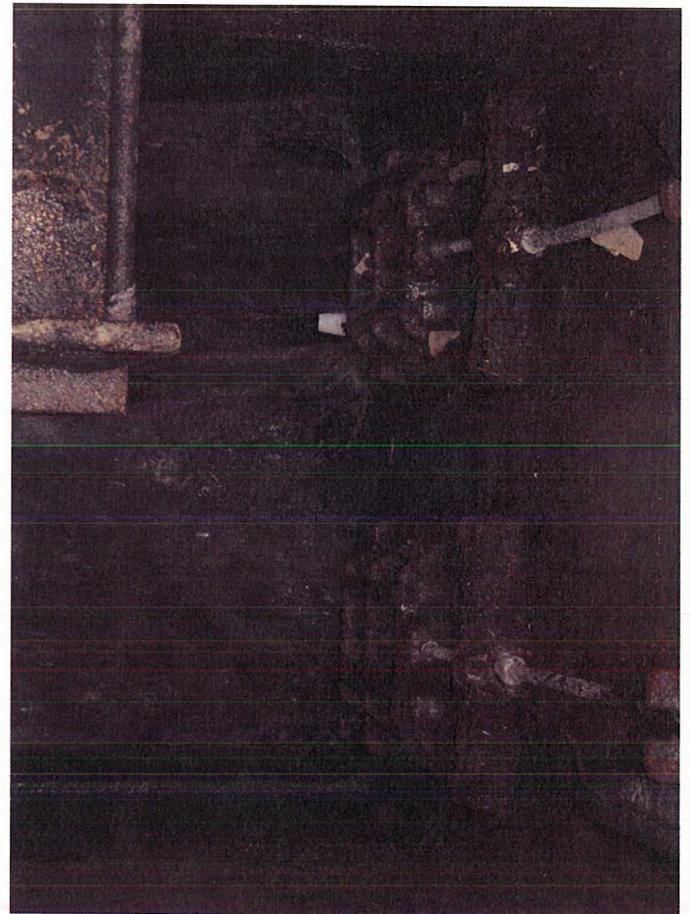
Mitchell_DryWeatherCell2



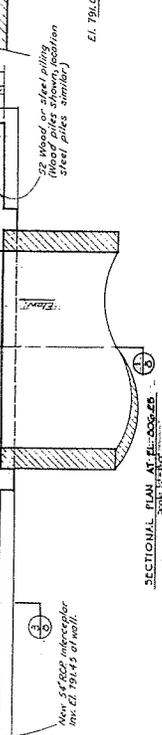
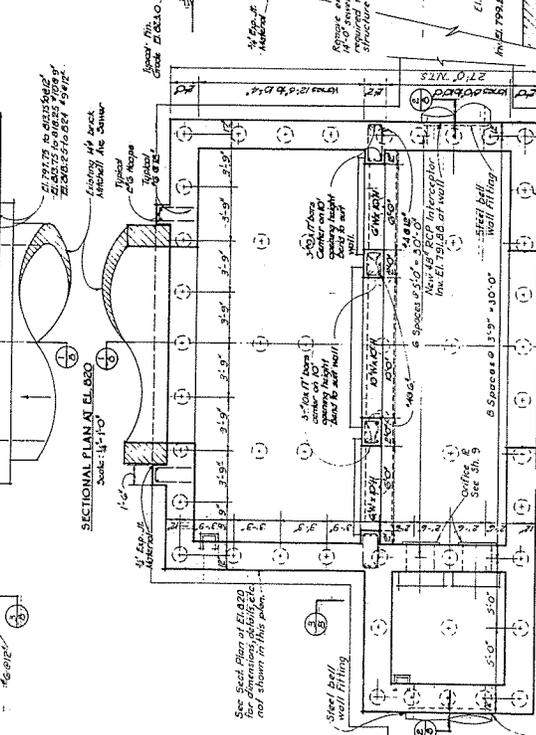
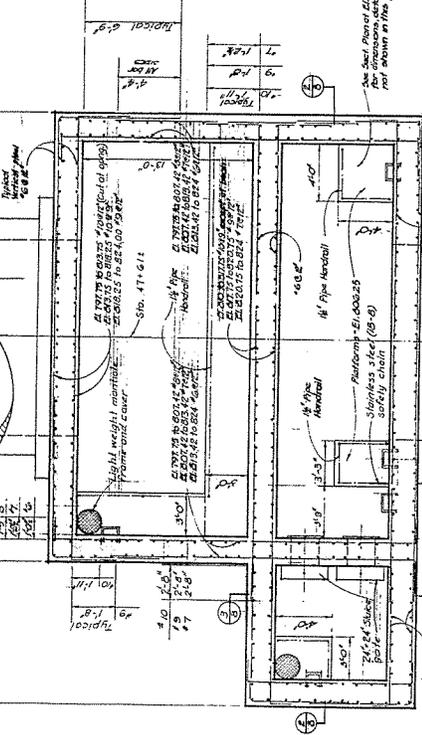
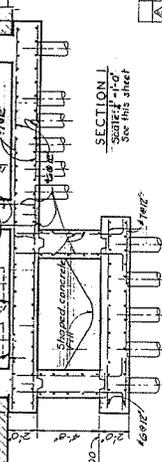
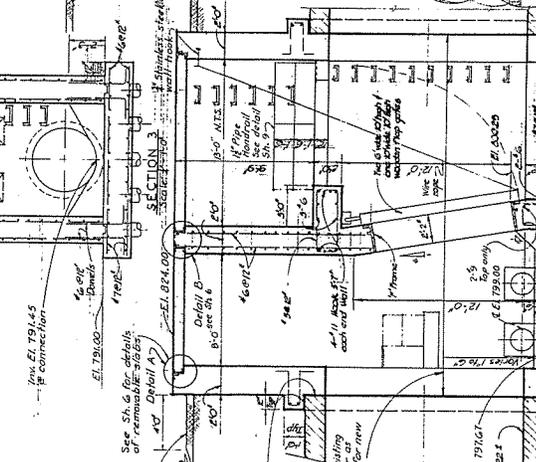
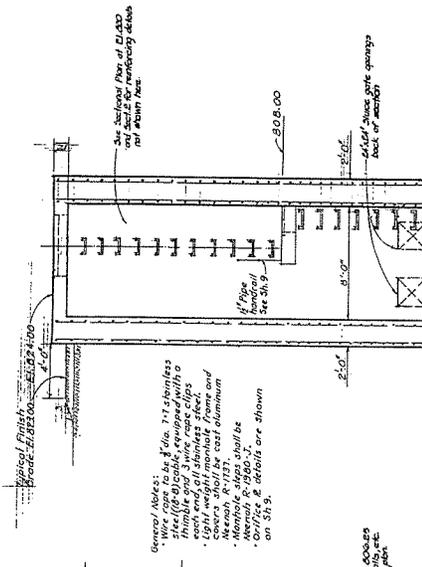
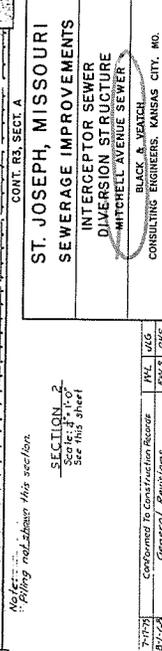
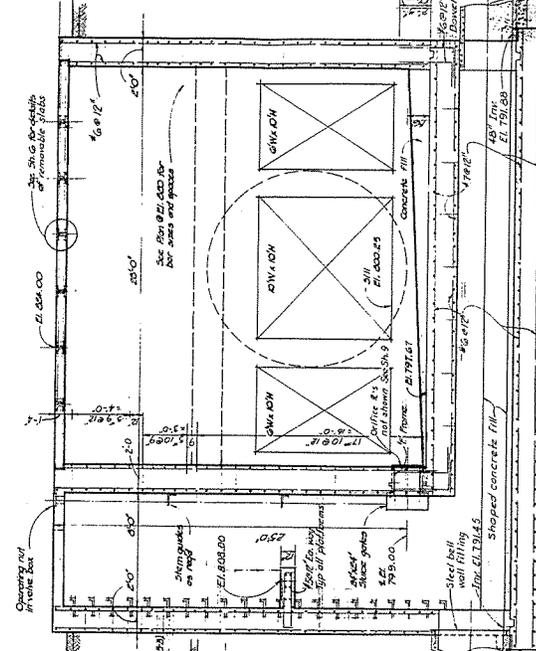
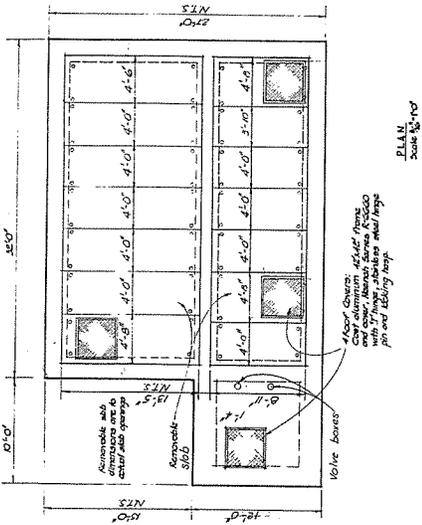
Mitchell_DryWeatherCell1



Mitchell_DryWeatherCell



Mitchell_SluiceGates



ST. JOSEPH, MISSOURI
SEWERAGE IMPROVEMENTS
DIVERSION STRUCTURE
MITCHELL AVENUE SEWER

BLACK & VEATCH
 CONSULTING ENGINEERS, KANSAS CITY, MO.
 DRAWN BY: [Name]
 CHECKED BY: [Name]
 DATE: 12-26-57

NO.	DATE	REVISIONS
1	1/17/58	Confirmed to Construction Bureau
2	1/21/58	General Revisions
3	1/21/58	General Revisions
4	1/21/58	General Revisions
5	1/21/58	General Revisions
6	1/21/58	General Revisions
7	1/21/58	General Revisions
8	1/21/58	General Revisions
9	1/21/58	General Revisions
10	1/21/58	General Revisions

SECTION 2
 Scale: 1/4"=1'-0"
 See this sheet

SECTION 1
 Scale: 1/4"=1'-0"
 See this sheet

SECTION 3
 Scale: 1/4"=1'-0"
 See this sheet

SECTION 4
 Scale: 1/4"=1'-0"
 See this sheet

SECTION 5
 Scale: 1/4"=1'-0"
 See this sheet

SECTIONAL PLAN AT EL. 850
 Scale: 1/4"=1'-0"
 See this sheet

SECTIONAL PLAN AT EL. 800-85
 Scale: 1/4"=1'-0"
 See this sheet

PROJECT 3113

Diversion Name: Duncan Street

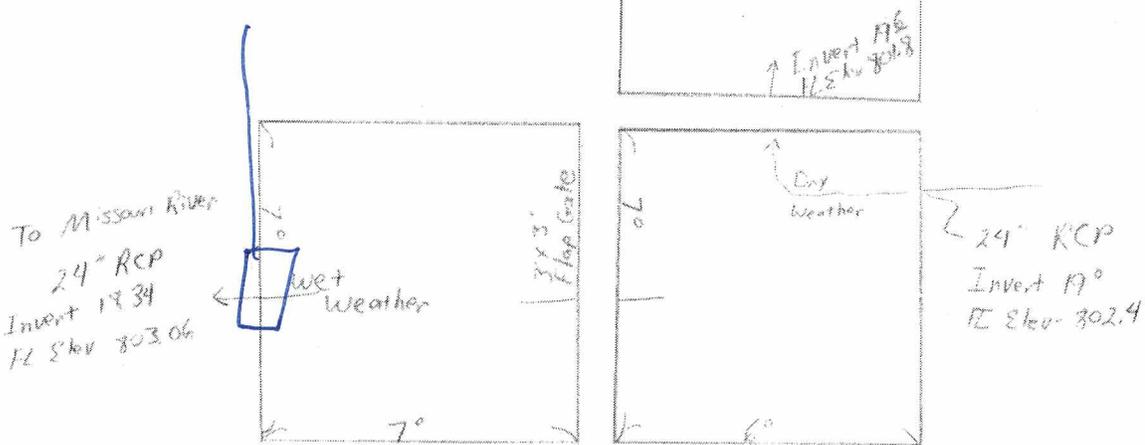
Picture Numbers: _____

2 cbs

causes an overflow

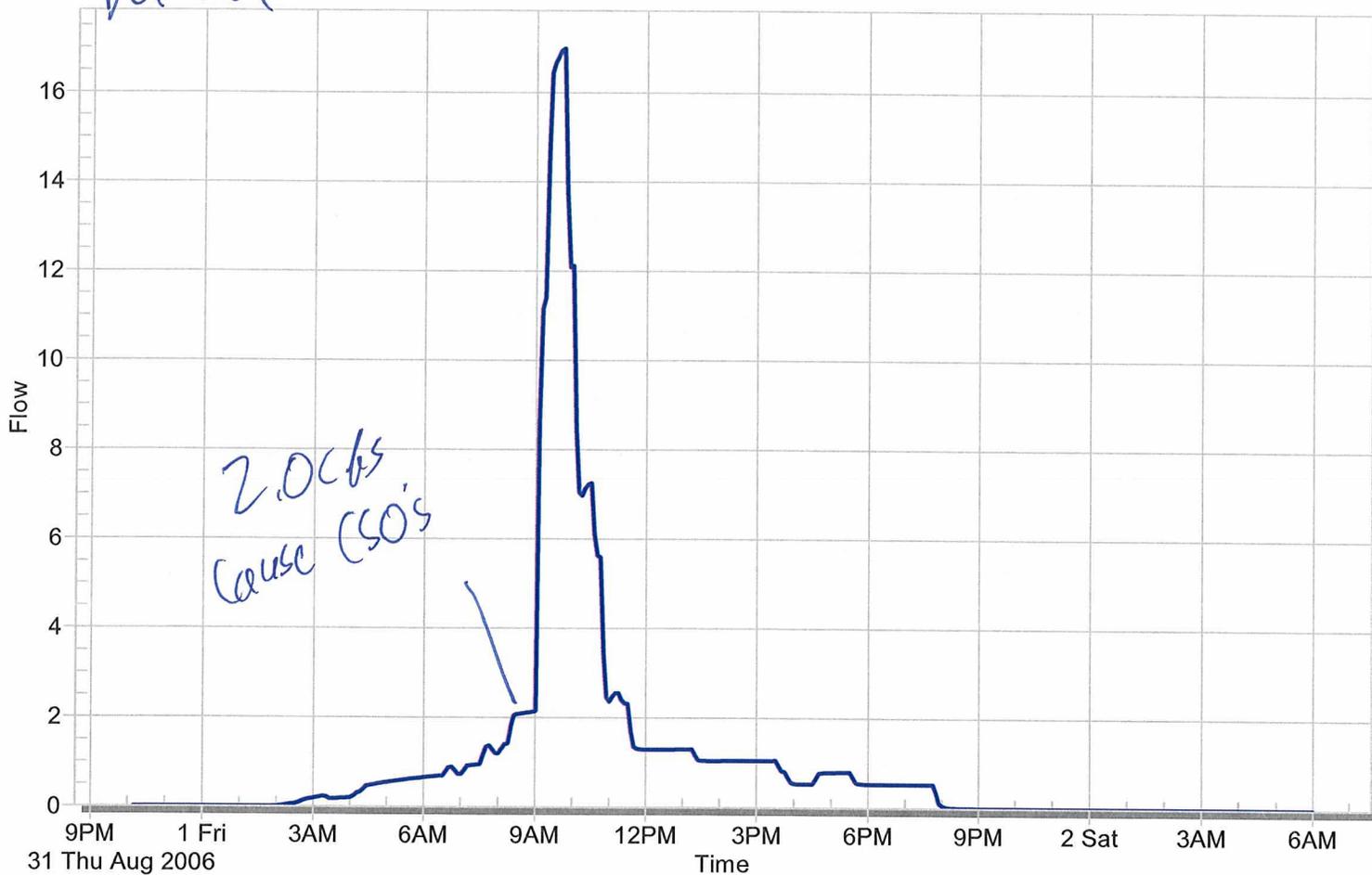
Does it
really have
the orifice
plate still on??

Has Flap
gate

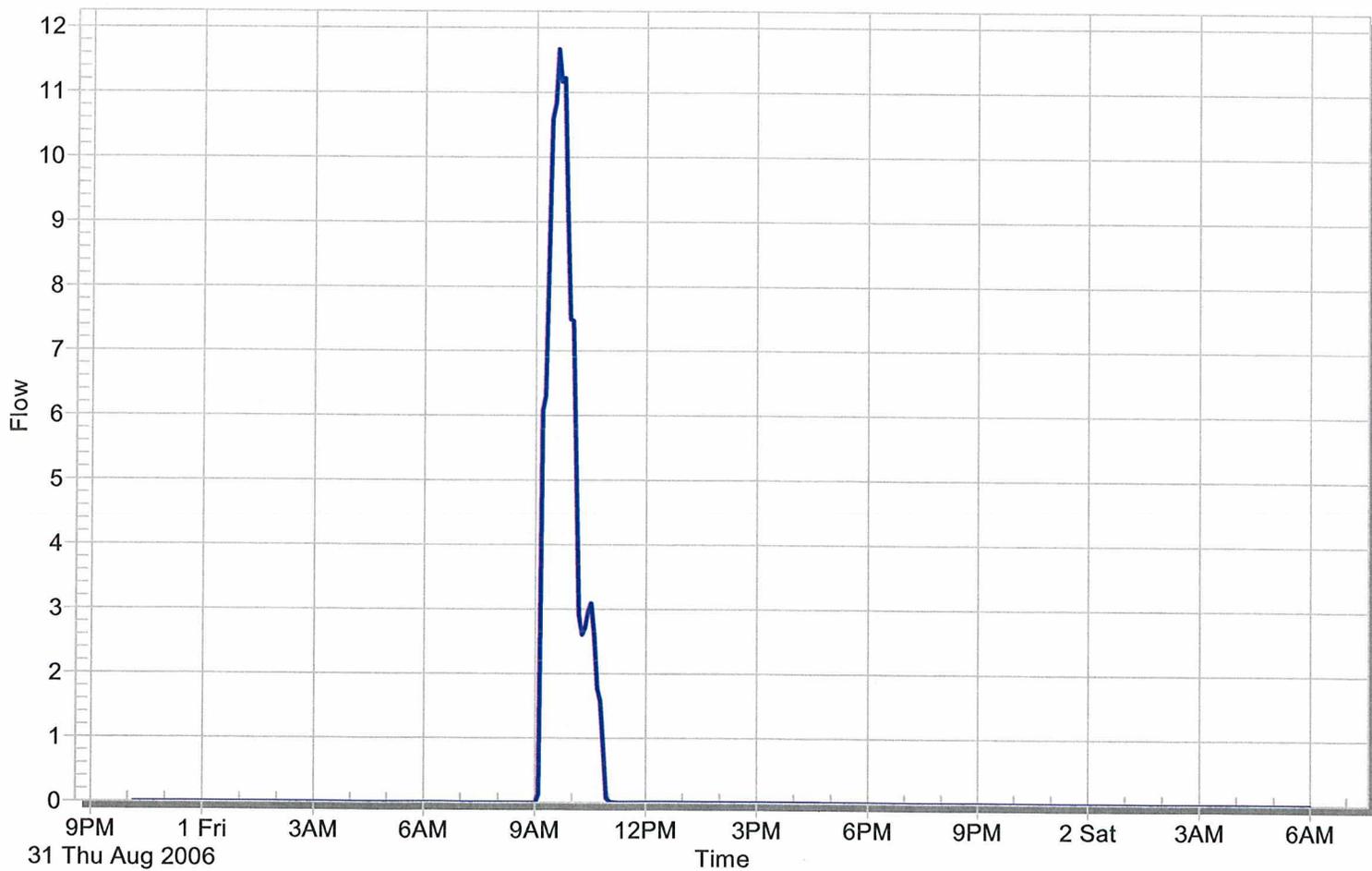


Vertical

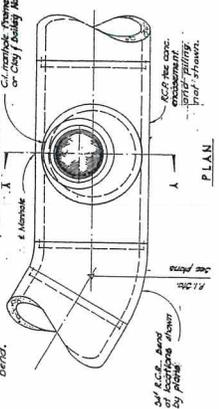
Conduit 05D0015C from 83-2 to 83-18



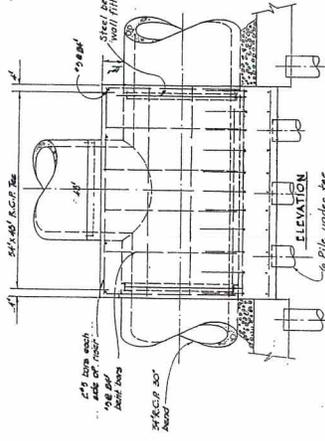
Conduit 05D0010C from 83-18-2 to 83-19



Notes: * Where an elevation drop is indicated across the bend by the pipe riser, this drop is in addition to the grade of the adjoining riser.
 * For location purposes, Type A manholes are located by PL station or sewer line. At stations where horizontal pipe riser shall be located upstream and adjacent to bend.

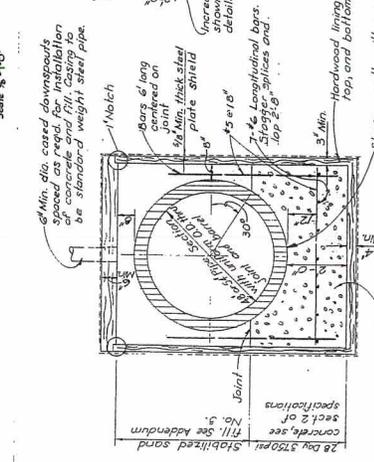


PLAN



ELEVATION

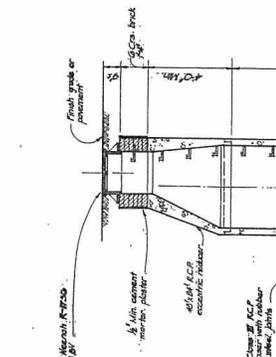
TYPE A MANHOLE
Scale: 1/4" = 1'-0"



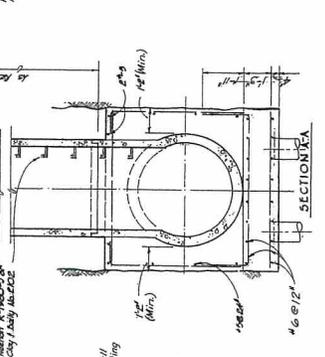
TYPICAL CROSS SECTION
Scale: 1/4" = 1'-0"

TYPICAL LONGITUDINAL SECTION
Scale: 1/4" = 1'-0"

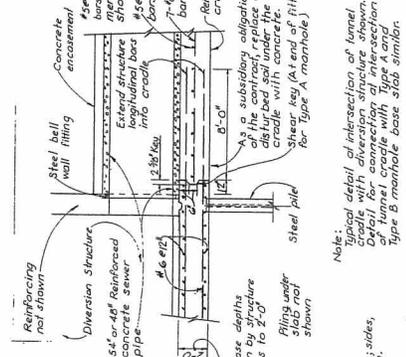
ALTERNATIVE II - WOOD BOX TUNNEL



PLAN

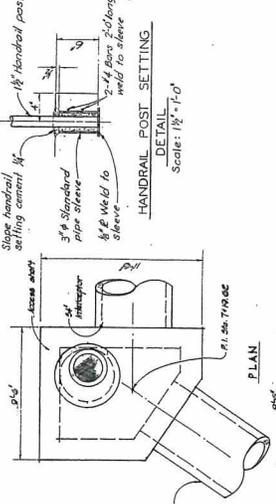


SECTION A

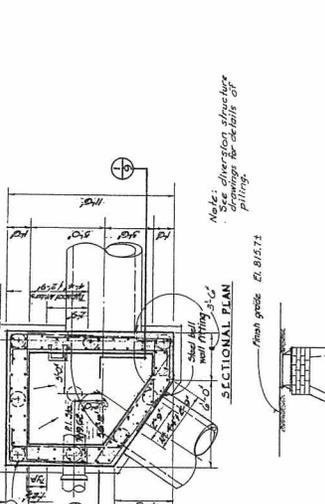


TYPICAL LONGITUDINAL SECTION
Scale: 1/4" = 1'-0"

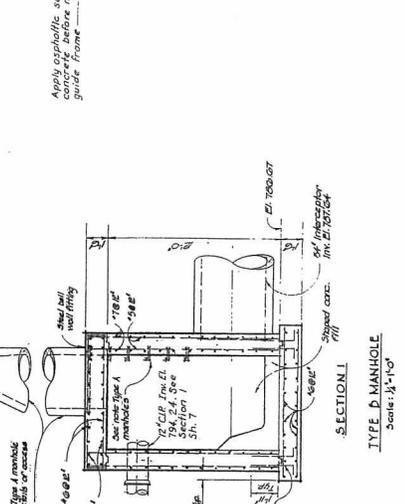
ALTERNATIVE I - WOOD BOX TUNNEL



HANDRAIL POST SETTING
Scale: 1/2" = 1'-0"



SECTIONAL PLAN

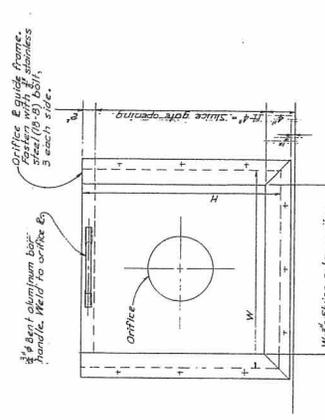


SECTION I
Scale: 1/4" = 1'-0"

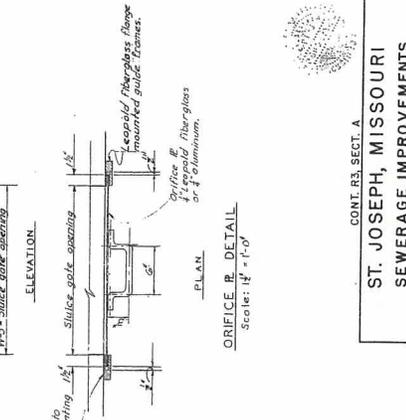
ALTERNATIVE I - WOOD BOX TUNNEL

DIVERSION LOCATIONS	STRUCTURE	ORIFICE B. SIZE W H	ORIFICE DIAMETER
Hickory St.		2' x 22"	6"
Duncan St.		15' x 15'	2'
Mitchell St.		15' x 15'	2'
Mitchell Ave.		27' x 28' 1/2" Round	18"

ORIFICE B. SCHEDULE



ELEVATION



PLAN

ORIFICE B. DETAIL
Scale: 1/2" = 1'-0"

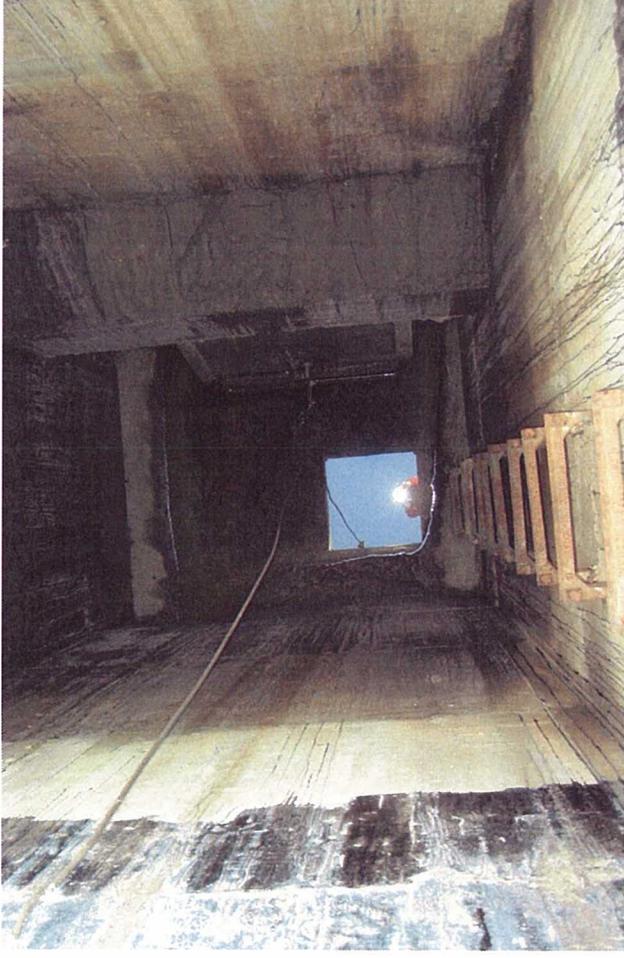
CONT. R3, SECT. A
ST. JOSEPH, MISSOURI
 SEWERAGE IMPROVEMENTS
 INTERCEPT SEWER
 MANHOLE DETAILS

7-17-78	Confirmed To Construction Records	WFL	JLG
8-1-78	Added wood box tunnel details	EMS	RIS
11-28-78	Added Orifice B. Schedule and Details	EMS	WRC
NO. DATE	Revision	BY	CHKD
	1	J.E.G.	J.E.G.
	2	J.E.G.	J.E.G.
	3	J.E.G.	J.E.G.
	4	J.E.G.	J.E.G.
	5	J.E.G.	J.E.G.
	6	J.E.G.	J.E.G.
	7	J.E.G.	J.E.G.
	8	J.E.G.	J.E.G.
	9	J.E.G.	J.E.G.
	10	J.E.G.	J.E.G.

BLACK & VEATCH
 CONSULTING ENGINEERS, KANSAS CITY, MO.
 CONTRACT NO. 78-100-07
 SHEET NO. 9 OF 10



Duncan_24InToRiver



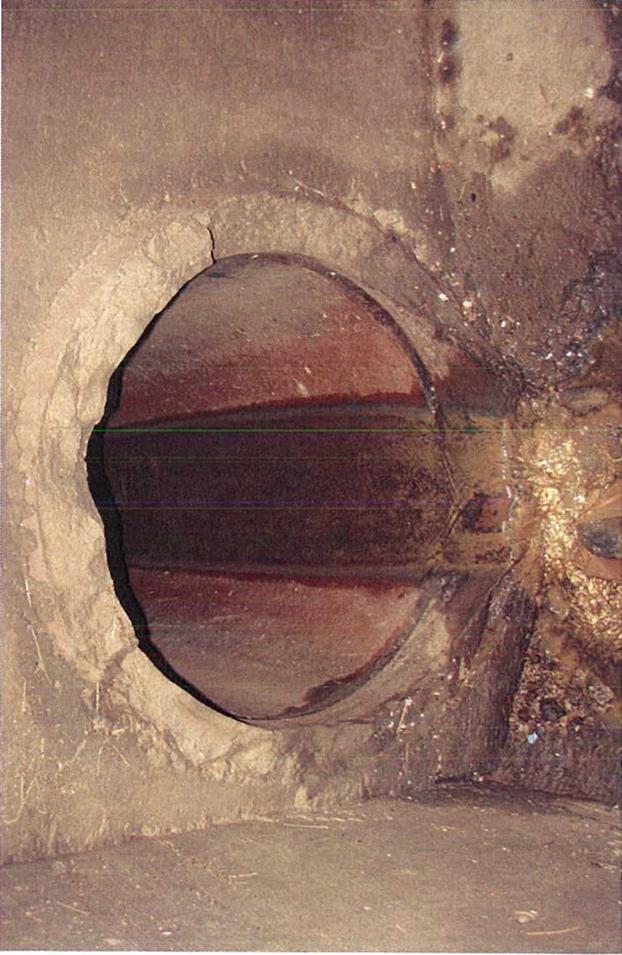
Duncan_WetWeatherCell



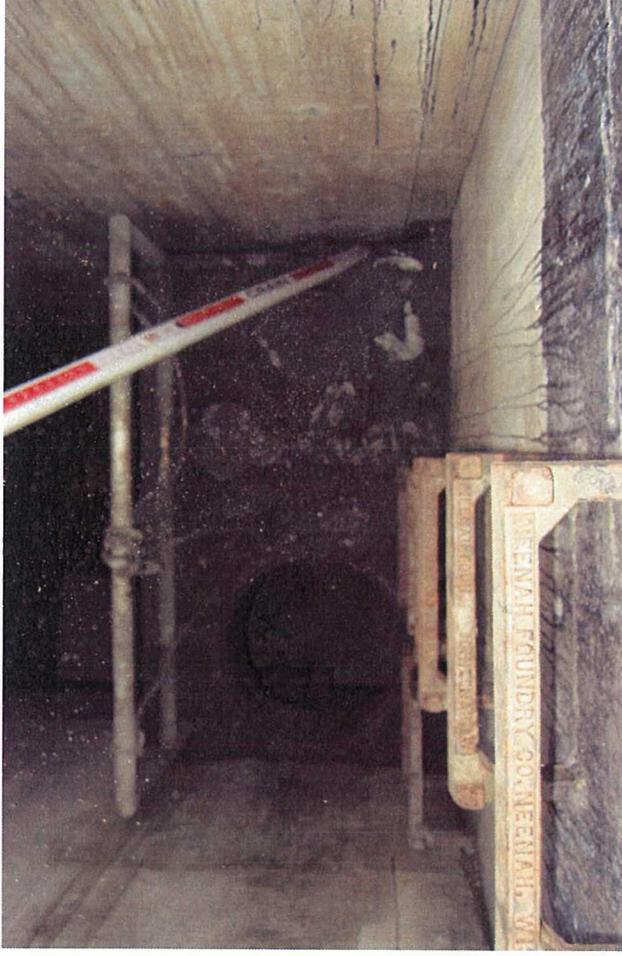
Duncan_DryWeatherCell



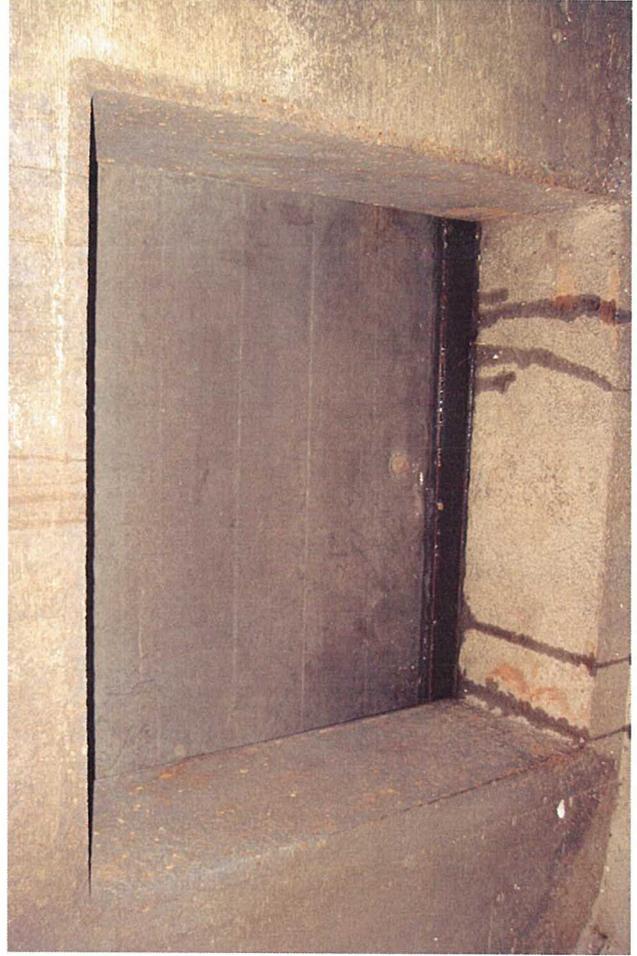
Duncan_FlapGate



Duncan24InInFlow



Duncan_DryWeatherCell1



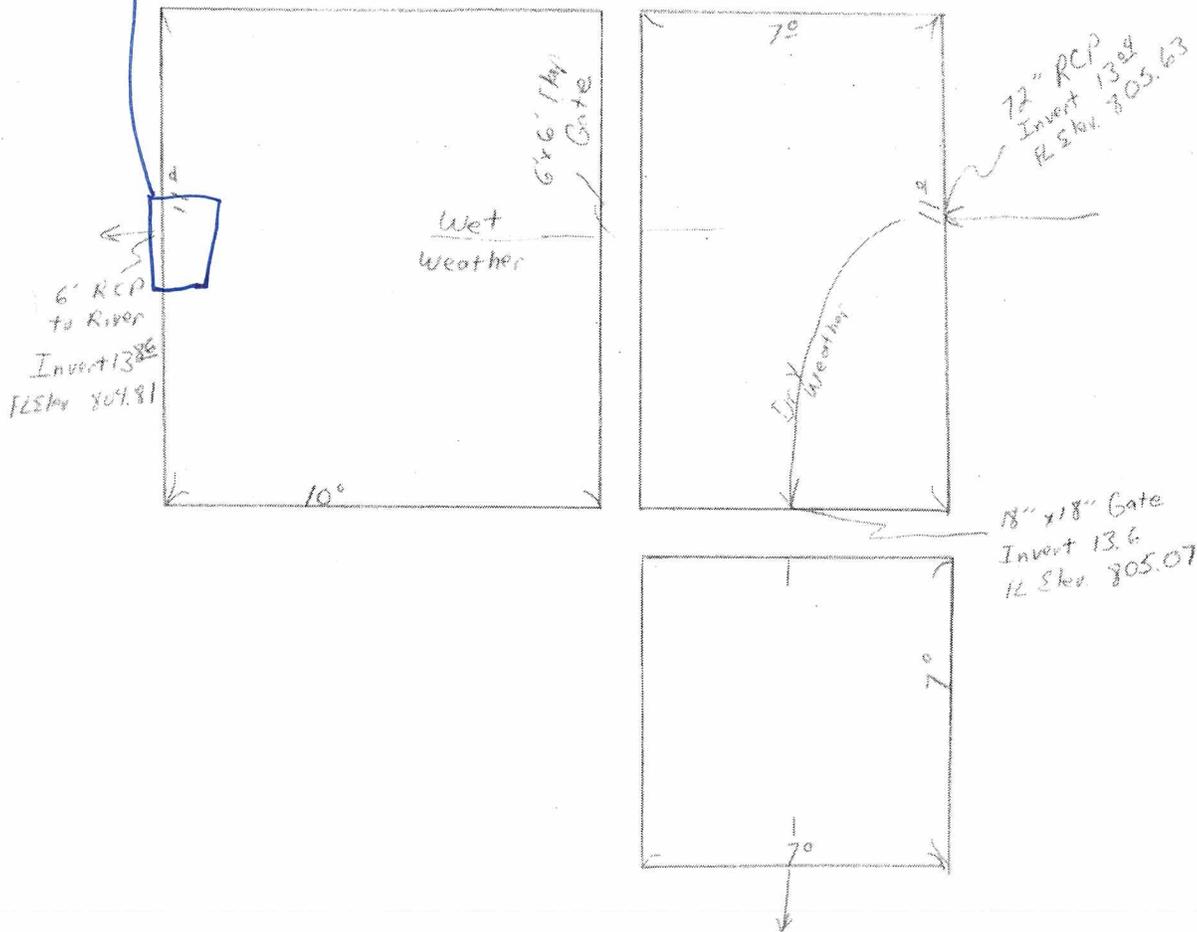
Duncan_FlapGate1

Diversion Name: Maple

Picture Numbers: _____

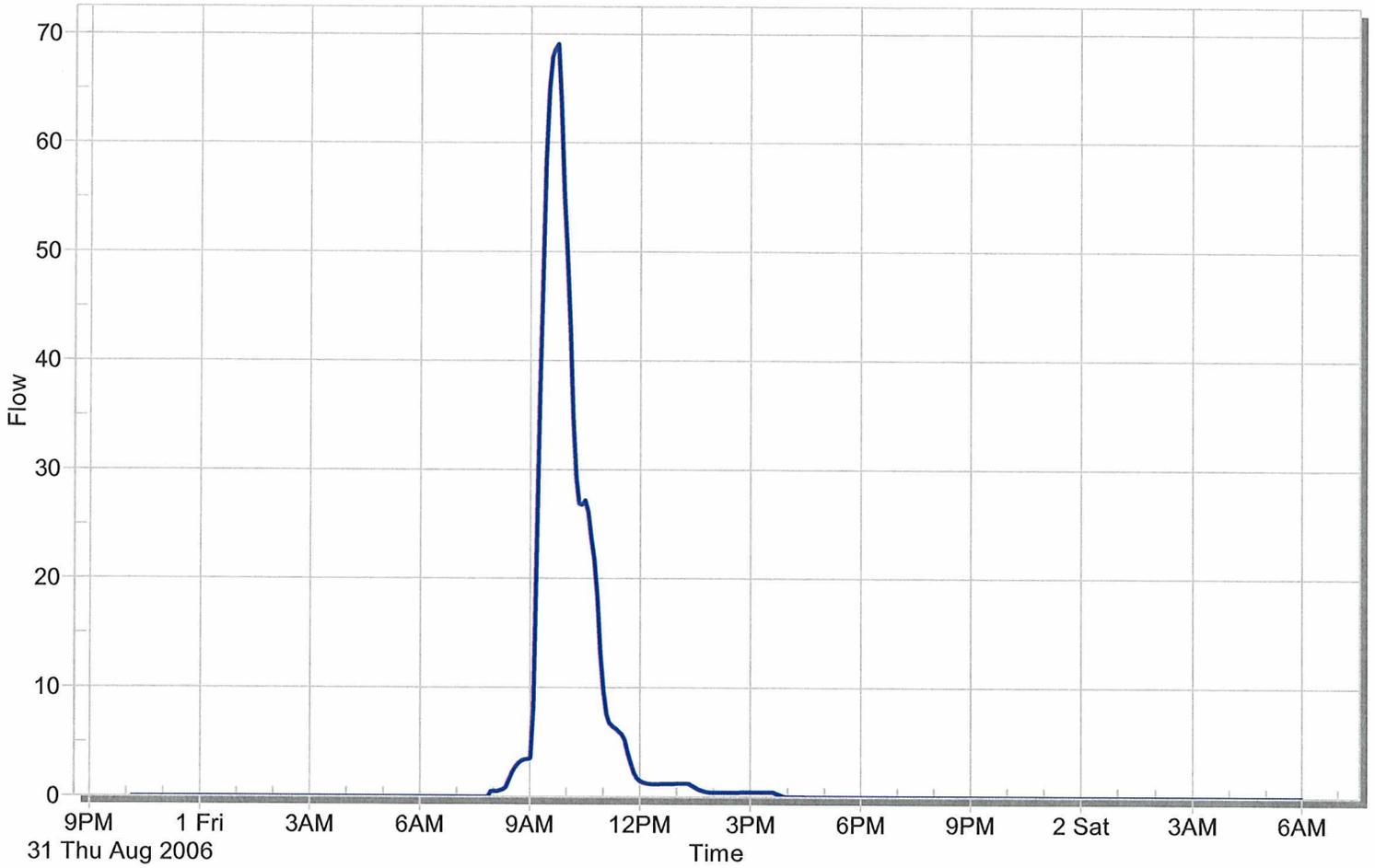
5.5 CBS Inflow
Causes a CSO

Has Flap Gate

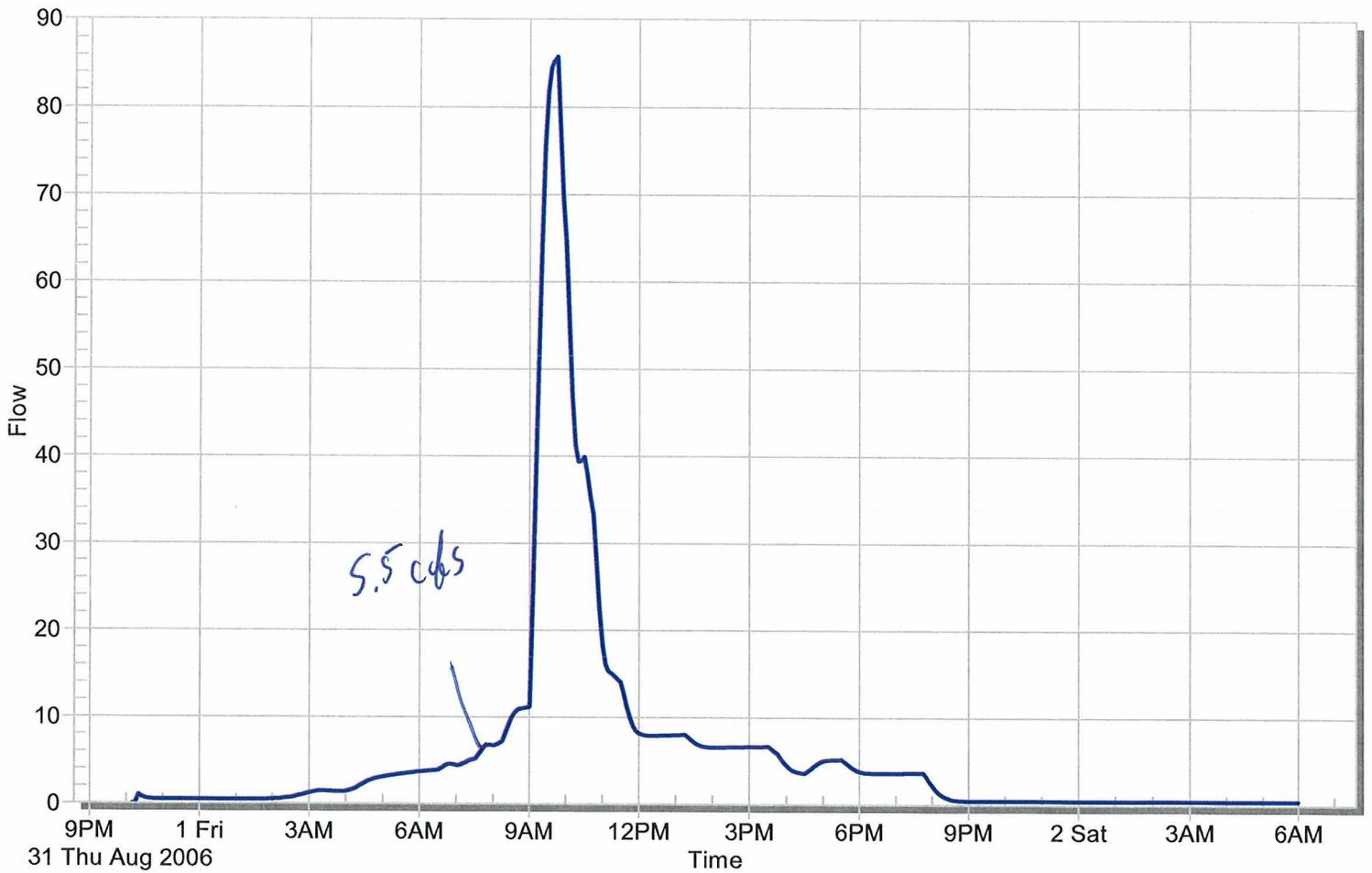


Maple

Conduit 05M0015C from 84-8-2 to 84-9



Conduit 05M0018C from 64-8 to 84-8



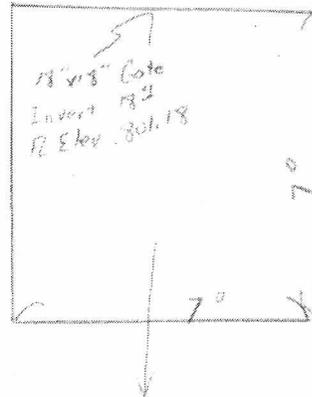
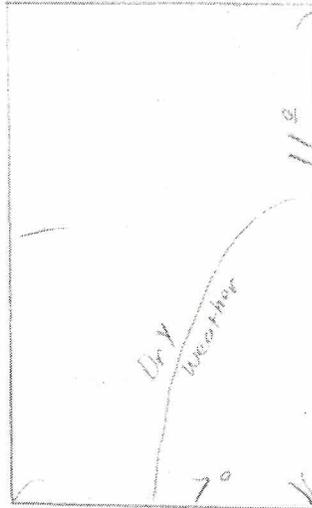
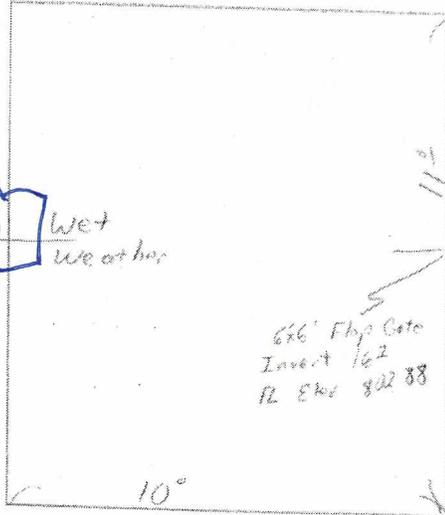
Diversion Name: Hickory

Picture Numbers: _____

S chg Inlet
causes C-90

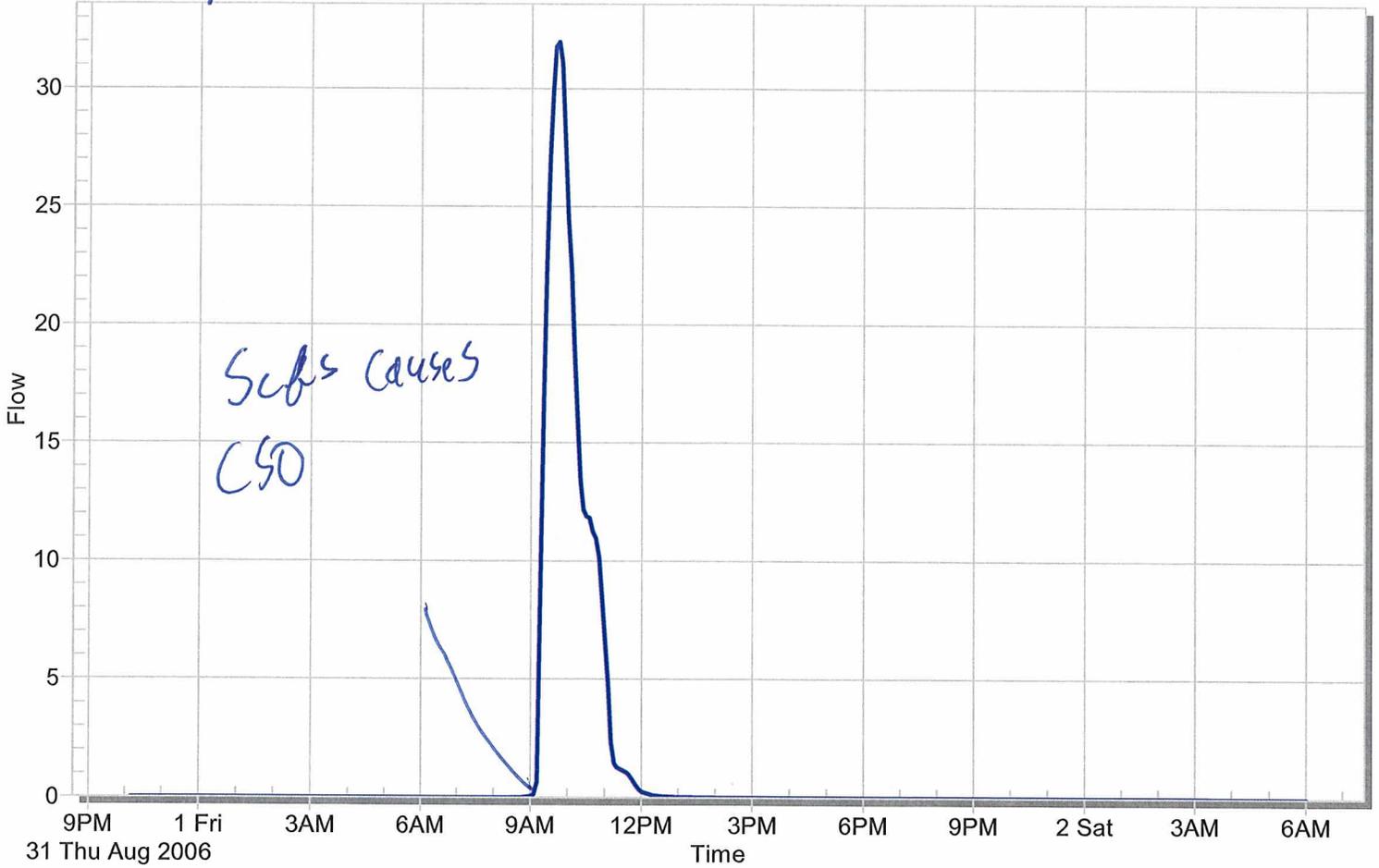
Flap Gate

to River
72" RCP
Invert 17 3
H. Elev 801.28

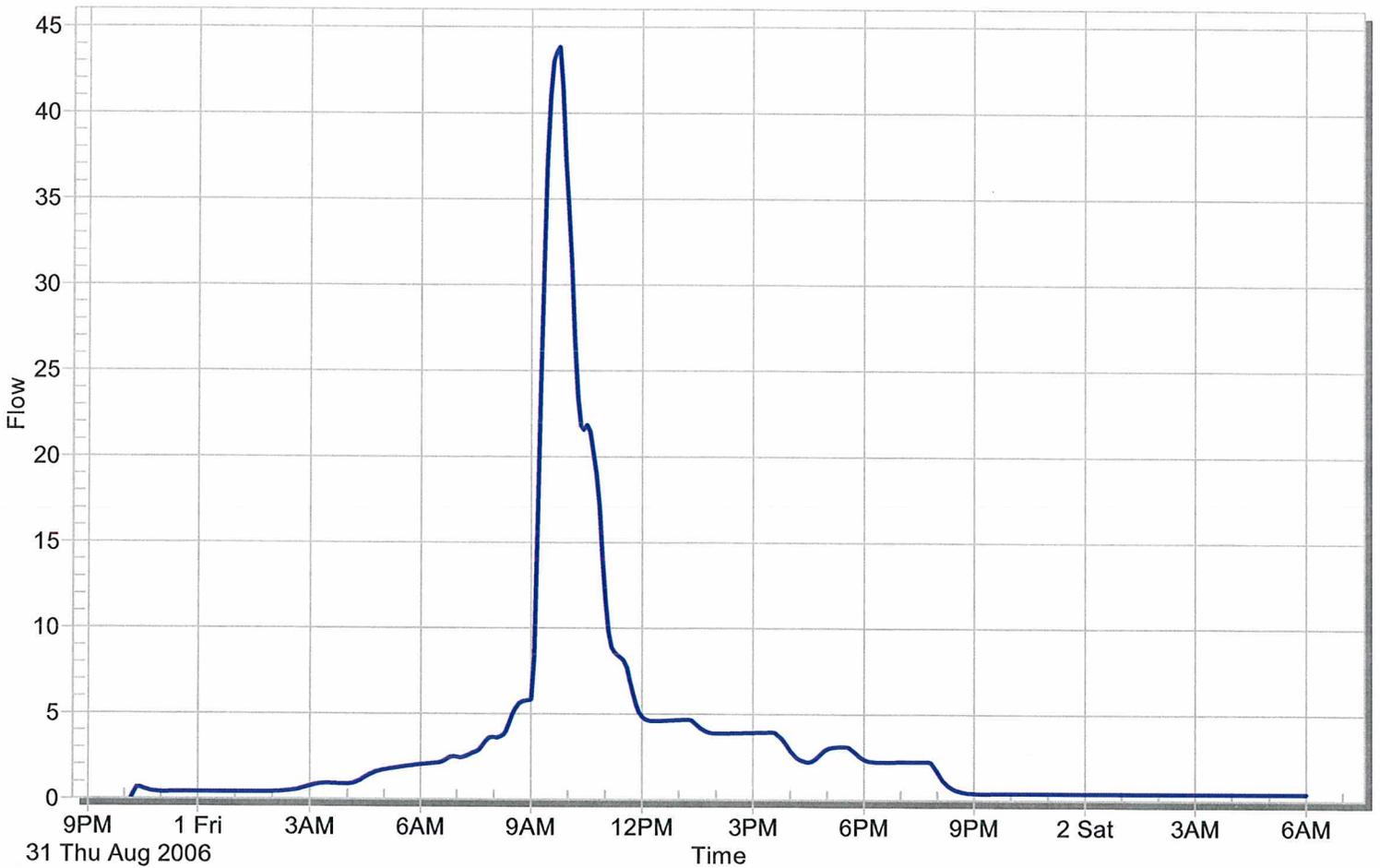


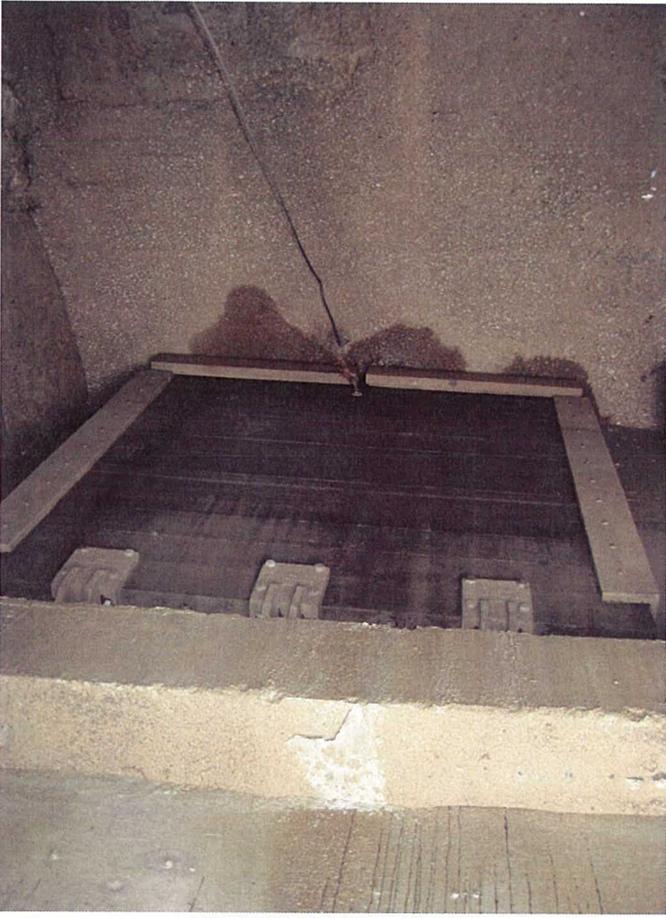
Hickory

Conduit 05H0003C from 33-0 to 33-RIVER

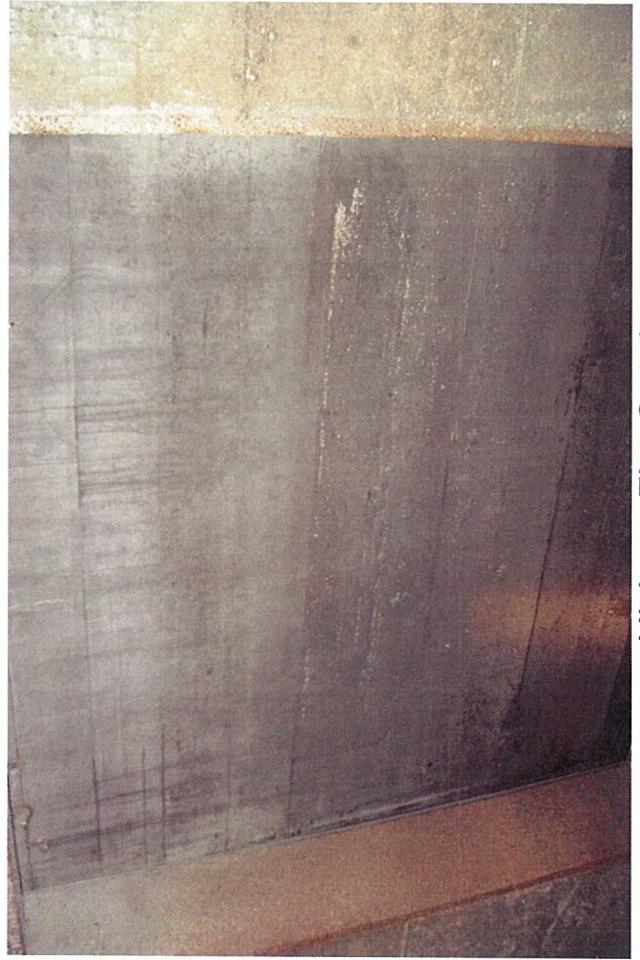


Conduit 05H0006C from 33-2 to 33-1





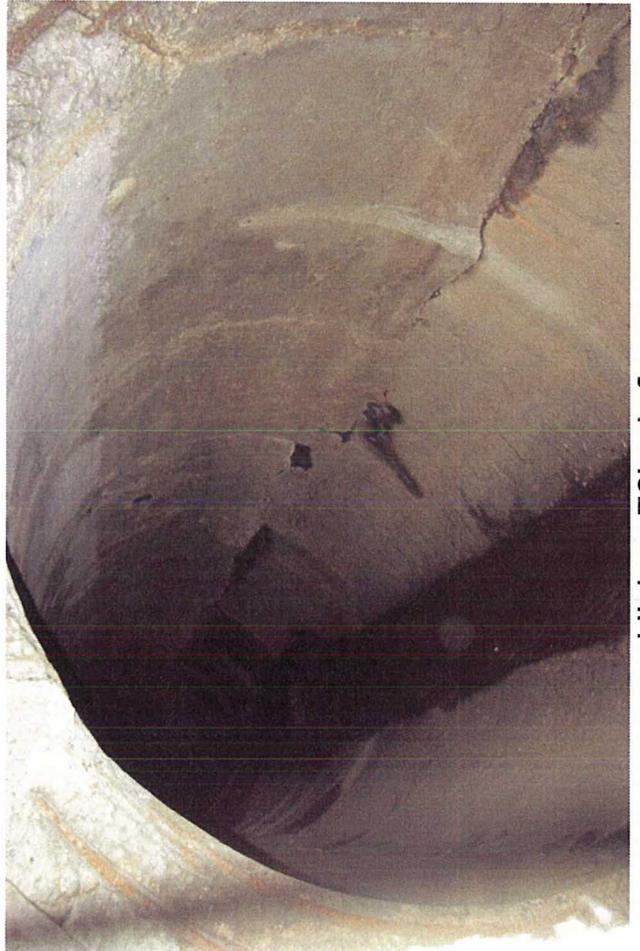
Hickory_FlapGate



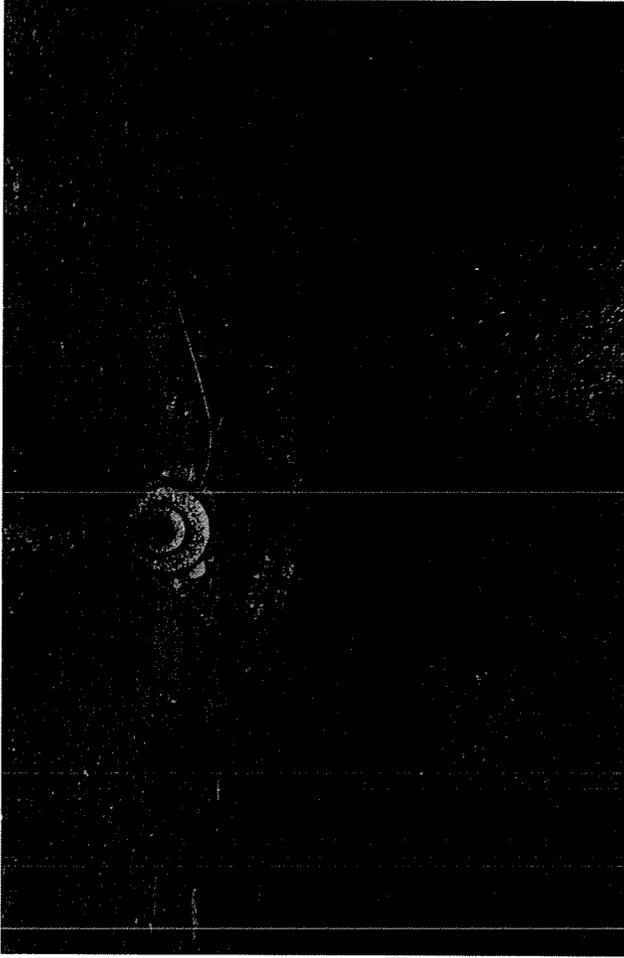
Hickory_FlapGate1



Hickory_SluiceGate3



Hickory72In_Inflow



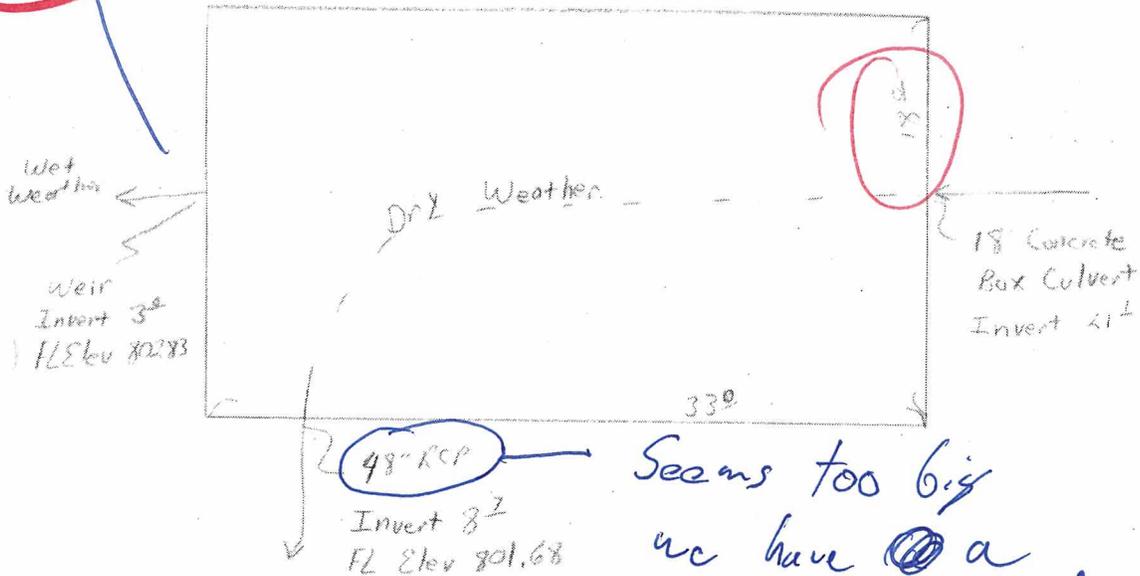
Hickory_SluiceGate2

Diversion Name: White head

Picture Numbers: _____

CSO's occur @ 19cfs

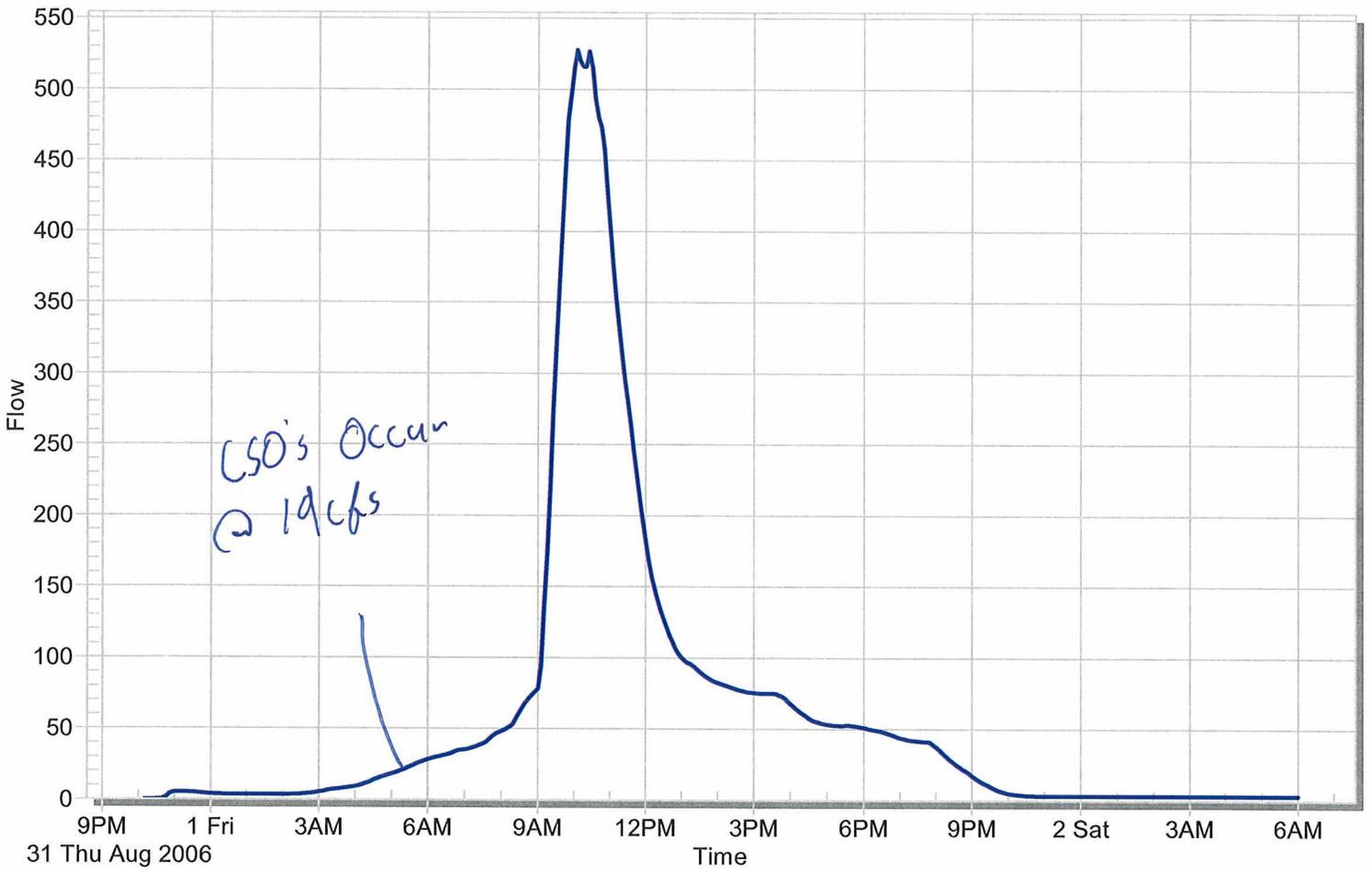
No Flap Gate



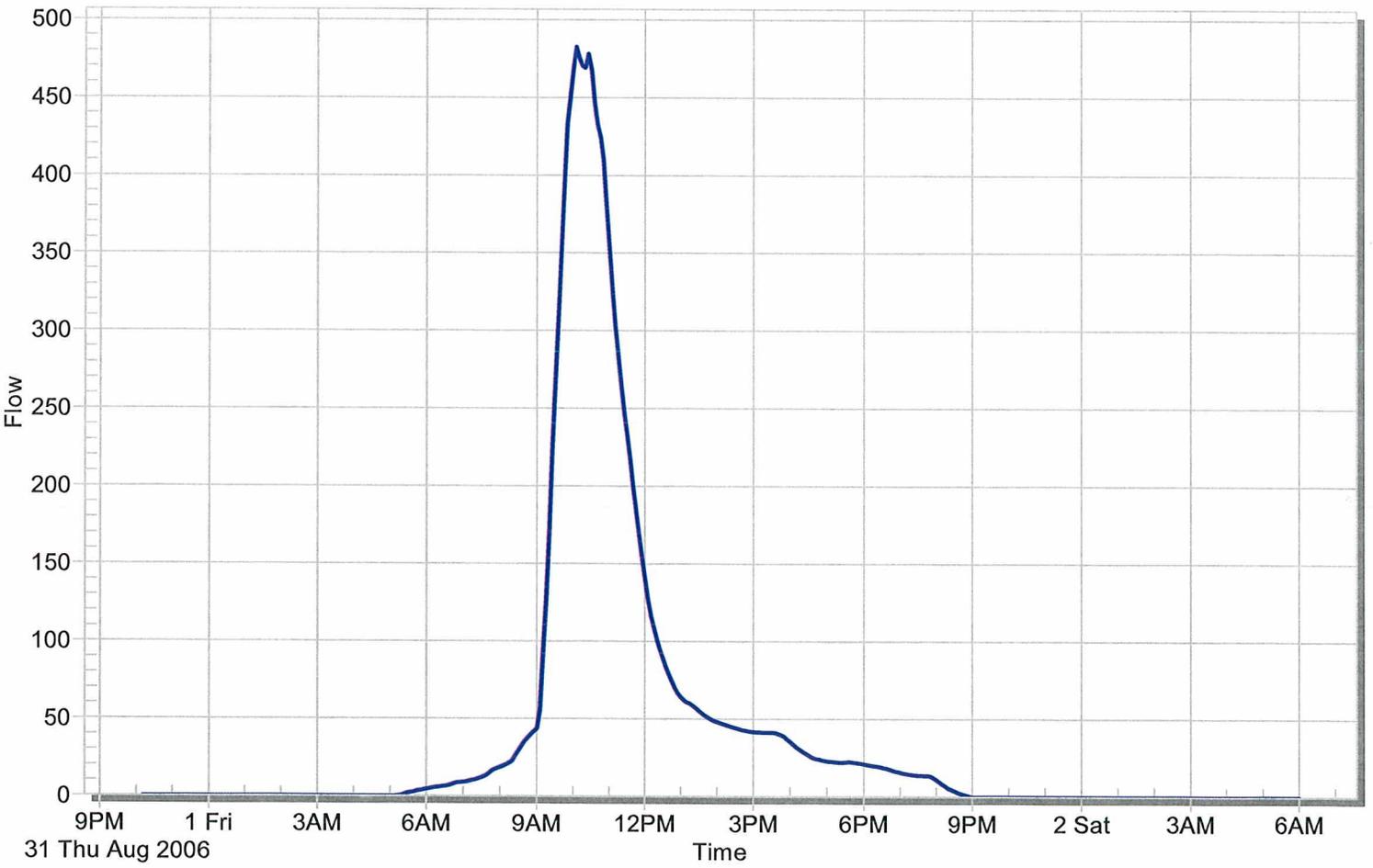
Seems too big
we have @ a
30" pipe in @ model.

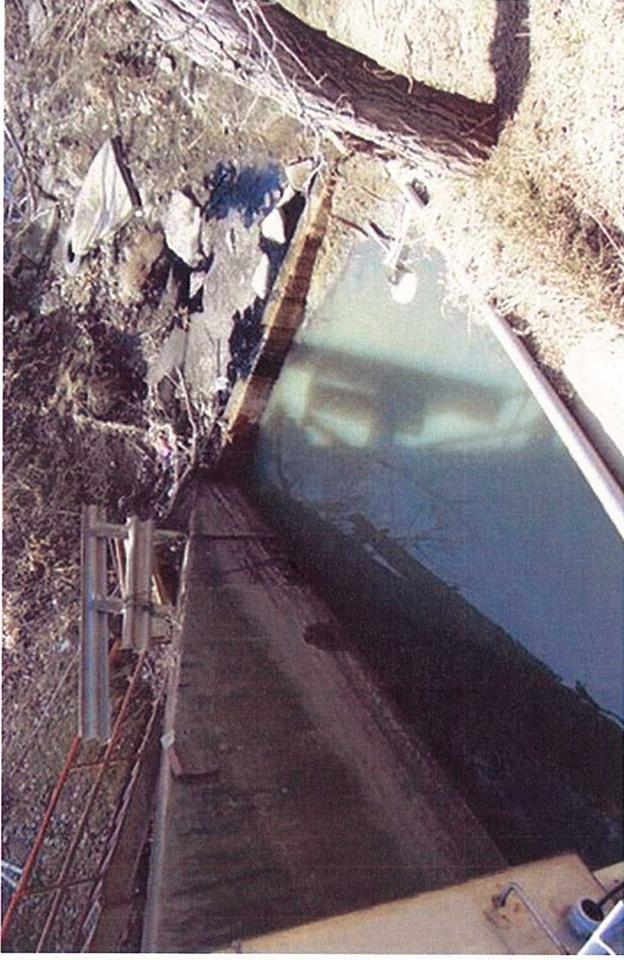
Whitehead

Conduit 0600021C from WMS-18 to WMS-19



Conduit 0600018C from WMS-19 to WMS-20





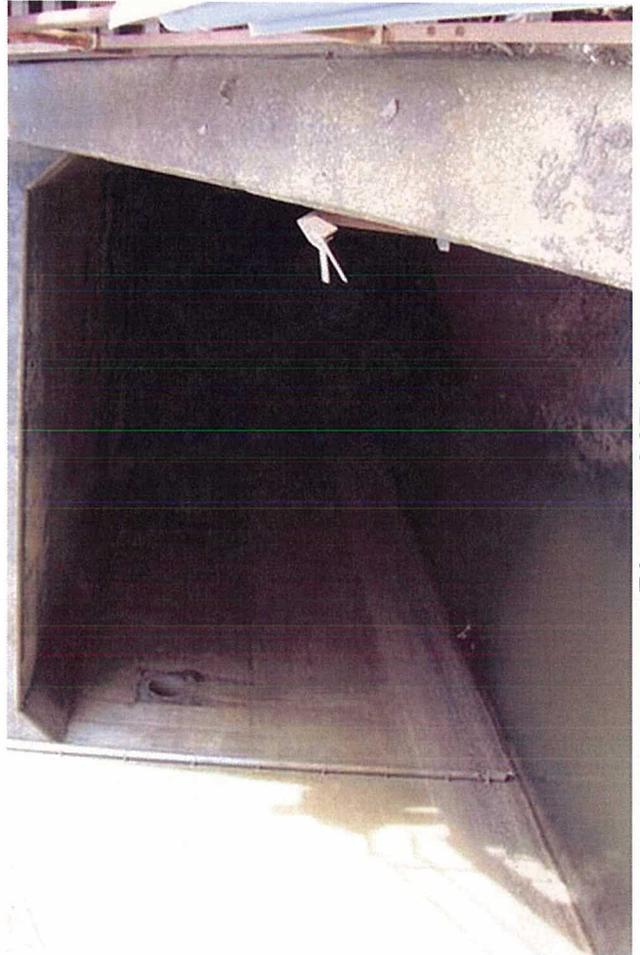
Picture 064-1



Picture 065-1



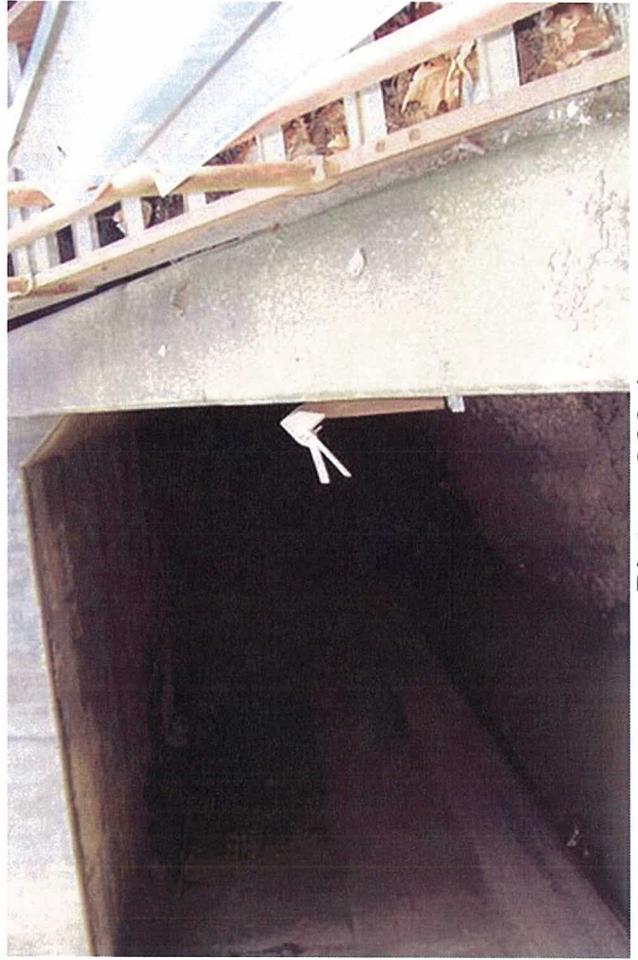
Picture 066-1



Picture 067-1



Picture 068-1



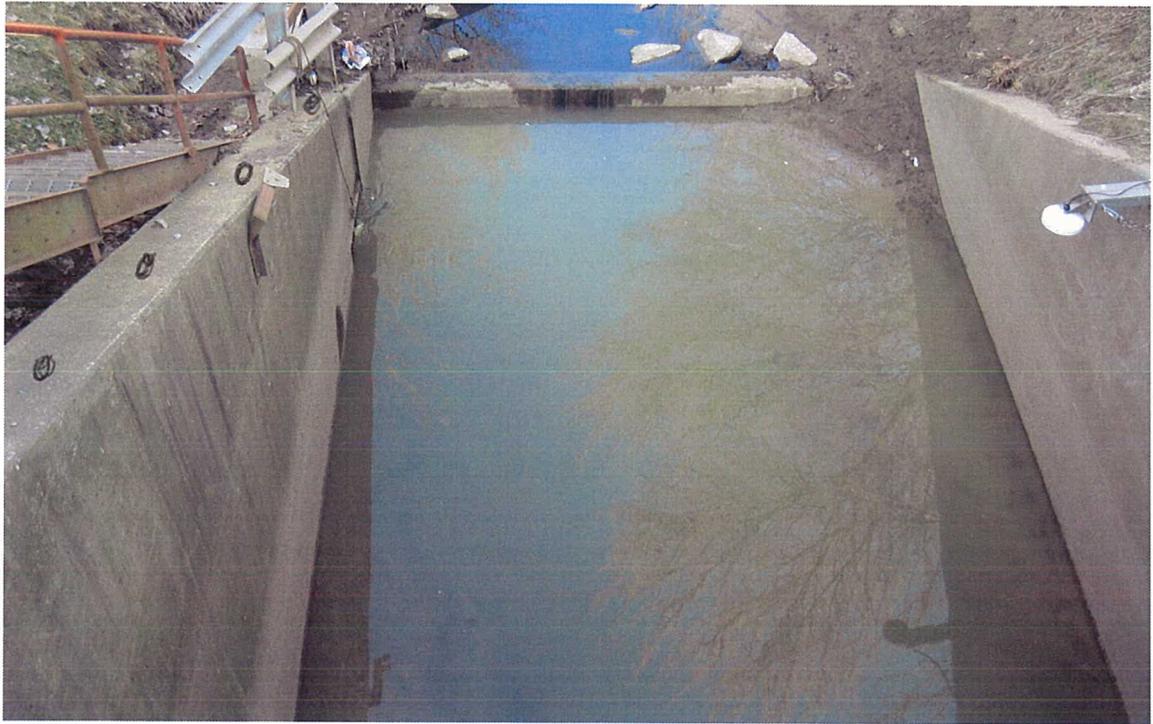
Picture 069-1



Picture 070-1



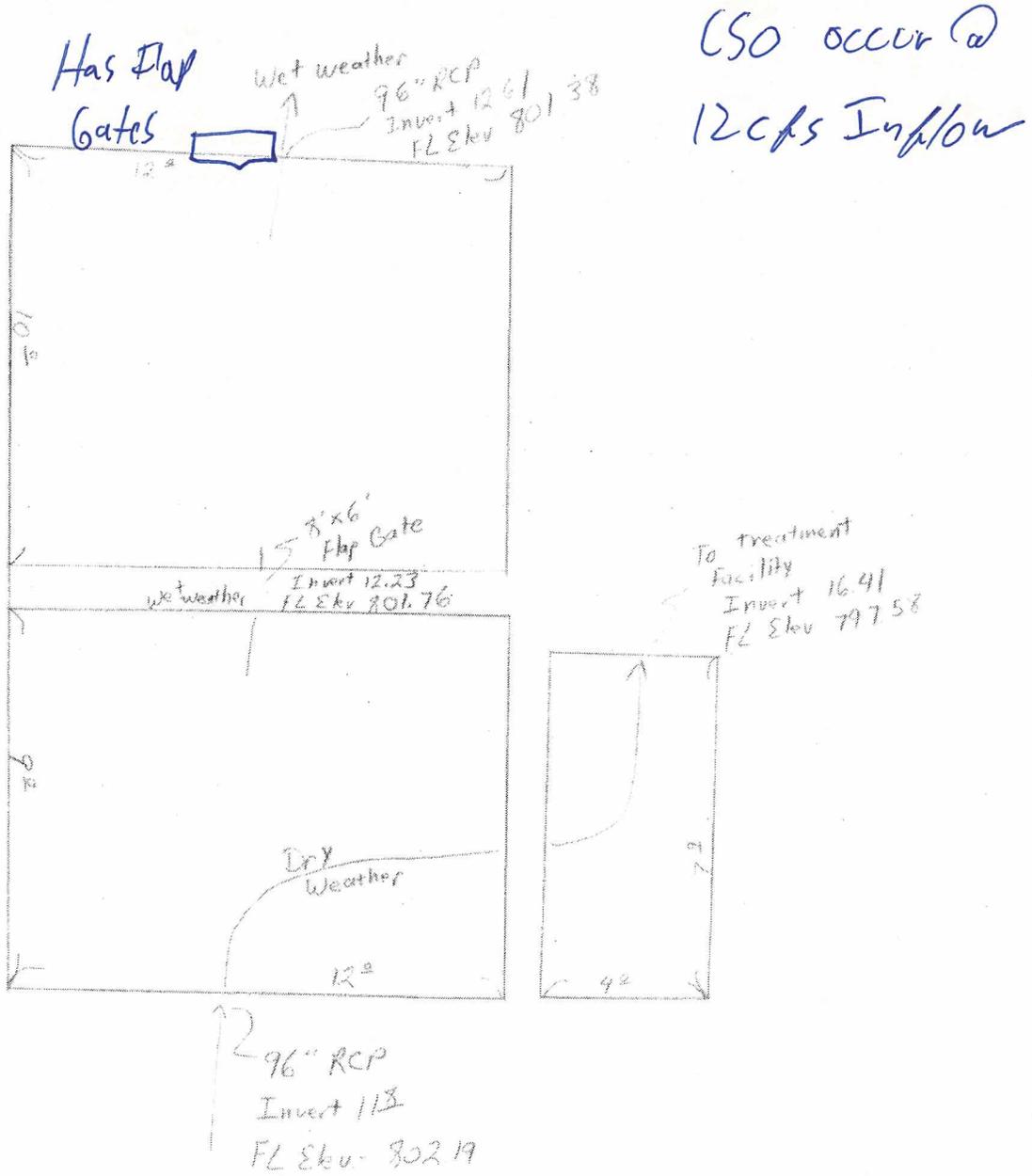
Whitehead



Whitehead1

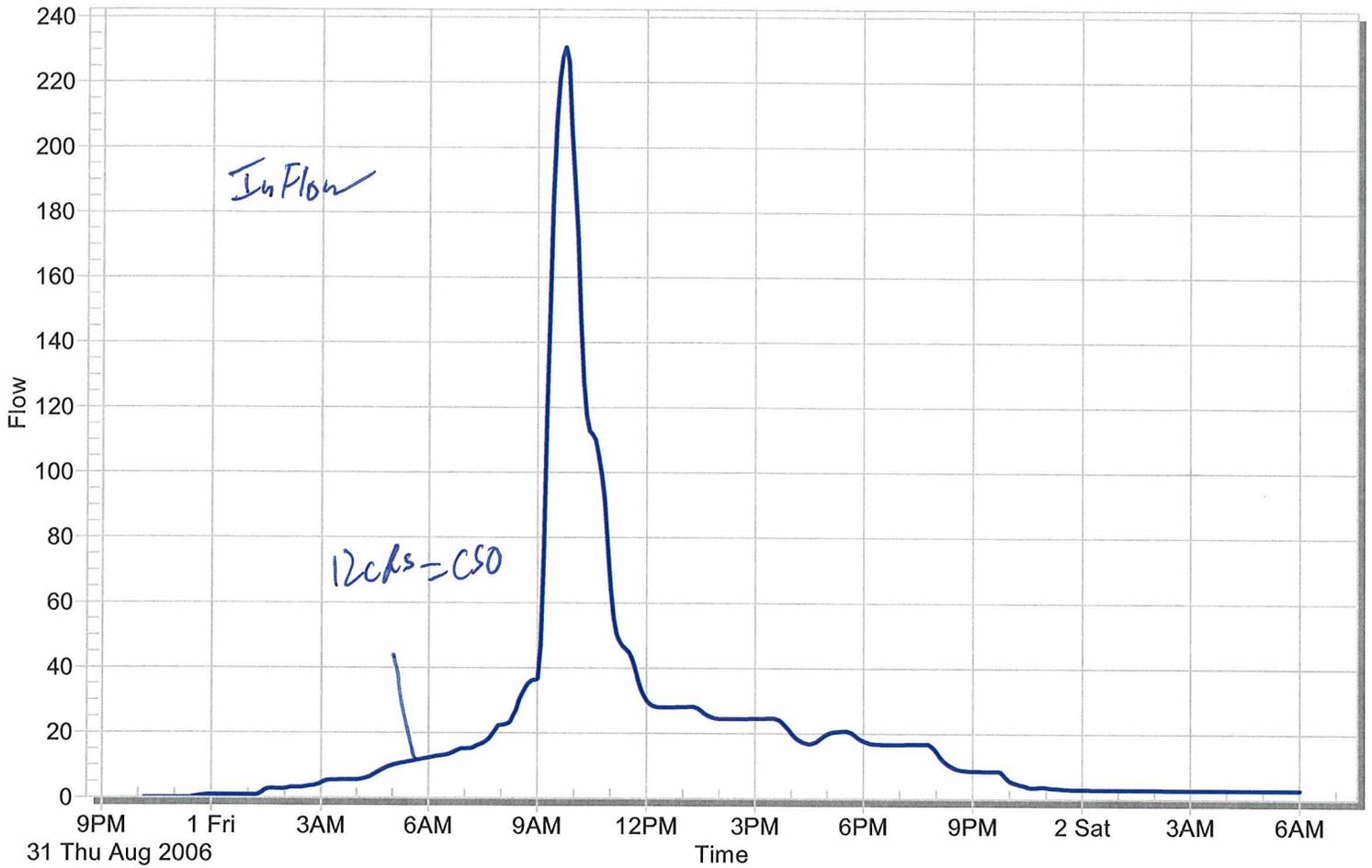
Diversion Name: Missouri Avenue

Picture Numbers: _____

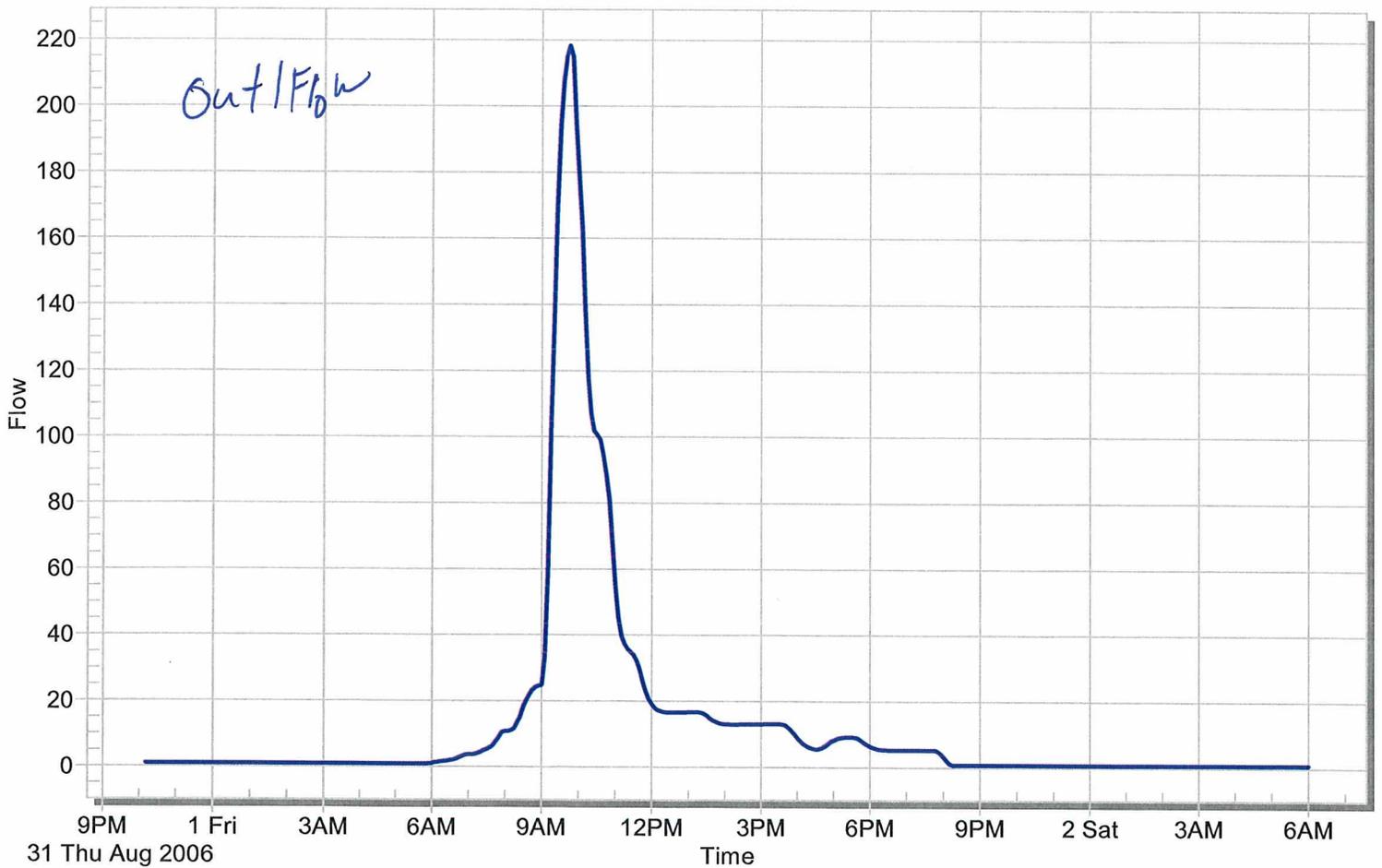


MO. Ave

Conduit 0700015C from MOAVE-7 to MOAVE-8



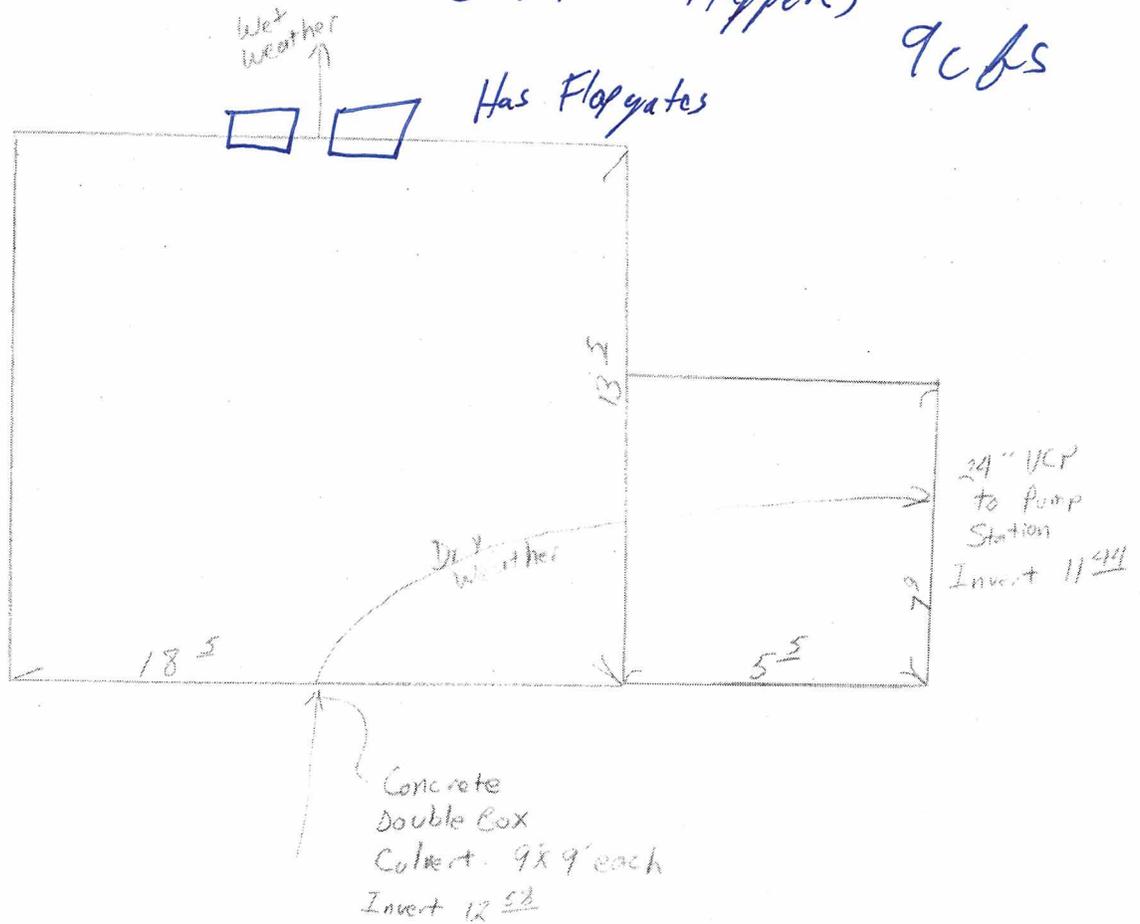
Conduit 0700012C.1 from MOAVE-9 to MOAVE-8



Diversion Name: Brown's Branch

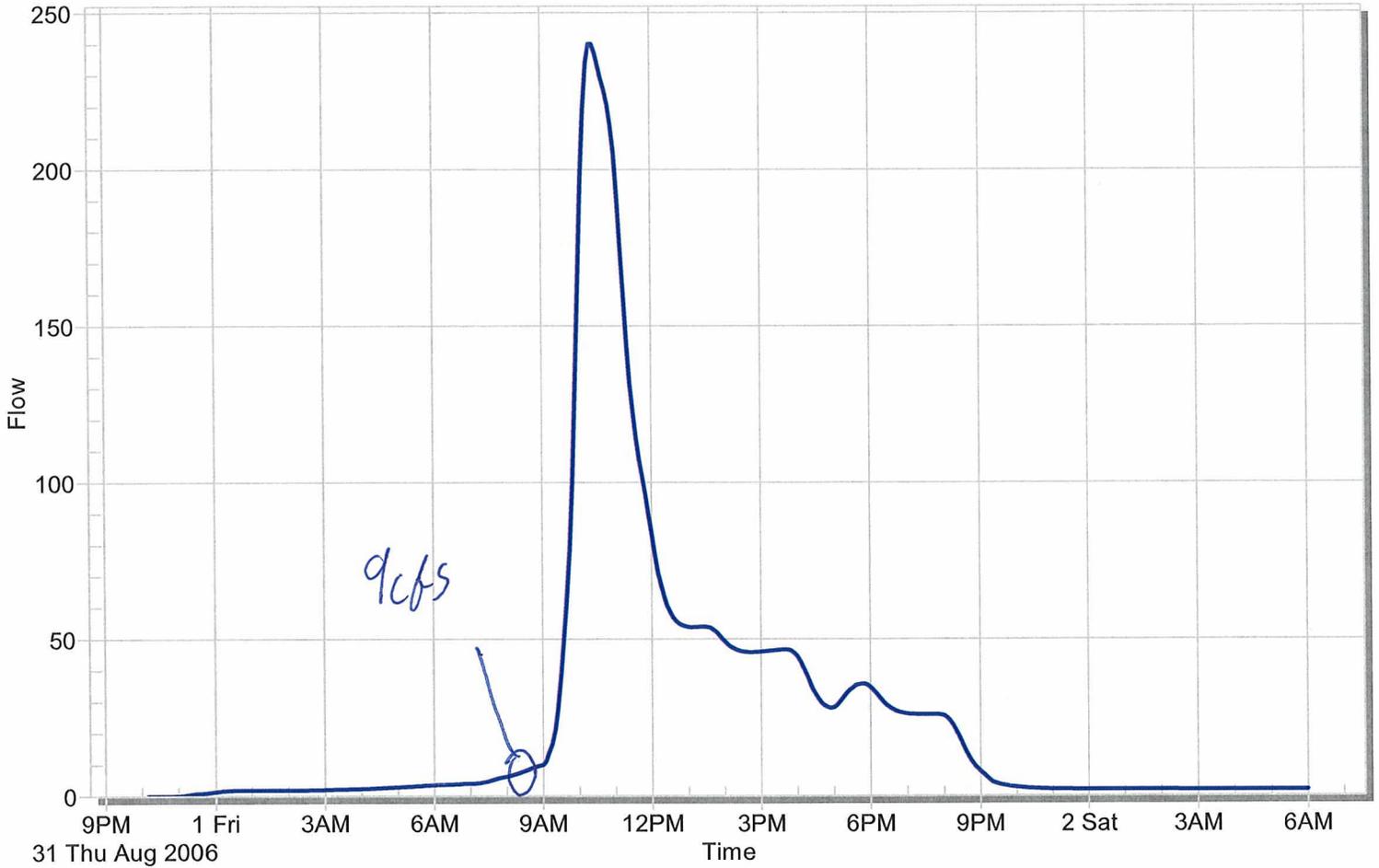
Picture Numbers: _____

Over-Flow Happens when In Flow = 9 cfs

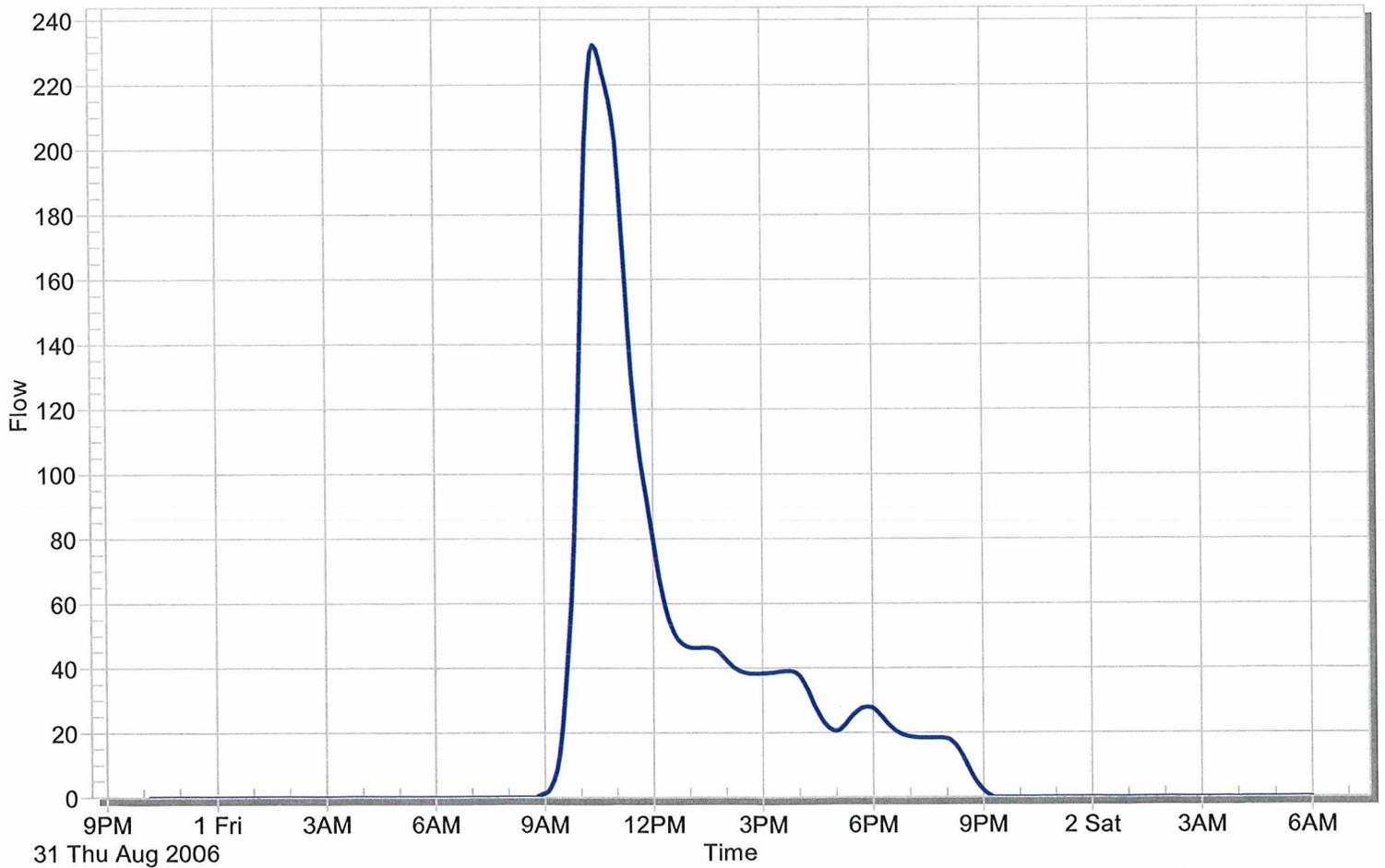


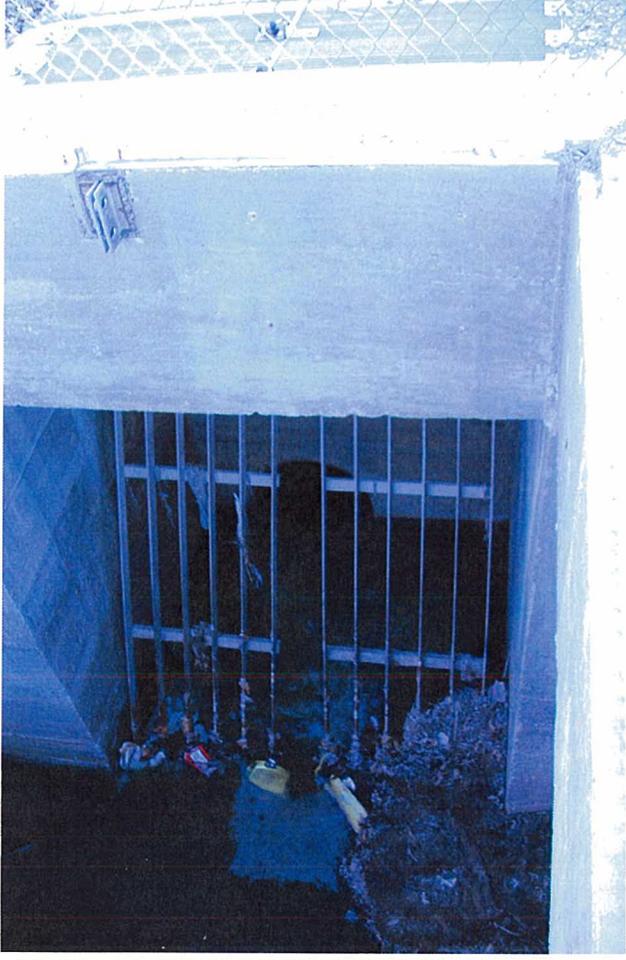
Browns Branch

Conduit 0800006C from BNB-23 to BNB-24

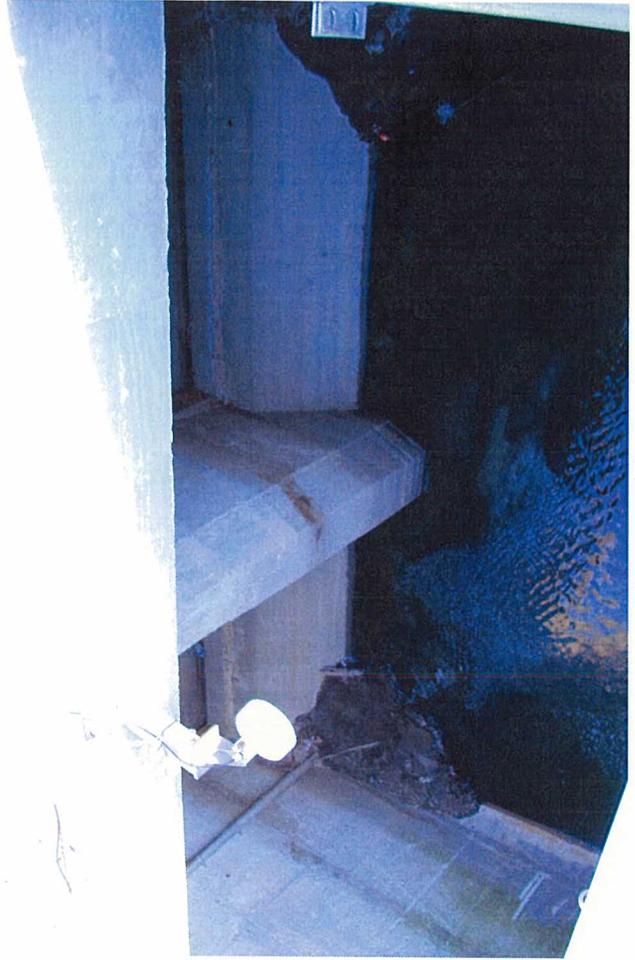


Conduit 0800003C.1 from BNB-24 to BNB-25

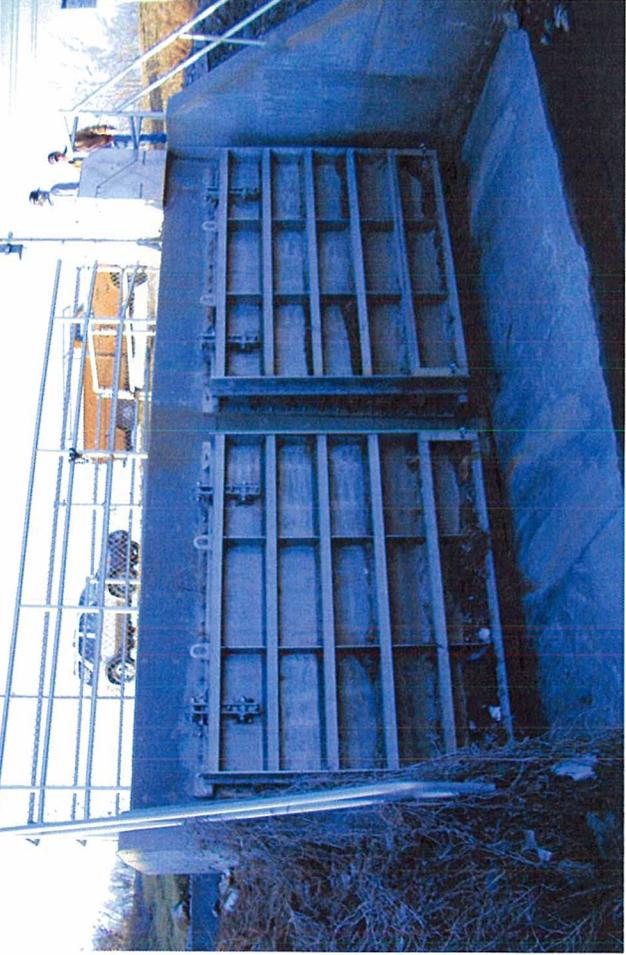




BrownsBranch_BarScreen



BrownsBranch



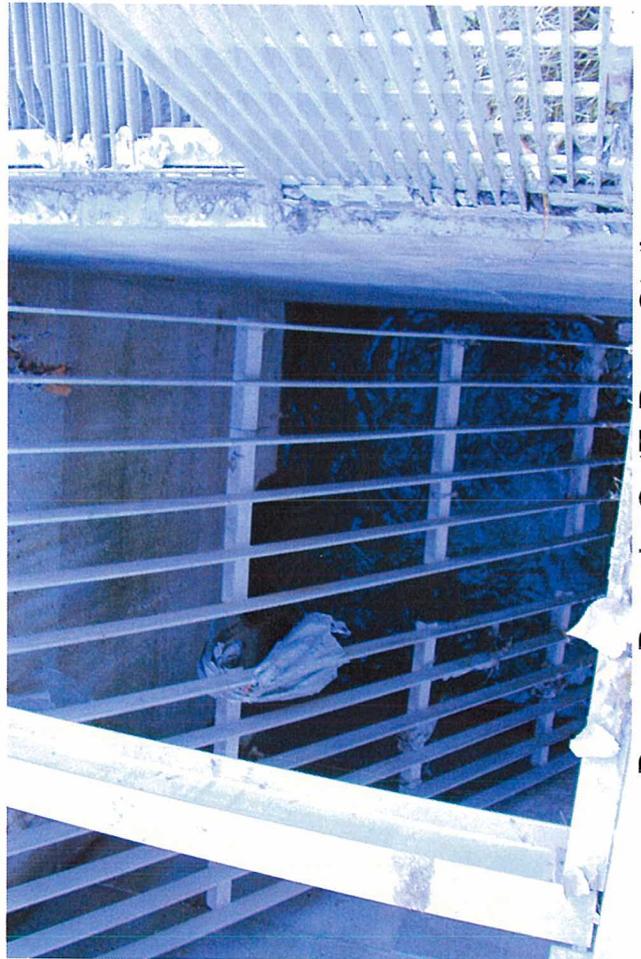
BrownsBranch_FlapGate



BrownsBranch_WestBox_Inflow



BrownsBranch_EastBox_Inflow



BrownsBranch_OutToPumpStation

Appendix B

Opinion of Probable Project Cost Breakdown

St. Joseph, Missouri
TM-CSO-8 - Diversion Structure Modifications
With Automated Screens

Item Description	Units	Unit Cost	Quantity	Total Cost
Diversion Structure Modifications				
Blacksnake				
Automated Trash Rake and Screen	each	574,000	1	574,000
Concrete for Trash Rake Structure	cu yd	1,500	30	45,000
Replacement 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Blacksnake Subtotal				651,000
Francis				
New 24" by 12" Slide Gate	each	12,000	1	12,000
Demolition	LS			10,000
Charles				
New 48" by 24" Slide Gate	each	0	1	-
Demolition	LS			-
Messanie				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Patee				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Olive				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Duncan				
New 36" by 18" Slide Gate	each	18,000	1	18,000
Demolition	LS			10,000
Maple				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Hickory				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Miscellaneous Slide Gate				210,000
Whitehead				
Automated Trash Rake and Screen	each	574,000	1	574,000
Concrete for Trash Rake Structure	cu yd	1,500	20	30,000
16 ft by 16 ft Flap Gate	LS	39,000	1	39,000
Concrete for Outfall Enclosure	cu yd	1,500	70	105,000
New 36" by 36" Slide Gate	each	22,000	1	25,000
Demolition	LS			10,000
Whitehead Subtotal				783,000
Brown's Branch				
Automated Trash Rake and Screen	each	255,000	1	255,000
Concrete for Trash Rake Structure	cu yd	1,500	10	15,000
Demolition	LS			10,000
Brown's Branch Subtotal				280,000
Base Subtotal				1,924,000
Electrical, Instrumentation, and Control		LS	25%	351,000
Sitework	LS	10%		192,000
Subtotal				2,467,000
General Requirements		LS	12%	296,000
Flood Protection (placeholder)	cu yd	25	-	-
Site Remediation (placeholder)	cu yd	150	500	75,000
Subtotal				2,838,000
Contingency	LS	25%		710,000
Land Acquisition (placeholder)	sq ft	1.33	-	-
Opinion of Probable Construction Cost				3,548,000
Engineering, Legal, & Administration	LS	20%		710,000
Opinion of Probable Project Cost				4,258,000

St. Joseph, Missouri
TM-CSO-8 - Diversion Structure Modifications
Without Automated Screens

Item Description	Units	Unit Cost	Quantity	Total Cost
Diversion Structure Modifications				
Blacksnake				
Automated Trash Rake and Screen				
Concrete for Trash Rake Structure				
Replacement 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Blacksnake Subtotal				32,000
Francis				
New 24" by 12" Slide Gate	each	12,000	1	12,000
Demolition	LS			10,000
Charles				
New 48" by 24" Slide Gate	each		1	-
Demolition	LS			
Messanie				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Patee				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Olive				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Duncan				
New 36" by 18" Slide Gate	each	18,000	1	18,000
Demolition	LS			10,000
Maple				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Hickory				
New 48" by 24" Slide Gate	each	22,000	1	22,000
Demolition	LS			10,000
Miscellaneous Slide Gate				210,000
Whitehead				
Automated Trash Rake and Screen				
Concrete for Trash Rake Structure				
16 ft by 16 ft Flap Gate	LS	39,000	1	39,000
Concrete for Outfall Enclosure	cu yd	1,500	70	105,000
New 36" by 36" Slide Gate	each	22,000	1	25,000
Demolition	LS			10,000
Whitehead Subtotal				179,000
Brown's Branch				
Automated Trash Rake and Screen				
Concrete for Trash Rake Structure				
Demolition				
Brown's Branch Subtotal				-
Base Subtotal				421,000
Electrical, Instrumentation, and Control		LS	25%	-
Sitework	LS	10%		42,000
Subtotal				463,000
General Requirements		LS	12%	56,000
Flood Protection (placeholder)	cu yd	25	-	-
Site Remediation (placeholder)	cu yd	150	350	53,000
Subtotal				572,000
Contingency	LS	25%		143,000
Land Acquisition (placeholder)	sq ft	1.33	-	-
Opinion of Probable Construction Cost				715,000
Engineering, Legal, & Administration	LS	20%		143,000
Opinion of Probable Project Cost				858,000