Kansas Citys, Missouri and Kansas
Flood Risk Management Feasibility Study

Engineering Appendix to the Final Feasibility Report

Chapter A-5

CIVIL DESIGN

CID-KS UNIT

CHAPTER A-5
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CHAPTER A-5
CIVIL DESIGN
CID-KS UNIT

This chapter presents the results of the civil design evaluation performed as part of the future conditions analysis for the Central Industrial District (CID) Unit of the Kansas Citys, Missouri and Kansas, Flood Risk Management Project.

A-5.1 SITE SELECTION AND PROJECT DEVELOPMENT

A-5.1.1 Introduction

The U.S. Army Corps of Engineers (USACE), Kansas City District designed and constructed the Kansas Citys protection system. This portion of the study considers raises on the CID Unit to the 0.2% (500-year)-plus-3-feet, water surface profile elevation, hereafter referred to as N500+3.

The CID-Kansas Unit is located in Wyandotte County, Kansas, along the right bank of the Kansas River from mile 3.1 (Approximately Turkey Creek outfall) to mile 367.3 of the Missouri River, near the Wastewater Treatment Facility of the Unified Government. The flood protection unit includes levees, floodwalls, riprap, and levee toe protection, toe drains along the concrete floodwalls, surfaced levee crown, ramps, and turnouts, seeded landside slopes of levees, stop log gaps, sandbag gaps, drainage structures, relief wells, and pumping plants. Stationing of the unit begins at the lower end (L.E.). The L.E. is one continues levee with CID-Missouri. CID-Missouri ends with Station 89+37.34 which is equivalent to CID-Kansas Stationing of 0+00. CID-Kansas Unit ends at Station 167+95.

A-5.1.2 Levee Footprint

The unit includes sections of levee and floodwall. All alternatives include widening the levee footprint, replacing floodwalls or placing a floodwall on top of existing levee. Stability berms, area fill, or underseepage features are needed as indicated by the geotechnical analysis.

A-5.1.3 Borrow Area

Prospective borrow areas were identified by the Sponsor and screened through joint Corps and Sponsor efforts during the Phase I portion of this feasibility project. Regarding borrow area, Phase 1 focused on the Argentine Unit. The borrow area for CID Unit will be the same as for Argentine and Armourdale Units. See Exhibit 1 “Borrow Area for Proposed Argentine, Armourdale, and CID-KS Unit Raise” for a discussion of the borrow area for the project.

A-5.1.4 Haul Routes

Haul routes from the borrow site at WaterOne to various points along the levee/floodwall alignment were generated based on the limited access points to the levee/floodwall system along

the CID-KS Unit. Exhibit 3, also sheet C3 of the Mapbook, shows the haul routes and their distances from WaterOne to various access points along the CID-KS Unit.

A-5.2 REAL ESTATE CONSIDERATIONS

Research is currently being conducted by NWK Real Estate Staff to complete Preliminary Attorney's Opinion of Compensability as utilities are identified. Any conclusion or categorization that an item is a utility or facility relocation would result in work to be performed at the cost of the non-federal sponsor as part of LERRD responsibilities and is preliminary only. During PED, the Government will make a final determination of the relocations necessary for the construction, operation or maintenances of the project after further analysis and completion and approval of Final Attorney's Opinions of Compensability for each of the impacted utilities and facilities. Further detail on all real estate issues, will be discussed in the Real Estate Plan, to be included in future ITR reviews and as part of the main Engineering Feasibility Report. See also the real estate plan for a discussion of real estate issues pertaining to borrow area.

A-5.3 UTILITY RELOCATIONS

A review of the Kansas City District's criteria for utility lines was performed. Based on discussions, a criteria document specific to this project was developed. See attached document "Kansas City's Levee and Floodwall Gravity and Utility Pipeline Guidance" (Exhibit 3). This document was used in determining the disposition of existing utility lines crossing the Central Industrial District, Kansas.

5.3.1 Utility Levee Crossings, Critical Zone, and Construction Impacted

The study of utilities crossing the Central Industrial District, Kansas Unit was conducted to estimate costs for relocation or removal of functioning or abandoned utilities. Using the criteria indicated above, it was determined that most pressure pipelines currently passing under the levee would be relocated over the levee. See attached drawing titled "Typical Utility Crossing Levee Raise" (Exhibit 3). See attached table titled "CID-KS Utility and Drainage Crossings: Inventory and Action for N500+3 Raise" (Exhibit 4) for the recommended action for each utility crossing the levee. Utilities will be relocated up and over the levee.

5.3.1.1 Summary of Utilities that Require Relocation

The utilities that require relocation are listed in Table 1: Utilities that Require Relocation. Most of the utilities are currently located on an existing bridge structure that either penetrate through the top of the levee or near the base of the floodwall. It is anticipated that these utilities with either have to be extended beyond their existing penetration point for purposes of complying with the current guidance or for purposes of constructing the raise. The power lines at station 124+60 service the Turkey Creek Sewer Gates. Currently this line penetrates under the floodwall. This line will be relocated up and over the floodwall.

Table 1: Utilities that Require Relocation

Station (ft.)	Conduit Function
18+10	Fiber Optic
Approx 18+20	Fiber Optic
18+75	Fiber Optic
18+75	Fiber Optic
19+85	Fiber Optic and Railroad Communication
25+90	Gas
Approx 25+90	Oxygen
Approx 25+90	Gas
26+10	Gas
26+10	Water
57+10	Water
57+10	Power
57+50	Water
75+50	Fiber Optic
75+60	Fiber Optic
85+20	Water
104+50	Fiber Optic
Approx 124+60	Power

Utility crossing recommendations are based on the N500+3 raise, therefore the quantities for the cost estimate is also based on the N500+3 raise. For the N500+0 and N500+5 alternatives, recommendations for utility crossings are the same as for N500+3. Cost estimates and quantities used for determining the N500+3 cost will be used for the N500+0 and the N500+5. There is negligible difference between the three raises in regards to recommended utility crossings. This approach for estimating the N500+0 and the N500+5 raise is similar to the approach taken in Phase 1 when cost estimating the Argentine Unit utility crossings.

5.3.2 Special Design and Construction Considerations

The project team will conduct specific utilities relocation coordination and design planning prior to levee raise construction contract award. In recent projects, this relocation work has proven very problematic if not thoroughly scheduled and coordinated. Even though sponsors (and utility owners) are responsible for most utilities relocations (for those utilities deemed without legal compensability), the Kansas City District must be consulted for approval of the relocation design and schedule. Detailed planning for utility relocations and assignment of responsibilities is fully developed by the latter stages of the PED phase. All parties (sponsor, utility owner, and Corps of Engineers) must prepare for a highly coordinated utility relocation effort as the levee raise begins.

Where lines are shown as abandoned or to be abandoned, the Kansas City's Levee and Floodwall Utility Crossings Criteria will be followed.

5.3.2.1Storm Drain, Utility, and Other Modifications due to Area Fill

Areas indicated as "area fill" located approximately 32+50 to 38+00; 63+00 to 74+75; and 77+00 and 94+50 will require the placement of soil and essentially raising the existing ground surface elevation. This will impact the drainage system, overhead power and lighting system, and a privately own billboard in these areas and modifications will have to be made.

These areas are existing parking areas for adjacent businesses and temporary accommodations will have to be made. Power for the overhead lighting will be temporary relocated and put back when construction is finished. The high mast light and billboard will also have to be temporarily relocated.

5.3.3 Power Lines

Large capacity power lines cross the CID-KS Unit. Of these large capacity lines, all cross the levee and the Kansas River and therefore have substantial structures holding them in place. These structures do not interfere with the proposed levee raise or the floodwall raise. Table 2: Power Lines is a list of the stations currently crossed by large capacity power lines and other lines running parallel to the levee.

Table 2: Power Lines

Station (ft.)	Function
22+50	Large Capacity Power Lines
53+00	Power pole and guy wire (relocation)
53+50	Guy Wire (relocation)
60+00	Power & telephone (remove)
131+30	Large Capacity Power Lines
57+25 to approx 73+80	Power Lines (relocate)
Gateway 2000 Pump Plant to Field Pump House	Power Lines (remove)
Approx 120+00 to Approx 133+00	Power Lines (protect)

The existing clearance between most of the power lines and top of levee is approximately 40 feet although this will need to be verified during a land survey during detailed design phases. The N500+3 alternative results in a levee raise in the range of 3 feet to 5 feet. Coordination with the Board of Public Utilities (BPU) determined that the required clearance between the power lines and the levee is 20.9 feet. This clearance is based on the National Electric Safety Code (NESC). With the maximum raise of 5 feet reducing the minimum clearance to 35 feet, the clearance between the power lines and the levee is adequate.

Power lines running parallel (landward) with the levee will be protected, relocated, or removed during construction. Table 2 Power Lines summarizes these features.

5.3.4 Utility Uplift

The study of uplift on existing utilities was conducted to estimate costs for relocation or removal of functioning or abandoned utilities. Utilities were identified in the critical zone for uplift concern, based on geotechnical and N500+3 conditions.

Water and sanitary sewer utility mapping was obtained from the Unified Government of Wyandotte County and the Board of Public Utilities. Storm sewers that do not cross the levee were not mapped because uplift is generally not a concern as long as both ends of the pipe are open to atmosphere. Being open to atmosphere at both ends allows the pipe to fill during inundation. Storm sewers are typically metal or concrete and are heavy enough not to float when filled with water. For the purposes of uplift it was assumed that underground electrical lines (UGE) were not affected. The information on natural gas lines and petroleum lines within the 500-foot zone was limited but was evaluated where the information was available. No known petroleum lines are located within the critical zone. Natural gas and water service lines to buildings are generally less than 6 inches in diameter and not located near the levee. Based on

the uplift spreadsheets, lines 6 inches and smaller are generally not affected by uplift, therefore only lines 6 inches and greater have been evaluated.

For this study, the CID-KS Unit was broken into ten segments for analysis with each segment having its own geotechnical features. The geotechnical input consisted of impervious blanket thickness and foundation sands thickness as well as levee dimensions, berm dimensions, bedrock depth, and soil density. Exhibit 6 "CID-KS Utility Uplift Spreadsheet: Data Entry Worksheet" displays the existing geotechnical and dimensional conditions for each levee segment. For this study, the driving head of water represents the nominal 500-year plus 3 feet level of protection. The locations of underseepage control features were considered in regards to uplift on utility lines. A factor of safety of 1.1 was used assuming each pipe is empty to determine uplift.

Exhibit 7 contains a sample calculation for utility uplift. It shows how each of the geotechnical, dimensional, and hydraulic gradient inputs are used to calculate potential uplift concerns. The utility uplift spreadsheets for levees are based on this sample calculation. A set of spreadsheets was developed for each utility crossing the levee. Uplift was evaluated for each utility. If uplift was not a concern then no further evaluation was done on that pipe.

If uplift is found to be a concern, then uplift was evaluated further from the toe up to 500 feet. The distance from the levee at which the factor of safety equals 1.1 at the depth of the utility is the length of the utility that needs a remedy.

The results are summarized in the attached tables labeled, Exhibit 8 "Utility Uplift Summary." The tables provide a list of utilities, indicating the levee segment, the size and type of line, and the length of line to be lowered or covered to alleviate uplift concern. The remedy developed to address uplift is concrete anchors.

Utility uplift recommendations are based on the N500+3 raise, therefore the quantities for the cost estimate is also based on the N500+3 raise. For the N500+0 and N500+5 alternatives, quantities for utility uplift are not the same as for N500+3. Quantities used for determining the N500+3 cost will be adjusted up for the N500+5 alternative and down for the N500+0 alternative. This approach for estimating the N500+0 and the N500+5 raise is similar to the approach taken in Phase 1 for estimating the Argentine Unit utility uplift recommendations. Based on Argentine quantities for uplift, the quantity of piping for the N500+0 raise will be calculated at 80% of the N500+3 quantity. The quantity of piping for the N500+5 raise will be calculated at 120% of the N500+3 quantity. The number of manholes to be replaced will remain the same for all alternatives, N500+0, N500+3, and N500+5.

5.3.5 Inspection Trench

Since the proposed construction primarily involves raising the existing protection, no specific locations for new inspection trenches are indicated or considered. In the event that conditions are encountered in the field which warrant investigation, an inspection trench may be used.

5.4 REFERENCES

1 American Water Works Association “Steel Pipe – A Guide for Design and Installation”, AWWA M11 4, 2004.
2 Hydraulic Institute “Hydraulic Institute Engineering Data Book” Hydraulic Institute, Cleveland, Ohio.
3 EM 1110-2-1913, “Engineering and Design – Design and Construction of Levees”
4 Kansas City District regional specific guidance www.nwk.usace.army.mil/local_protection/levees.html

EXHIBIT 1
Borrow Area for Proposed Argentine, Armourdale, and CID-KS Unit Raise

Prospective borrow areas were identified by the Sponsor and screened through joint Corps and Sponsor efforts during the Phase I portion of this feasibility project. Regarding borrow area, Phase 1 focused on the Argentine Unit. Because the borrow area for Armourdale will be the same as for Argentine, this write-up was taken from the Phase I report and updated to include the Armourdale Unit raises.

ARGENTINE

Total required fill quantities for Argentine are 90,301, 257,881, and 508,281 compacted cubic yards (ccy) for N500, N500+3, and N500+5 raises, respectively. The N500+3 raise is the recommended alternative for Phase 1, therefore 258,000 ccy will be used for estimating borrow needs. For Argentine, the proposed levee raise accounts for about half of the fill requirement and stability or underseepage berms account for the other half. Subsurface investigation of the borrow area provided the required geotechnical information for the materials to be used in the levee.

ARMOURDALE

Total required borrow quantities from WaterOne for Armourdale is approximately 330,000 bcy for the N500+3 raise. This quantity is based on balancing cut and fill on site and then calculating what is required to supplement on-site material with that from WaterOne.

CID-KS

Total required borrow quantities for WaterOne for CID-KS is approximately 88,300 bcy for the N500+3 raise. This quantity is based on balancing cut and fill on site and then calculating what is required to supplement on-site material with that from WaterOne.

The attached WaterOne Borrow Area Typical Cross Section and table summarize the borrow material needs for Argentine, Armourdale and CID-KS. See “WaterOne Borrow Area Typical Cross Section”, for a typical cross section for the borrow area excavation.

Roughly 45 acres will be needed for Armourdale’s 330,000 bank cubic yard requirement and roughly 18 acres will be needed for CID-KS’s 88,300 bank cubic yard requirement. This assumes that impervious material is obtained in a 3-foot layer with random material obtained below that from a 2 to 3-foot layer. For all of borrow requirements for Argentine, Armourdale, and CID-KS, approximately 93 acres will be needed assuming impervious material is obtained from a 3-foot layer and random obtained from a 2 to 3 foot layer below that. The impervious layer thickness assumption is critical to estimating the acreages to be used from WaterOne. The 3-foot impervious thickness assumption was derived from the eight boring logs.

Cultural resource investigation into the WaterOne borrow site resulted in a maximum excavation depth of 10 feet. The US Army Corps of Engineers recommended a maximum

excavation depth of 10 feet and the Kansas State Historic Preservation Officer has concurred with Corps' recommendation that no archeological survey is needed for borrow activity kept to a depth of 10 feet or less.

BORROW AREA SEARCH

Originally, the Argentine & Armourdale foreshore areas were considered due to their close proximity to the Argentine unit. As HTRW investigations were undertaken for areas of interest, however, various regions of contamination were discovered which eliminated most of these areas from consideration. Total remaining available fill in these areas, ASSUMING NO FURTHER HTRW DISCOVERIES, is approximately 143,000 CY (see FIGURE 1 - "FORESHORE"). Figure 1 reflects avoidance of known HTRW concerns, a minimum 300' standoff distance from existing levees or floodwalls, and maximum depth of excavation of ordinary high water (OHW) minus 4 feet. It is recommended that this area be retained for further consideration during project engineering & design, though there is a possibility that further HTRW investigations will make even the remaining material unusable. Even if no further HTRW issues are discovered, any borrow from this area would need chemical analysis sampling at a rate of 1 sample (about $1000) per 5000 cy of borrow due to the known contamination and associated legal entanglements in the area.

Since the remaining foreshore quantity alone (assuming future HTRW clearance) is marginal for the N500 raise and insufficient for the other two prospective modifications to the Argentine unit, efforts were taken to identify alternative borrow areas as close to the project as possible. FIGURE 2 - "VICINITY MAP" shows various sites considered and investigated. Many of the sites near the project area were either very small or had other undesirable characteristics such as extremely high land values or prior industrial use. Several areas, as discussed on the following pages, were further investigated.

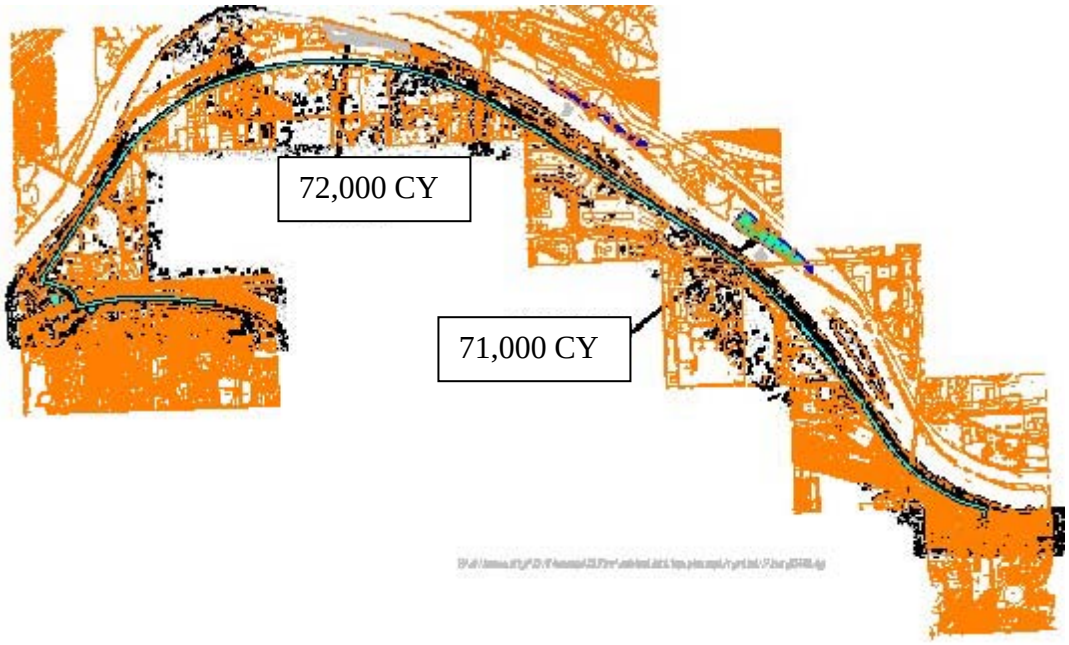


FIGURE 1 – FORESHORE

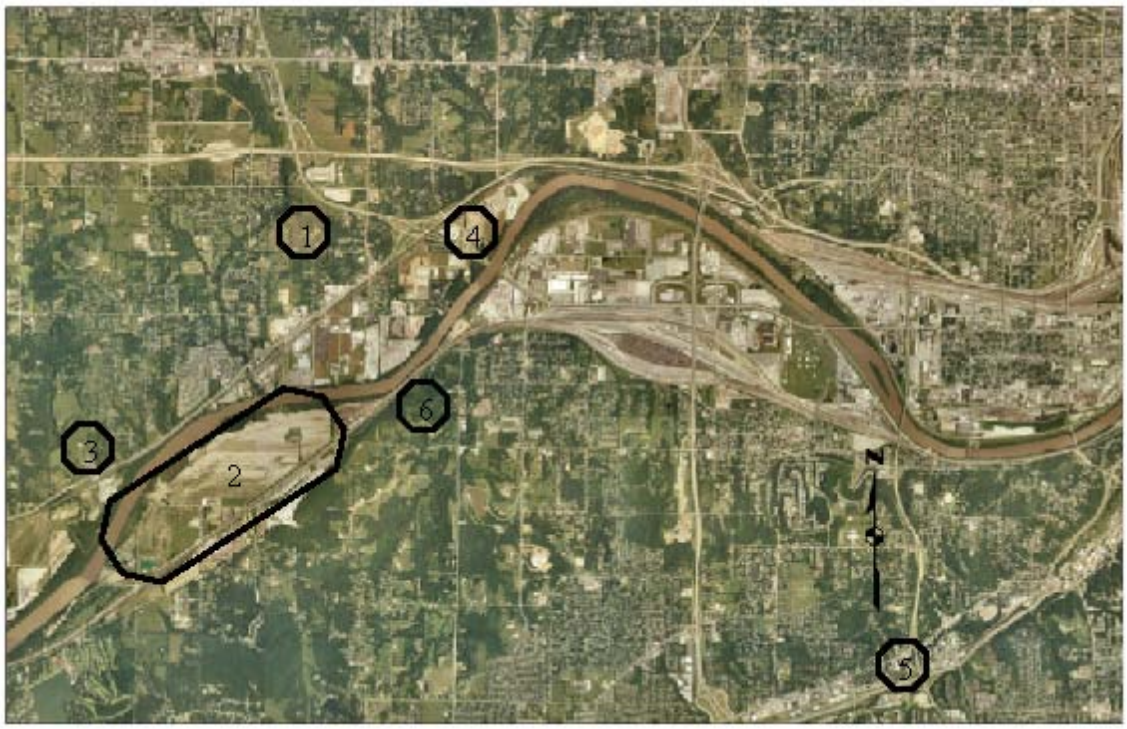


FIGURE - 2 VICINITY MAP

Area 1 is an open field south of the Turner Diagonal. The area is approximately 40 acres and appears to have been previously used as a borrow area. Since access to and from the area requires travel through residential neighborhoods on narrow routes, the area was not considered for further study.

Area 2 is in the Kansas River floodplain. The area is approximately 500 acres, 380 of which are owned by Water District One of Johnson County (WaterOne). This area appeared to be a good candidate for further consideration, and is discussed in detail below.

Area 3 is owned by Amino Brothers Construction and has previously been used as source of borrows. Approximately 200,000 cy of material is available, per conversation with the owner. This site may be a viable backup source for impervious materials, if required.

Area 4 is approximately 50 acres and used for a variety of commercial / industrial purposes. Since current appraised land values are in excess of $2000 per acre, this area was not considered for further study.

Area 5 is owned by Sandifer Leasing and has previously been used as source of borrows. Field investigations show little to no remaining fill, therefore the site was not considered for further study.

Area 6 is a large wooded hillside, which appears to be undisturbed. The area below is covered by a network of tunnels, originally used for limestone mining and currently for cold storage. Due to the likelihood of disturbing the tunnels below during earth moving operations,

this area was not considered for further study.

See TABLE 1 “BORROW AREA COMPARISON” for a summary comparison of prospective sites.

TABLE 1 - BORROW AREA COMPARISON

AREA	OWNER	HAUL DIST	PROS	CONS	ACTION
1	Unknown	2 miles	Close to site	Residential access, small	Remove from consideration
2	WaterOne	4 miles	Little or no cost	Haul distance	Investigate as primary source
3	Amino Bros.	5 miles	Bank source – expected to be impervious	Haul distance, cost of fill	Keep for possible contingency
4	5701 LLC	2 miles	Close to site	High cost of comm/ind property, developed	Remove from consideration
5	Sandifer	5 miles	None	Haul distance, look like no fill left	Remove from consideration
6	Unkonwn	3 miles	Bank	Haul distance,	Remove

AREA	OWNER	HAUL DIST	PROS	CONS	ACTION
			source-expected impervious	likelihood of damaging tunnels below	from consideration
Foreshore	KVDD easement	0 (Argentine) 4 miles (Armourdale)	Very close to site	Potential HTRW, legal entanglements, high chemical sampling cost	Keep for possible contingency

Area 2, shown below in additional detail in FIGURE 3, contains approximately 500 acres and is bounded by the Kansas River and Holliday Drive. WaterOne owns 380 acres in this area and uses the site for disposal of quicklime used in the water treatment process. Individual cells, each 5-10 acres and 20 feet deep, are excavated and, over the course of 3-5 years, filled with dewatered lime (40-60% solids). The cells are then capped with soil, and the excess soil stockpiled elsewhere onsite. During an October 2004 meeting with WaterOne staff, the requirements for the Argentine levee raise project were discussed in detail. WaterOne staff indicated a desire to dispose of excess materials and was interested in pursuing an agreement for

use of the excess materials. Soil boring logs for previous WaterOne well and disposal cell construction indicate significant deposits of silt and silty clay, both of which would qualify as impervious fill, in the area.

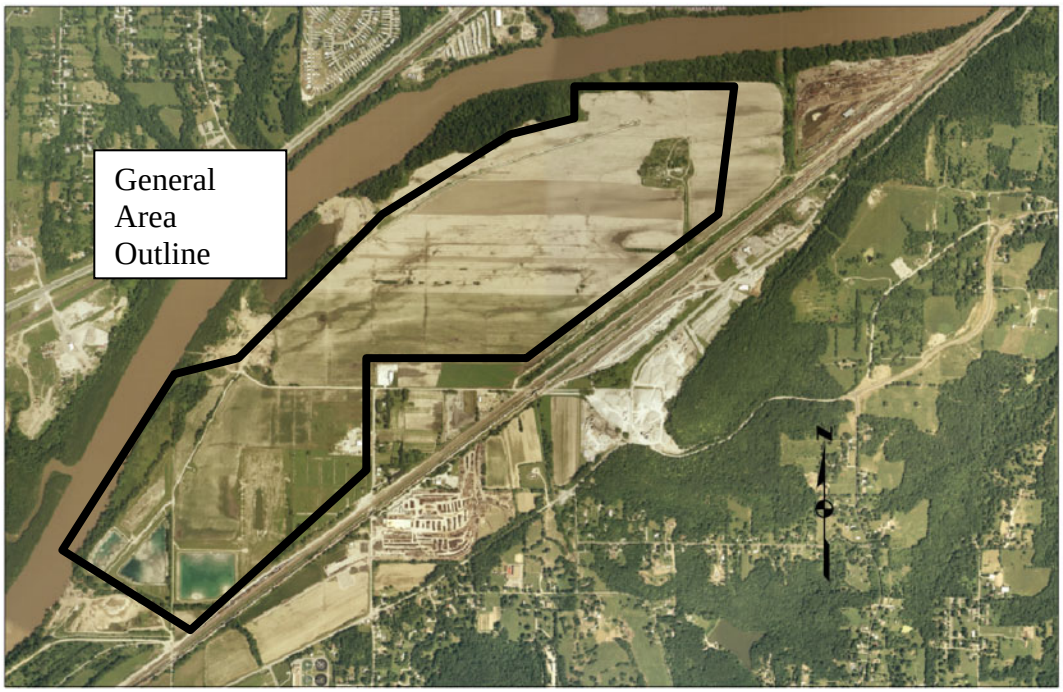


FIGURE 3 – BORROW AREA 2 - WATER ONE

Exploratory soil borings and chemical analysis sampling was conducted in January 2005. Chemical analysis entailed 3 grab samples for volatile organic compounds (VOCs) and three composite samples for metals, pesticides herbicides, and semivolatile organic compounds (SVOCs). Chemical analysis sampling points differed from soil boring locations, but were taken at various locations throughout the WaterOne property to assure representative results. All parameters tested were below action levels.

Subsurface Investigation.

Exploratory Borings.

The subsurface investigation of the borrow area consisted of 8 exploratory borings, 10 - feet deep, drilled with 3 ¾ ID Hollow Stem Auger with 3-inch inner barrel sampler. The borings location with WaterOne property delineated is shown in FIGURE 4 and the strip logs are included at the end of the paragraph. All holes were backfilled prior to leaving the site. No water was encountered during drilling or 24 hours after drilling. Forty (40) jar samples and 8 sack samples (1 composite sack sample for each boring) were collected from all borings. The boring logs show an impervious soil layer consisting of silts and clays extending up to 6 feet below the surface followed by a sandy aquifer. The central part of the borrow area has a thin layer of sand at the surface, varying between 1 and 4.5 feet in thickness, followed by 3 to 4 feet of silts and clay, on the top of the sandy aquifer. The sandy material can be used as backfill in the random portion of the landside levee embankment.

Laboratory Testing.

Selected samples of material obtained during the field exploration were tested to determine engineering and physical properties of the soils. Laboratory testing was performed by Geotechnology, Inc. The laboratory testing included Atterberg Limits, natural moisture contents, and Standard Proctor tests. The samples were grouped in 5 categories of similar characteristics and Atterberg Limits were performed on a representative sample of each category. The moisture content varies between 4 and 35%. Overburden clay and silt material was classified in accordance with ASTM D 2487 as lean clay (CL) or silt (ML). Three of the groups were determined to be non plastic, the other 2 groups were classified one as a lean clay (CL) and the other as silt (ML). The silt was determined to be non-plastic material. The Liquid Limit (LL) of the CL material varies between 39 and 47 and the Plasticity Index (PI) between 19 and 28. The results of the natural moisture content tests and performed on twenty five (25) disturbed samples and of the Atterberg Limits tests performed on 2 selected representative samples of clay material are shown in an enclosure at the end of the paragraph.

Three Standard Proctor Tests were performed on composite samples collected from the borrow areas conform ASTM D-698. The materials were classified as low plasticity clay with the LL between 52 and 55 and PI between 35 and 37 respectively. The maximum dry density varied between 107.5 and 102 pcf with the optimum moisture content varying between 18.5% and 20.5%.

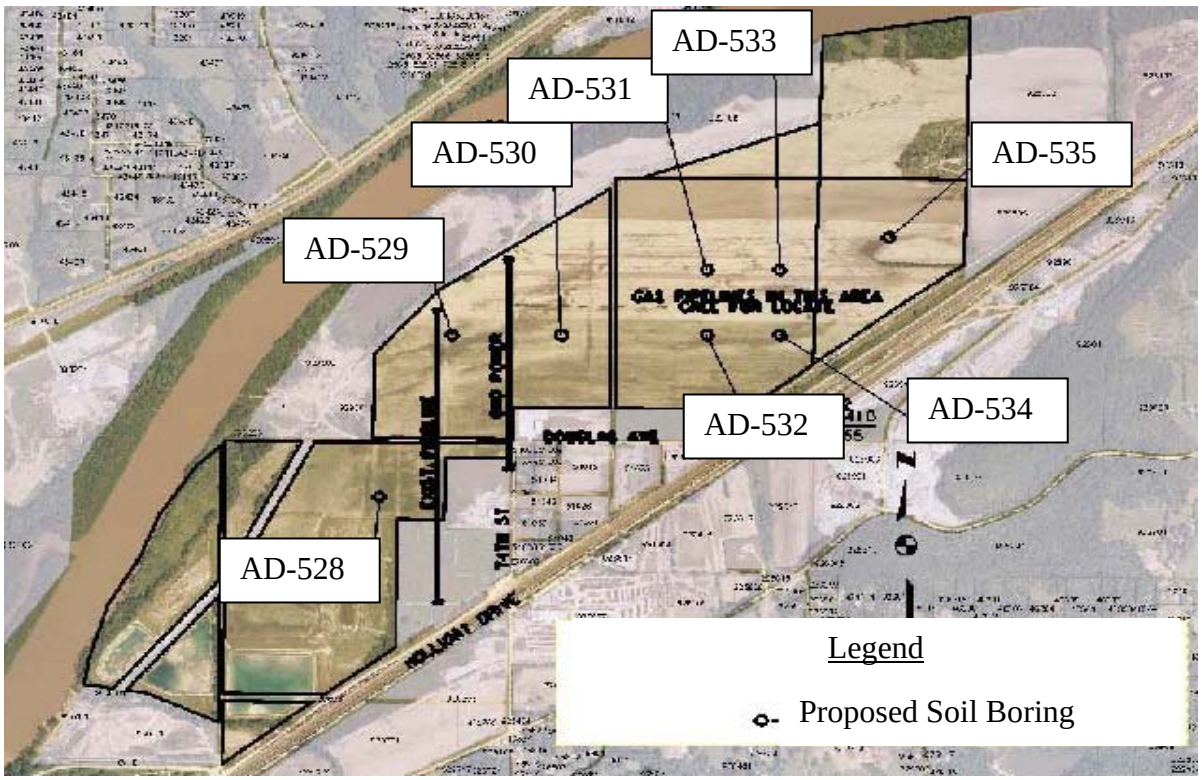
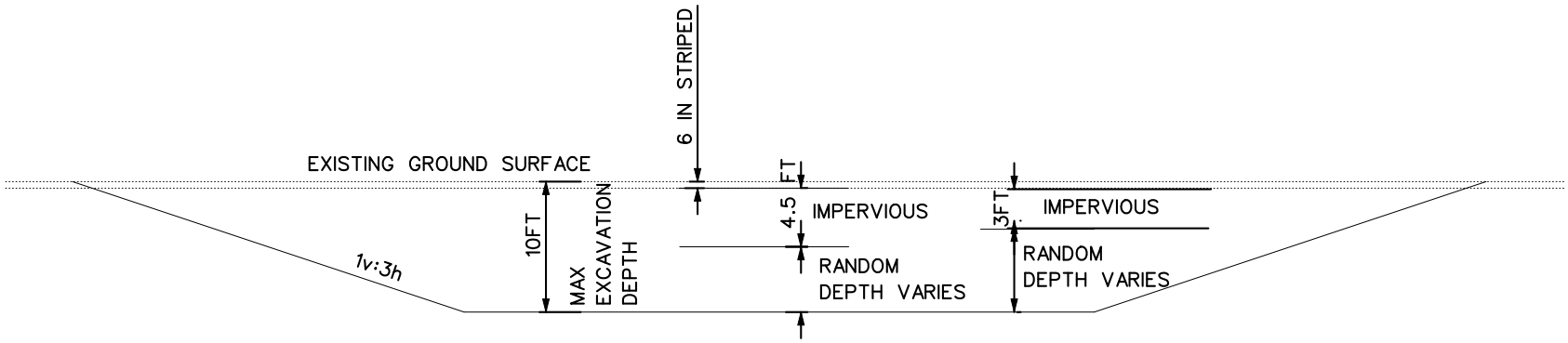


FIGURE 4 - SOIL BORINGS



Borrow Area Needs - Current Recommendation N500+3
Using Two Depths (3' and 5') for Impervious Excavation

					Impervious		Total		
	Total Borrow Quantity	Impervious	Random	Strip Top 6"	Depth of Excavation for Impervious Only	Area of Excavation	Maximum Depth of Excavation (1)	Minimum Depth of Excavation (4)	Total Area of Excavation (5)
	BCY	BCY	BCY		Feet	Acres	Feet	Feet	Acres
Armourdale	330,000	220,000	110,000	0.5	3	45	10	5	45
	330,000	220,000	110,000	0.5	5.0	27	10	8	27
CID-KS	88,300	88,260	-	0.5	3	18	10	4	18
	88,300	88,260	-	0.5	5.0	11	10	6	11
Argentine	282,700	144,226	138,490	0.5	3	30	10	6	30
	282,700	144,226	138,490	0.5	5.0	18	10	10	18
Total	701,000	452,486	248,490	0.5	3	93	10	5	93
	701,000	452,486	248,490	0.5	5.0	56	10	8	56

Notes

CCY Compacted Cubic Yards
BCY Bank Cubic Yards = CCY/0.8
BOTEA Back of the Envelope Analysis

Assumptions: Impervious material is generally located above other material
Estimate will be revised as levee/floodwall alignment is refined.
(1) Maximum depth of excavation is set to 10 feet.
Kansas State Historic Preservation Officer has concurred with Corps' recommendation that no archeological survey is needed for borrow activity kept to a depth of 10' or less
(2) (3) Comments Not used
(4) Minimum excavation depth is calculated using Alternative 2 - setting the acreage needed for random fill equal to that needed for impervious fill.
(5) Total area of excavation is the greater value returned when comparing the Impervious Area of Excavation and the Random Alt. 1 Area of Excavation

KANSAS CITYS LEVEES
FEASIBILITY PHASE 2

WATERONE
BORROW AREA
TYPICAL
CROSS SECTION

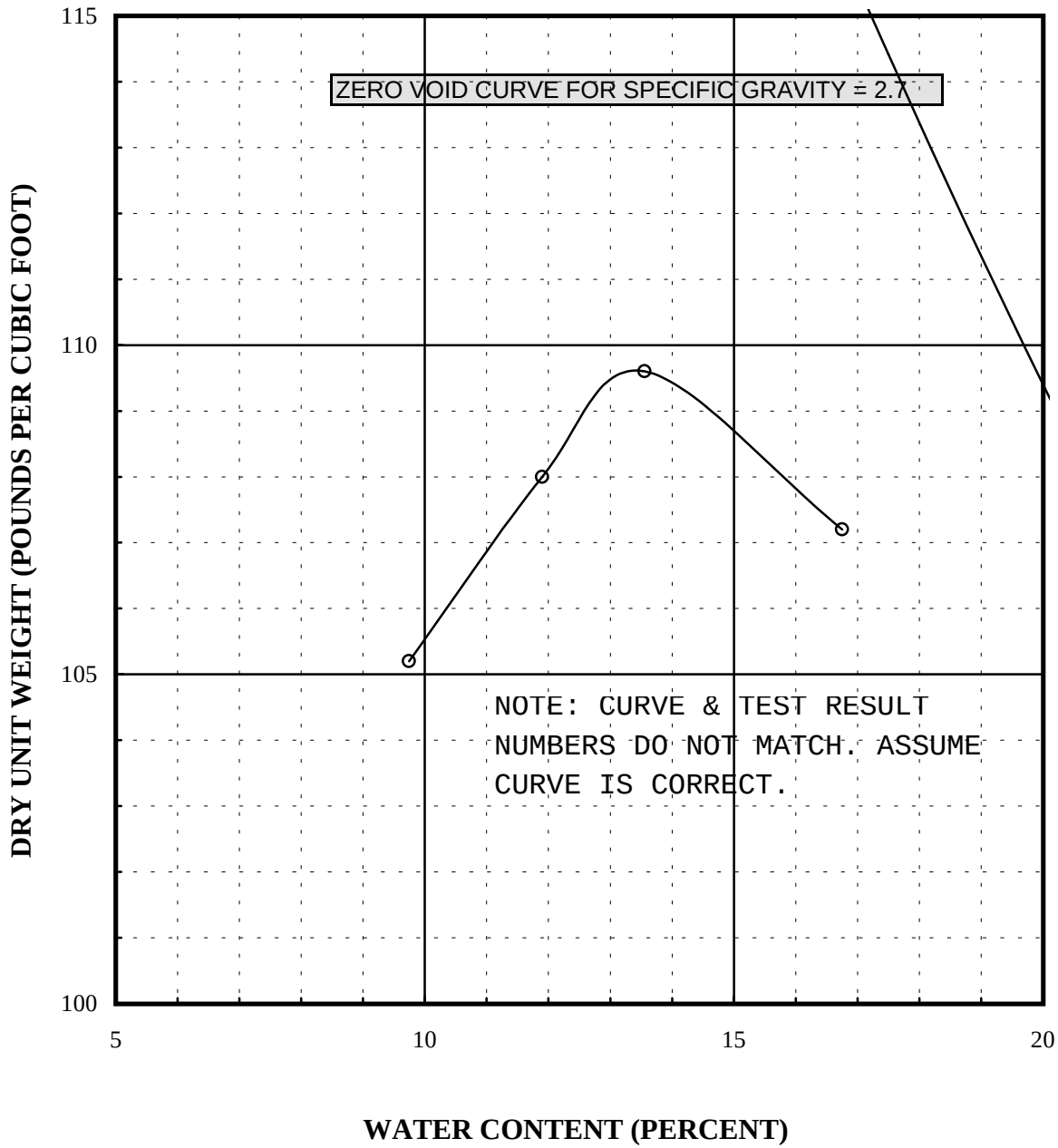
Date: November 13, 2008

	BORING NO.	Sample Depth (feet)	Sample No.	LABORATORY TESTS							Classification or Group Classification ASTM D2487
				Group Class.	Moisture Content %	Atterberg Limits			Standard Proctor		
						Liquid Limit	Plastic Limit	Plasticity Index	Max. Dry Density	Optima Water Content	
					ASTM D2216	ASTM D4318			ASTM 698 Method A		
SACK SAMPLES	AD-528	0.8-4.0	Sack-1	--	--	29	21	8	104.7	18.2	CL-dark brown sandy low plasticity CLAY
SACK SAMPLES	AD-529	3.0-6.0	Sack-1	--	--	27	17	10	113.9	14.6	SC-dark brown clayey SAND
SACK SAMPLES	AD-535	1.0-4.5	Sack-1	--	--	47	19	28	102.5	19.0	CL-dark brown sandy low plasticity CLAY
DISTURBED SAMPLES	AD-528	0.0-0.5	J-1	5	29.2	Not enough sample					
DISTURBED SAMPLES	AD-528	0.5-0.8	J-2	5							
DISTURBED SAMPLES	AD-528	0.8-4.0	J-3	1							
DISTURBED SAMPLES	AD-528	4.0-4.6	J-4	1	25.0	39	20	19			
DISTURBED SAMPLES	AD-528	4.6-8.4	J-5	3							
DISTURBED SAMPLES	AD-528	8.4-9.0	J-6	2							
DISTURBED SAMPLES	AD-529	0.0-1.0	J-1	4	27.5						
DISTURBED SAMPLES	AD-529	1.0-3.0	J-2	3							
DISTURBED SAMPLES	AD-529	3.0-4.0	J-3	4	21.2						
DISTURBED SAMPLES	AD-529	4.5-6.0	J-4	1	24.9						
DISTURBED SAMPLES	AD-529	6.0-10.0	J-5	3							
DISTURBED SAMPLES	AD-530	0.0-1.0	J-1	4							
DISTURBED SAMPLES	AD-530	1.0-1.5	J-2	3	4.0						
DISTURBED SAMPLES	AD-530	1.5-2.5	J-3	2	20.1	Non-plastic					
DISTURBED SAMPLES	AD-530	2.5-4.3	J-4	2	11.3						
DISTURBED SAMPLES	AD-530	4.3-8.0	J-5	2	25.2						
DISTURBED SAMPLES	AD-530	8.0-9.3	J-6	4		Non-plastic					

Group Classification Number:

1. CL - dark brown sandy low plasticity CLAY
2. ML - light brown low plasticity SILT
3. SP - tan fine-grained SAND
4. SM - dark brown silty SAND
5. FILL - dark brown gravelly low plasticity CLAY with sand
6. CL - dark brown low plasticity CLAY

BORING NO.	Sample Depth (feet)	Sample No.	LABORATORY TESTS							Classification or Group Classification ASTM D2487
			Group Class.	Moisture Content %	Atterberg Limits			Standard Proctor		
					Liquid Limit	Plastic Limit	Plasticity Index	Max. Dry Density	Optima Water Content	
				ASTM D2216	ASTM D4318			ASTM 698 Method A		
AD-531	0.0-1.0	J-1	4	14.4						
	1.0-3.5	J-2	1	22.2						
	3.5-4.0	J-3	2							
	4.0-6.5	J-4	2	25.1						
	6.5-9.0	J-5	3		Non-plastic					
AD-532	0.0-4.3	J-1	1	26.3						
	4.3-6.3	J-2	1	30.7						
	6.3-8.3	J-3	2							
AD-533	0.0-2.3	J-1	1	18.9						
	2.3-4.3	J-2	2	9.9						
	4.3-6.0	J-3	2	14.9						
	6.0-8.0	J-4	1	26.2						
	8.0-9.3	J-5	2							
ADU-534	0.0-4.0	J-1	1	25.7						
	4.0-6.0	J-2	2	30.7						
	6.0-6.5	J-3	6	35.4						
	6.5-7.0	J-4	1	28.3						
	7.0-9.0	J-5	2	15.5						
AD-535	0.0-4.5	J-1	6	20.3	47	19	28			
	4.5-7.5	J-2	1	29.5						
	7.5-8.5	J-3	2							
	8.5-9.5	J-4	3							
	9.5-10.0	J-5	2							



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor
ASTM D 698 Method A
Percent of Compaction N/A
Moisture Range ±% N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
104.7 pcf	18.2%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
29	21	8

DESCRIPTION

Dark brown, sandy low plasticity CLAY

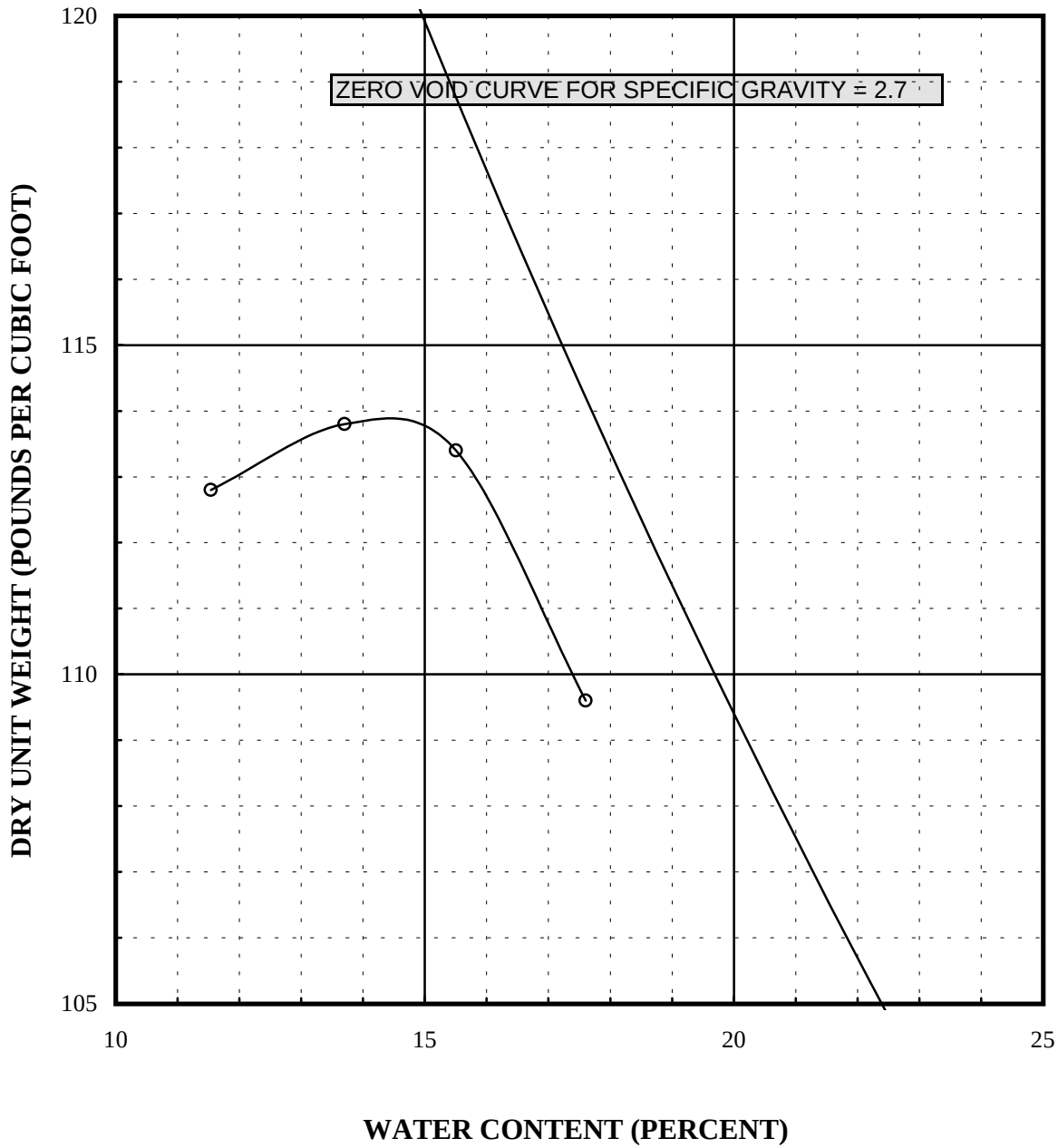
SAMPLE LOCATION

AD 528, 0.8-4.0 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0680806.52KM	**Test Date**	3/4/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1075	**Ch'd By**	ARK



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor
ASTM D 698 Method A
Percent of Compaction N/A
Moisture Range ±% N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
113.9 pcf	14.6%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
27	17	10

DESCRIPTION

Dark brown clayey SAND

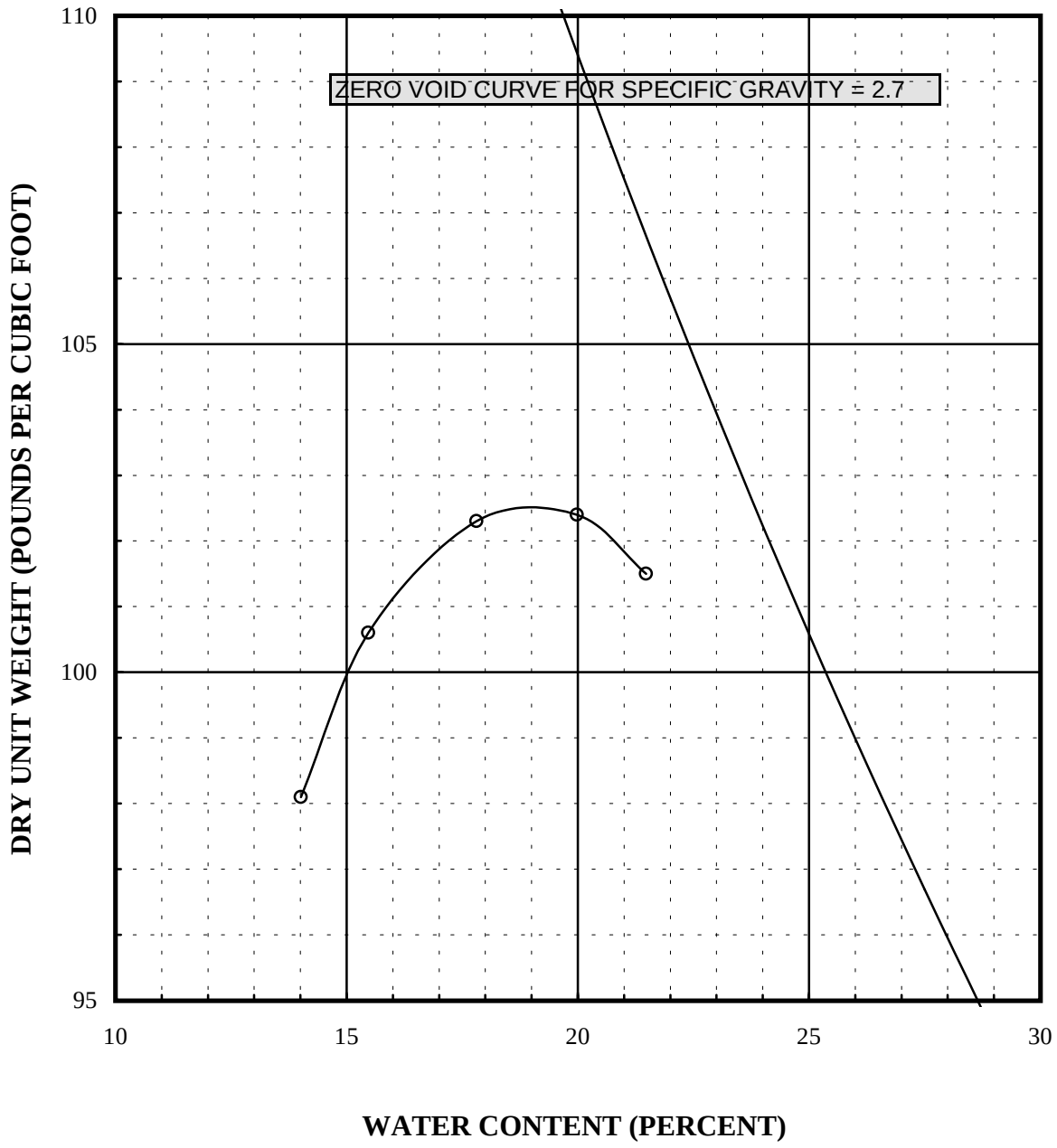
SAMPLE LOCATION

AD 529, 3.0-6.0 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0681901.32KT	**Test Date**	3/7/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1077	**Ch'd By**	ARK



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor
ASTM D 698 Method A
Percent of Compaction N/A
Moisture Range ±% N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
102.5 pcf	19.0%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
47	19	28

DESCRIPTION

Dark brown sandy low plasticity CLAY

SAMPLE LOCATION

AD 535, , 1.0-4.5 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0681901.32KT	**Test Date**	3/4/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1076	**Ch'd By**	ARK

LOG OF BORING AD-528

US Army Corps of Engineers ®

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-528
LOCATION: Kansas and Missouri
COORDINATES: N 14190735.79, E 1141877.29 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	DESCRIPTION OF STRATUM	USCS SYMBOL	LIQUID LIMIT (LL)	PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
0	CLAY HARD DRY BROWN frozen (0.5–0.8)				29.2	VG5	
						VG5	
2	GRAVELLY COBBLES MODERATELY HARD GREY decomposed rock; LEAN CLAY MEDIUM DAMP - MOIST DARK BROWN (0.8–4.6)	CL	29	8		VG1	
4		CL	39	19	25	VG1	
6	FINE SAND LOOSE - MEDIUM COMPACT DRY LIGHT BROWN (4.6–8.4)					VG3	
8							
10	SILT LOOSE DRY GREY (8.4–10.0)					VG2	

Bottom of hole - No Refusal
Backfilled to surface with cuttings and 3 bags Holeplug

LEGEND
- Fill (made ground)
- USCS Low Plasticity Clay
- USCS Poorly-graded Sand
- USCS Silt

OTHER LAB DATA: S: Minus 200 Sieve (%); U: Unconfined Compressive Strength (tsf); C: Confining Pressure (psi); F: Failure Strain (%); T: Total Sulfates; P: Soil pH

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG5 - FILL

LOG OF BORING AD-529

US Army Corps of Engineers ®

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-529
LOCATION: Kansas and Missouri
COORDINATES: N 14192413.68, E 1142543.89 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	USCS SYMBOL	LIQUID LIMIT (LL)	PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							FINE SAND FROZEN DARK BROWN (1.0)				27.5	VG4	
							FINE SAND LOOSE DRY BROWN (3.0)					VG3	
2													
4							CLAYEY SAND MEDIUM COMPACT DAMP-MOIST DARK BROWN (4.5)	SC	27	10	21.2	VG4	
							CLAY SOFT DAMP DARK BROWN very silty (6.0)				24.9	VG1	
6							FINE SAND LOOSE-MEDIUM DRY-DAMP LIGHT BROWN silty (10.0)					VG3	
8													
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug						

LEGEND

- USCS Silty Sand
- USCS Poorly-graded Sand
- USCS Clayey Sand
- USCS Low Plasticity Clay

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG3 - SP; VG4 - SM

LOG OF BORING AD-530

US Army Corps of Engineers ®

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-530
LOCATION: Kansas and Missouri
COORDINATES: N 14192416.14, E 1143534.5 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/12/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	USCS SYMBOL	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC INDEX PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							SILTY SAND FROZEN DARK BROWN fine grained (1.0)					VG4	
							(1.5)				4	VG3	
2							FINE SAND LOOSE DRY-DAMP BROWN poorly graded (2.5)				20	VG2	
							SILT MEDIUM COMPACT DAMP DARK BROWN (4.3)				11	VG2	
4							SILT MEDIUM COMPACT LIGHT BROWN				25	VG2	
6							SILT MEDIUM COMPACT DAMP GRAYISH BROWN sandy wet zone (8.0)						
8							SILTY SAND MEDIUM COMPACT DAMP LIGHT BROWN laminated fine grained (10.0)					VG4	
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug						

LEGEND

- USCS Silty Sand
- USCS Poorly-graded Sand
- USCS Silt

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG2 - ML; VG3 - SP; VG4 - SM

LOG OF BORING AD-531

US Army Corps of Engineers

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-531
LOCATION: Kansas and Missouri
COORDINATES: N 14193052.59, E 1144847.77 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC INDEX PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							SILTY SAND FROZEN LIGHT BROWN very fine grained (1.0)					14	VG4	
2							LEAN CLAY SOFT-VERY SOFT DAMP DARK BROWN very silty ~ 30-40 % silt (3.5)					22	VG1	
4							SILT LOOSE DRY BROWN with fine sand (4.0)						VG2	
6							SILT MEDIUM COMPACT DAMP BROWN slightly sandy ~ 10-15 % very fine sand (6.5)					25	VG2	
8							FINE SAND MEDIUM COMPACT - LOOSE DAMP-DRY LIGHT BROWN (10.0)	USCS Silty Sand; USCS Low Plasticity Clay; USCS Silt; USCS Poorly-graded Sand					VG3	
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG4 - SM

LOG OF BORING AD-532

US Army Corps of Engineers ®

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-532
LOCATION: Kansas and Missouri
COORDINATES: N 14192422.33, E 1144971.11 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							LEAN CLAY MEDIUM MOIST DARK BROWN frozen to 1.0 ft 4.3					26	VG1	
2														
4														
							LEAN CLAY MEDIUM MOIST-WET DARK BROWN silty 6.3					31	VG1	
6														
							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN sandy 10.0						VG2	
8														
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

USCS Low Plasticity Clay

USCS Silt

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML

LOG OF BORING AD-533

US Army Corps of Engineers
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-533
LOCATION: Kansas and Missouri
COORDINATES: N 14193066.09, E 1145518.24 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							LEAN CLAY MEDIUM DAMP DARK BROWN silty 2.3				19	VG1	
2							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with fine-grained sand 4.3				10	VG2	
4							SILT MEDIUM COMPACT DRY-DAMP BROWN with very fine-grained sand 6.0				15	VG2	
6							LEAN CLAY MEDIUM MOIST DARK BROWN with silt 8.0				26	VG1	
8							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with very fine-grained sand 10.0					VG2	
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug						

LEGEND
- USCS Low Plasticity Clay
- USCS Silt

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML

LOG OF BORING AD-534

US Army Corps of Engineers

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-534
LOCATION: Kansas and Missouri
COORDINATES: N 14192405.24, E 1145517.16 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/19/05 - 1/19/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							LEAN CLAY MEDIUM DAMP DARK BROWN silty					26	VG1	
2														
4							4.0							
							SILT MEDIUM COMPACT WET DARK BROWN clayey					31	VG2	
6							6.0							
							LEAN CLAY SOFT MOIST-WET DARK BROWN silty					35	VG6	
							6.5					28	VG1	
							7.0					16	VG2	
8							LEAN CLAY MEDIUM MOIST-WET DARK BROWN silty	USCS Low Plasticity Clay USCS Silt						
							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with very fine-grained sand							
10							10.0							
							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG6 - CL(LL=47,PI=28)

LOG OF BORING AD-535

US Army Corps of Engineers

Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-535
LOCATION: Kansas and Missouri
COORDINATES: N 14193402.93, E 1146504.01 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC INDEX PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA (S: Minus 200 Sieve (%) U: Unconfined Compressive Strength (tsf) C: Confining Pressure (psi) F: Failure Strain (%) T: Total Sulfates P: Soil pH)
0							LEAN CLAY SOFT DAMP DARK BROWN silty ~ 10-15% silt		CL CL	47 47	28 28	20	VG6	
2														
4							4.5							
							LEAN CLAY MEDIUM WET DARK BROWN silty					30	VG1	
6							7.5							
8							SILT MEDIUM COMPACT DAMP LIGHT BROWN with very fine-grained sand						VG2	
							8.5							
							FINE SAND LOOSE DRY LIGHT BROWN poorly graded						VG3	
							9.5							
10							SILT MEDIUM COMPACT DAMP-MOIST BROWN sandy						VG2	
							10.0							
							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

LEGEND:
- USCS Low Plasticity Clay
- USCS Silt
- USCS Poorly-graded Sand

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG6 - CL(LL=47,PI=28)

CID KS

Access Points and Ramps from Landward Side

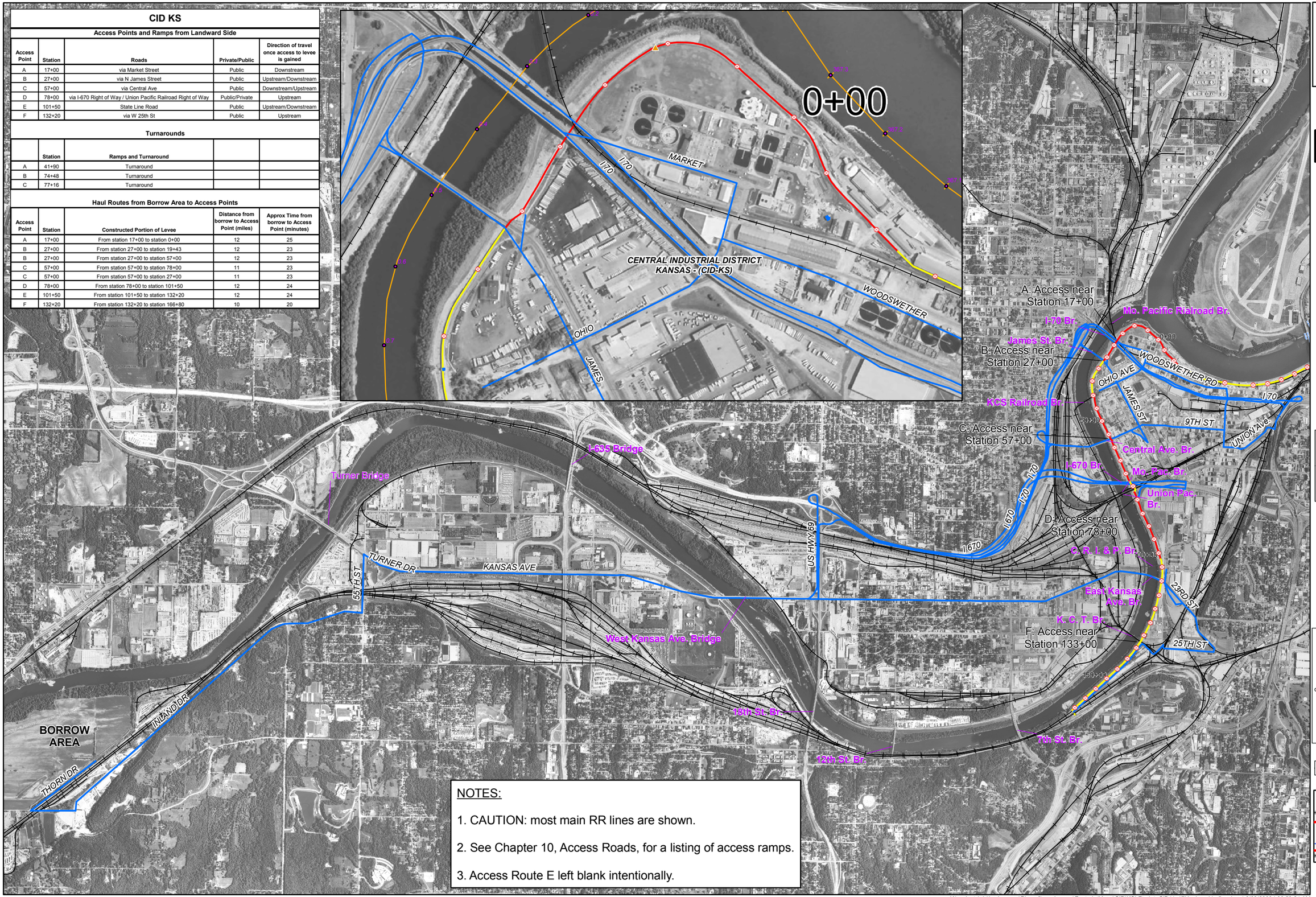
Access Point	Station	Roads	Private/Public	Direction of travel once access to levee is gained
A	17+00	via Market Street	Public	Downstream
B	27+00	via N James Street	Public	Upstream/Downstream
C	57+00	via Central Ave	Public	Downstream/Upstream
D	78+00	via I-670 Right of Way / Union Pacific Railroad Right of Way	Public/Private	Upstream
E	101+50	State Line Road	Public	Upstream/Downstream
F	132+20	via W 25th St	Public	Upstream

Turnarounds

	Station	Ramps and Turnaround		
A	41+90	Turnaround		
B	74+48	Turnaround		
C	77+16	Turnaround		

Haul Routes from Borrow Area to Access Points

Access Point	Station	Constructed Portion of Levee	Distance from borrow to Access Point (miles)	Approx Time from borrow to Access Point (minutes)
A	17+00	From station 17+00 to station 0+00	12	25
B	27+00	From station 27+00 to station 19+43	12	23
B	27+00	From station 27+00 to station 57+00	12	23
C	57+00	From station 57+00 to station 78+00	11	23
C	57+00	From station 57+00 to station 27+00	11	23
D	78+00	From station 78+00 to station 101+50	12	24
E	101+50	From station 101+50 to station 132+20	12	24
F	132+20	From station 132+20 to station 166+80	10	20



NOTES:

1. CAUTION: most main RR lines are shown.
2. See Chapter 10, Access Roads, for a listing of access ramps.
3. Access Route E left blank intentionally.

Kansas Citys, Missouri and Kansas

Flood Damage Reduction Project

Feasibility Study

CID (Kansas) Unit
August 2008

Haul Routes and Borrow Area Location

DRAFT
Working document
Not for public release

KEY
- Railroad
- Haul Route
- Station Tick Marks
- Floodwall
- Levee

N

US Army Corps of Engineers
Kansas City District

Photography Date: 2006

Projection: UTM Zone 15, Feet
Datum: NAD 83

Created by:
U.S. Army Corps of Engineers
Kansas City District, GDS Team

Users should refer corrections, additions, and comments for improving this product to:

GDS Coordinator,
U. S. Army Corps of Engineers,
Kansas City District,
601 East 12th, Room 812,
Kansas City, Missouri, 64106

0 750 1,500 3,000 Feet

Sheet C3

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Reviewed: July 5, 2007

Exhibit 3
KANSAS CITY'S LEVEE AND FLOODWALL GRAVITY AND UTILITY PIPELINE GUIDANCE

PURPOSE

The purpose of this document is to provide specific guidance during the feasibility phase of the Kansas City's Levee project as to the disposition of existing utilities and drainage structures within the sections of levee and floodwall to be raised. This guidance will be used for the feasibility level of effort in order to develop reasonable costs associated with the modification of drainage structures and the relocation of utilities.

Uplift of utilities within the critical zone of the levee or floodwall will be addressed in accordance with COE criteria. Uplift is not addressed in this KCL guidance.

REFERENCES

	Local Protection – Web page guidance
	Local Protection - Guidebook on web page (Guidance for work Proposed Near or within Federally Constructed Flood Risk Management Projects)
EM 1110-2-1913	Design and Construction of Levees
EM 1110-2-2902	Conduits, Culverts, and Pipes
EM 1110-2-3102	General Principles of Pumping Station Design and Layout
EM 1110-2-3104	Structural and Architectural Design of Pumping Stations
EM 1110-2-3105	Mechanical and Electrical Design of Pumping Stations (Changes 1 of 2)

GRAVITY PIPELINES

Existing pipelines crossing the levee that do not meet current COE criteria shall be replaced with pipelines that are compliant. Existing pipelines that meet current COE criteria shall remain with the following exceptions:

Any Corrugated Metal Pipe (CMP) with a diameter greater than 36" shall be replaced with a minimum diameter 48" Reinforced Concrete Pipe (RCP).

Any pipe inadequate to handle the drainage shall be replaced with a minimum diameter 48" RCP.

Any pipe known to have joints that are not watertight shall be replaced with a minimum diameter 48" RCP.

For new pipe installations, CMP will not be allowed.

Pipe strengths, unless otherwise known, will be assumed to be that required by Corps criteria at the time of their installation. Pipe condition shall be determined by field assessment.

GATEWELLS AND POSITIVE CLOSURES

In areas where levee raises are performed, positive closure will be provided for all drainage and utility lines crossing the levee. EM 1110-2-1913 states that gravity lines that penetrate the embankment or foundation of a levee must be provided with devices to assure positive closure. This criteria also states that gravity lines should be provided with flap-type or slide-type service gates on the riverside of the levee. Because the KS River and MO River are not fast rising rivers, a flap gate will not be recommended on existing outfalls where sluice gates are present but no flap gate. For new outfall structures, however, flap gates will generally be installed.

Emergency means of closure is suggested for gravity lines in addition to the positive closure device. Historically, a flap gate on the end of the pipe has acted as this second closure device. However, it is possible to use sandbags or concrete to fill a gatewell as a means of emergency closure during a flood situation, although this is not the recommended alternative.

All gatewells within the Kansas City Levee study area are considered confined spaces. OSHA regulations and Corp EM 385-1-1 require anyone entering a confined space to comply with specific confined space entry requirements. New or modified gatewells will be designed so that these confined space entry requirements can be met. For example, space will be provided above the gatewell opening so that a tripod can be set to facilitate non-entry rescue.

NON-GRAVITY PIPELINES CROSSING THROUGH OR UNDER LEVEES

It is preferable for all pipes or conduits to cross over the levee rather than penetrate the embankment or foundation materials. This includes pipes carrying fiber optic, pressurized gas or pressurized liquid. Where raises are made to the levee, existing non-gravity pipelines should be relocated over the crest of the new levee raise. See detail “Typical Utility Crossing Levee Raise”. A determination to relocate existing lines will be made on a case-by-case basis.

Pressure pipe

All pipes allowed to penetrate the embankment or foundation of a levee must be provided with devices to assure positive closure. These valves shall be placed in close proximity to the levee and have capability to be closed rapidly to prevent gas or fluid from escaping within or beneath a levee should the pipe rupture within these areas.

Provisions for closure of pressure pipes on the water side must also be provided to prevent backflow of floodwater into the protected area should the pipe rupture.

Casing Pipes, Cased Pipes and Conduits Crossing Through or Under Levees (Telecommunications)

It is preferred that conduits or casing pipes cross up and over the levee. However, where it is not possible to go over the levee, casing pipes or conduits must be installed in accordance with COE criteria. Refer to COE Guidebook located on the KC District website for directional drilling procedures.

ABANDONED PIPELINES

Pipelines, which are currently abandoned and grouted in accordance with COE criteria under or through the levee, will not be disturbed. Pipes that have been abandoned and do not meet criteria or it is unknown if they meet criteria shall be removed or properly abandoned according to COE criteria. Pipelines that are currently active but are to be abandoned as part of this project will be removed or abandoned according to COE criteria.

Removal

For feasibility purposes only, the following guidance is used in determining if an abandoned pipeline will be removed or abandoned in-place in accordance with Corps criteria.

> Where levee heights are less than 10 feet and when an abandoned utility is buried less than 5 feet below the base of the levee, the abandoned utility crossing under the levee should be removed unless special circumstances warrant a different approach.

Exploration Trench

For cost estimating purposes during feasibility, all known pipes are assumed to be located as shown on maps and plans or as located in the field during feasibility site visits.

No exploration trenches will be specified during feasibility. However, it is noted that during PED phase, it may be determined that exploration trenches will be needed during construction in order to find some utilities or to verify that some utilities do not exist as shown on the drawings.

Grouting Abandoned Pipelines

If a pipe does not meet the requirement for removal, the pipe should be properly abandoned by filling with a grout based substance, e.g., cement-bentonite, or flowable fill. The grout or flowable fill mix should be approved by the Corps of Engineers. The grout shall be fluid enough, and pumped in the up-slope direction so that the pipe will be completely filled leaving no voids. Points of access need to be made into the pipe at

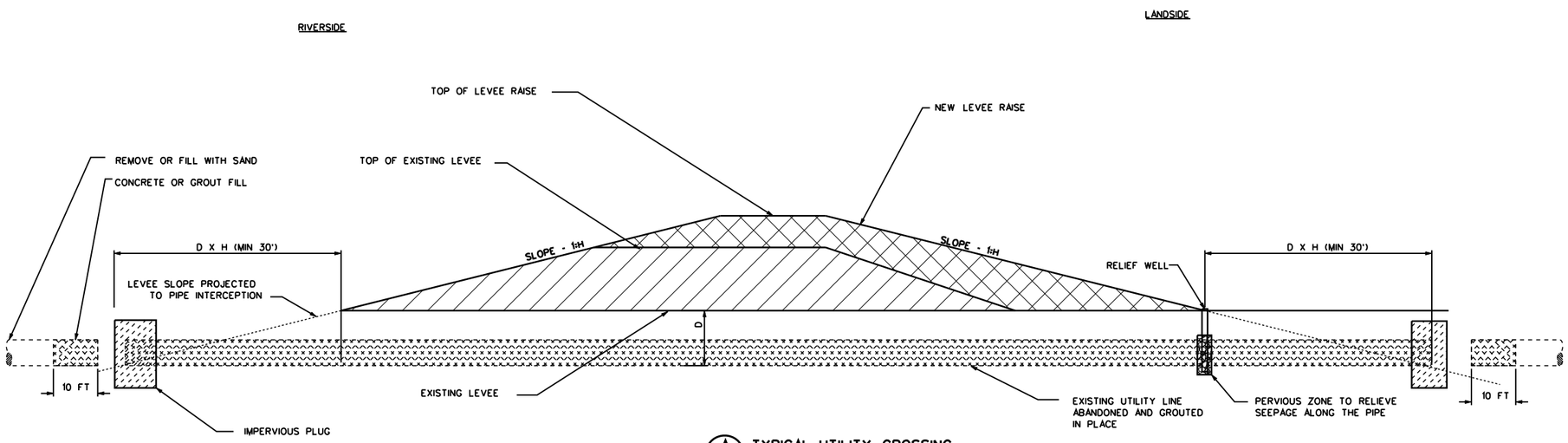
sufficient intervals to accomplish the grouting, see detail "Typical Utility Abandonment" for additional details regarding abandoning a utility in place.

OTHER CONSIDERATIONS

Special consideration will be given to existing pipe crossings on a case-by-case basis when hazardous, toxic, and radioactive waste (HTRW) concerns or real estate issues exist. HTRW concerns exist in various locations along the Kansas City Seven Levee system. When it is not desirable to disturb the existing ground due to HTRW concerns, the final recommendation for removing/relocating an existing utility will weigh the risks involved with disturbing the ground against leaving an existing utility in place. When real estate issues exist, the final recommendation will consider how real estate is affected.

SUMMARY OF RECOMMENDATIONS

For sections of levee or floodwall to be raised or modified, current Corps requirements will be extended to all components of that levee section, including any pipes and closure structures therein. When it is not practical to meet Corps requirement, each utility will be evaluated on a case-by-case basis.



A TYPICAL UTILITY CROSSING

SCALE: NTS

NOTES:
1. THE PREFERENCE IS TO REMOVE PIPES LOCATED IN OR UNDER THE LEVEE. IF NOT FEASIBLE, THIS DETAIL SHOULD BE ADHERED TO UNLESS APPROVED OTHERWISE. THIS DETAIL IS FEASIBILITY LEVEL DETAIL AND WILL REQUIRE ADDITIONAL INFORMATION FOR PED.

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

Designed by: MRC
Date: DECEMBER 2006
Drawn by: MRC
Drawing code: X
Checked by: HWM
Plot scale: NA
Submitted by: HWM
CADD File Name: UTILCROSSINGDETAIL V8

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY STUDY PHASE 2
ARMOURDALE

TYPICAL UTILITY
ABANDONMENT - LEFT IN PLACE

Sheet Reference Number:
XX

CID-KS Utility and Drainage Crossings: Inventory and Action for N500+3 Raise **Date: 10-June-08**
Created by: Cassidy Garden Peer Reviewed by: Hank Mildenberger

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
1	(83+22LE CID MO)	42"	Ohio Ave. Pump Plant Abandoned Outfall	Land to Riv	SEE PUMP STATION EVAL	RCP	130	NA	*		Abandoned 42" Conc. Conduit Filled with Sand. Conc plug on riverside just before gatewell.	No Action
2	-5+85 (83+52 LE CID MO)	42"	Ohio Ave. Pump Plant Outfall	Land to Riv	SEE PUMP STATION EVAL	RCP	100	Sluice Gate and Flap Gate	730.5	KCK		See Pump Station Evaluation
3	-1+77 (87+60 LE CID MO)	66"	Treated WW Plant Effluent	Land to Riv	Gravity	RCP	60	Sluice Gate	745.69	KCK		See Pump Station Evaluation
4	10+81	*	Drainage Structure	Land to Riv	Gravity	RCP	*	Sluice Gate	746	KCK	Treatment Plant Diversion.	See Structural Evaluation
5	18+10	NA	Fiber Optic	NA	NA	*	*	NA	*	Sprint	Crosses Railroad Bridge.	Relocate up and over the levee. Assume closest tie-in point is 500 feet.
6	Approx 18+20	*	Fiber Optic	NA	NA	*	*	NA	*		Cross Railroad Bridge, see photos CIDKS 08 & 09	Relocate up and over the levee. Assume closest tie-in point is 500 feet.
7	18+75	NA	Fiber Optic	NA	NA	*	*	NA	*	Level 3 Comm	Crosses Railroad Bridge.	Relocate up and over the levee. Assume closest tie-in point is 500 feet.
8	18+75	NA	Fiber Optic	NA	NA	*	*	NA	*	Williams Comm	Crosses Railroad Bridge.	Relocate up and over the levee. Assume closest tie-in point is 500 feet.
9	19+85	3"	Fiber Optic and Railroad Communication	NA	NA	Concrete Tube	*	NA	753		Underground 3" comm line is either active or abandoned in place since previous research indicates a comm line on the Lewis and Clark Viaduct.	This line will have to be relocated up and over based on the levee raise in this area.
10	19+90	66"	Sanitary Sewer	Riv to Land	Gravity: Forcemain on one side of river, gravity sewer on other side	RCP	*	Sluice Gate	748.5	KCK	Sanitary sewer consists of 2-36" CIP under KS River from the Armourdale Forcemain Interceptor and the Fairfax Forcemain Interceptor to a CID-KS Riverside Gatewell.	See Structural Evaluation
11	Approx 22+50	2 lines	Overhead Power	NA	NA	n	NA	NA	NA			No Action, these are large overhead power poles that cross the Kansas River. No concerns with clearance.

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
12	25+90	12"	Gas	NA	Pressure	*	*	*	751	*	Abandoned Main	No Action
13	Approx 25+90	8"	Oxygen	*	Pressure	Steel	*	*	760	Praxair	Located on Bridge. Utility goes up and over floodwall and penetrates embankment on landside of wall. The utility is assumed to be top of wall which is 760.	This line will have to be relocated up and over based on the levee raise in this area. Approximate length of relocation 120 feet.
14	Approx 25+90	8"	Gas	NA	Pressure	Steel	*	*	760		Located on Bridge. Utility goes up and over floodwall and penetrates embankment on landside of wall. The utility is assumed to be top of wall which is 756.	This line will have to be relocated up and over based on the levee raise in this area. Approximate length of relocation 150 feet.
15	26+10	8"	Gas	NA	Pressure	Steel	*	*	760.8		Located on Bridge. Utility goes up and over floodwall and penetrates embankment on landside of wall. The utility is assumed to be top of wall which is 760.8.	Relocate line to accommodate raise. Approximate length of relocation 150 feet.
16	26+10	12"	Water	NA	Pressure	Steel	*	2-12" water valves & 2 - 1 1/2" Drain Valves	760.8		Located on Bridge. Utility goes up and over floodwall and penetrates embankment on landside of wall. The utility is assumed to be top of wall which is 760.8.	Relocate line to accommodate raise. Approximate length of relocation 150 feet.
17	37+07	18"	Mistletoe Yards Pump Plant outfall	Land to Riv	SEE PUMP STATION EVAL	CIP	*	Sluice Gate and Flap Gate	733.5			See Pump Station Evaluation
18	50+98	10"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	734.43			See Structural Evaluation
19	52+07	10"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	733.73			See Structural Evaluation

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
20	56+92	10"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	735.8			See Structural Evaluation
21	57+10	12"	Water	NA	Pressure	*	*	*	NA		Located on Central Avenue Bridge with valves and meter.	Relocate line to accommodate raise. Approximate length of relocation 110' feet. Replace 48" MH @ 6' depth
22	57+50	12"	Water	NA	Pressure	*	*	*	NA		No evidence of being in existence	No Action
23	57+10	NA	Power	NA	NA	NA	NA	NA	NA			Power comes from wood pole and attaches to overhead steel on the bridge. Some modification will need to be made to avoid this during construction. Assume relocation of 2 poles and approximate 300' of line.
24	58+35	84"	KCK Flood Pump Station #16 (New Central Avenue Pump Plant) outfall	Land to Riv	SEE PUMP STATION EVAL	RCP	*	Sluice Gate, 3-Gate Valves and Flap Gate	729	KCK		See Pump Station Evaluation
25	Approx 59+03	12"	*	*	*	CIP	*	*	738		Source of Information is Record Drawings. Likely has been removed.	No Action
26	62+78	12"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	731.8		This drainage structure has a drop	See Structural Evaluation

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
27	67+65	18"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	729.9			Raise Existing Manhole 4 feet. See Structural Evaluation for gatewell.
28	71+70	18"	Storm Sewer	Land to Riv	Gravity	CIP	*	Gate Valve and Flap Gate	729.4			See Structural Evaluation
29	74+21	24"	Stock Yards #3 Pump Plant Outfall	Land to Riv	SEE PUMP STATION EVAL	CIP	*	Sluice Gate and Flap Gate	729.4			See Pump Station Evaluation
30	Approx 74+60	15"	*	*	*	CIP	*	*	*		Record Drawings Indicate this has been removed.	No Action
31	75+50	NA	Fiber Optic	NA	NA	*	NA	NA	*	IXC Comm	Located on Missouri Pacific Bridge	Relocate up and over floodwall. Assume closest tie-in point is 4000 feet.
32	75+60	NA	Fiber Optic	NA	NA	*	NA	NA	*	MCI	Located on Missouri Pacific Bridge	Relocate up and over floodwall. Assume closest tie-in point is 4000 feet.
33	77+80	42"	Storm Sewer	Land to Riv	Gravity	RCP	*	Sluice Gate and Flap Gate	725.5			See Structural Evaluation
34	80+90	60"	Gateway 2000 Pump Plant Outfall	Land to Riv	SEE PUMP STATION EVAL	RCP	*	Sluice Gate and Flap Gate	NA	Gateway 2000		See Pump Station Evaluation

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
35	84+90	18"	South Stockyards Conduit 1:	Land to Riv	SEE PUMP STATION EVAL	CIP	*	Sluice Gate and Flap Gate	725.5		The pipe drains the central portion of the south stockyards area immediately adjacent to the levee.	See Pump Station Evaluation
36	85+20	8"	Water	NA	Pressure	*	*	*	*		Water line up wall	Cut line on River Side toe of levee. Remove 16' of pipe at retaining wall. Grout approx 2900' of length.
37	88+19	24"	South Stockyards Conduit 2:	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	728		The pipe drains the south-central portion of the south stockyards area immediately adjacent to the levee.	No Civil Action. See Structural Evaluation
38	94+32	18"	South Stockyards Conduit 3:	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	732			No Civil Action. See Structural Evaluation
39	98+05	24"	Stock Yards #1 Outfall	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	726.5			No Civil Action. See Structural Evaluation
40	102+52	12"	American Royal Drive: The flow drains off of the road along the American Royal area.	Land to Riv	SEE PUMP STATION EVAL	CIP	*	Sluice Gate and Flap Gate	730.8			No Civil Action. See Structural Evaluation
41	104+50	NA	Fiber Optic	NA	NA	*	*	NA	*	Williams Comm		Relocate up and over the floodwall. Assume closest tie-in point is 300 feet.
42	106+49	6'x6'	Kemper Arena Pump Plant outfall	Land to Riv	Gravity	RCB	*	Sluice Gate and Flap Gate	726.7	KCMO		No Civil Action. See Structural Evaluation

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
43	Approx 124+60	*	Power	*	*	*	*	*	NA			Power for Turkey Creek Sewer Gates. Power currently goes under floowall. Relocate power to go over floodwall. Assume 150' length of line relocate and new power pole (wood).
44	124+83	Double 17' x 18'	Turkey Creek sewer outlet	Land to Riv	Gravity	RCB	*	Sluice Gate (LW) and Flap Gates (RW)	722.7	KCMO		See Structural Evaluation
45	Approx 131+30	4-lines	Overhead Power	*	*	*	NA	*	NA			No Action, these are large overhead power poles that cross the Kansas River. No concerns with clearance.
46	138+29	36"	Railroad Yards Conduit 1: The flow is from the railroad tracks area immediately adjacent to the levee.	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	738.5			See Structural Evaluation
47	152+28	24"	Railroad Yards Conduit 2: The flow is from the railroad tracks area immediately adjacent to the levee.	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	745.4			See Structural Evaluation
48	159+70	42"	Railroad Yards Conduit 3: The flow is from the railroad tracks area immediately adjacent to the levee.	Land to Riv	Gravity	CIP	*	Sluice Gate and Flap Gate	736.1			See Structural Evaluation
49	Approx 165+72	2"	Unknown	*	*	*	*	*	*		According to the Operational Drawings, this pipe has been plugged.	No Action
50	Approx 166+08	4"	Unknown	*	*	*	*	*	*		According to the Operational Drawings, this pipe has been plugged.	No Action

CID-KS Utility and Drainage Crossings: Inventory and Action for N500+3 Raise **Date: 10-June-08**
Created by: Cassidy Garden Peer Reviewed by: Hank Mildenberger

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
51	167+95	10"	Southern end of levee unit	Land to Riv	Gravity	CIP	*	Sluice Gate (LW)	751 +/-			See Structural Evaluation

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
1	(83+22LE CID MO)	Abandoned 42" Conc. Conduit Filled with Sand. Conc plug on riverside just before gatewell	Not included in HNTB information			
2	-5+85 (83+52 LE CID MO)	Slice and Flap Gate, Elev 730.5 Station, elevation, size, conduit composition, and control type were verified on Operational Drawings. General area and size verified on Record Drawings.	A. The outlet is located at mile 378.43 on the Missouri River. B. As noted in the pump plant information, sanitary flow no longer contributes to the plant and the percent impervious has increased. However, the total flow reaching the plant remains the same in the Design River Condition because the sewer capacity controls.Sluice Gate (LW) and Flap Gate (RW)	42", City Owned PS outles	General area verified on KCK Sanitary & Storm Mapping.	Station, owner, control type and size were verified on Inspection Check List.
3	-1+77 (87+60 LE CID MO)	Station, elevation, size, conduit composition, and control type were verified on Operational Drawings.	Treatment Plant Outfall	KCK Owner	General area verified on KCK Sanitary & Storm Mapping.	Station, owner, control type and size were verified on Inspection Check List.
4	10+81	Station, elevation, and control type were verified on Operational Drawings. Operational Drawings state "Drainage Structure."	Treatment Plant Diversion	KCK Owner	General area verified on KCK Sanitary & Storm Mapping.	Station, owner, and control type were verified on Inspection Check List.
5	18+10					
6	Approx 18+20					
7	18+75					
8	18+75					
9	19+85	O&Ms show a telephone cable 3" at about the same elevation as the 66" Sanitary Sewer line. According to HNTB, the line is on the Lewis and Clark Viaduct Station, size, and conduit composition were verified on Operational Drawings.	on Lewis and Clark Viaduct			Schlup, Becker & Brennan Consulting Eng: KS River Crossing Sewage Force Main Drawings - 1965 indicates asbestos cement pipe.
10	19+90	Station, size, conduit composition, and control type were verified on Operational Drawings. Operational Drawings also indicate this is a force main and invert elevation 748.5.	Sanitary sewer siphon consists of 2-36" CIP on R.S.		KCK Sanitary & Storm Mapping indicate 2-36" CIPs in this area. FIELD VERIFY	Schlup, Becker & Brennan Consulting Eng: KS River Crossing Sewage Force Main Drawings - 1965 Station, owner, and size were verified on Inspection Check List. Inspection Check List indicate 3-sluice gates which would indicates the possibility of a depressed sewer.
11	Approx 22+50					

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
12	25+90					
13	Approx 25+90					
14	Approx 25+90					
15	26+10	Line on Bridge Location and size were verified on Operational Drawings.				KGS shows crossing at bridge, size verified.
16	26+10	2 1.5" drain lines located near 2 12" water lines Location and size were verified on Operation Drawings. Operation Drawings show 2- 1.5" drain valves and 2-12" drain valves located on bridge.				
17	37+07	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and approximate elevation have been verified on the Record Drawings.	A. The pipe serves as the outlet for a pump plant which drains the area immediately adjacent to the pump station. B. As noted in the pump plant information, the sanitary flow has been diverted to the treatment plant. No other significant changes have occurred.		General area verified on KCK Sanitary & Storm Mapping.	Control type and size were verified on Inspection Check List. Inspection Check List indicates a stationing of 37+06, a 1' difference. Need to verify there are not 2 utilities in the area.
18	50+98	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location, size, and conduit composition have been verified on the Record Drawings. Record Drawings indicate this pipe is at elevation 736.6' which is more than 2 feet of difference.	A. There is an inlet for this pipe just upstream of the levee. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area. Flow is coming from the property surrounding the industrial buildings in the immediate area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type and size were verified on Inspection Check List.
19	52+07	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location and conduit composition have been verified on the Record Drawings. Record Drawings indicate this pipe is at elevation 742.1' which is more than 8 feet of difference. Record Drawings indicate 8" pipe.	A. There is an inlet for this pipe just upstream of the levee. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area. Flow is contributed by the low area north of the Central Avenue Bridge.		General area verified on KCK Sanitary & Storm Mapping.	Station and control type were verified on Inspection Check List and size indicates 10".

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
20	56+92	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location, size, and conduit composition have been verified on the Record Drawings. Record Drawings indicate approximate elevation of 739.3 feet which is about 3.5 foot of difference.	A. The conduit is just on the north side of the Central Avenue Bridge. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. It is likely that this pipe does not receive much runoff presently because of the Central Avenue Pump Plant.		KCK Sanitary & Storm Mapping indicate two outfalls in this area and one stub. FIELD VERIFY	Control type and size were verified on Inspection Check List. Inspection Check Lists indicate stationing of 56+91, a 1' difference.
21	57+10	Operational Drawings indicate 2 water lines, size verified.	on Central Avenue Bridge			
22	57+50					
23	57+10					
24	58+35	Location, size, and control type were verified on Operational Drawings.	A. The conduit is just on the south side of the Central Avenue Bridge. B. The outfall is not on the Operational Drawing from July, 1980 that HNTB had in the original research. The KAW Valley Drainage District provided HNTB with an Operational Drawing set from July, 1980 that has this outlet drawn in at its location. C. As noted in the pump plant information, design data is limited. The length of the outlet pipe is estimated to be 170 feet from the KAW Valley operational drawings. However, it is not thought that the drainage area has changed in the past 15 years.		General area verified on KCK Sanitary & Storm Mapping.	Station and size were verified on Inspection Check List. Inspection check List indicates in addition to Sluice and Flap Gates, 3-Gate Valves.
25	Approx 59+03	Record Drawings indicate a pipe at this location.				
26	62+78	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and approximate elevation have been verified on the Record Drawings.	A. The conduit drains the stockyards area south of the Central Avenue Bridge, which now contains a concrete plant. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. C. The existance of the concrete plant has increased the percent impervious, although no estimates can be made.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type and size were verified on Inspection Check List.

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
27	67+65	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and approximate elevation have been verified on the Record Drawings.	A. The conduit drains the stockyards area south of the Central Avenue Bridge and north of the Missouri Pacific Railroad Bridge. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Control type and size were verified on Inspection Check List. Inspection Check List indicates a stationing of 67+85, a 20' difference. Need to verify there are not 2 utilities in the area.
28	71+70	O&M says gate valve and sluice. Location, elevation, size, and conduit composition were verified on Operational Drawings. Operation Drawings indicate 1-Gate Valve and 1-Sluice Gate. Approximate location, size, and conduit composition have been verified on the Record Drawings. Approximate elevation is 731.4 feet.	A. The conduit drains the stockyards area south of the Central Avenue Bridge and just north of the Missouri Pacific Railroad Bridge. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		KCK Sanitary & Storm Mapping indicate 2 outfalls in this area. FIELD VERIFY	Station, control type and size were verified on Inspection Check List.
29	74+21	Location, elevation, size, conduit composition, and control type were verified on Operational Drawings. Approximate location, size, and conduit composition have been verified on the Record Drawings. Approximate elevation is 723.1 feet.	A. The outfall is just north of the Missouri Pacific Railway Bridge. B. As noted in the pump plant information, the sanitary flow no longer goes to the pump plant and the Gateway 2000 Pump Plant cut off some of the drainage area to the Stockyards Pump Plant (formerly called Stockyards #3 Pump Plant).		General area verified on KCK Sanitary & Storm Mapping.	Station, control type and size were verified on Inspection Check List.
30	Approx 74+60	Source of Information is Record Drawings.				
31	75+50					
32	75+60					
33	77+80	Location, size, and control type were verified on Operational Drawings.	I-670 has a stand-alone stormwater drainage system and is conveyed through the floodwall. Conditions have not changed with respect to this drainage contribution and disposal.	KVDD: 2 flap gates	General area verified on KCK Sanitary & Storm Mapping.	Station and size were verified on Inspection Check List. Inspection Check List indicates 2 flap gates.
34	80+90		A. The Gateway 2000 Pump Plant outfall conduit replaced the Stockyards #2 Pump Plant outfall. B. The pump plant was designed to have certain pumping capacities at the given river stages. Therefore, the exact service area information was not obtainable in a reasonable amount of time. It was estimated from drainage area mapping provided by the designer of the plant. The estimated percent impervious shown in the table was determined by visual inspection of 1996 aerial photographs. The contributing area to the conduit should not have changed since the design of the pipe.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
35	84+90	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, elevation, size and comments have been verified on the Record Drawings.	A. There is an 18" VCP coming into the gatewell on the landside. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
36	85+20					
37	88+19	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and elevation are verified on the Record Drawings.	A. There is a 24" VCP coming into the gatewell on the landside and two drop inlets upstream. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
38	94+32	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and elevation are verified on the Record Drawings.	A. There is an 18" VCP coming into the gatewell on the landside and inlets just upstream. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		KCK Sanitary & Storm Mapping indicate 2 outfalls in this area. FIELD VERIFY	Station, control type, and size were verified on Inspection Check List.
39	98+05	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and elevation are verified on the Record Drawings.	A. There is a 24" VCP coming into the gatewell on the landside. B. As noted in the pump plant information, part of the contributing flow was cut off by Kemper Arena Pump Plant. However, the pump is likely still inadequate.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
40	102+52	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and elevation are verified on the Record Drawings.	A. There is a 12" VCP coming into the gatewell on the landside from American Royal Drive. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. The drainage area has not changed, as it is a roadway.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
41	104+50					
42	106+49	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings.	A. The city of Kansas City, Missouri has very little information on the pump plant. HNTB contacted the designers in charge of runoff disposal from the new Butler Manufacturing building which will be constructed to the north of Kemper Arena. The percent impervious shown is an estimate from the designers. B. As noted in the pump plant information, the Butler Manufacturing building area may drain to the Kemper Arena Pump Plant upon construction.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
43	Approx 124+60	Power goes underground at this location				
44	124+83	Location, elevation, size, and conduit compostion were verified on Operational Drawings. Operational Drawings indicate 2 sluice gates.	A. The 25th and Fairmont Pump Station, as well as the Southwest Boulevard Pump Station discharge into this pressure sewer. B. As noted in the pump plant information, sanitary flow has been diverted from contributing pump plants. However, impervious area has increased in the pump plant service areas which has created increased runoff.		General area verified on KCK Sanitary & Storm Mapping.	Station and size were verified on Inspection Check List. Inspection Check List indicates 2 sluice gates.
45	Approx 131+30	Four overhead powerlines				
46	138+29	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, and conduit composition are verified on the Record Drawings. Record Drawings indicate approximate elevation of 740 feet.	A. The KAW Valley Drainage District indicated that the conduit drains the railroad tracks along the levee. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
47	152+28	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and approximate elevation are verified on the Record Drawings.	A. The KAW Valley Drainage District indicated that the conduit drains the railroad tracks along the levee. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
48	159+70	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings. Approximate location, size, conduit composition, and approximate elevation are verified on the Record Drawings.	A. The KAW Valley Drainage District indicated that the conduit drains the railroad tracks along the levee. B. No information was given pertaining to the drainage area of this gravity flow pipe. The missing information can be estimated if deemed necessary. There are no indications that significant changes have taken place in the surrounding area.		General area verified on KCK Sanitary & Storm Mapping.	Station, control type, and size were verified on Inspection Check List.
49	Approx 165+72	Approximate location, and size are verified on the Record Drawings.				
50	Approx 166+08	Approximate location, and size are verified on the Record Drawings.				

		CID-KS UTILITY CROSSINGS, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
51	167+95	Location, elevation, size, conduit compostion, and control type were verified on Operational Drawings.	A. The pipe discharges through the floodwall just on the east side of a stoplog gap. B. The KAW Valley Drainage District does not have any information on this pipe and considers it insignificant.		Not Located on KCK Sanitary & Storm Mapping FIELD VERIFY	Station, control type, and size were verified on Inspection Check List.

		CID-KS CRITICAL ZONE UTILITIES, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
	KS, MO state line to approx 5+00	15"	Toe Drain	Toward MO	Gravity	Perforated CMP	140' under toe	None	Varies 750 to 748.3		Flow toward Hannibal Bridge	See Geotechnical Evaluation
	Lewis and Clark Viaduct to James Street Viaduct	12"	Gas	*	Pressure	*	690' under toe	*	751	*	Abandoned Main	Verify during construction that this line have been either removed or plugged. If not either grout in place or remove.
	Approx James Street Viaduct to approx 38+00	NA	Overhead power	landward side	NA	NA	Land side critical zone	NA	NA		Power poles and lines outside Levee RoW	For the area fill remove and replace 8 light poles with single lines.
	approx 50+98 to approx 68+00	36"	Storm Sewer	Parallel to Levee	Gravity	RCP	Land side critical zone	None	Assume 20'		36" Assume RCP. Approximately 200' from centerline of levee	No Action
	Approx 68+00 to Approx 82+00	30"	Storm Sewer	Parallel to Levee	Gravity	CIP	Land side critical zone	None	See notes		At station 68+00 approx 150' from centerline of levee. At station 72+00 approx 200' from centerline of levee. From Approx sta 68+00 to approx sta 81+00 ave depth is 21.5'. From Approx sta 81+00 to 82+00 ave depth is 9'.	Modify Manholes to accommodate fill. Raise precast manholes 5'. Manholes 1, 2c, 5 are 5' diameter. Manhole 4 is 6' diameter. Replace manholes 6 and 7. Manholes 6 and 7 are 6' diameter and 10 and 11 feet deep respectively.
	Approx 82+00 to Approx 94+50	15", 18", 30"	Storm Sewer	Parallel to Levee	Gravity	ESVCP	Land side critical zone	None	varies			Modify Manhole and Sewerline to accommodate fill. Raise Manhole number 9, 10, 11. Manholes 9 and 10 are 5' diameters and manhole 11 is 6' diameter. Raise manholes 6, 5 and 2 feet respectively. Replace 580' of 15" ESVCP, 380' of 18" ESVCP, and 260' of 30" ESVCP with equivalent diameter RCP.
	Approx 98+50 to Approx 103+00	12"	Storm Sewer	Parallel to Levee	Gravity	ESVCP	Land side critical zone	None	14.73			No Action
	Approx 67+65	15"	Lateral Drain	Parallel to Levee	Gravity	ESVCP	Land side critical zone	None	Assume depth of 5'			To be abandoned in place.
	Approx 53+00	NA	Anchor Wire	NA	NA	NA	Land side critical zone	NA	NA			Relocate single wood power pole outside of footprint of levee raise. Approx relocate of 20'

		CID-KS CRITICAL ZONE UTILITIES, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES										
Map Ref. #	**Station (ft.)**	**Conduit Size**	**Conduit Function**	**Flow Direction**	**Flow Type**	**Conduit Composition**	**Conduit Length Below Flood Protection (ft.) Existing Conditions**	**Control Structure Type**	**Elev of Invert**	**Owner/ Compensable Interest**	**Comments**	**Action**
	Approx 53+50	NA	Anchor Wire	NA	NA	NA	Land side critical zone	NA	NA			Relocate single wood power pole outside of footprint of levee raise. Approx relocate of 20'
	Approx 58+00	NA	Billboard	NA	NA	NA	Land side critical zone	NA	NA			Relocate billboard approximately 60'
	Approx 57+25 to 73+80	NA	Power	NA	NA	NA	Land side critical zone	NA	NA			Levee raise will require a relocation of 15 wooden poles and 1800' of line. Relocate to the toe of the levee approx 20' from existing location
	Approx 60+00	NA	Power and Telephone	NA	NA	NA	Land side critical zone	NA	NA			Power and telephone terminate at pump station. No action required.
	Gateway 2000Pump Plant to Field Pump House	NA	Power	*	*	*	*	*	NA			Remove Power poles and lines and do not replace. Approximately 600' minimum of 3 strands and 4 poles.
	Approx 85+20 to approx 101+00	4", 8" & 10"	Water	*	*	*	*	*	*		Runs parallel to levee approx 100' off centerline, landward and services Kansas City Stock Yards.	Grout waterlines. Assume Max depth of 6'. Total length of grout 2900'
	Approx 98+00 to Approx 106+00	4" & 8"	Water	*	*	*	*	*	*		Water lines within critical zone.	Included in the length above
	Approx 120+00 to Approx 133+00	NA	Power	*	*	*	*	*	*		Power lines run parallel to levee approximately 75' off centerline, landward.	Power services Turkey Creek Sto
	Approx 146+00 to unknown		Interior drainage								Interior drainage with drop inlets running parallel to levee approximately 50' off center.	No Action
	Sprint Parking Storm Drain Mod											Remove subdrainage system including curb inlets and area inlets. Replace after area fill.

		CID-KS CRITICAL ZONE UTILITIES, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
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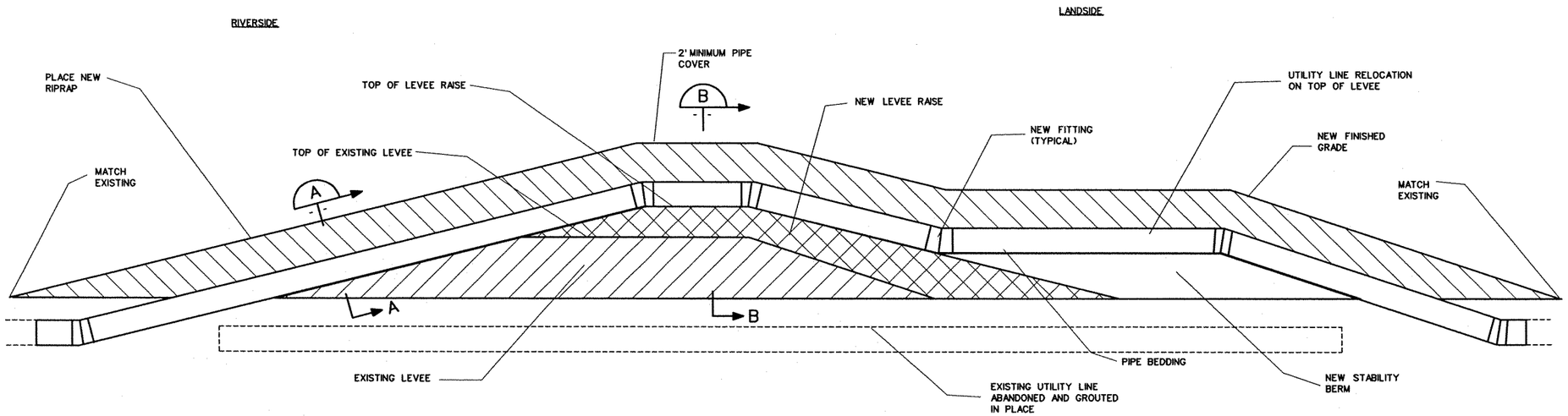
	KS, MO state line to approx 5+00	Needs to be inspected	Located under landward toe of levee and has 3 manholes on this line.			
	Lewis and Clark Viaduct to James Street Viaduct	Groute or remove whichever is cheapest.	Gas main runs parallel to levee from Lewis & Clark Viaduct and crosses levee at 25+90. Not sure if it goes through or over levee on bridge Operational Drawings show this line running parallel to the levee and approx 20' off centerline of the levee and crosses at 25+90. Record Drawings indicate an existing gas line and a lowered gas line and size has been verified.			
	Approx James Street Viaduct to approx 38+00	As long as there is enough clearance to construct the poles are Okay				
	approx 50+98 to approx 68+00	Leave It.	Sanitary Sewer line runs parallel to levee from approx 50+98 to approx 71+70. Sanitary line is located approximately 150' to 200' off center landward of levee.			
	Approx 68+00 to Approx 82+00					
	Approx 82+00 to Approx 94+50					
	Approx 98+50 to Approx 103+00					
	Approx 67+65					
	Approx 53+00	Move	Operational Drawings indicate two anchor wires coming from powerlines, anchoring 12' off centerline and 26' off centerline of levee. **FIELD VERIFY**			

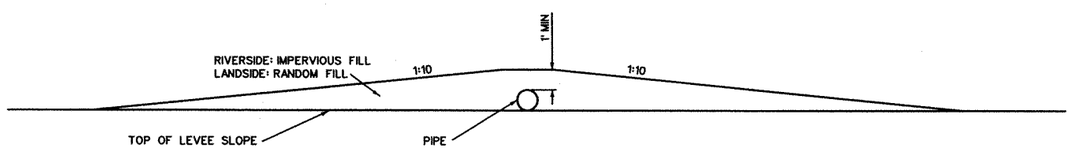
		CID-KS CRITICAL ZONE UTILITIES, GENERAL INFORMATION, AND RECOMMENDED ACTION FOR N500+3 RAISE, BACKGROUND DOCUMENTS AND RESEARCH NOTES				
Map Ref. #	**Station (ft.)**	**Reference Sited o&m Manual (1978) and 1979 Operations Manual (Operational Drawing, Appendix I Record Drawings Vol One)**	**Reference Sited: HNTB**	**Reference Sited: Site visits and KVDD**	**Reference Sited: Wyandotte County CAD files (not QC checked by County)**	**Other (Inspection Check List, Kansas Gas Service)**
	Approx 53+50	Move	Operational Drawings indicate two anchor wires coming from powerlines, anchoring 12' off centerline and 26' off centerline of levee. **FIELD VERIFY**			
	Approx 58+00					
	Approx 57+25 to 73+80	As long as there is enough clearance to construct the poles are Okay	Numerous Power lines run parallel to levee from approximately 53+00 to 73+80 where Well Number 4 is plugged.			
	Approx 60+00	Field Verify, these may go to pump plant	Operational Drawings indicate power and telephone lines 14' off centerline and 42' off centerline of levee. FIELD VERIFY			
	Gateway 2000Pump Plant to Field Pump House	Verify that this line ends at Stock Yards #1 and only services Stock Yards #1 then remove				
	Approx 85+20 to approx 101+00	Determine where water is coming from and find records of abandoment. If abandoned preference is to dig it up.	Water line crosses and then follows parallel to levee approximately 100' of centerline. Ending location is unclear			
	Approx 98+00 to Approx 106+00	Part of system above see notes above.				
	Approx 120+00 to Approx 133+00	Leave as is.				
	Approx 146+00 to unknown					
	Sprint Parking Storm Drain Mod					

		CID-KS UTILITY AND DRAINAGE CROSSINGS: INVENTORY LEGEND
Legend		
DS	Drainage Structure	All Drainage Structures that say No Action, mean there is no action recommended for utility outlet relocation.
FW	Floodwall	Structural or pumping analysis may indicate other recommendations and should be referred to for gatewell structural analysis
Land to Riv	Landside to Riverside	Direction of Flow for sanitary sewers was obtained from Wyandotte County Sewer AutoCad files
LEV	Levee	All elevations presented in this spreadsheet are based on NGVD 29 ???????
NA	Not Applicable	See detail "Typical Utility Abandonment - Left In Place" for how to abandon utility
OH	Overhead utility (does not penetrate flood protection)	
PP	Pump Plant	
RCB	Reinforced Concrete Box	
RCP	Reinforced Concrete Pipe	
Riv to Land	Riverside to Landside	
SL	Stop Log Gap	
SP	steel pipe	
*	Information Not Found	
OD	Operational Drawings	
ICL	Inspection Check List	
KGS	Kansas Gas Service	
KCKSS	KCK Sanity & Storm	



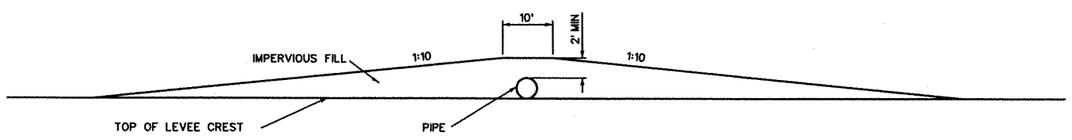
A TYPICAL UTILITY CROSSING

SCALE: NTS



A RIVERSIDE AND LANDSIDE SLOPE

SCALE: NTS



B LEVEE CREST

SCALE: NTS

NOTES:
1. IF PERMISSION IS GRANTED FOR A PIPELINE TO CROSS THE LEVEE BELOW THE TOP OF LEVEE, A POSITIVE CUTOFF VALVE OR GATE CLOSURE WILL BE INSTALLED AT THE RIVERSIDE SHOULDER OF THE LEVEE ROAD.

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

Date:
Drawing code:
Plot scale: NA
CADD File Name: UTILCROSSINGDETAILV8

Designed by: MRC
Drawn by: MRC
Checked by: HWM
Submitted by: HWM

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY LEVEL DESIGN

TYPICAL UTILITY CROSSING LEVEE RAISE

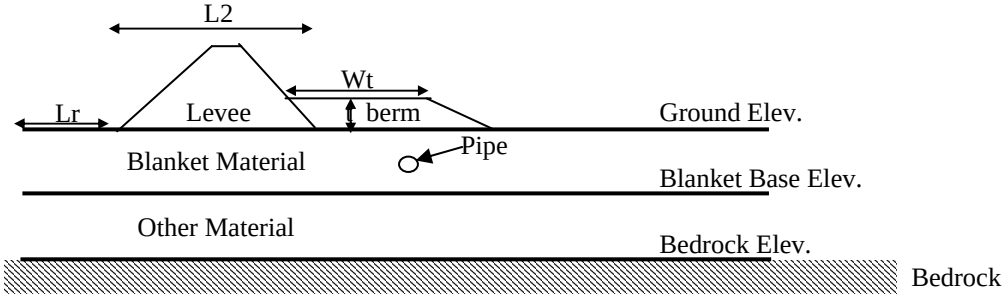
Sheet Reference Number:
XX

CID-KS Uplift: Data Entry Worksheet
Kansas City Levees Phase 2

Created By:	Cassidy Garden	Date:	2-Jun-08
		Date Modified:	2-Jun-08
Peer Reviewed By:	Hank Mildenberger	Date:	

How to Use this Spreadsheet

Insert parameters into cells highlighted in orange and the corresponding spreadsheets will update automatically.
Spreadsheets are linked, therefore spreadsheets must stay in their original directories to maintain links.
CID Unit was separated ten stretches based on geotech and seepage criteria and numbered L1 to L10



CID-KS Uplift: Data Entry Worksheet
Kansas City Levees Phase 2

Levee Type Number		**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**L8**	**L9**	**L10**
Station Start		80+54.12 MC	28+00	38+00	63+00	74+75	77+00	97+00	107+00	116+00	127+00
Station End		28+00 KS	38+00	63+00	74+75	77+00	97+00	107+00	116+00	127+00	168+00
Levee Width, L2 (from geotech)		40	65	60	100	150	150	100	70	70	70
Riverside Blanket Width, Lr (from geotech)		0	0	0	0	0	0	0	0	0	0
Top of Levee Elev. (n500 + 3ft)		760.9	762.0	763.0	765.0	765.5	767.0	767.5	768.0	769.0	771.0
Berm Width for the w/ Berm option, Wt (ft) (from geotech)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Berm Height for the w/Berm option, t (feet) (from geotech)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ground Elev. Landside		760	748	751	751	760	749	755	752	757	755
Blanket Bottom Elev. Landside (from Geotech)		726	721	720	720	722	720	720	720	721	728
Bedrock Elev. (from O&M manual Borings)		670	670	670	670	670	670	670	670	670	670
Pipe Depth ft. (enter on spreadsheet		Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Pipe Diameter in. (enter on spreadsheet)		Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Blanket Soil Type (from geotech)		ML	CH	ML-CL	ML-CL	CL	ML-CL	ML	ML	ML	CL
Blanket Soil Unit Weight, soil density (pcf)		115	115	115	115	115	115	115	115	115	115
Blanket Thickness Dbo ft (from geotech EC-GD) landside		34	27	31	31	38	29	35	32	36	27
Depth of Sands Df ft (from Geotech EC-GD)		56	51	50	50	52	50	50	50	51	58
Max Head or Levee Height ft (from geotech EC-GD)		0.9	14.0	12.0	14.0	5.5	18.0	12.5	16.0	12.0	16.0
Notes			Area Fill		Area Fill	Bridge Fill	Area Fill		Relief Wells		Relief Wells

Input Data
Calculated

NA Not Applicable

CID-KS Uplift: Data Entry Worksheet
Kansas City Levees Phase 2

NOMENCLATURE for all Uplift Spreadsheets

Input

(Kf/Kb)R = riverside permeability
(Kf/Kb)L = landside permeability
DbL = landside blanket thickness
Dbr = riverside blanket thickness
Dbo = levee toe blanket thickness
Df = thickness of pervious foundation
Lr = length of riverside blanket
LL = length of landside blanket
H = max head or levee height
L2 = levee base width
t = berm height, ft
ground elevation = average elevation of landside ground

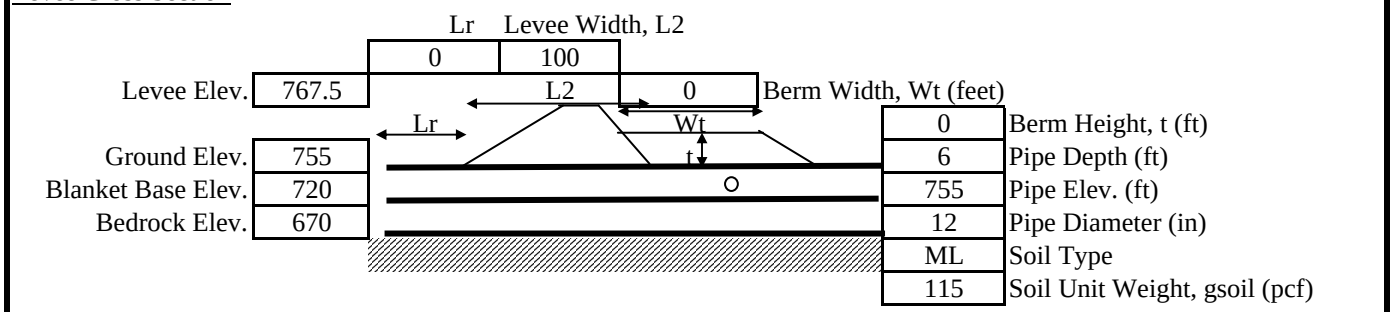
Output

Cr = riverside effective length coefficient
CL = landside effective length coefficient
where C = [(Kf/Kb) * Df * Db]1/2
L1 = riverside effective length
where L1 = C * (e (2LR/C-1)) / (e(2LR/C+1))
Le = landside effective length
Lt = total effective length
ho = head above tailwater at levee toe
io = seepage gradient
ic = critical gradient = (γsat-γwater)/γwater

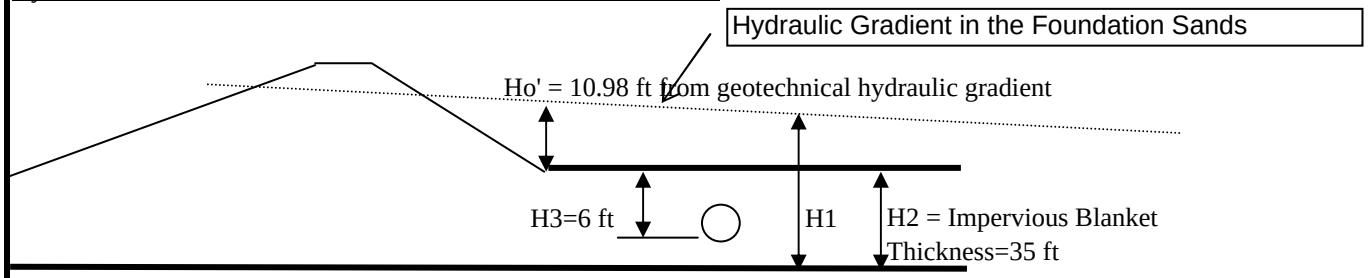
Kansas City's Levees - Phase 2 - DRAFT
CID-KS - Utility Uplift Sample Calculation at Station 100+00 (Distance from toe - 0ft)

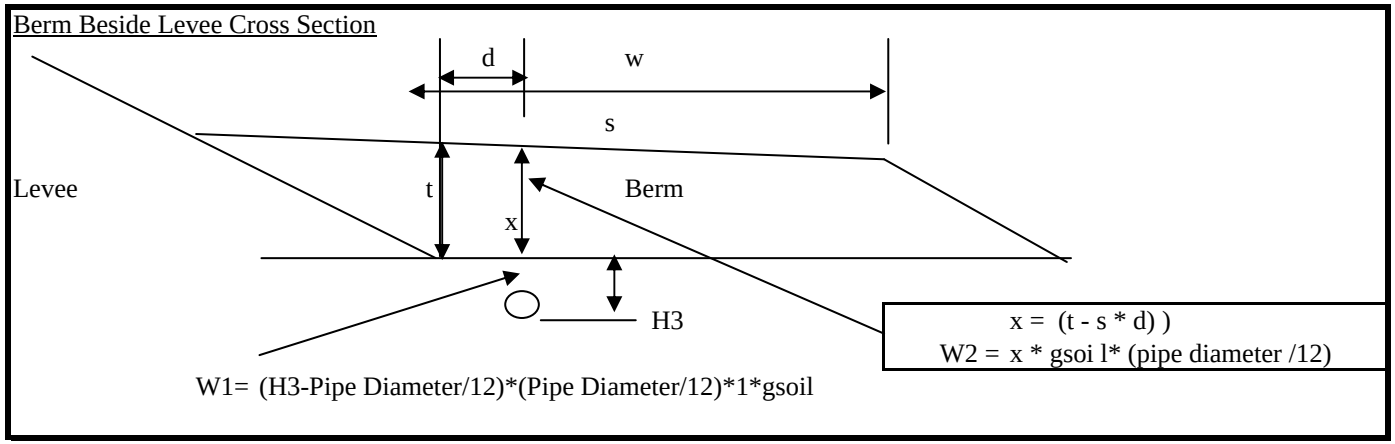
By: Cassidy Garden	Date Created:	14-Aug-07
	Date Modified:	7-Nov-08
Peer Reviewed By: Hank Mildenberger	Date Reviewed:	30-Nov-08

Levee Cross Section



Hydraulic Gradient in Levee Cross Section - Without Relief Wells





Definitions

H1 = Height of Hydraulic Gradient above base of Impervious Blanket - ft
H2 = Impervious Blanket Thickness - ft
H3 = Depth of Pipe Invert -ft
Ho' = Excess head above ground surface (initial Ho' is calculated at toe of levee by geotechnical engineer) - ft
Lr = Length of riverside blanket (determined by geotechnical engineer) - ft
L1 = Riverside effective length (calculated by geotechnical engineer) - ft
L2 = Levee Width (toe to toe) - ft
Wt = Berm Width - ft
t = Berm Height at toe of levee- ft
x = Berm Height at structure (pipe)- ft
s = slope of berm
Ws = weight of structure (pipe) per foot of length
18.97 lb per ft (12" Diameter Steel Pipe, .375" wall thickness, Manual of Steel Construction)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((3/12)^2) *1*62.4 = 12 lb/lf
S = surcharge loads = weight of saturated soils above structure = W1 + W2
W1 = Surcharge load above structure (not including berm)
W2 = Surcharge load of berm above structure
P1 = Pressure at the base of the impervious blanket at the location of the structure being investigated
P3 = Pressure at the base of the structure (pipe) being investigated
U = Uplift force on the project area of structure = Area of pipe * P3
Wg = weight of surcharge water above top surface of structure control by gravity flow = 0 for pipes
SFf = Flotation Safety Factor = (Ws+Wc+S)/(U-Wg)

Sample Calculations

Sample Calculations are done at the toe of the levee (distance from toe = 0 ft)

H1

H1 = Ho' + Ground Elev - Impervious Blanket Base Elev

H1 = 10.98 ft + 755 ft - 720 ft = 45.98 ft

P3

P3 = H3 x (H1/H2) x gwater

P3 = 6 ft x (45.98ft /35ft) x 62.4 pcf = 491.85 psf

Wc

Wc = pi x r^2 x gwater

Wc = 3.1416 x ((6"/12)^2) x 62.4 pcf = 49 lb/lf

S

S = W1 + W2

W1 = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*gsoil

W1 = (6 ft - 12"/12) x (12"/12) x 115 pcf x 1 lf

W1 = 575 pounds

W2 = (t - s x d) (Pipe Diameter/12) x 1 lf x gsoil

W2 = (0 - (0.00 x 0))x (12/12 x 1 lf x 115 psf) = 0 pounds

S = W1 + W2 = 575 + 0 = 575 pounds

U

U = Area of pipe * P3 = (Pipe Diameter/12) x 1 ft x P3

U = 12"/12 x 491.85 psf x 1 ft

U = 491.85 lb

SFf (Pipe Full) (w/o berm)

SFf = Flotation Safety Factor = (Ws+Wc+S)/(U-Wg)

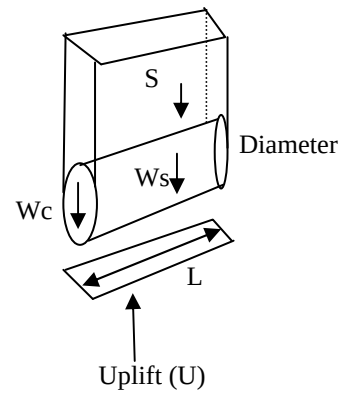
SFf = (49.56 + 49 + 575)/(491.85-0)

SFf = 1.37

SFf (Pipe Empty) (w/o berm)

SFf = (49.56 + 575)/(491.85-0)

SFf = 1.27



U = P3 * diameter * l

Using L = 1

Kansas City Levees Phase 2
Created By: Cassidy Garden Modified By:

Peer Reviewed By: Hank Mildenberger Modified: 14-Jul-08

Length of Utility (feet) and number of Manholes within Uplift Concern Area

	Station		Storm Sewer							Water							Gas	
Levee	Begin	End	12"	15"	18"	24"	30"	36"	MH	8"	12"	20"	24"	30"	48"	72"	16"	20"
L1	80+54.12	28+00 KS	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L2	28+00	38+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L3	38+00	63+00	No Up Lift Concerns								50						N U L C	
L4	63+00	74+75	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L5	74+75	77+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L6	77+00	97+00					650		5	No Up Lift Concerns							N U L C	
L7	97+00	107+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L8	107+00	116+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L9	116+00	127+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
L10	127+00	168+00	No Up Lift Concerns							No Up Lift Concerns							N U L C	
Total			0	0	0	0	650	0	5	0	50	0	0	0	0	0	0	0

MH Manhole
SS Sanitary Sewer
FM Forcemain
NULC No Up Lift Concerns

Unified Government of Wyandotte County AutoCAD maps were used to determine depth of Sanitary Sewer Lines when possible. If no depth was provided on AutoCAD maps, then a depth of 40" was assumed. This assumption is conservative and would show more cases of uplift concern then may be present.

General Quantities Calculations

Quantities for CID-KS

Demolition

Utility Demolition

See Utility Spreadsheet for details

Access and Staging Areas

Staging Area 1		
Clearing and Grubbing Area at 6-inch depth	1.7	Acres
Staging Area 4		
Clearing and Grubbing Area at 6-inch depth	0.3	Acres

Fence Lines

Removal of fence line at Area fill 32+50 to 38+00		
Length	900	ft
Removal of fence line at Area fill 77+00 to 94+50		
Length	400	ft

Pavements and lighting

Removal of Asphalt at Area Fill 32+50 to 38+00		
Area	171919	ft^2
Number of light poles (wood poles)	8	each
Removal of Asphalt, curb & gutter at Area Fill 77+00 to 94+50		
Area	176680	ft^2
Number of light poles (Aluminum poles)	8	each
Curb and gutter	3300	

Other

High Mast Light Pole	1	unit
Billboard	1	unit

Construction

Utility Relocation

See Utility Spreadsheet for details

Access and Staging Areas

Staging Area 1		
Length of chainlink fence	1579	ft
Number of gates	1	
Total Area	72301	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1339	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3)	2410	Ton
Staging Area 2		
Length of chainlink fence	1262	ft
Number of gates	2	
Total Area	81790	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1515	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3)	2726	Ton
Staging Area 3		
Length of chainlink fence	1218.56576	ft
Number of gates	2	
Total Area	57681.2511	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1068	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3)	1922.70837	Ton
Staging Area 4		
Length of chainlink fence	938	ft
Number of gates	1	
Total Area	43977.8327	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	814.4	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3)	1465.9	Ton
Access Roads		
Total Area	167980	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	3111	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3)	5599	Ton

Fence Lines

Replace fence line at Area fill 32+50 to 38+00		
Length	900	ft

Replace fence line at Area fill 77+00 to 94+50

Length	400	ft

Pavements and lighting

Replace Asphalt at Area Fill 32+50 to 38+00

Area	171919	ft^2
Depth of Asphalt	5	inches
Volume of Asphalt	2653	Yd^3
Depth of Aggregate Surface Course	6	inches
Volume of Aggregate Surface Course	3184	Yd^3
Replace Number of light poles (wood poles)	8	each

Replace Asphalt, curb & gutter at Area Fill 77+00 to 94+50

Area	176680	ft^2
Depth of Asphalt	5	inches
Volume of Asphalt	2727	Yd^3
Depth of Aggregate Surface Course	6	inches
Volume of Aggregate Surface Course	3272	Yd^3
Replace Number of light poles (Aluminum poles)	8	each

Other

High Mast Light Pole	1	unit
Billboard	1	unit

Staging Area Deconstruction and Seeding and Mulching

Contractor shall remove fencing, remove aggregate surfacing, backfill with top soil, grade, and seed and mulch

Staging Area 1		
Length of chainlink fence REMOVAL	1579	ft
Number of gates REMOVAL	1	
Total Area	72301	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1339	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3) REMOVAL	2410	Ton
Seeding and Mulching	2	acres
Staging Area 2		
Length of chainlink fence REMOVAL	1262	ft
Number of gates REMOVAL	2	
Total Area	81790	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1515	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3) REMOVAL	2726	Ton
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Staging Area 3		
Length of chainlink fence REMOVAL	1218.56576	ft
Number of gates REMOVAL	2	
Total Area	57681.2511	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	1068	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3) REMOVAL	1922.70837	Ton
Seeding and Mulching	1	acres
Staging Area 4		
Length of chainlink fence REMOVAL	938	ft
Number of gates REMOVAL	1	
Total Area	43977.8327	ft^2
Depth of Aggregate Surface Course	6	inches
Volume ot Aggregate Surface Course	814.4	Yd^3
Tons of Aggregate Surface Course (1.8 Tons/Yd^3) REMOVAL	1465.9	Ton
Seeding and Mulching	1	acres

Seeding and Mulching at borrow area.

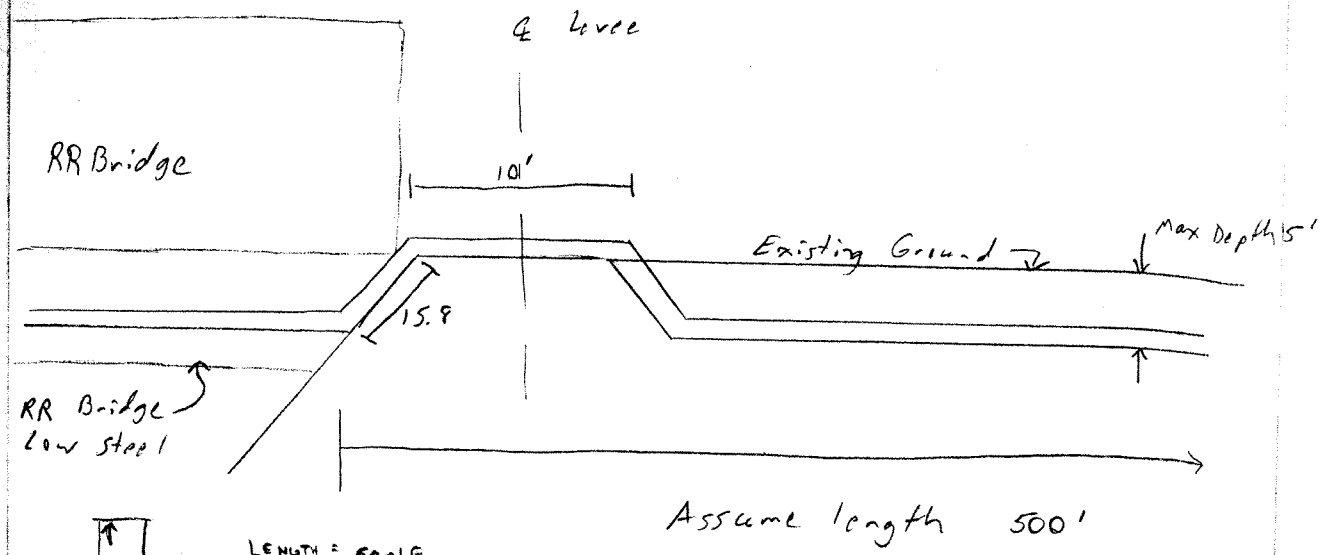
Maximum area to be reseeded	88	acres

Seeding and Mulching on the levee and area fills

Length of levee	6515	ft
Length of slope on levee	775	ft
Area of levee to be seed and mulched	116	acres
Area fill 35+50 to 38+00	0	
Area fill 63+00 to 74+75	1.7	acres
Area fill 63+00 to 74+75	6.6	acres

Utilities that Require Relocation Calculations

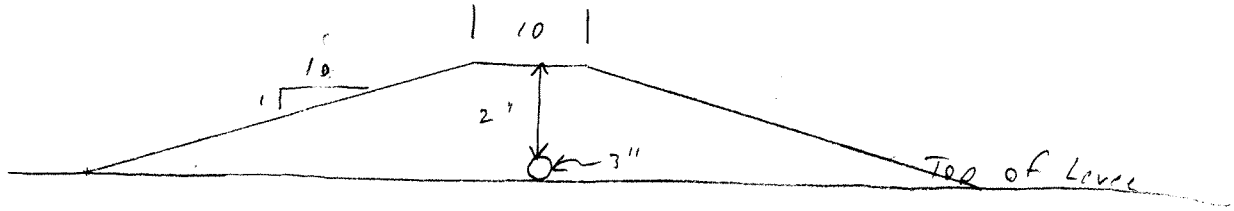
Fiber Optics at 18+10, 18+20, 18+25, 18+75, 19+85

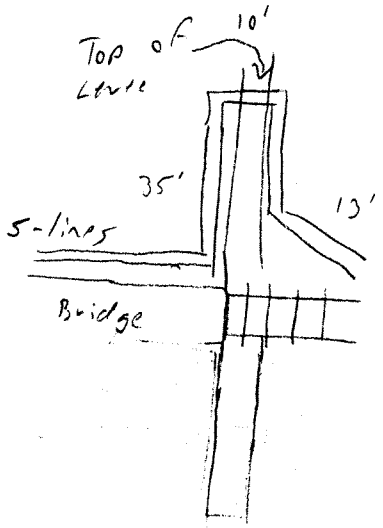


LENGTH = 500 LF

EXCAVATION

$$(.5)(5) = \frac{(2.5\,SF)(500\,LF)}{27\,CF/cy} = 46\ cy$$





Length of fiber & Conduit Relocation 500'

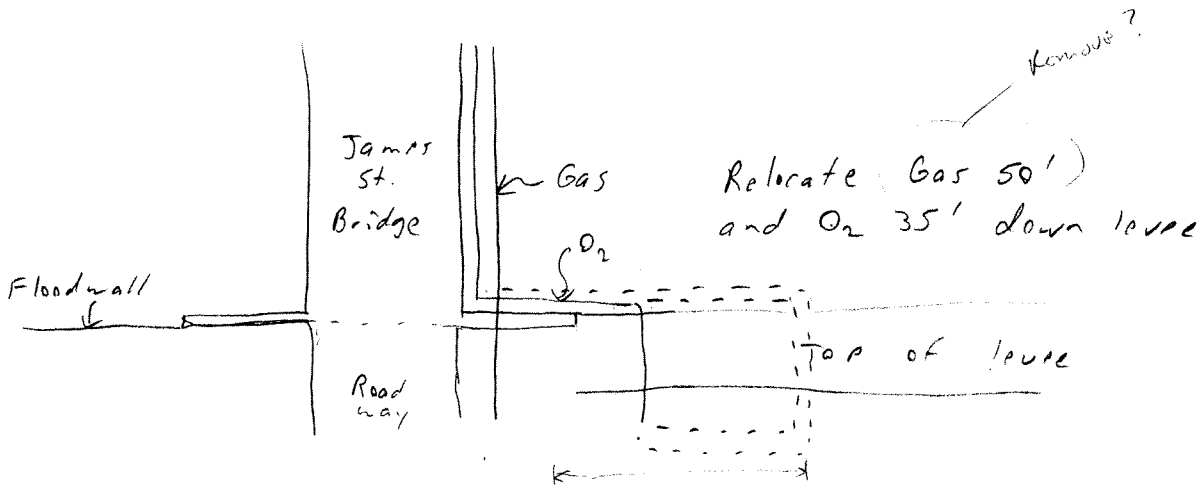
Quantity of material for Cover ~~870~~ yd³

57

Sta 25+90 & 25+90 O_2 & Gas

Length of pipe relocation = 150' for gas

Length of pipe relocation = 120 for O_2

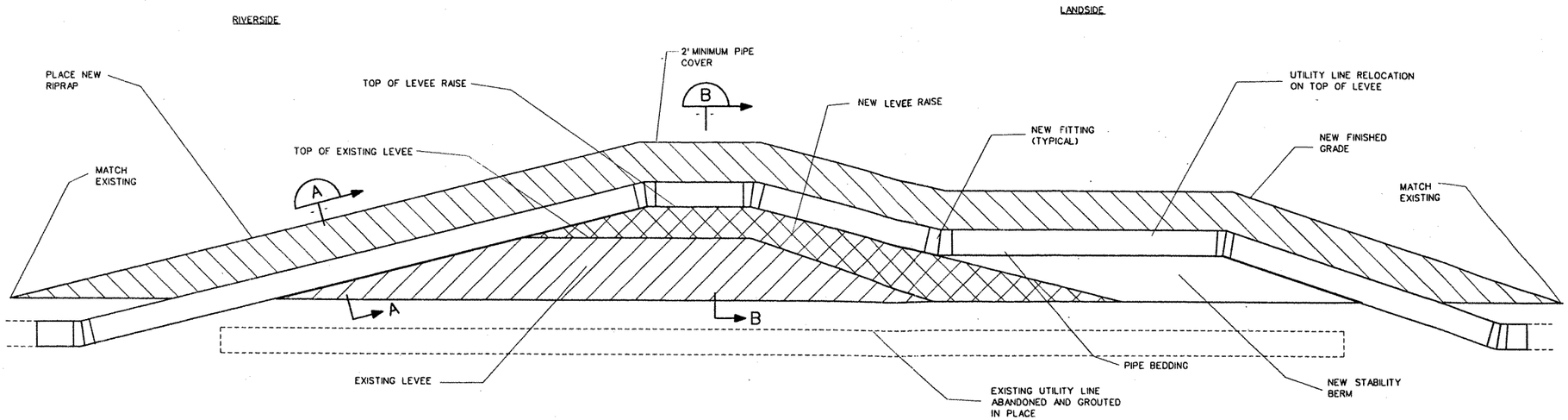


Volume of material for cover 76 cy

Exc - $\frac{(50)(3)(3)}{27} = 17$ cy

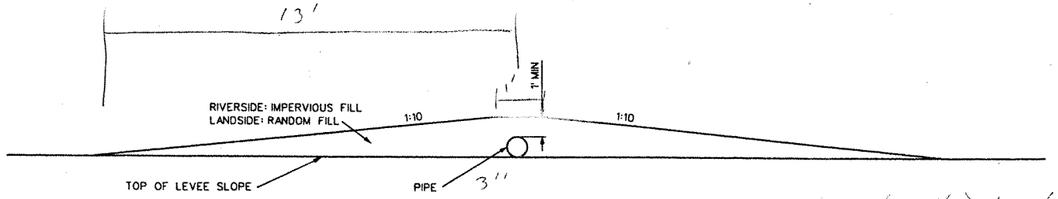
Stor P.C

Exhitbit 5: Typical Utility Crossing



A TYPICAL UTILITY CROSSING

SCALE: NTS



A RIVERSIDE AND LANDSIDE SLOPE

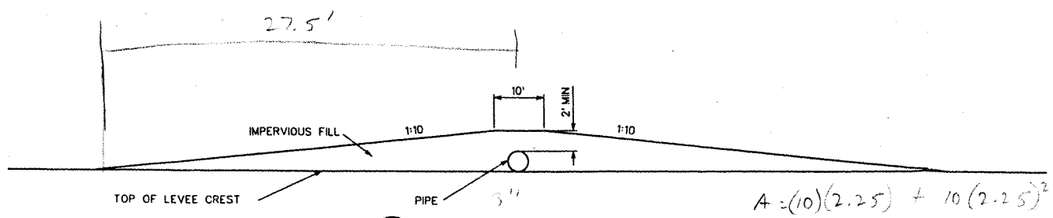
SCALE: NTS

Area = (1.25)(1) + 10 (1.25)^2 = 16.9 ft^2/2 = 8.45'

Length = 48'

Volume = 405.6 ft^3

Double for Each side = 811.2 ft^3



B LEVEE CREST

SCALE: NTS

A = (10)(2.25) + 10 (2.25)^2 = 73.1 ft^2

Length = 10'

Volume = 731 ft^3

NOTES:
1. IF PERMISSION IS GRANTED FOR A PIPELINE TO CROSS THE LEVEE BELOW THE TOP OF LEVEE, A POSITIVE CUTOFF VALVE OR GATE CLOSURE WILL BE INSTALLED AT THE RIVERSIDE SHOULDER OF THE LEVEE ROAD.

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr

Designed by: MRC
Drawn by: MRC
Checked by: HWM
Submitted by: HWM
Date: MARCH 2007
Drawing code:
Plot scale: NA
CADD File Name: TYPICALUTILITYCROSS...

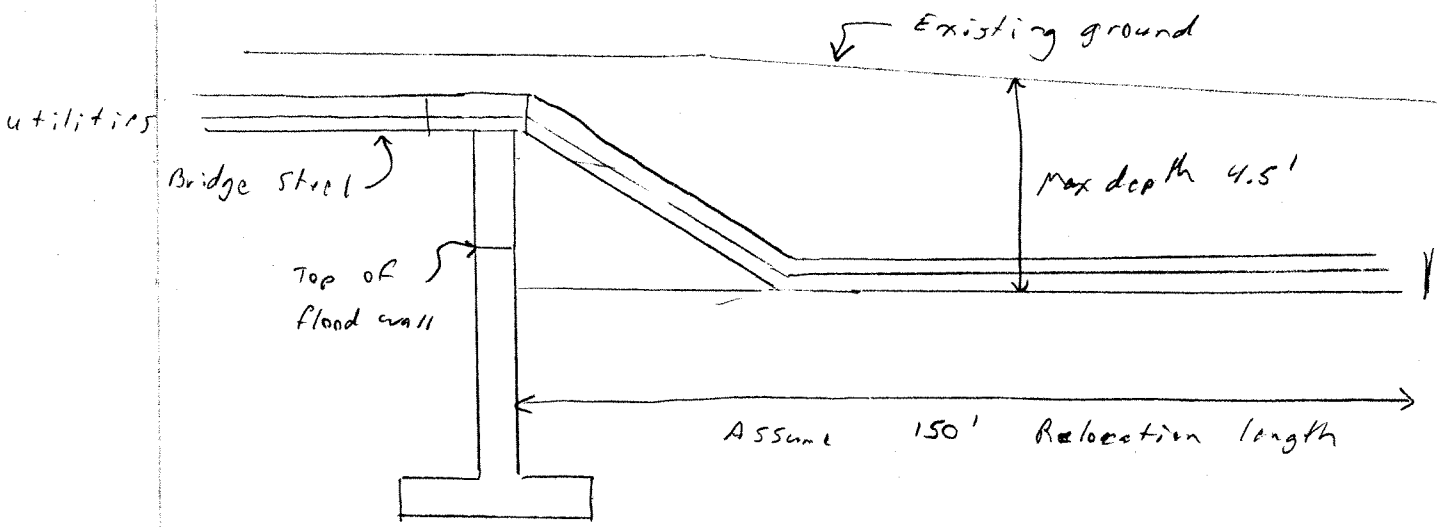
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

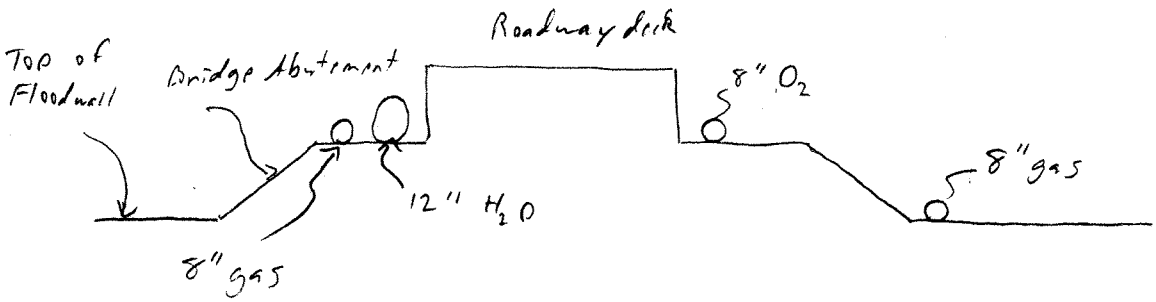
KANSAS CITY LEVEES
FEASIBILITY LEVEL DESIGN

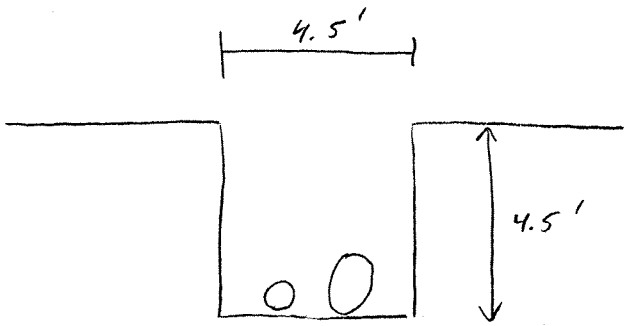
TYPICAL UTILITY CROSSING FOR LEVEE RAISE

Sheet Reference Number:
XX

utilities at 26+10 and 26+10







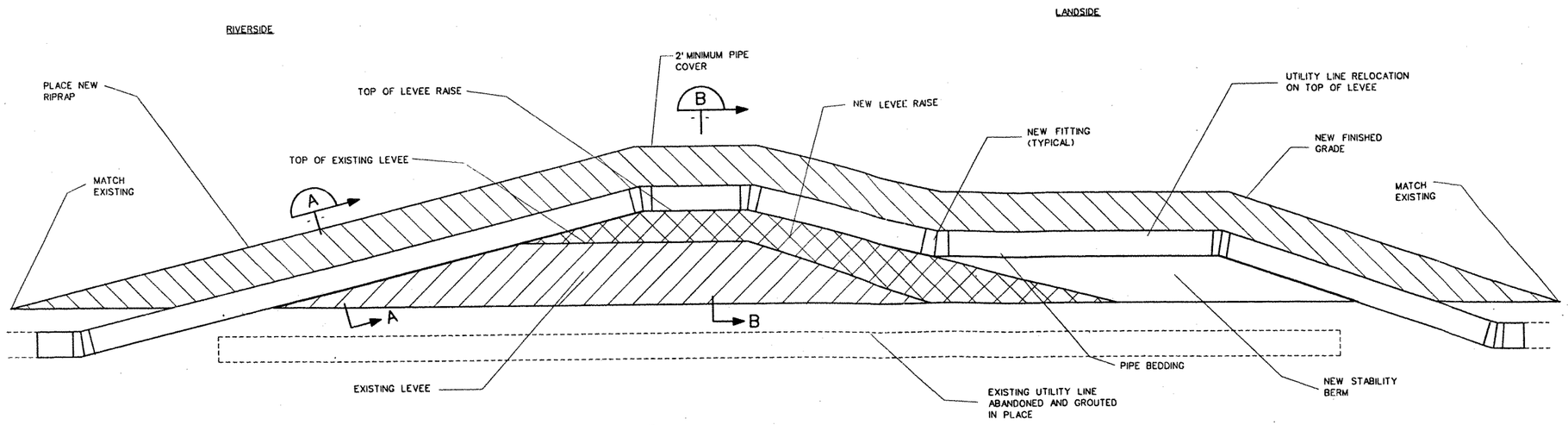
$A = 20.25\ ft^2$
$V = 3037.5\ ft^3$
$112.5\ yd^3$

Total length of pipe relocate 150'

Volume of Excavation 112.5 yd^3

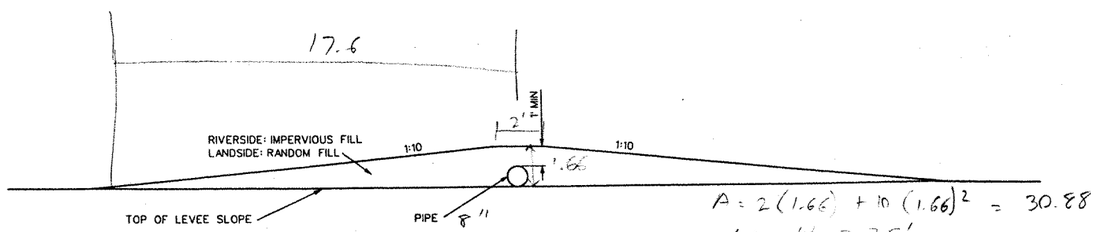
TOPS 35-600 - 100 sheets 35-800 - 200 sheets

Exhitbit 5: Typical Utility Crossing



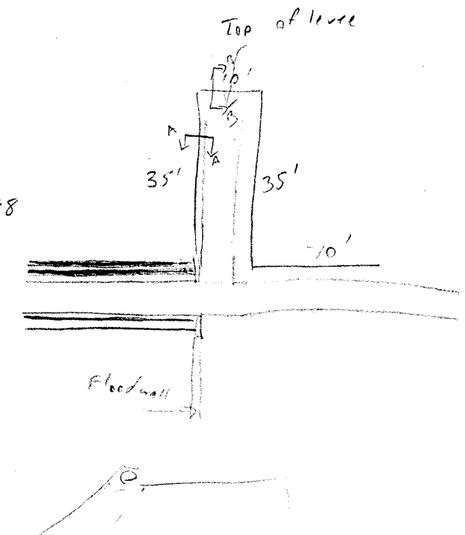
A TYPICAL UTILITY CROSSING

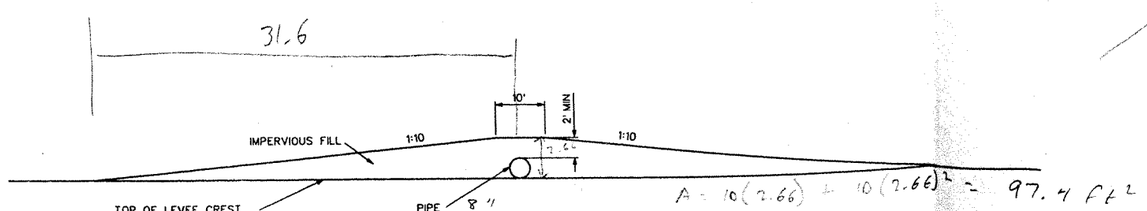
SCALE: NTS



A RIVERSIDE AND LANDSIDE SLOPE

SCALE: NTS





B LEVEE CREST

SCALE: NTS

NOTES:
1. IF PERMISSION IS GRANTED FOR A PIPELINE TO CROSS THE LEVEE BELOW THE TOP OF LEVEE, A POSITIVE CUTOFF VALVE OR GATE CLOSURE WILL BE INSTALLED AT THE RIVERSIDE SHOULDER OF THE LEVEE ROAD.

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr

Designed by: MRC
Date: MARCH 2007
Drawn by: MRC
Drawing code:
Checked by: HWM
Plot scale: NA
Submitted by: HWM
CADD File Name: TYPICALUTILITYCROSS...

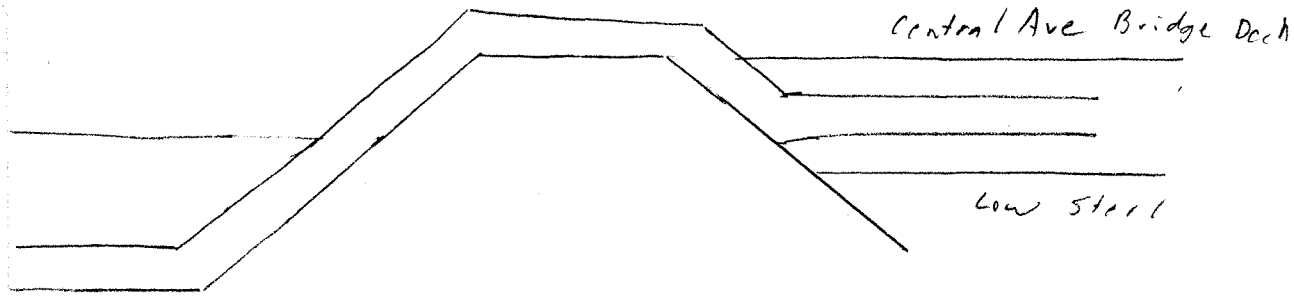
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

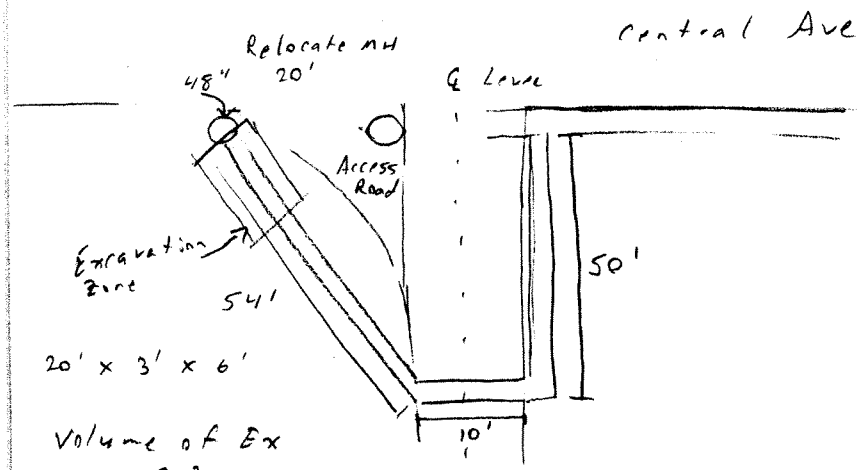
KANSAS CITY LEVEES
FEASIBILITY LEVEL DESIGN

TYPICAL UTILITY CROSSING FOR LEVEE RAISE

Sheet Reference Number:
XX

STA 57+10

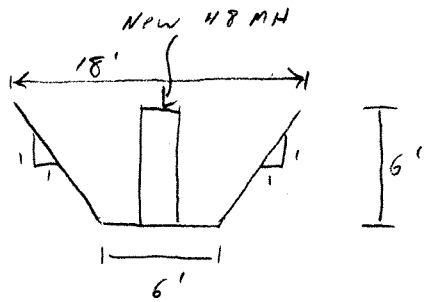




Ending is LXC
How much Demo
How much Backfill

20' x 3' x 6'

Volume of Ex
360 ft³
14 cy



Total length of pipe relocation 110'

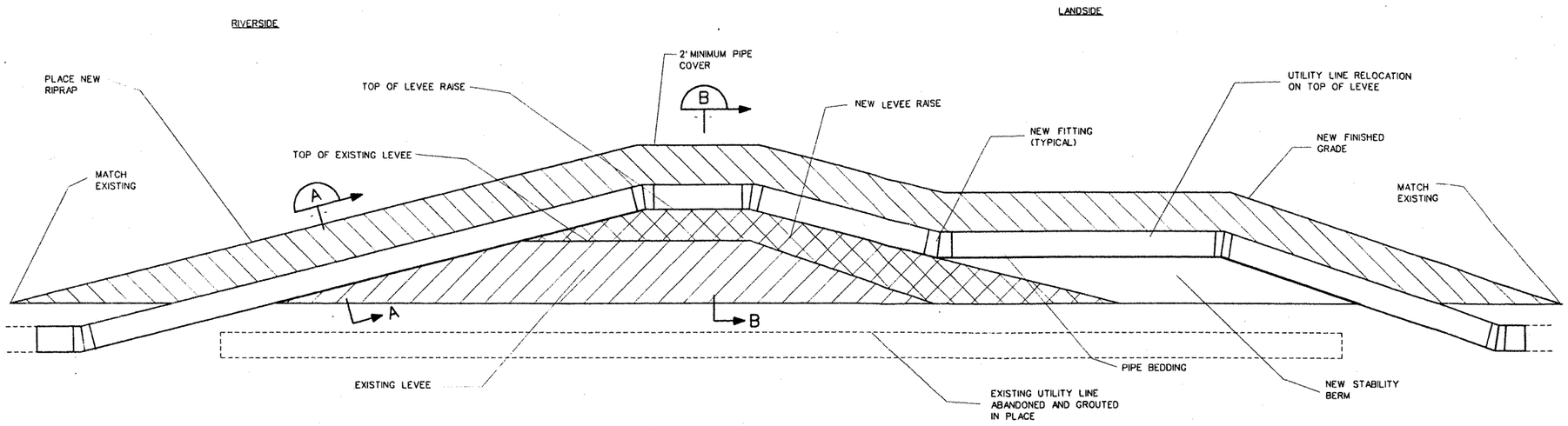
Replace 1 - 48" diam MH @ 6' depth

Volume of Cover - 174 cy

Volume of Excavation 54 cy

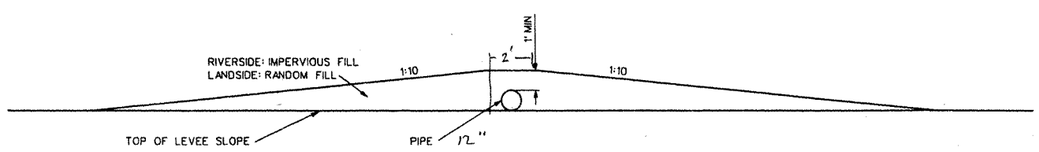
Volume 848 ft³
31 cy

Exhitbit 5: Typical Utility Crossing



A TYPICAL UTILITY CROSSING

SCALE: NTS

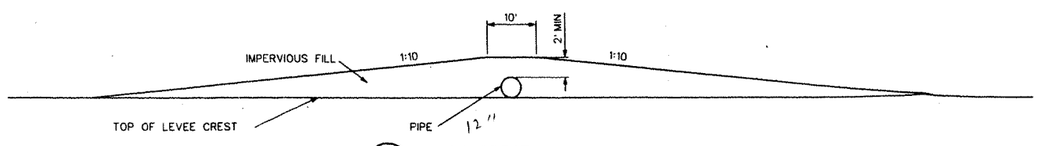


A RIVERSIDE AND LANDSIDE SLOPE

SCALE: NTS

Riverside
Length = 50'
Area = (2)(2) + ½(2)(20) = 22
Volume = 1100 ft³

Land side
Length = 54'
Area = (2)(2) + 2(20) = 44
Volume = 2376 ft³



B LEVEE CREST

SCALE: NTS

Top
Length = 10'
Area = 3(10) + 30(3) = 120'
Volume = 1200 ft³

NOTES:
1. IF PERMISSION IS GRANTED FOR A PIPELINE TO CROSS THE LEVEE BELOW THE TOP OF LEVEE, A POSITIVE CUTOFF VALVE OR GATE CLOSURE WILL BE INSTALLED AT THE RIVERSIDE SHOULDER OF THE LEVEE ROAD.

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

Designed by: MRC
Drawn by: MRC
Checked by: HWM
Submitted by: HWM
Date: MARCH 2007
Drawing code:
Plot scale: NA
CADD File Name: TYPICALUTILITYCROSS...

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY LEVEL DESIGN

TYPICAL UTILITY CROSSING FOR LEVEE RAISE

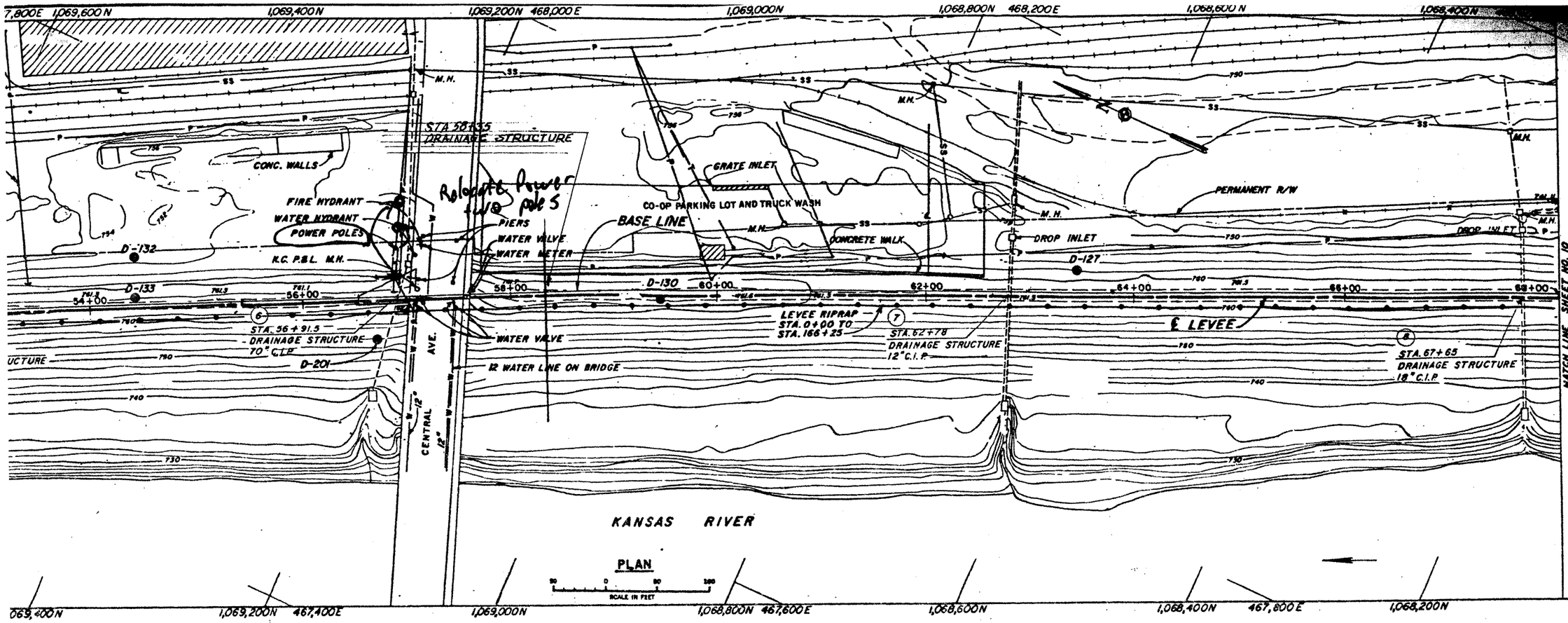
Sheet Reference Number:
XX

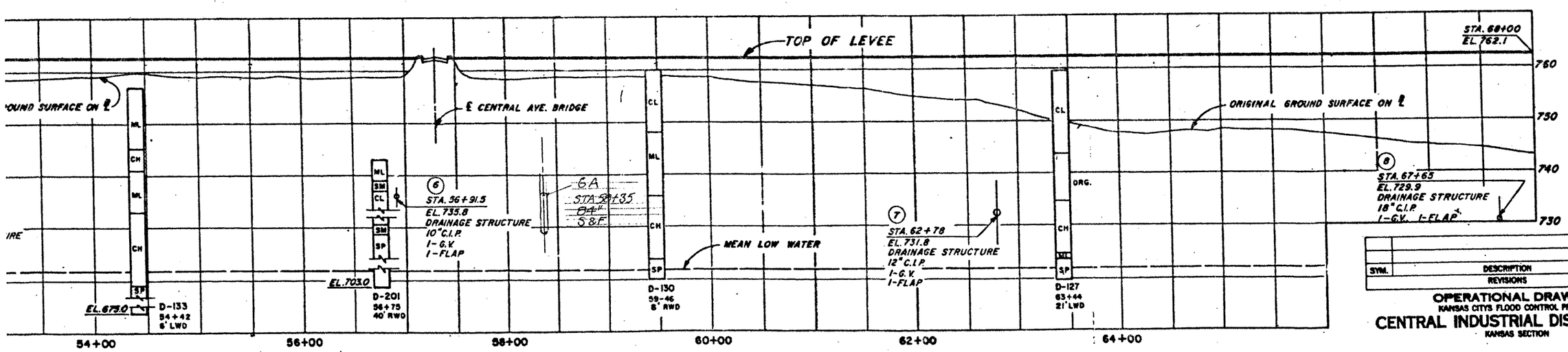
Sta 57+10	Power	

Power comes from wood pole & attaches to overhead steel on the bridge

Assume relocation of two poles & approx 300' of line

CAMPAD





PROFILE

SYM.	DESCRIPTION	DATE	APP'D
	REVISIONS		

OPERATIONAL DRAWING
KANSAS CITY'S FLOOD CONTROL PROJECT
CENTRAL INDUSTRIAL DISTRICT UNIT
KANSAS SECTION

PLAN, PROFILE, AND UNDERGROUND EXPLORATIONS
STA. 51+00 TO STA. 68+00

In 15 sheets — Sheet No. 9 — Scale: as shown

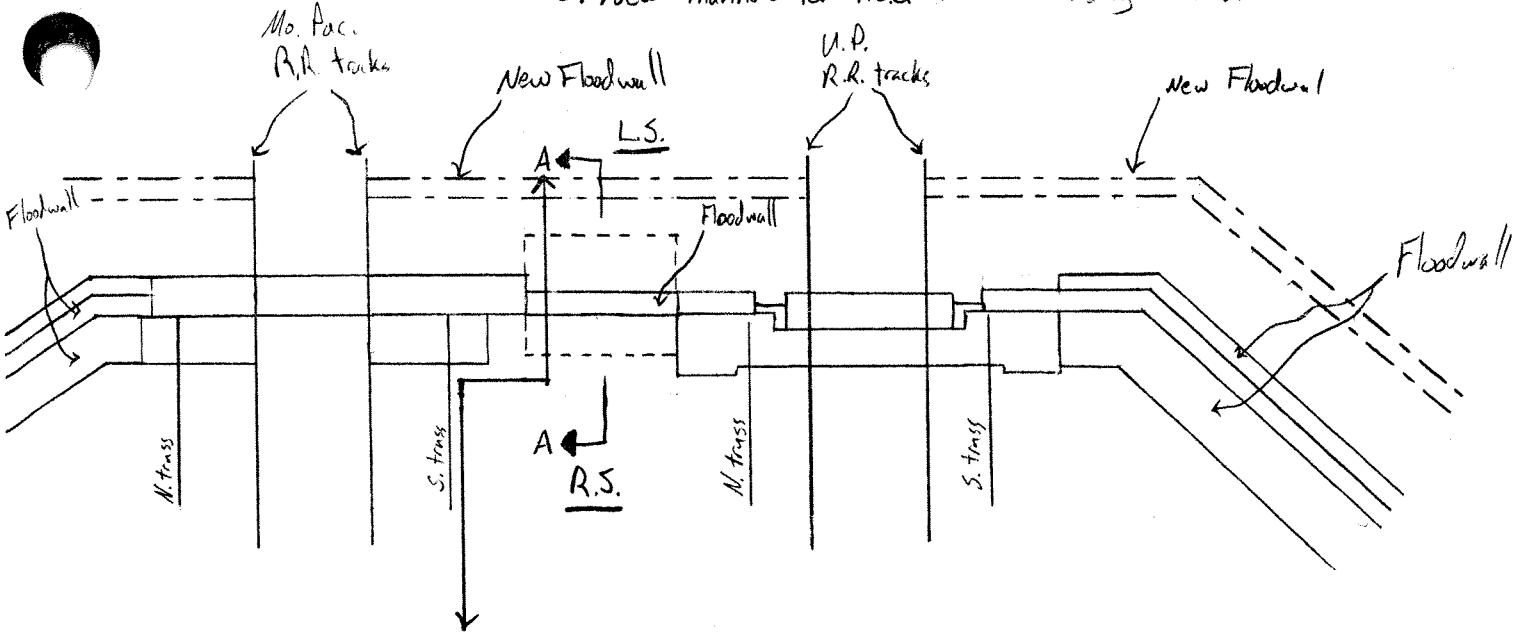
CORPS OF ENGINEERS U. S. ARMY
KANSAS CITY DISTRICT
JULY 1960

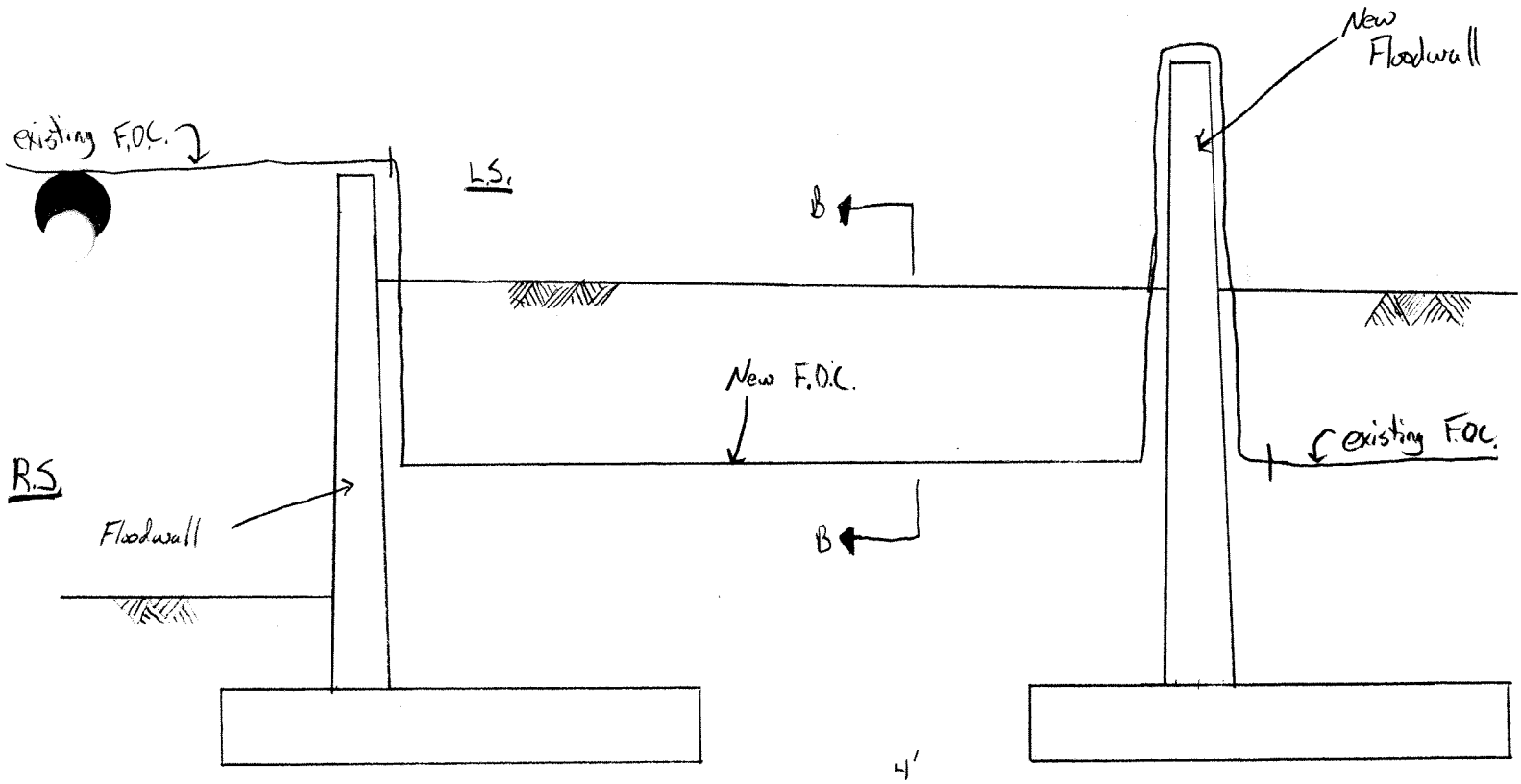
DESIGNED BY: L.E.V. DRAWN BY: J.W.J. CHECKED BY: J.R.M. FILE NO. OPN-A-10-0295

INCLOSURE 2 SHEET NO. 9

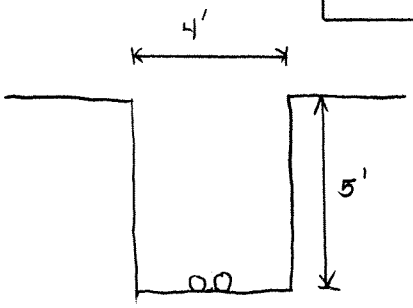
Assumptions

1. Closest tie in is 4000 ft.
2. New manhole for F.O.C. 100' from existing floodwall





SECTION A
Scale 3/16" = 1'

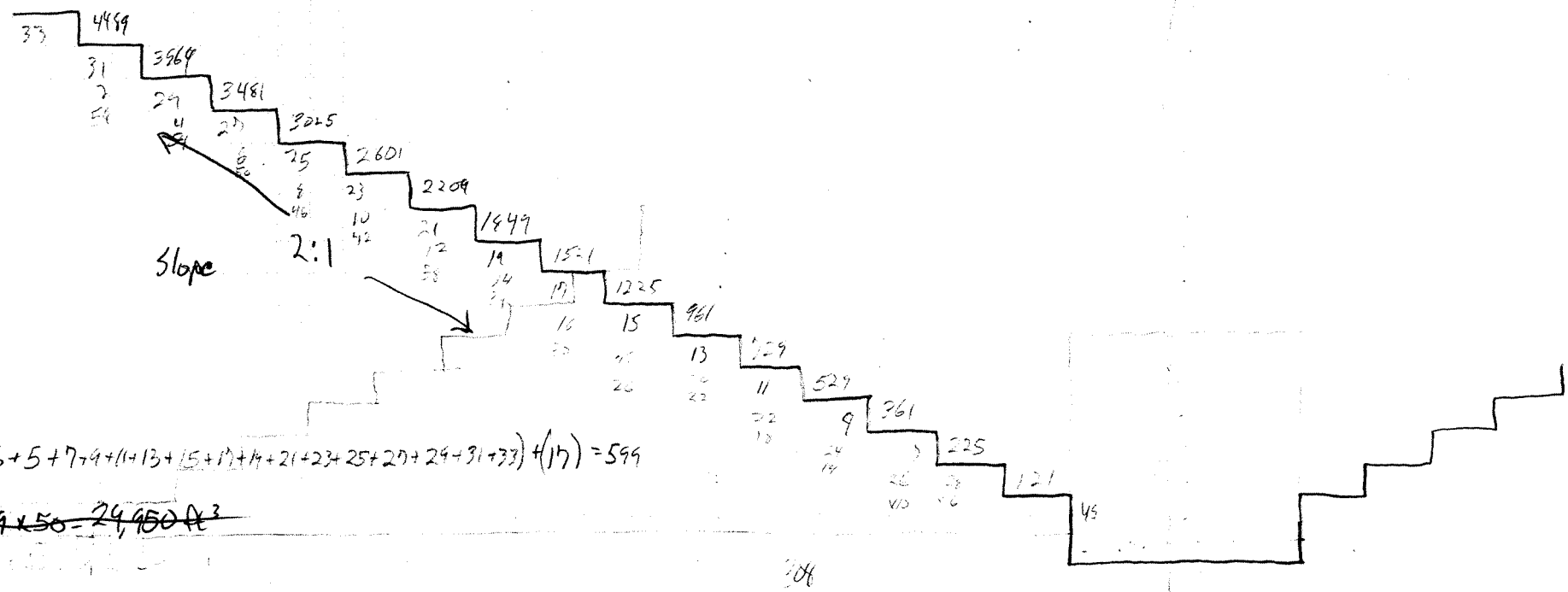


Section B

$A = 20\ ft^2$

$V = 20ft^2 (100ft)$

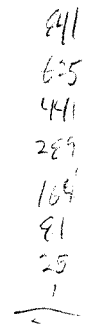
$\boxed{V = 2000ft^3}$



$A = 2(6+5+7+9+11+13+15+17+19+21+23+25+27+29+31+33) + (17) = 599$

~~$V = 599 \times 50 = 29{,}950\ ft^3$~~

$V = 35{,}930\ ft^3$

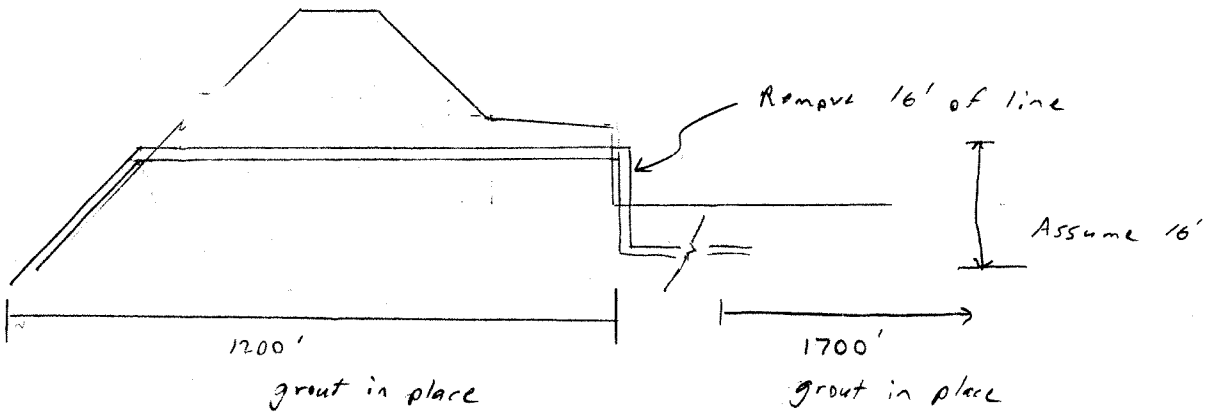


Total Length of new conduit 100'

Total Length of restringing fibers 4000'

Total Excavation 2000 ft^3 ~ 75 Cy

Sta 85+20

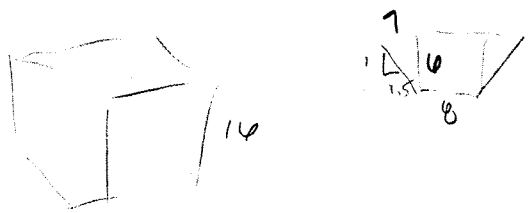


Excavation required minor

8" Line
Length 2900'

Quantity of grout = 1020 ft^3

Assume 3 PITS

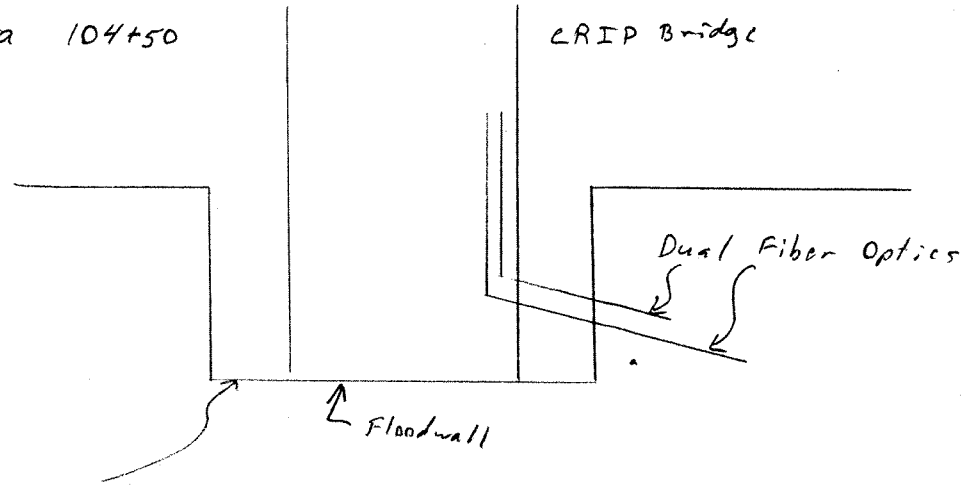


102 SF × 16

= ~~303~~ 60 cy / PIT

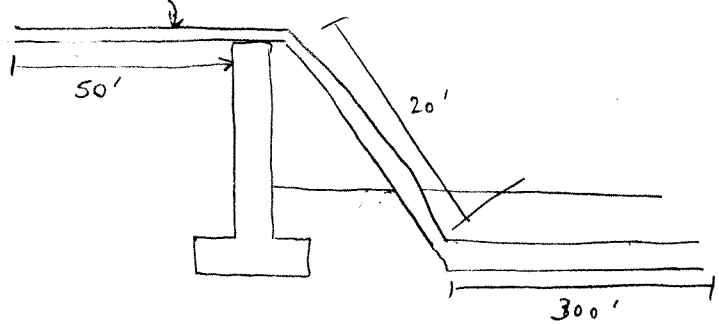
100 cy

Sta 104+50



1) Build this section of floodwall first

Relocate lines up and over

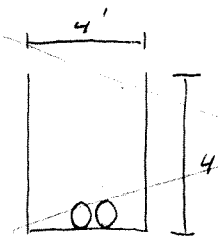


Total length of conduit replacement 50'

Restring fibers approx length 1000'

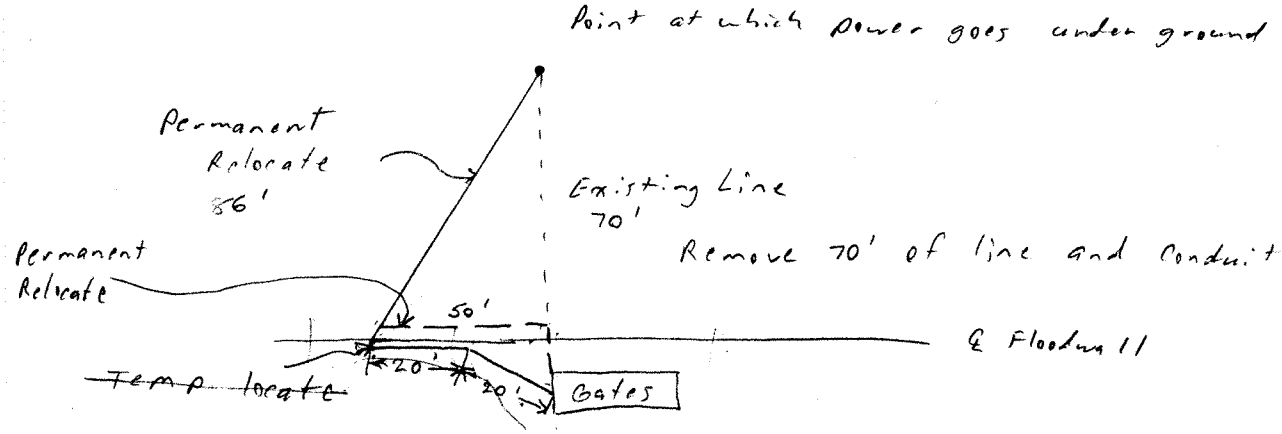
Excavation

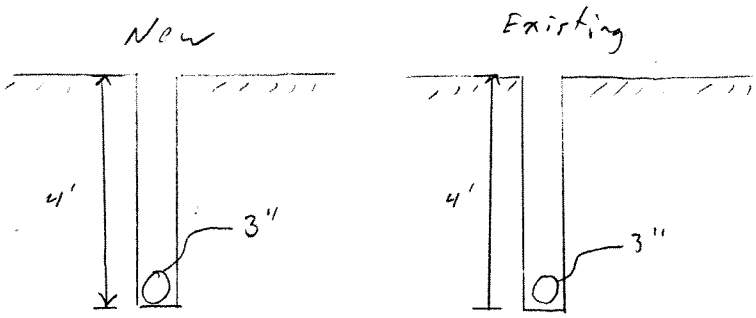
Not Needed



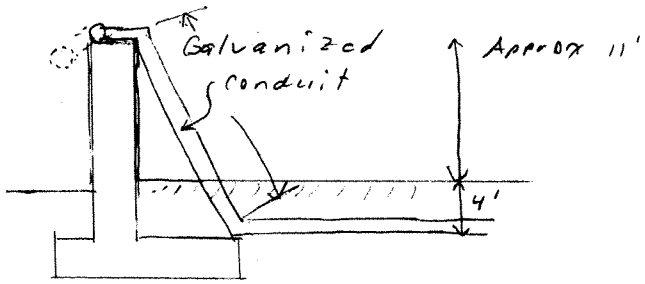
Area = 16 ft²
Length = 370 ft
Volume = 5920 ft³ = 220 yd³

Sta 124 + ~~83~~ 60 Power Relocation





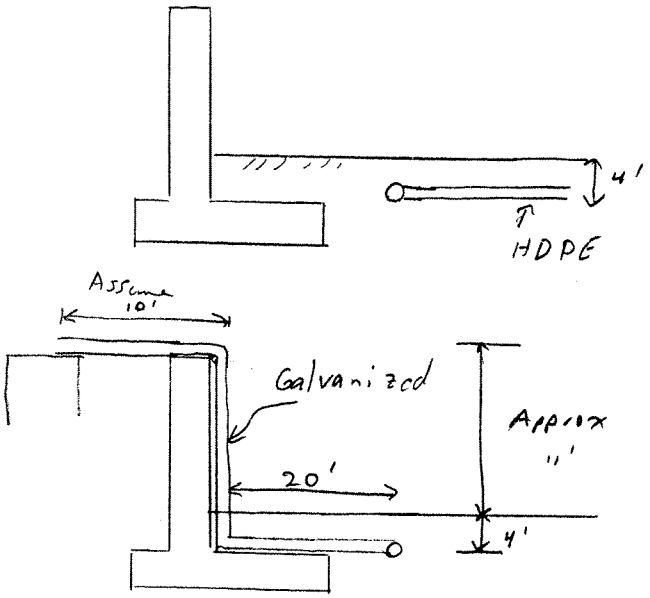
$\frac{(136)(4)(2)}{27} = 40$

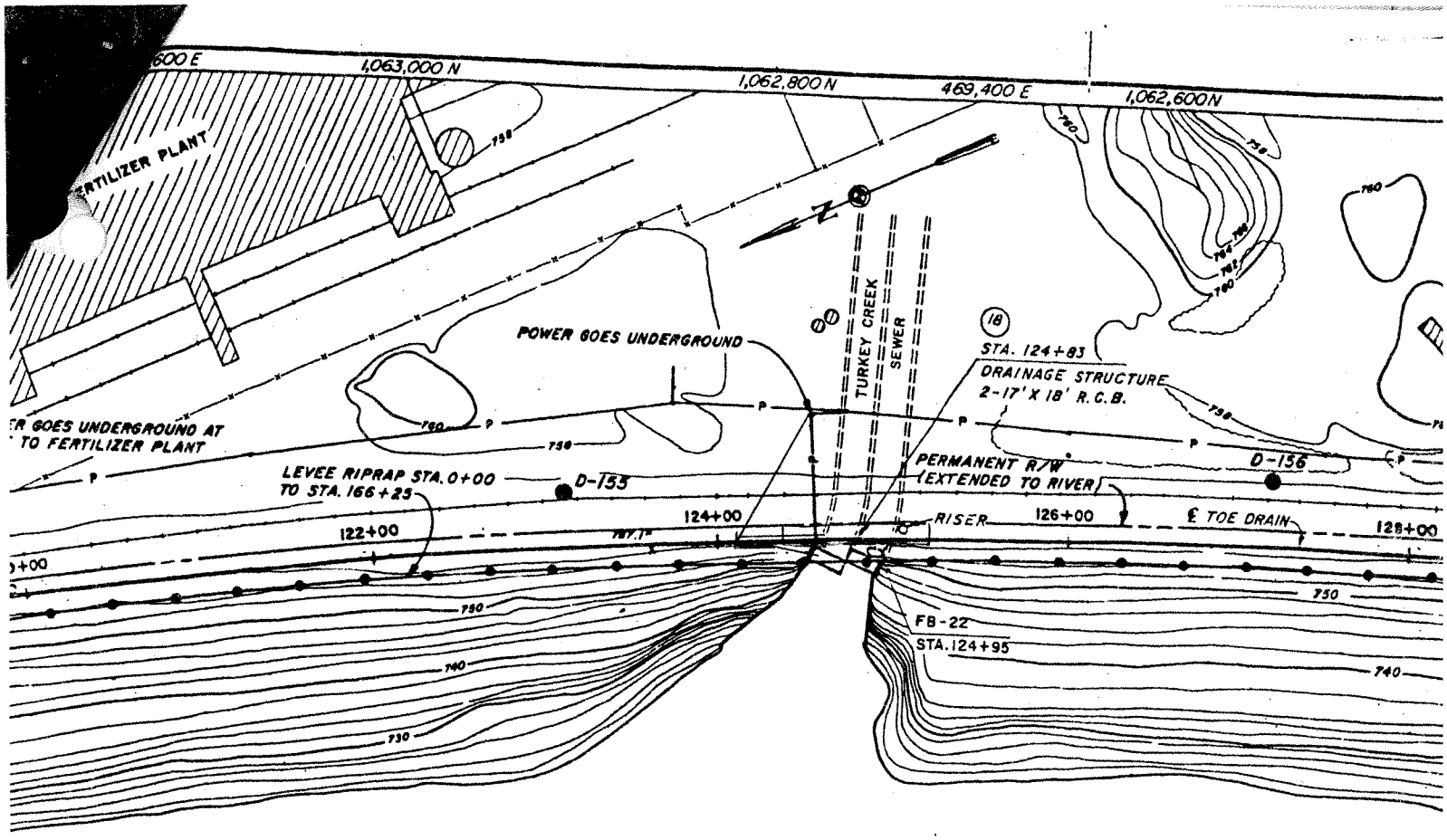


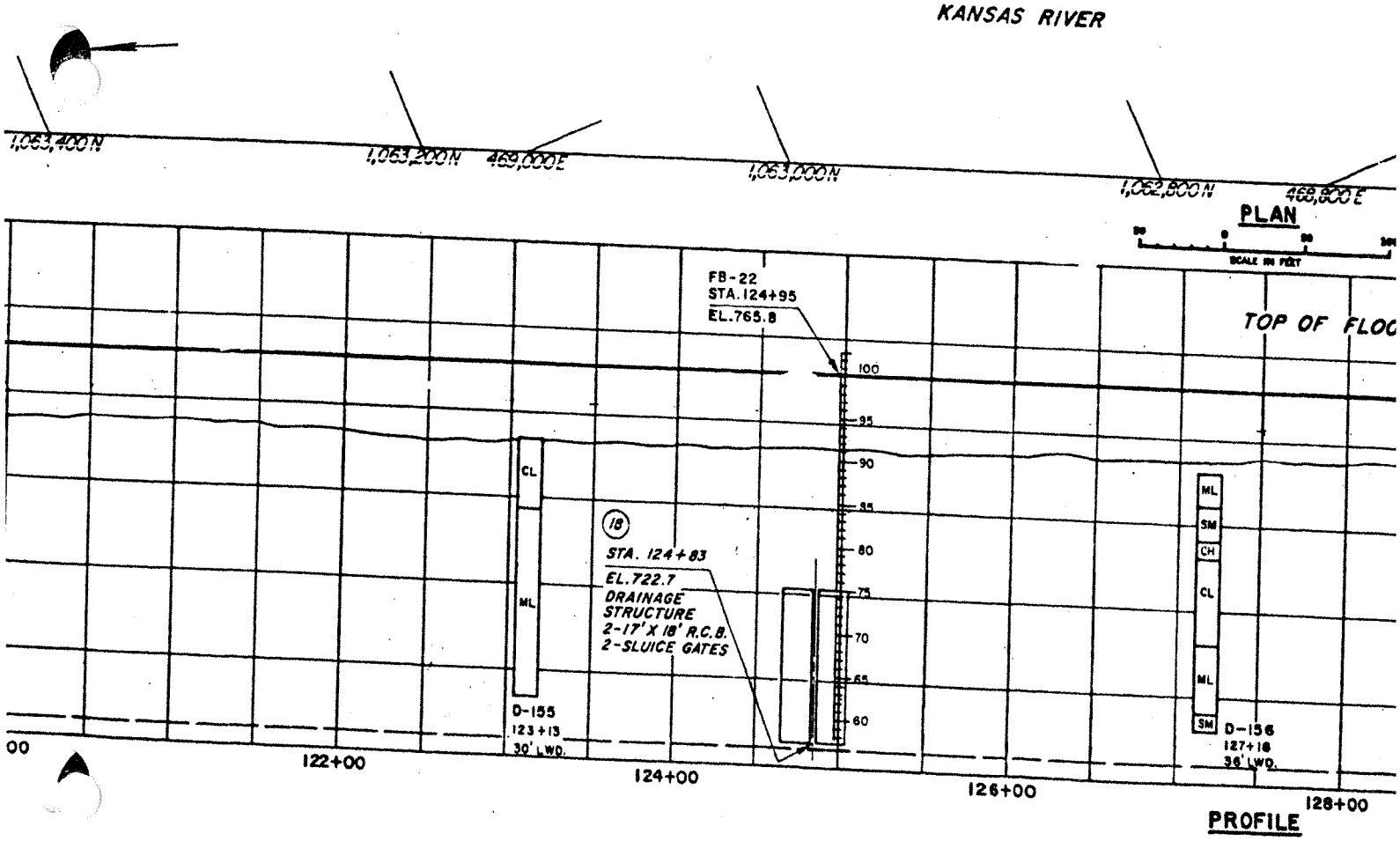
Temp

1) Relocate power 86' HDPE to toe of floodwall
2) Temp locate 60' Galvanized up and over floodwall
3) Relocate Temp 60' to permanent 95'. Galvanized

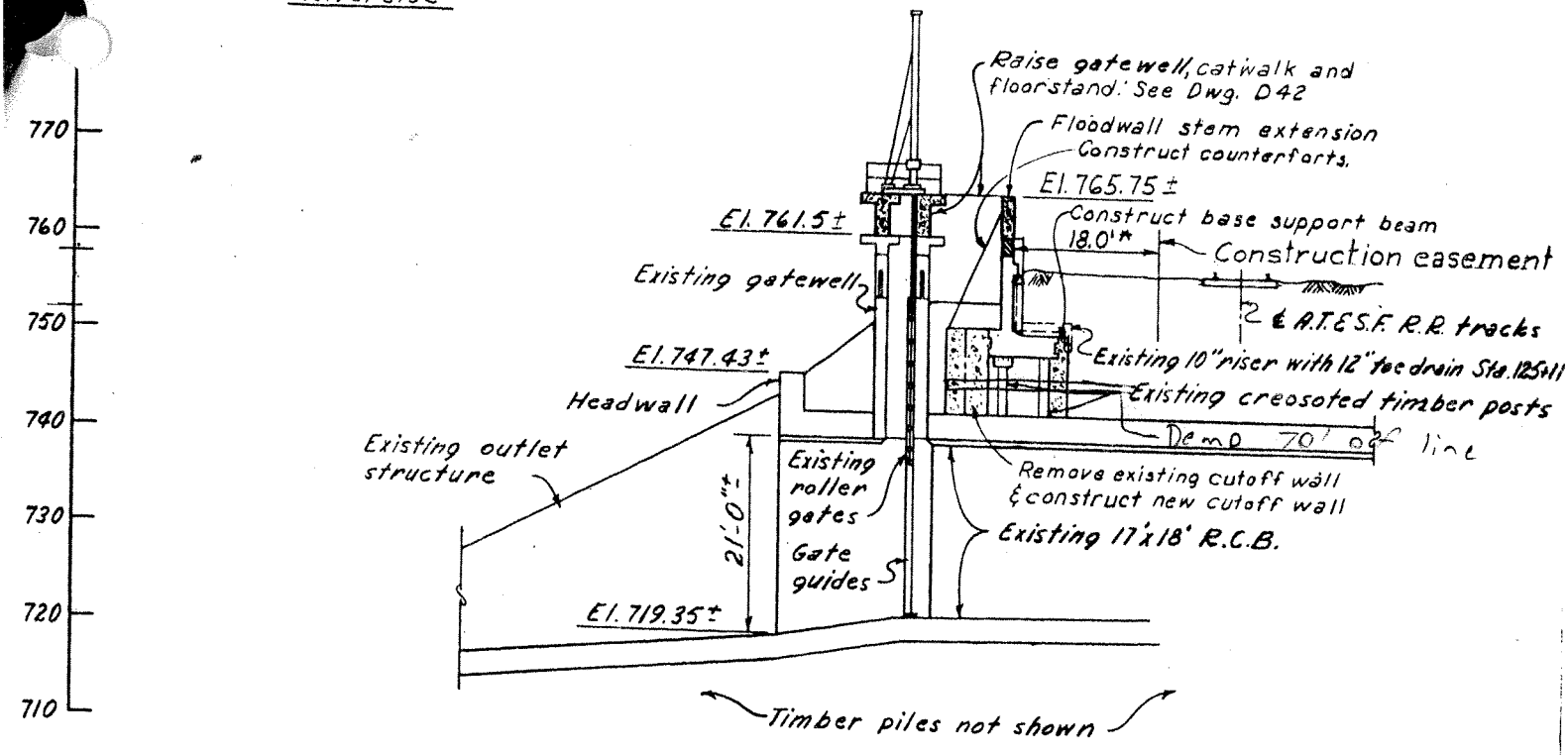
Exc - $\frac{(70')(4)(2')}{27} = 21$ cy


4'
HDPE
Assume
10'
Galvanized
Approx
11'
20'
4'


600 E
1,063,000 N
1,062,800 N
469,400 E
1,062,600N
FERTILIZER PLANT
POWER GOES UNDERGROUND
TURKEY CREEK SEWER
STA. 124+83
DRAINAGE STRUCTURE
2-17' X 18' R.C.B.
GOES UNDERGROUND AT
TO FERTILIZER PLANT
LEVEE RIPRAP STA. 0+00
TO STA. 166+25
D-155
D-156
PERMANENT R/W
(EXTENDED TO RIVER)
124+00
126+00
122+00
128+00
RISER
℄ TOE DRAIN
FB-22
STA. 124+95
750
740
730
760
KANSAS RIVER


1,063,400 N
1,063,200 N
469,000 E
1,063,000 N
1,062,800 N
468,800 E
PLAN
SCALE IN FEET
FB-22
STA. 124+95
EL. 765.8
TOP OF FLOO
STA. 124+83
EL. 722.7
DRAINAGE STRUCTURE
2-17' X 18' R.C.B.
2-SLUICE GATES
CL
ML
SM
CH
D-155
123+13
30' LWD.
D-156
127+18
36' LWD.
100
95
90
85
80
75
70
65
60
122+00
124+00
126+00
128+00
PROFILE

Riverside



SECTION THRU ℄ TURKEY CREEK SEWER
STATION 124+83 ±

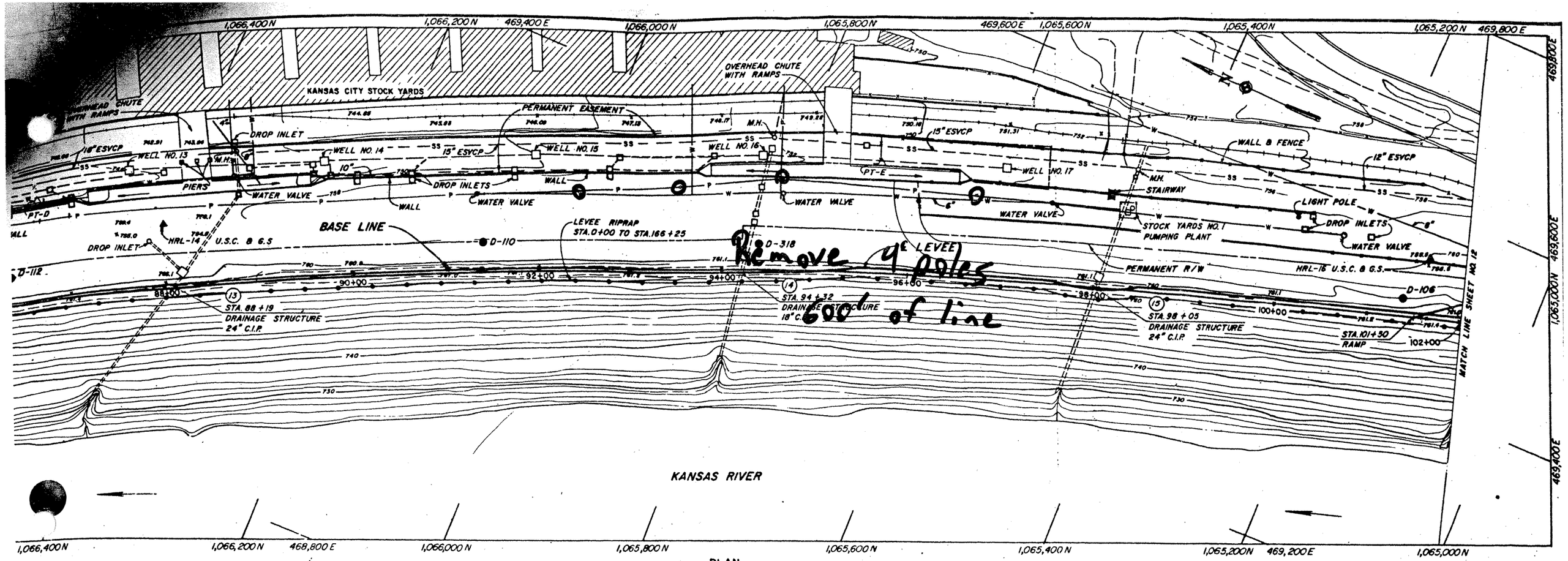
NOTE:
For levee section details, see Dwgs. B1 thru B5

RECORD DRAWING

Powerline Relocations Calculations

Sta ~ 94+00

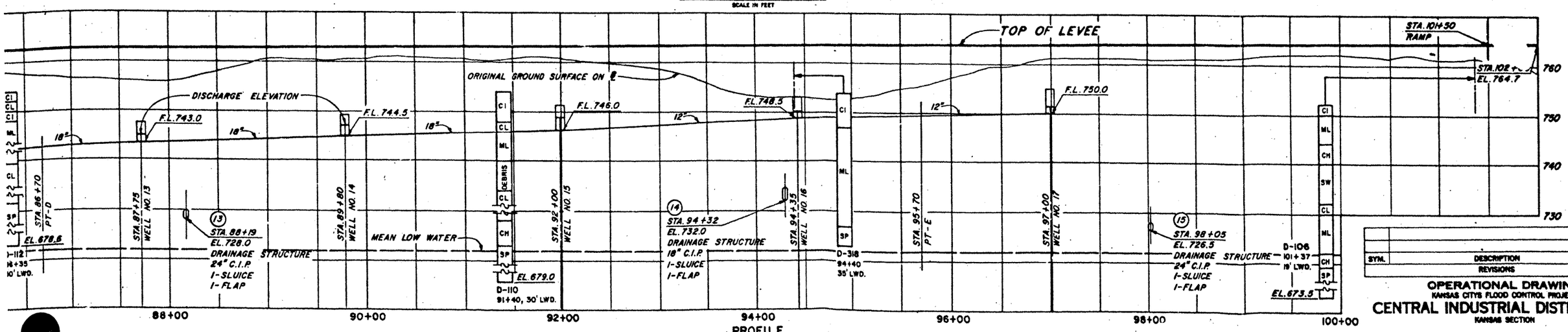
Gateway 2000 Pump Plant to Field pump house
Remove 4 power poles
Remove Approx 600 ft/strand assume 3 strands



Remove 4' poles 600' of line

PLAN

SCALE IN FEET



PROFILE

SYM.	DESCRIPTION	DATE	APP'D
	REVISIONS		

OPERATIONAL DRAWING

KANSAS CITY'S FLOOD CONTROL PROJECT

CENTRAL INDUSTRIAL DISTRICT UNIT

KANSAS SECTION

PLAN, PROFILE AND UNDERGROUND EXPLORATIONS STA. 85 + 00 TO STA. 102 + 00

In 15 sheets | Sheet No. 11 | Scale: as shown

CORPS OF ENGINEERS U. S. ARMY

KANSAS CITY DISTRICT

JULY 1960

DESIGNED BY: J.F.V. DRAWN BY: J.W.P. CHECKED BY: J.H.M.

Approx 57+25 to 73+80

Relocate 15 wooden power poles 1500' of wire

3 strands

Relocate approx 20' to the of new levee.

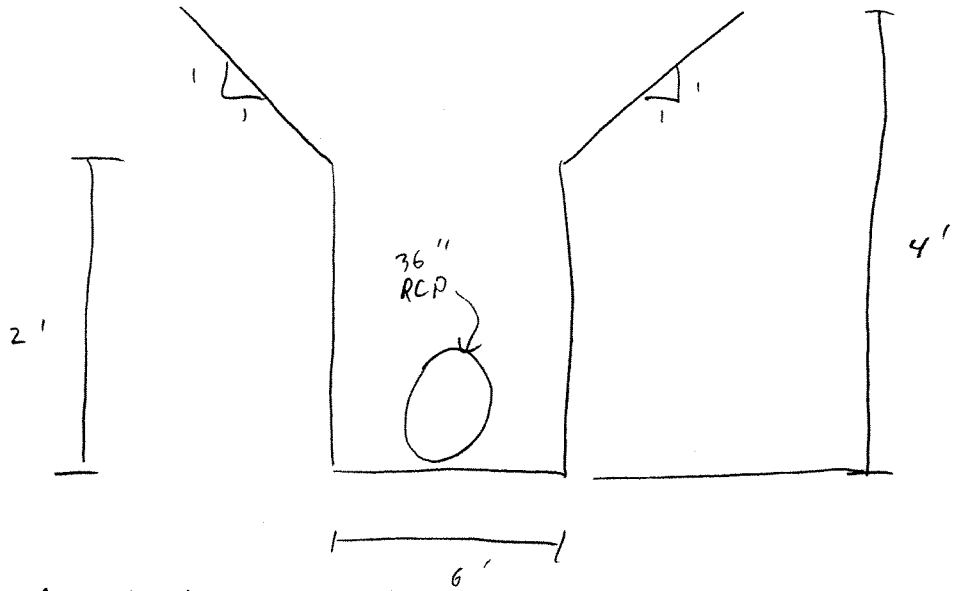
Storm Drain Modifications due to Area Fill Requirements Calculations

Area Fill 32+50 to 38+00 Area Inlet Modification
Summary

1) Construct 300' New RCP (tie into existing system)
2) Construct 48" diameter Precast drop Inlet
3) Demo existing drop Inlet (48" diam)
4) Excavation for
   a) New pipe = 311 yd^3
   b) New Inlet = 12 yd^3
   c) Demo old Inlet = 7 yd^3
5) Backfill for
   New pipe = 232 yd^3
   New Inlet = 7 yd^3
   Old Inlet = 12 yd^3

Area Fill 32+50 + 38+00 Inlet Mod

Excavation - pipe



$A = (6)(4) + (2)(2) = 28 ft^2$

$L = 300'$

$V = 8400 \ ft^3 = \underline{\underline{311 \ yd^3}}$

Back fill - pipe

$A = (6)(4) + (2)(2) - \pi/4 (36/12)^2 = 21 \ ft^2$

$L = 300'$

$V = 6280 \ ft^3 = \underline{\underline{232 \ yd^3}}$

Approx James St to sta 38+00

Remove for area fill.

Replace after paving

Remove & Replace 3 light poles

1,071,200 N
1,071,000 N
1,070,800 N
467,400 E
1,070,600 N
1,070,400 N
1,070,200 N
1,070,000 N
1,069,800

FORDYCE CONCRETE INC.

S-G METALS INDUSTRIES INC.

FUEL OIL TANKS

STA. 50+98
DRAINAGE STRUCTURE
10" C.I.P.

S-G METALS INDUSTRIES INC.

PERMANENT R/W

LEVEE RIPRAP
STA. 0+00 TO 166+25

BASE LINE

STA. 41+90
TURNAROUND

FLOODWALL (BASE LINE)

D-400

MATCH LINE SHEET NO. 7

34+00
36+00
38+00
40+00
42+00
44+00
46+00
48+00

MISTLETOE PUMPING PLANT

RISER

D-142

D-194

D-191

D-190

D-198

D-136

STA. 37+06.5
DRAINAGE STRUCTURE
18" C.I.P.

EQUATION: 40+61.66 BK. = 40+91.60 AH.

℄ LEVEE

KANSAS RIVER

KANSAS RIVER

1,071,200 N
1,071,000 N
1,070,800 N
466,800 E
1,070,600 N
1,070,400 N
1,070,200 N
1,070,000 N
467,000 E
1,069,800 N

PLAN

SCALE IN FEET

STA. 34+00
760.63

TOP OF FLOODWALL

ORIGINAL GROUND SURFACE LANDSIDE OF WALL

TOP OF FLOODWALL BASE

BOTTOM OF FLOODWALL BASE

BOTTOM OF CONCRETE SHEET PILING

MEAN LOW WATER

STA. 37+06.5
EL. 733.5
DRAINAGE STRUCTURE
18" C.I.P.
1-SLUICE
1-FLAP

D-400
36+33
98' LWD.

EL. 680.5
D-142
39+05
21' LWD.

36+00
38+00
40+00

EQUATION: 40+61.66 BK. = 40+91.60 AH.

STA. 41+90
TURNAROUND

TOP OF LEVEE

ORIGINAL GROUND SURFACE ON ℄

D-194
41+50
10' RWD.

D-191
43+45
℄

D-190
45+40
5' LWD

MEAN LOW WATER

EL. 704.5
D-198
46+90
30' RWD.

EL. 683.5
D-136
49+41
℄

STA. 51+00
762.1

STA. 50+98
EL. 734.43
DRAINAGE STRUCTURE
10" C.I.P.
1-GV
1-FLAP

42+00
44+00
46+00
48+00

PROFILE

SYM.

OPE
KANS
CENTRAL I

PLAN, PROFILE
ST

In 15 sheets

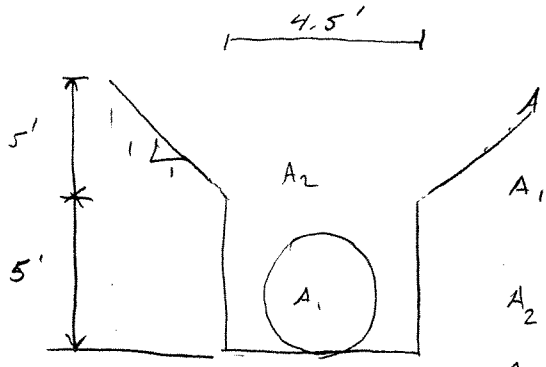
CON

DESIGNED BY: J.F.V.

Sprint Parking subsurface drainage Modification

1) Assume 10 curb inlets to be removed
2) Assume 3 Area inlets to be removed
3) Assume 1000' of concrete pipe to be removed

Excavation Quantity for removal of pipe



Assume All pipe is 36" diameter

$A_1 = \frac{\pi}{4}\left(\frac{36}{12}\right)^2 = 7.07 \text{ ft}^2$

$A_2 = (4.5)(10) + (5)(5) = 70 \text{ ft}^2$

$A_3 = A_2 - A_1 = 70 - 7.07 = 63 \text{ ft}^2$

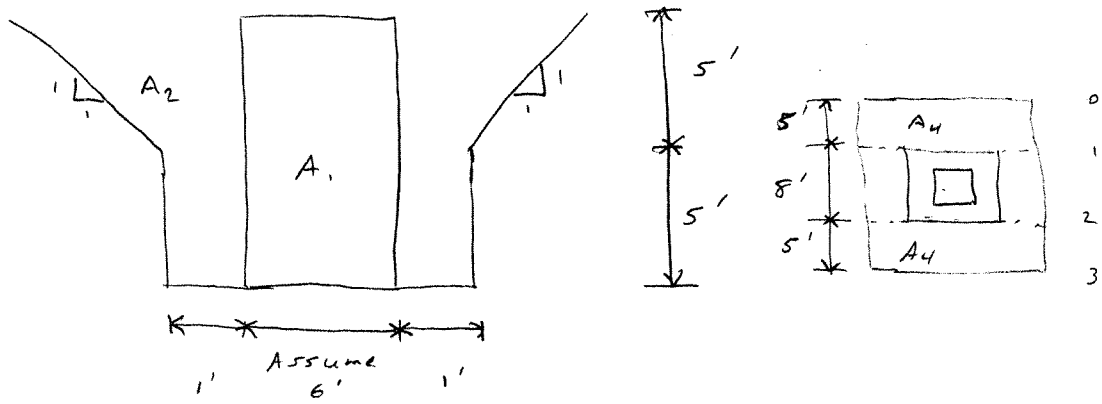
Total Excavation $= \frac{63\,(1000)}{27} = \underline{\underline{2340 \text{ yd}^3}}$

Back Fill Quantity for removal of pipe

$\frac{70\,(1000)}{27} = \underline{\underline{2600 \text{ yd}^3}}$

Area Inlet
&
curb Inlet

Assume all inlets are 6'x6'x10'



$A_1 = (6)(10) = 60 \ ft^2$

$A_2 = (8)(10) + (5)(5) = 105 \ ft^2$

$A_3 = A_2 - A_1 = 45 \ ft^2$

$A_4 = \frac{1}{2}(5)(5) = 12.5 \ ft^2$

Total Excavation Volume

$\frac{(45)(8)}{27} = 14 \ yd^3$

$2\left(\frac{(12.5)(18)}{27}\right) = 17 \ yd^3$

$= (31 \ yd^3)(13) = \underline{\underline{403 \ yd^3}}$

Total Back fill Volume

$\frac{(105)(8)}{27} = 32 \ yd^3$

$2\left(\frac{(12.5)(18)}{27}\right) = 17 \ yd^3$

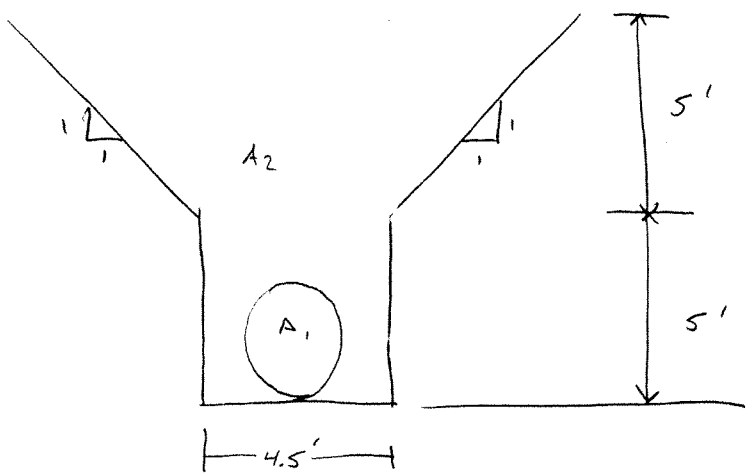
$= 49 \ yd^3 \ (13) = \underline{\underline{637 \ yd^3}}$

1) Assume 7 new curb inlets

2) Assume 1 new area inlet

3) Assume 1075' new 36" diameter concrete pipe

Excavation Quantity for new pipe



$$A_1 = \frac{\pi}{4}\left(\frac{36}{12}\right)^2 = 7.07 \text{ ft}^2$$

$$A_2 = (4.5)(10) + (5)(5) = 70 \text{ ft}^2$$

$$A_3 = A_2 - A_1 = 63 \text{ ft}^2$$

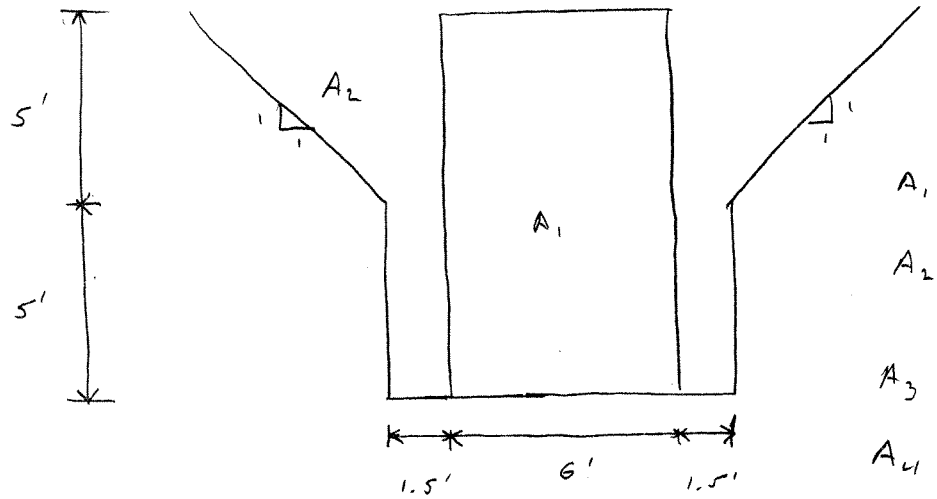
Total Excavation for new pipe

$$\frac{70(1075)}{27} = \underline{\underline{2800 \text{ yd}^3}}$$

Backfill Quantity for new pipe

$$\frac{63(1075)}{27} = \underline{\underline{2510 \text{ yd}^3}}$$

Assume All curb inlets and area inlet is 6' x 6' x 10'

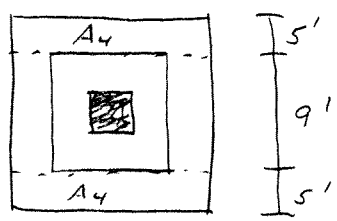


$A_1 = (6)(10) = 60 \ ft^2$

$A_2 = (9)(10) + (5)(5) = 115 \ ft^2$

$A_3 = A_2 - A_1 = 55 \ ft^2$

$A_4 = \frac{1}{2}(5)(5) = 12.5 \ ft^2$



Total Excavation for new inlets

$\frac{(115)(9)}{27} = 40 \ yd^3$

$2\frac{(12.5)(5)}{27} = 5 yd^3$

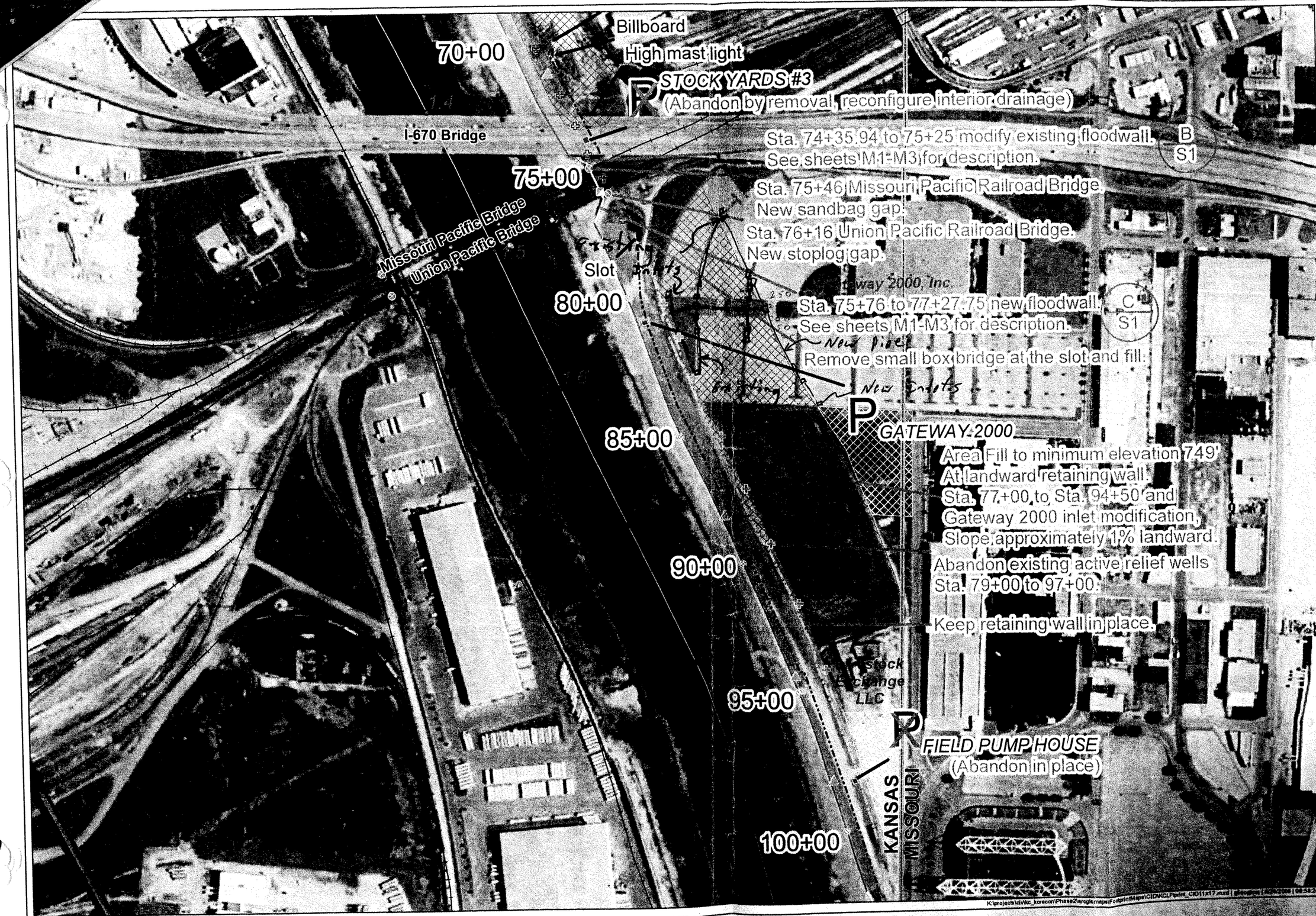
$= 45 yd^3 (8) = \underline{360 \ yd^3}$

Total back fill for new inlets

$\frac{55(9)}{27} = 20 \ yd^3$

$2\frac{(12.5)(5)}{27} = 5 yd^3$

$= 25 yd^3 (8) = \underline{200 \ yd^3}$



Kansas Citys, Missouri and Kansas

Flood Damage Reduction Project

Feasibility Study

Recommended Plan

CID (Kansas) Unit
June 2008

Black text indicates existing features
Red text indicates new or modified features

DRAFT
Working document
Not for public release

KEY

Existing Levee Features
- Closure Structure
- Gatewell
- Active Relief Well
- Abandonned Relief Well
- Station Tick Marks
- Pump Plant
- Retaining wall
- Existing Right of Way
- Railroad
- Floodwall
- Levee

Proposed Features
- Closure Structure
- Relief Well
- Floodwall
- Road
- Area Fill
- Staging/Stockpile Area
- Levee raise

N

US Army Corps of Engineers
Kansas City District

Photography Date: 2006

Projection: UTM Zone 15, Feet
Datum: NAD 83

Created by:
U.S. Army Corps of Engineers
Kansas City District, GDS Team

Users should refer corrections, additions, and comments for improving this product to:

GDS Coordinator,
U.S. Army Corps of Engineers,
Kansas City District,
601 East 12th, Room 812,
Kansas City, Missouri, 64106

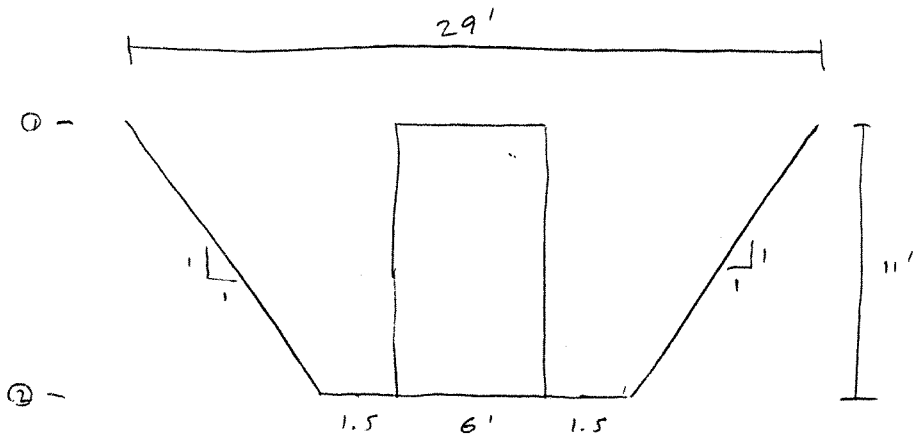
0 75 150 300 Feet

Sheet A4

Approx 68+00 to 82+00

Replace MH 6 & 7

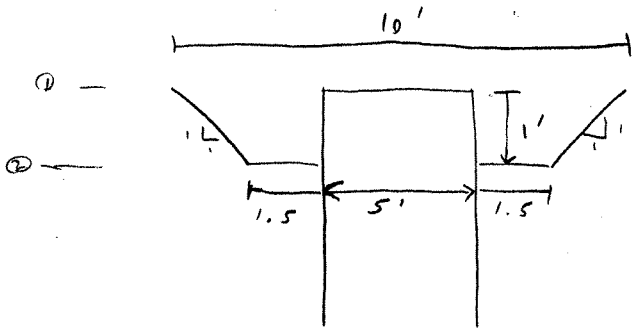
Raise MH 1, 2c, 5, and 4



① Area $= \frac{\pi}{4} 29^2 = 660.5 \text{ ft}^2$

② Area $= \frac{\pi}{4} 9^2 = 63.6 \text{ ft}^2$

Volume $= \frac{(660.5 + 63.6)}{2} (11) = 3982.8 \text{ ft}^3 \rightarrow 148 \text{ yd}^3$



Area $= \frac{\pi}{4} 10^2 = 78.5 \text{ ft}^2$

Area $= \frac{\pi}{4} 8^2 = 50.3 \text{ ft}^2$

Volume $= \frac{(78.5 + 50.3)}{2} (1) = 64.4 \text{ ft}^3 \rightarrow 2.5 \text{ yd}^3$

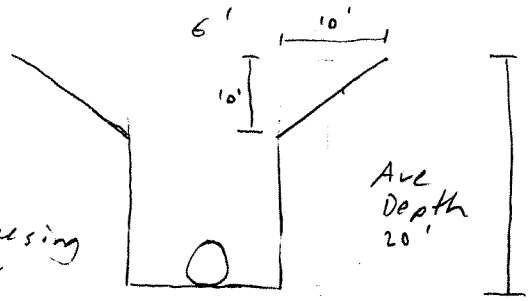
Quantity of Excavation
for replacement 148 yd^3 per MH

Quantity of Excavation
for raise = 2.5 yd^3

Approx 82+00 to Approx 94+50

Raise manholes 9, 10, and 11
Raise MH 9 - 6' Raise MH 10 - 5' Raise MH 11 - 1.5'
Quantity of excavation for each MH raise is 2.5 yd^3

Replace 580 linear feet of 15" VCP with 15" RCP



Max Depth 22'

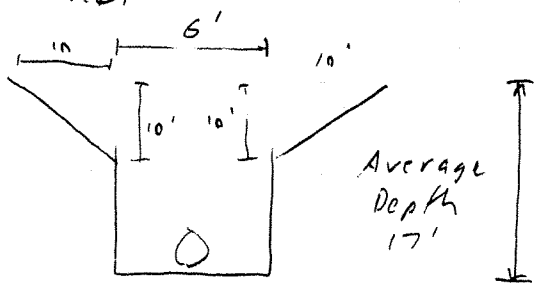
Assume using Trench Box 6x14 with 25' depth cut capability

Ave Depth 20'

Area = 220 ft^2
Length = 580'

Volume = 127600 ft^3
4726 yd^3 / .8 = 5907

Replace 380 linear feet of 18" VCP with 18" RCP



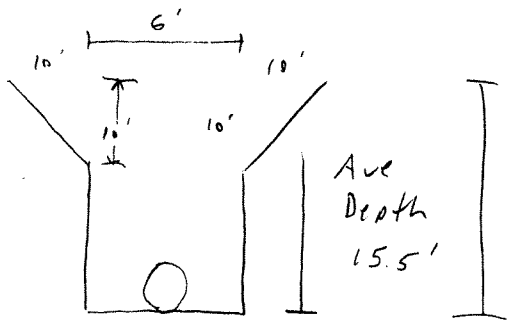
Max Depth 18'

Average Depth 17'

Area = 202 ft^2
Length = 380

Volume = 76760 ft^3
= 2843 yd^3

Replace 260 linear feet of 30" VCP with 30" RCP



Max Depth 16'

Ave Depth 15.5'

Area = 193 ft^2
Length = 260

Volume = 50180 ft^3
= 1859 yd^3

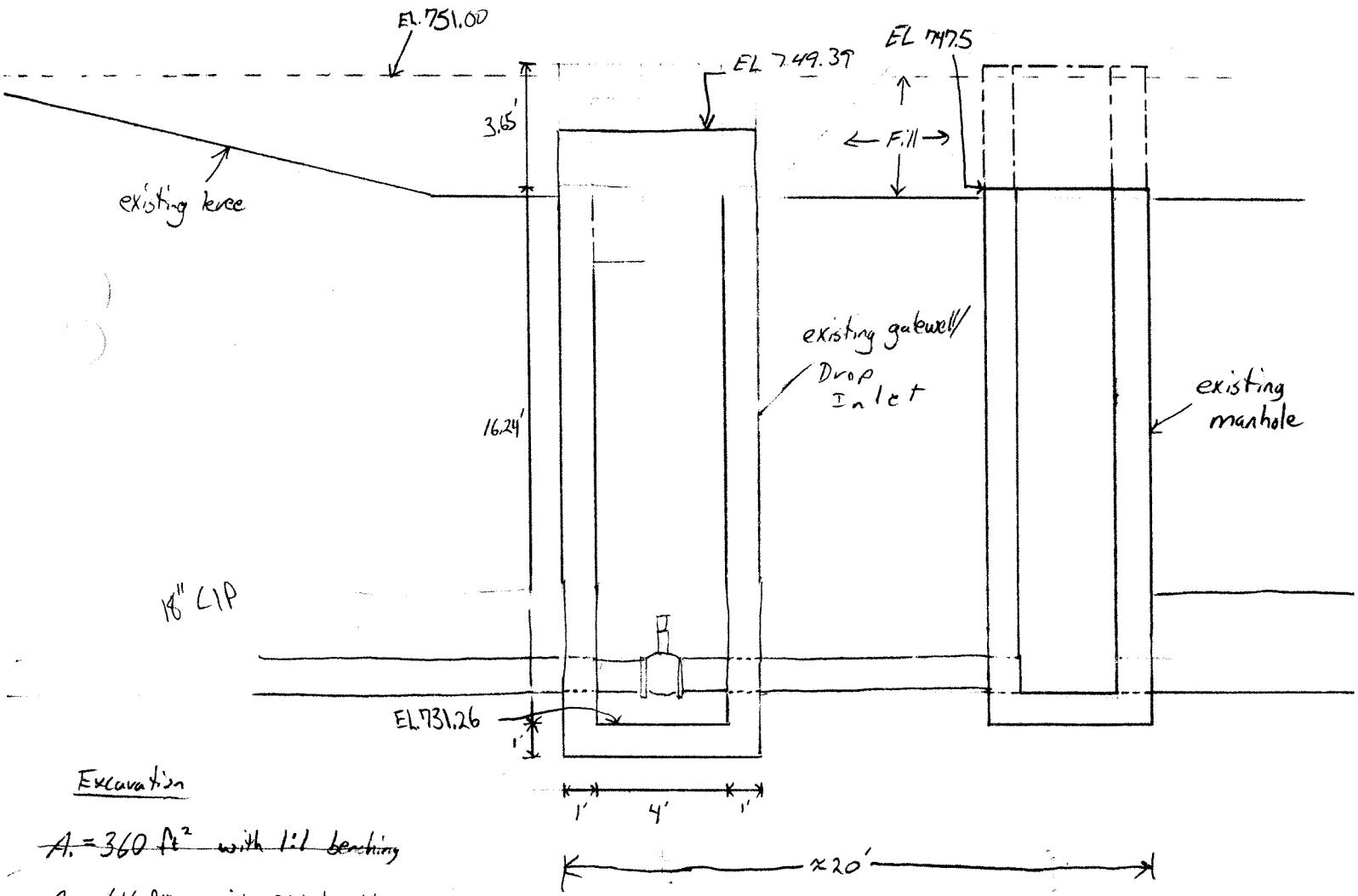
67+65
UL-27

- - - - New fill Elevation

— — — — New Structure

Assumptions

1. No asphalt or concrete pavement adjacent to gatewell.
2. Raise existing MH 4'
3. See structural Evaluation for existing Gatewell/Drop Inlet



Excavation

~~A = 360 ft² with 1:1 benching~~

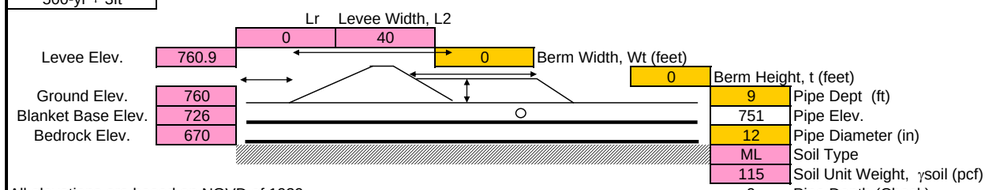
~~A = 616 ft² with 2:1 benching~~

	15,080 ft³ with 1:1 SAY 800CY AVG
~~V:~~	~~8,636 ft³ with 2:1~~

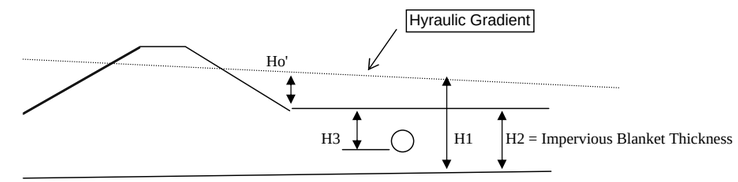
~~Include 35' of shoring to prevent excavation into toe of levee~~ - No Shoring Necessary in the Levee. Excavation will remove some of the levee.

Assuming excavation continues 15 ft past drop inlet and manhole.

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
28+00 KS	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 12 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	0.85	751	726	760	9	34	34.9	575.7	50	49	920	576	0	1.77	1.68
25	0.83	751	726	760	9	34	34.8	575.3	50	49	920	575	0	1.77	1.69
50	0.80	751	726	760	9	34	34.8	574.8	50	49	920	575	0	1.77	1.69
100	0.75	751	726	760	9	34	34.7	574.0	50	49	920	574	0	1.77	1.69
125	0.72	751	726	760	9	34	34.7	573.6	50	49	920	574	0	1.78	1.69
150	0.70	751	726	760	9	34	34.7	573.2	50	49	920	573	0	1.78	1.69
200	0.66	751	726	760	9	34	34.7	572.4	50	49	920	572	0	1.78	1.69
300	0.57	751	726	760	9	34	34.6	571.1	50	49	920	571	0	1.78	1.70
400	0.50	751	726	760	9	34	34.5	569.9	50	49	920	570	0	1.79	1.70
500	0.44	751	726	760	9	34	34.4	568.9	50	49	920	569	0	1.79	1.70

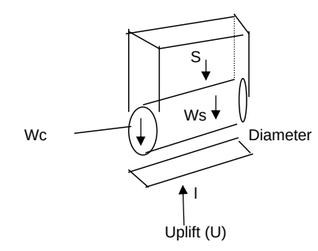
Ws Calc
12 -in steel 1lf
49.56
Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 12-inch Nom Diam Steel Pipe, OD 12.75" wall thickness .375")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((6/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 760 | Distance from toe (ft) 0 | Ws = 50 | Wc = 49 Full

Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	760	0		50	49			
9	751	920	576	50	49	1.77	1.68	-336.27
10	750	1035	640	50	49	1.77	1.70	
11	749	1150	704	50	49	1.77	1.70	
12	748	1265	768	50	49	1.78	1.71	
13	747	1380	832	50	49	1.78	1.72	
14	746	1495	896	50	49	1.78	1.72	
15	745	1610	960	50	49	1.78	1.73	
16	744	1725	1023	50	49	1.78	1.73	
17	743	1840	1087	50	49	1.78	1.74	



U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 80+54.12 M to 28+00 KS
For pipe diam (in): 12
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
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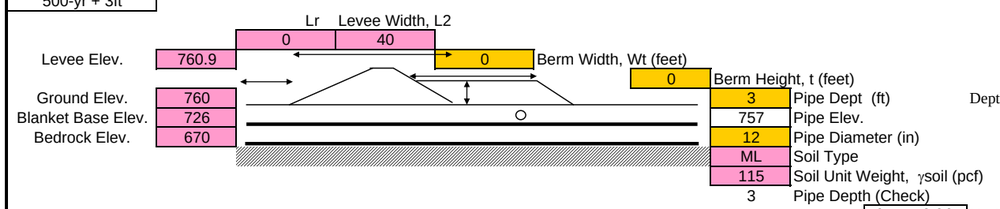
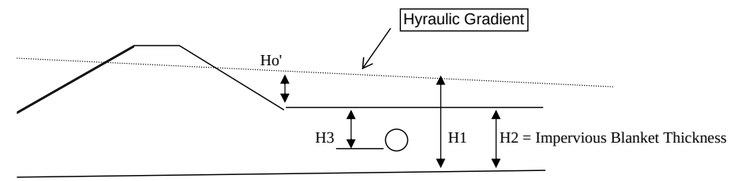
500-yr + 3ft																								



Depth Unknown assume 3'



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0	0.85	757	726	760	3	34	34.9	191.9	50	49	230	192	0	1.71	1.46
25	0.83	757	726	760	3	34	34.8	191.8	50	49	230	192	0	1.71	1.46
50	0.80	757	726	760	3	34	34.8	191.6	50	49	230	192	0	1.71	1.46
100	0.75	757	726	760	3	34	34.7	191.3	50	49	230	191	0	1.72	1.46
125	0.72	757	726	760	3	34	34.7	191.2	50	49	230	191	0	1.72	1.46
150	0.70	757	726	760	3	34	34.7	191.1	50	49	230	191	0	1.72	1.46
200	0.66	757	726	760	3	34	34.7	190.8	50	49	230	191	0	1.72	1.47
300	0.57	757	726	760	3	34	34.6	190.4	50	49	230	190	0	1.73	1.47
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Ws Calc
12 -in steel 1lf
49.56

Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = 62.58 lb per ft (16-inch Diameter Steel Pipe, .375" thick)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((6/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)^2*1*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)

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	760	0		50	49		
3	757	230	192	50	49	1.71	1.46
4	756	345	256	50	49	1.73	1.54
5	755	460	320	50	49	1.75	1.59
6	754	575	384	50	49	1.75	1.63
7	753	690	448	50	49	1.76	1.65
8	752	805	512	50	49	1.77	1.67
9	751	920	576	50	49	1.77	1.68
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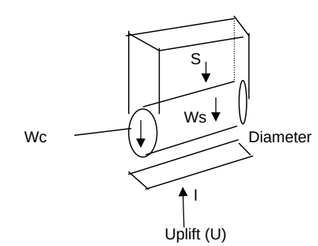

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For levee stretch: 80+54.12 M to 28+00 KS
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There is no uplift concern at a depth of 10 feet or deeper within 500 feet landward of the levee

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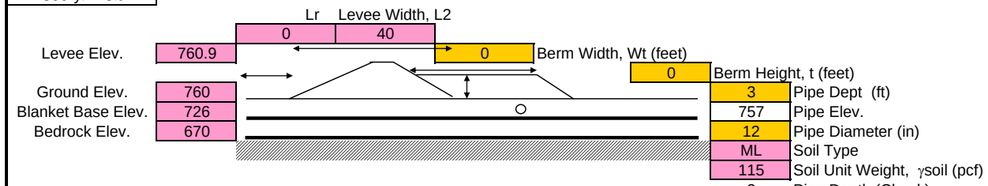

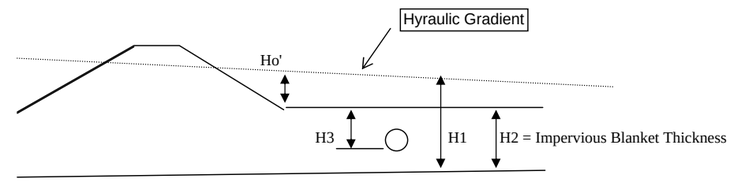

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9	751	920	576	50	49	1.77	1.68	
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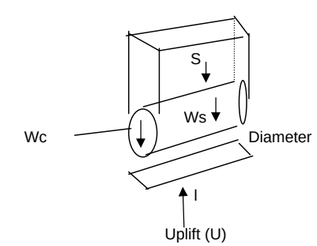

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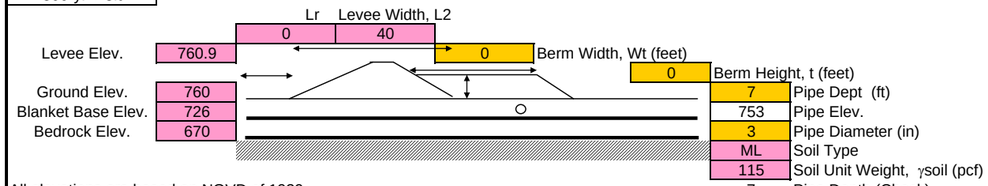
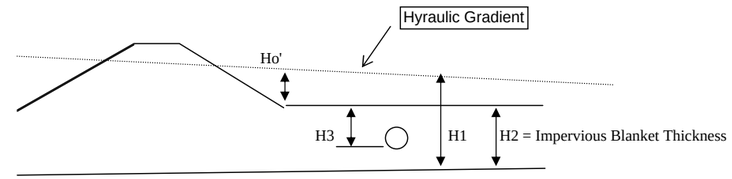
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
28+00 KS	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe ###########	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	0.85	753	726	760	7	34	34.9	447.8	9	3	194	112	0	1.84	1.82
25	0.83	753	726	760	7	34	34.8	447.4	9	3	194	112	0	1.84	1.82
50	0.80	753	726	760	7	34	34.8	447.1	9	3	194	112	0	1.85	1.82
100	0.75	753	726	760	7	34	34.7	446.4	9	3	194	112	0	1.85	1.82
125	0.72	753	726	760	7	34	34.7	446.1	9	3	194	112	0	1.85	1.82
150	0.70	753	726	760	7	34	34.7	445.8	9	3	194	111	0	1.85	1.82
200	0.66	753	726	760	7	34	34.7	445.2	9	3	194	111	0	1.85	1.83
300	0.57	753	726	760	7	34	34.6	444.2	9	3	194	111	0	1.86	1.83
400	0.50	753	726	760	7	34	34.5	443.3	9	3	194	111	0	1.86	1.83
500	0.44	753	726	760	7	34	34.4	442.5	9	3	194	111	0	1.87	1.84

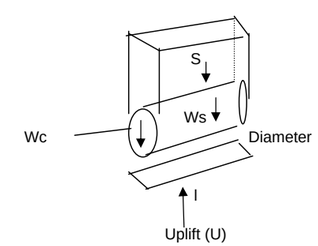
Ws Calc
3 -in concrete 1lf
9.2039

Wc Calc
3.06

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length (3-inch Internal Diam Concrete, Class 2 Nonreinforced wall thick .75")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((3/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

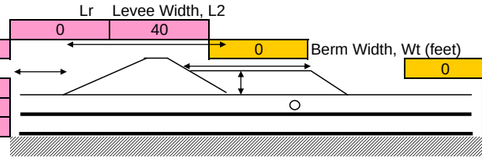
Ground Elev 760		Distance from toe (ft) 0				
	Ws = 9		Wc = 3 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**	
Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty
760	0		9	3		
753	194	112	9	3	1.84	1.82
752	223	128	9	3	1.84	1.81
751	252	144	9	3	1.83	1.81
750	280	160	9	3	1.83	1.81
749	309	176	9	3	1.83	1.81
748	338	192	9	3	1.82	1.81
747	367	208	9	3	1.82	1.81
746	395	224	9	3	1.82	1.81
745	424	240	9	3	1.82	1.81



U = P3 * diameter * l
Using l = 1

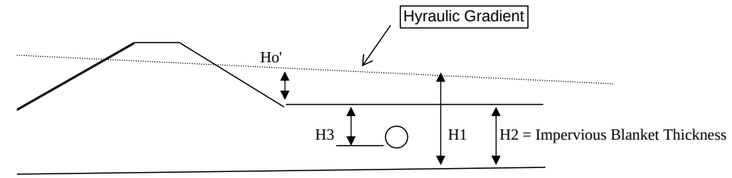
Conclusions
For levee stretch: 80+54.12 M to 28+00 KS
For pipe diam (in): 3
There is no uplift concern at a depth of 40 inches (3.3 feet) or greater within 500 feet landward of the leve

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
28+00 KS	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.

11.5 Pipe Depth (Check)



No Berm Calcs

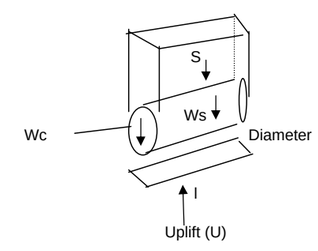
d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 66 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	0.85	748.5	726	760	11.5	34	34.9	735.6	1542	1483	3795	4046	0	1.69	1.32
25	0.83	748.5	726	760	11.5	34	34.8	735.1	1542	1483	3795	4043	0	1.69	1.32
50	0.80	748.5	726	760	11.5	34	34.8	734.5	1542	1483	3795	4040	0	1.69	1.32
100	0.75	748.5	726	760	11.5	34	34.7	733.4	1542	1483	3795	4034	0	1.69	1.32
125	0.72	748.5	726	760	11.5	34	34.7	732.9	1542	1483	3795	4031	0	1.69	1.32
150	0.70	748.5	726	760	11.5	34	34.7	732.4	1542	1483	3795	4028	0	1.69	1.32
200	0.66	748.5	726	760	11.5	34	34.7	731.4	1542	1483	3795	4023	0	1.70	1.33
300	0.57	748.5	726	760	11.5	34	34.6	729.7	1542	1483	3795	4014	0	1.70	1.33
400	0.50	748.5	726	760	11.5	34	34.5	728.2	1542	1483	3795	4005	0	1.70	1.33
500	0.44	748.5	726	760	11.5	34	34.4	726.9	1542	1483	3795	3998	0	1.71	1.33

Ws Calc 66 -in steel 1lf
1542
Wc Calc 1483

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 1542 lb/ft (66-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((33/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)^2*1*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

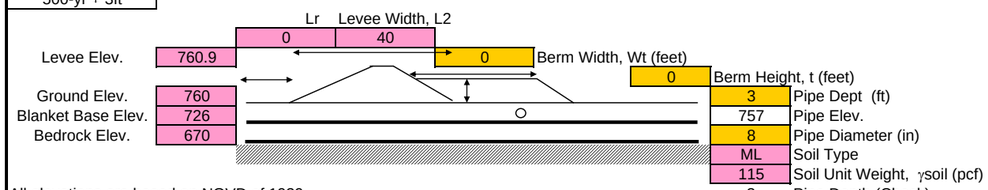
Ground Elev 760		Distance from toe (ft) 0			Uplift Safety Extreme Case (1.1 REQ'D)	
	Ws = 1542		Wc = 1483 Full			
Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty
760	0		1542	1483		
748.5	3795	4046	1542	1483	1.69	1.32
747.5	4428	4398	1542	1483	1.69	1.36
746.5	5060	4750	1542	1483	1.70	1.39
745.5	5693	5102	1542	1483	1.71	1.42
744.5	6325	5453	1542	1483	1.71	1.44
743.5	6958	5805	1542	1483	1.72	1.46
742.5	7590	6157	1542	1483	1.72	1.48
741.5	8223	6509	1542	1483	1.73	1.50
740.5	8855	6861	1542	1483	1.73	1.52



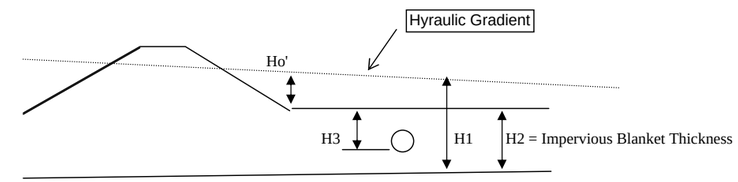
U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 80+54.12 M to 28+00 KS
For pipe diam (in): 66
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 200 feet landward of the levee
There is uplift concern at a depth of 4.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
28+00 KS	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 8 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	0.85	757	726	760	3	34	34.9	191.9	29	22	179	128	0	1.79	1.62
25	0.83	757	726	760	3	34	34.8	191.8	29	22	179	128	0	1.79	1.62
50	0.80	757	726	760	3	34	34.8	191.6	29	22	179	128	0	1.79	1.62
100	0.75	757	726	760	3	34	34.7	191.3	29	22	179	128	0	1.80	1.63
125	0.72	757	726	760	3	34	34.7	191.2	29	22	179	127	0	1.80	1.63
150	0.70	757	726	760	3	34	34.7	191.1	29	22	179	127	0	1.80	1.63
200	0.66	757	726	760	3	34	34.7	190.8	29	22	179	127	0	1.80	1.63
300	0.57	757	726	760	3	34	34.6	190.4	29	22	179	127	0	1.81	1.63
400	0.50	757	726	760	3	34	34.5	190.0	29	22	179	127	0	1.81	1.64
500	0.44	757	726	760	3	34	34.4	189.6	29	22	179	126	0	1.81	1.64

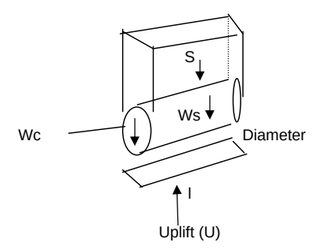
Ws Calc
8 -in steel 1lf
28.55
Wc Calc
22

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 8-inch Nom Diam Steel Pipe, OD 8.625" wall thickness .322")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((4/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 760 | Distance from toe (ft) 0 | Ws = 29 | Wc = 22 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

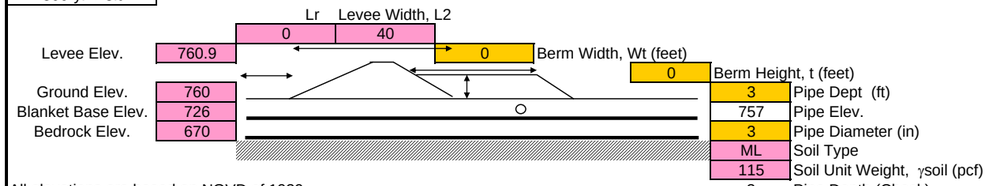
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	760	0		29	22			
3	757	179	128	29	22	1.79	1.62	-66.71
4	756	256	171	29	22	1.79	1.67	
5	755	332	213	29	22	1.79	1.69	
6	754	409	256	29	22	1.79	1.71	
7	753	486	299	29	22	1.80	1.72	
8	752	562	341	29	22	1.80	1.73	
9	751	639	384	29	22	1.80	1.74	
10	750	716	426	29	22	1.80	1.74	
11	749	792	469	29	22	1.80	1.75	



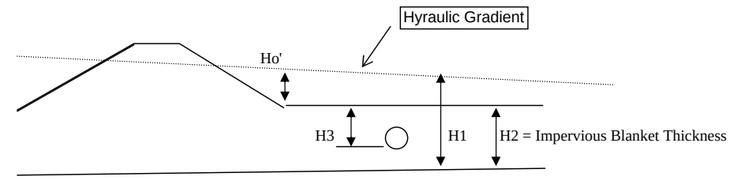
U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 80+54.12 M to 28+00 KS
For pipe diam (in): 8
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L1																							feet	
Stationing Range																								
80+54.12 MO	300	300	34	34	34	56	0.9	0.84	0	0	33.53	0	40	756	796	796	0.85	0.85	0.85	0.03	756	756	0	0.000
28+00 KS	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 3 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	0.85	757	726	760	3	34	34.9	191.9	8	3	79	48	0	1.87	1.81
25	0.83	757	726	760	3	34	34.8	191.8	8	3	79	48	0	1.87	1.81
50	0.80	757	726	760	3	34	34.8	191.6	8	3	79	48	0	1.87	1.81
100	0.75	757	726	760	3	34	34.7	191.3	8	3	79	48	0	1.88	1.81
125	0.72	757	726	760	3	34	34.7	191.2	8	3	79	48	0	1.88	1.81
150	0.70	757	726	760	3	34	34.7	191.1	8	3	79	48	0	1.88	1.81
200	0.66	757	726	760	3	34	34.7	190.8	8	3	79	48	0	1.88	1.82
300	0.57	757	726	760	3	34	34.6	190.4	8	3	79	48	0	1.88	1.82
400	0.50	757	726	760	3	34	34.5	190.0	8	3	79	47	0	1.89	1.82
500	0.44	757	726	760	3	34	34.4	189.6	8	3	79	47	0	1.89	1.83

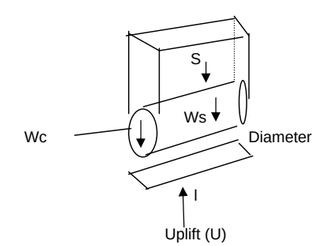
Ws Calc
3 -in steel 1lf
7.58

Wc Calc
3

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 3-inch Nom Diam Steel Pipe, OD 3.5" wall thickness .216")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((1.5/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

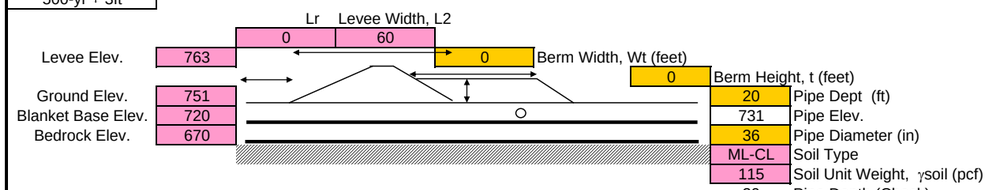
Ground Elev 760		Distance from toe (ft) 0				
	Ws = 8		Wc = 3 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**	
Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty
760	0		8	3		
757	79	48	8	3	1.87	1.81
756	108	64	8	3	1.85	1.80
755	137	80	8	3	1.84	1.80
754	165	96	8	3	1.83	1.80
753	194	112	8	3	1.83	1.80
752	223	128	8	3	1.82	1.80
751	252	144	8	3	1.82	1.80
750	280	160	8	3	1.82	1.80
749	309	176	8	3	1.82	1.80

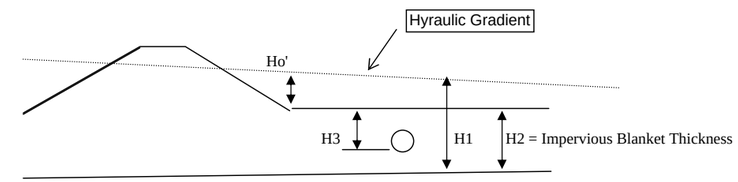


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 80+54.12 M to 28+00 KS
For pipe diam (in): 3
There is no uplift concern at a depth of 40 inches (3.3 feet) or greater within 500 feet landward of the levee

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L3																							feet	
Stationing Range																								
38+00	400	400	31	31	31	50	12	0.84	0	0	2.34	0	60	787	847	847	11.15	11.15	11.15	0.36	787	787	0	0.000
63+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 36 -in RCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	11.15	731	720	751	20	31	42.2	1696.9	524	441	5865	5091	0	1.34	1.26
25	10.80	731	720	751	20	31	41.8	1682.9	524	441	5865	5049	0	1.35	1.27
50	10.46	731	720	751	20	31	41.5	1669.3	524	441	5865	5008	0	1.36	1.28
100	9.82	731	720	751	20	31	40.8	1643.4	524	441	5865	4930	0	1.39	1.30
125	9.51	731	720	751	20	31	40.5	1631.0	524	441	5865	4893	0	1.40	1.31
150	9.22	731	720	751	20	31	40.2	1619.0	524	441	5865	4857	0	1.41	1.32
200	8.65	731	720	751	20	31	39.6	1596.2	524	441	5865	4789	0	1.43	1.33
300	7.62	731	720	751	20	31	38.6	1554.7	524	441	5865	4664	0	1.46	1.37
400	6.71	731	720	751	20	31	37.7	1518.1	524	441	5865	4554	0	1.50	1.40
500	5.91	731	720	751	20	31	36.9	1485.9	524	441	5865	4458	0	1.53	1.43

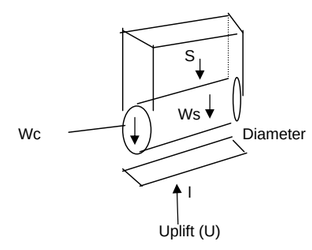
Ws Calc 36 -in RCP 1lf
524
Wc Calc 441

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 524 lb/ft (36-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 751 | Distance from toe (ft) 0 | Ws = 524 | Wc = 441 Full

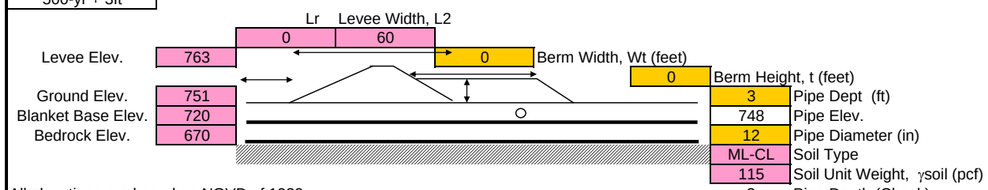
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		524	441			
20	731	5865	5091	524	441	1.34	1.26	-789.26
21	730	6210	5345	524	441	1.34	1.26	
22	729	6555	5600	524	441	1.34	1.26	
23	728	6900	5854	524	441	1.34	1.27	
24	727	7245	6109	524	441	1.34	1.27	
25	726	7590	6363	524	441	1.34	1.28	
26	725	7935	6618	524	441	1.34	1.28	
27	724	8280	6872	524	441	1.35	1.28	
28	723	8625	7127	524	441	1.35	1.28	



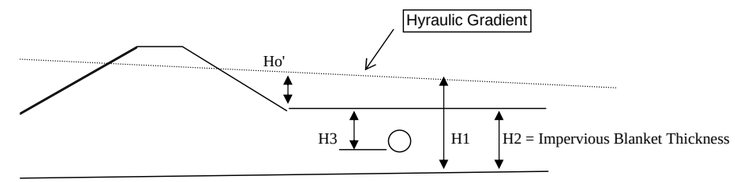
U = P3 * diameter * l

Conclusions
For levee stretch: 38+00 to 63+00
For pipe diam (in): 36

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L3																							feet	
Stationing Range																								
38+00	400	400	31	31	31	50	12	0.84	0	0	2.34	0	60	787	847	847	11.15	11.15	11.15	0.36	787	787	0	0.000
63+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

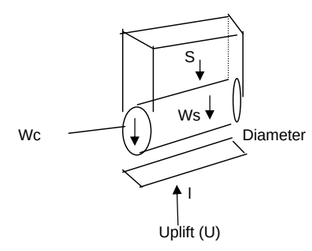
d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 12 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	11.15	748	720	751	3	31	42.2	254.5	50	49	230	255	0	1.29	1.10
25	10.80	748	720	751	3	31	41.8	252.4	50	49	230	252	0	1.30	1.11
50	10.46	748	720	751	3	31	41.5	250.4	50	49	230	250	0	1.31	1.12
100	9.82	748	720	751	3	31	40.8	246.5	50	49	230	247	0	1.33	1.13
125	9.51	748	720	751	3	31	40.5	244.6	50	49	230	245	0	1.34	1.14
150	9.22	748	720	751	3	31	40.2	242.9	50	49	230	243	0	1.35	1.15
200	8.65	748	720	751	3	31	39.6	239.4	50	49	230	239	0	1.37	1.17
300	7.62	748	720	751	3	31	38.6	233.2	50	49	230	233	0	1.41	1.20
400	6.71	748	720	751	3	31	37.7	227.7	50	49	230	228	0	1.44	1.23
500	5.91	748	720	751	3	31	36.9	222.9	50	49	230	223	0	1.47	1.25

Ws Calc
12 -in steel 1lf
49.56
Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 12-inch Nom Diam Steel Pipe, OD 12.75" wall thickness .375")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((6/12)^2) *1*62.4 = 49 pl
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

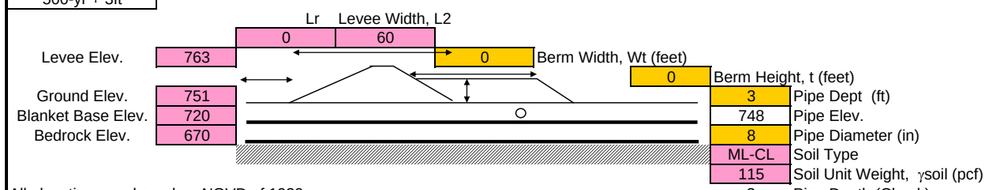
	Ground Elev 751		Distance from toe (ft) 50					
		Ws = 50		Wc = 49 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		50	49			
3	748	230	250	50	49	1.31	1.12	-4.13
4	747	345	334	50	49	1.33	1.18	
5	746	460	417	50	49	1.34	1.22	
6	745	575	501	50	49	1.35	1.25	
7	744	690	584	50	49	1.35	1.27	
8	743	805	668	50	49	1.35	1.28	
9	742	920	751	50	49	1.36	1.29	
10	741	1035	835	50	49	1.36	1.30	
11	740	1150	918	50	49	1.36	1.31	



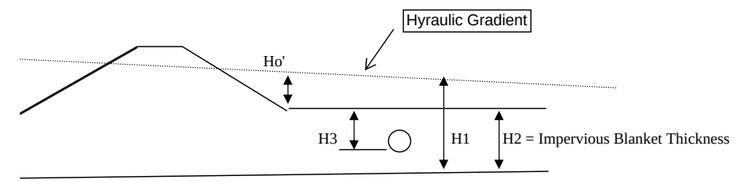
U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 38+00 to 63+00
For pipe diam (in): 12
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L3																							feet	
Stationing Range																								
38+00	400	400	31	31	31	50	12	0.84	0	0	2.34	0	60	787	847	847	11.15	11.15	11.15	0.36	787	787	0	0.000
63+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

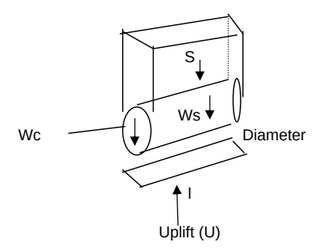
d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 8 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	11.15	748	720	751	3	31	42.2	254.5	29	22	179	170	0	1.35	1.22
25	10.80	748	720	751	3	31	41.8	252.4	29	22	179	168	0	1.36	1.23
50	10.46	748	720	751	3	31	41.5	250.4	29	22	179	167	0	1.37	1.24
100	9.82	748	720	751	3	31	40.8	246.5	29	22	179	164	0	1.39	1.26
125	9.51	748	720	751	3	31	40.5	244.6	29	22	179	163	0	1.41	1.27
150	9.22	748	720	751	3	31	40.2	242.9	29	22	179	162	0	1.42	1.28
200	8.65	748	720	751	3	31	39.6	239.4	29	22	179	160	0	1.44	1.30
300	7.62	748	720	751	3	31	38.6	233.2	29	22	179	155	0	1.47	1.33
400	6.71	748	720	751	3	31	37.7	227.7	29	22	179	152	0	1.51	1.37
500	5.91	748	720	751	3	31	36.9	222.9	29	22	179	149	0	1.54	1.40

Ws Calc
8 -in steel 1lf
28.55
Wc Calc
22

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 12-inch Nom Diam Steel Pipe, OD 8.625" wall thickness .322")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((6/12)^2) *1*62.4 = 49 pl
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

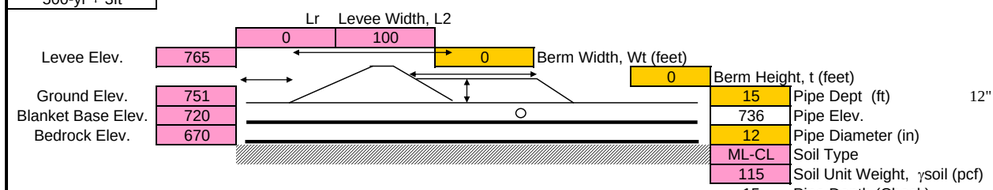
	Ground Elev 751		Distance from toe (ft) 0					
		Ws = 29		Wc = 22 Full		Uplift Safety Extreme Case (1.1 REQ'D)		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		29	22			
3	748	179	170	29	22	1.35	1.22	-20.78
4	747	256	226	29	22	1.35	1.26	
5	746	332	283	29	22	1.35	1.28	
6	745	409	339	29	22	1.35	1.29	
7	744	486	396	29	22	1.35	1.30	
8	743	562	453	29	22	1.35	1.31	
9	742	639	509	29	22	1.35	1.31	
10	741	716	566	29	22	1.35	1.32	
11	740	792	622	29	22	1.35	1.32	

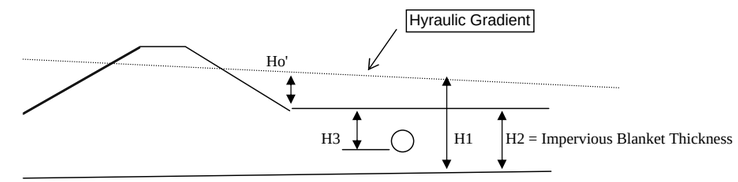


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 38+00 to 63+00
For pipe diam (in): 8
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L4																							feet	
Stationing Range																								
63+00	400	400	31	31	31	50	14	0.84	0	0	2.10	0	100	787	887	887	12.42	12.42	12.42	0.40	787	787	0	0.000
74+75	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 12 -in CIP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	12.42	736	720	751	15	31	43.4	1311.1	93	49	1610	1311	0	1.34	1.30
25	12.03	736	720	751	15	31	43.0	1299.4	93	49	1610	1299	0	1.35	1.31
50	11.66	736	720	751	15	31	42.7	1288.0	93	49	1610	1288	0	1.36	1.32
100	10.94	736	720	751	15	31	41.9	1266.3	93	49	1610	1266	0	1.38	1.34
125	10.60	736	720	751	15	31	41.6	1256.0	93	49	1610	1256	0	1.39	1.36
150	10.27	736	720	751	15	31	41.3	1246.0	93	49	1610	1246	0	1.41	1.37
200	9.64	736	720	751	15	31	40.6	1226.9	93	49	1610	1227	0	1.43	1.39
300	8.49	736	720	751	15	31	39.5	1192.2	93	49	1610	1192	0	1.47	1.43
400	7.47	736	720	751	15	31	38.5	1161.7	93	49	1610	1162	0	1.51	1.47
500	6.58	736	720	751	15	31	37.6	1134.8	93	49	1610	1135	0	1.54	1.50

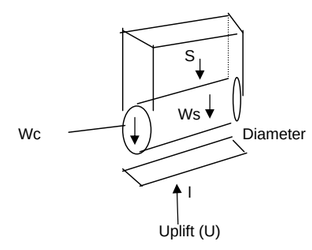
Ws Calc 12 -in CIP 1lf
93
Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 93 lb/ft (12-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 751 | Distance from toe (ft) 0 | Ws = 93 | Wc = 49 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

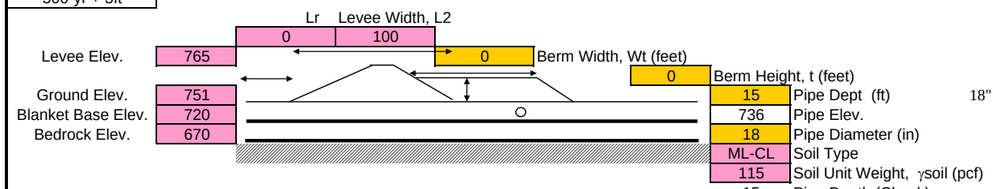
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		93	49			
15	736	1610	1311	93	49	1.34	1.30	-260.82
16	735	1725	1398	93	49	1.34	1.30	
17	734	1840	1486	93	49	1.33	1.30	
18	733	1955	1573	93	49	1.33	1.30	
19	732	2070	1661	93	49	1.33	1.30	
20	731	2185	1748	93	49	1.33	1.30	
21	730	2300	1836	93	49	1.33	1.30	
22	729	2415	1923	93	49	1.33	1.30	
23	728	2530	2010	93	49	1.33	1.30	

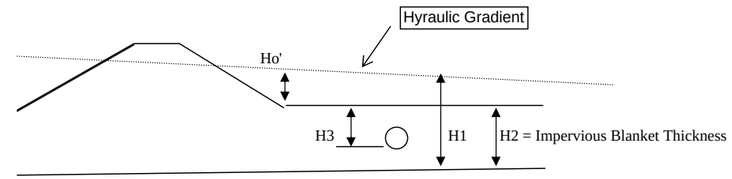


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 63+00 to 74+75
For pipe diam (in): 12
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L4																							feet	
Stationing Range																								
63+00	400	400	31	31	31	50	14	0.84	0	0	2.10	0	100	787	887	887	12.42	12.42	12.42	0.40	787	787	0	0.000
74+75	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 18 -in CIP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	12.42	736	720	751	15	31	43.4	1311.1	168	110	2329	1967	0	1.33	1.27
25	12.03	736	720	751	15	31	43.0	1299.4	168	110	2329	1949	0	1.34	1.28
50	11.66	736	720	751	15	31	42.7	1288.0	168	110	2329	1932	0	1.35	1.29
100	10.94	736	720	751	15	31	41.9	1266.3	168	110	2329	1900	0	1.37	1.31
125	10.60	736	720	751	15	31	41.6	1256.0	168	110	2329	1884	0	1.38	1.33
150	10.27	736	720	751	15	31	41.3	1246.0	168	110	2329	1869	0	1.39	1.34
200	9.64	736	720	751	15	31	40.6	1226.9	168	110	2329	1840	0	1.42	1.36
300	8.49	736	720	751	15	31	39.5	1192.2	168	110	2329	1788	0	1.46	1.40
400	7.47	736	720	751	15	31	38.5	1161.7	168	110	2329	1743	0	1.50	1.43
500	6.58	736	720	751	15	31	37.6	1134.8	168	110	2329	1702	0	1.53	1.47

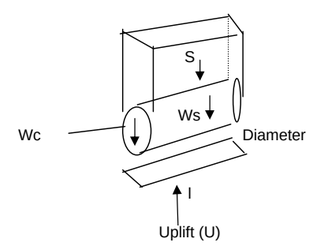
Ws Calc
18 -in CIP 1lf
168
Wc Calc
110

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length168 lb/ft (18-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 751 | Distance from toe (ft) 0 | Ws = 168 | Wc = 110 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

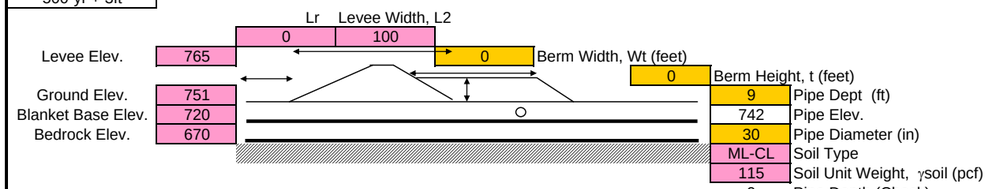
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		168	110			
15	736	2329	1967	168	110	1.33	1.27	-333.48
16	735	2501	2098	168	110	1.33	1.27	
17	734	2674	2229	168	110	1.32	1.27	
18	733	2846	2360	168	110	1.32	1.28	
19	732	3019	2491	168	110	1.32	1.28	
20	731	3191	2622	168	110	1.32	1.28	
21	730	3364	2753	168	110	1.32	1.28	
22	729	3536	2884	168	110	1.32	1.28	
23	728	3709	3015	168	110	1.32	1.29	

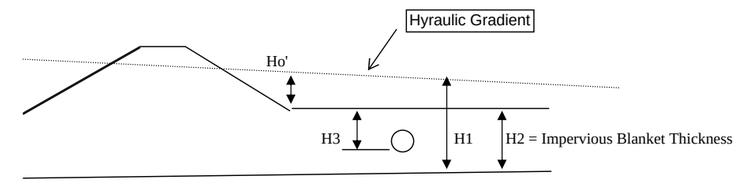


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 63+00 to 74+75
For pipe diam (in): 18
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L4																							feet	
Stationing Range																								
63+00	400	400	31	31	31	50	14	0.84	0	0	2.10	0	100	787	887	887	12.42	12.42	12.42	0.40	787	787	0	0.000
74+75	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 30 -in RCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	12.42	742	720	751	9	31	43.4	786.6	384	306	1869	1967	0	1.30	1.15
25	12.03	742	720	751	9	31	43.0	779.6	384	306	1869	1949	0	1.31	1.16
50	11.66	742	720	751	9	31	42.7	772.8	384	306	1869	1932	0	1.32	1.17
100	10.94	742	720	751	9	31	41.9	759.8	384	306	1869	1900	0	1.35	1.19
125	10.60	742	720	751	9	31	41.6	753.6	384	306	1869	1884	0	1.36	1.20
150	10.27	742	720	751	9	31	41.3	747.6	384	306	1869	1869	0	1.37	1.21
200	9.64	742	720	751	9	31	40.6	736.2	384	306	1869	1840	0	1.39	1.22
300	8.49	742	720	751	9	31	39.5	715.3	384	306	1869	1788	0	1.43	1.26
400	7.47	742	720	751	9	31	38.5	697.0	384	306	1869	1743	0	1.47	1.29
500	6.58	742	720	751	9	31	37.6	680.9	384	306	1869	1702	0	1.50	1.32

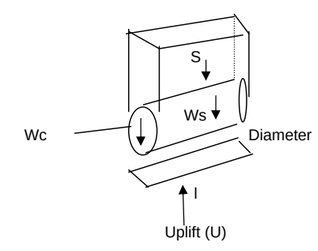
Ws Calc 30 -in RCP 1lf
384
Wc Calc 306

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 384 lb/ft (30-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 751 | Distance from toe (ft) 0 | Ws = 384 | Wc = 306 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

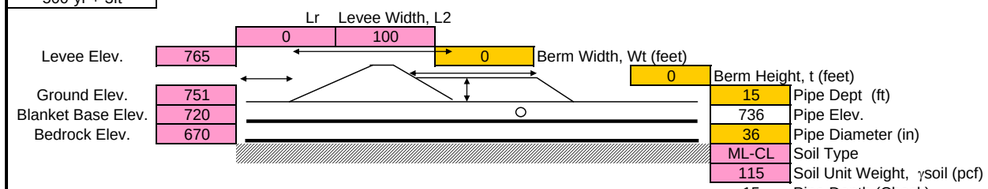
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		384	306			
9	742	1869	1967	384	306	1.30	1.15	-89.48
10	741	2156	2185	384	306	1.30	1.16	
11	740	2444	2404	384	306	1.30	1.18	
12	739	2731	2622	384	306	1.30	1.19	
13	738	3019	2841	384	306	1.31	1.20	
14	737	3306	3059	384	306	1.31	1.21	
15	736	3594	3278	384	306	1.31	1.21	
16	735	3881	3496	384	306	1.31	1.22	
17	734	4169	3715	384	306	1.31	1.23	

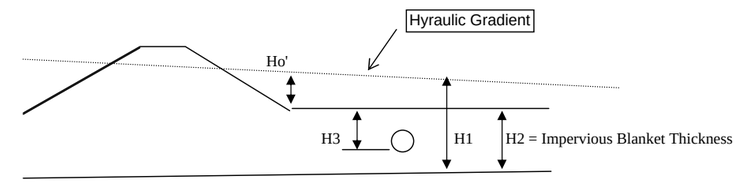


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 63+00 to 74+75
For pipe diam (in): 30
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L4																							feet	
Stationing Range																								
63+00	400	400	31	31	31	50	14	0.84	0	0	2.10	0	100	787	887	887	12.42	12.42	12.42	0.40	787	787	0	0.000
74+75	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





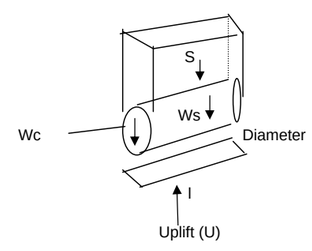
d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 36 -in RCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	12.42	736	720	751	15	31	43.4	1311.1	524	441	4140	3933	0	1.30	1.19
25	12.03	736	720	751	15	31	43.0	1299.4	524	441	4140	3898	0	1.31	1.20
50	11.66	736	720	751	15	31	42.7	1288.0	524	441	4140	3864	0	1.32	1.21
100	10.94	736	720	751	15	31	41.9	1266.3	524	441	4140	3799	0	1.34	1.23
125	10.60	736	720	751	15	31	41.6	1256.0	524	441	4140	3768	0	1.35	1.24
150	10.27	736	720	751	15	31	41.3	1246.0	524	441	4140	3738	0	1.37	1.25
200	9.64	736	720	751	15	31	40.6	1226.9	524	441	4140	3681	0	1.39	1.27
300	8.49	736	720	751	15	31	39.5	1192.2	524	441	4140	3577	0	1.43	1.30
400	7.47	736	720	751	15	31	38.5	1161.7	524	441	4140	3485	0	1.46	1.34
500	6.58	736	720	751	15	31	37.6	1134.8	524	441	4140	3404	0	1.50	1.37

Ws Calc 36 -in RCP 1lf
524
Wc Calc
441

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 524 lb/ft (36-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

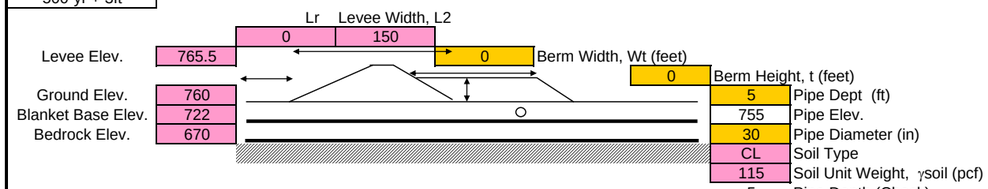
	Ground Elev 751		Distance from toe (ft) 0			Uplift Safety Extreme Case (1.1 REQ'D)		
		Ws = 524		Wc = 441 Full				
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	751	0		524	441			
15	736	4140	3933	524	441	1.30	1.19	-337.45
16	735	4485	4195	524	441	1.30	1.19	
17	734	4830	4458	524	441	1.30	1.20	
18	733	5175	4720	524	441	1.30	1.21	
19	732	5520	4982	524	441	1.30	1.21	
20	731	5865	5244	524	441	1.30	1.22	
21	730	6210	5507	524	441	1.30	1.22	
22	729	6555	5769	524	441	1.30	1.23	
23	728	6900	6031	524	441	1.30	1.23	

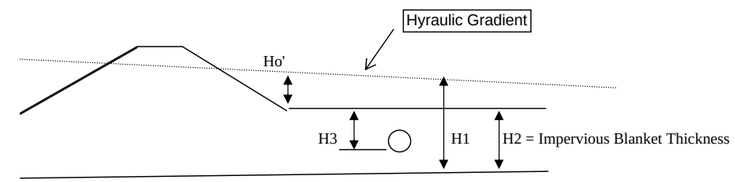


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 63+00 to 74+75
For pipe diam (in): 36
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L5																							feet	
Stationing Range																								
74+75	500	500	38	38	38	52	5.5	0.84	0	0	6.70	0	150	994	1144	1144	4.78	4.78	4.78	0.13	994	994	0	0.000
77+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





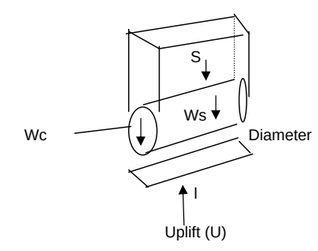
d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 30 -RCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	4.78	755	722	760	5	38	42.8	351.2	384	306	719	878	0	1.60	1.26
25	4.66	755	722	760	5	38	42.7	350.3	384	306	719	876	0	1.61	1.26
50	4.54	755	722	760	5	38	42.5	349.3	384	306	719	873	0	1.61	1.26
100	4.32	755	722	760	5	38	42.3	347.5	384	306	719	869	0	1.62	1.27
125	4.21	755	722	760	5	38	42.2	346.6	384	306	719	867	0	1.63	1.27
150	4.11	755	722	760	5	38	42.1	345.7	384	306	719	864	0	1.63	1.28
200	3.91	755	722	760	5	38	41.9	344.1	384	306	719	860	0	1.64	1.28
300	3.53	755	722	760	5	38	41.5	341.0	384	306	719	853	0	1.65	1.29
400	3.20	755	722	760	5	38	41.2	338.2	384	306	719	846	0	1.67	1.30
500	2.89	755	722	760	5	38	40.9	335.7	384	306	719	839	0	1.68	1.31

Ws Calc
30 -in RCP 1lf
384
Wc Calc
306

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 384 lb/ft (30-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

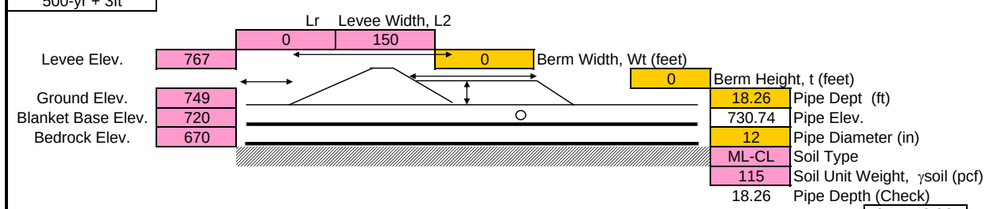
	Ground Elev 760		Distance from toe (ft) 0					
		Ws = 384		Wc = 306 Full		Uplift Safety Extreme Case (1.1 REQ'D)		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	760	0		384	306			
5	755	719	878	384	306	1.60	1.26	-136.85
6	754	1006	1054	384	306	1.61	1.32	
7	753	1294	1229	384	306	1.61	1.36	
8	752	1581	1405	384	306	1.62	1.40	
9	751	1869	1581	384	306	1.62	1.43	
10	750	2156	1756	384	306	1.62	1.45	
11	749	2444	1932	384	306	1.62	1.46	
12	748	2731	2107	384	306	1.62	1.48	
13	747	3019	2283	384	306	1.62	1.49	

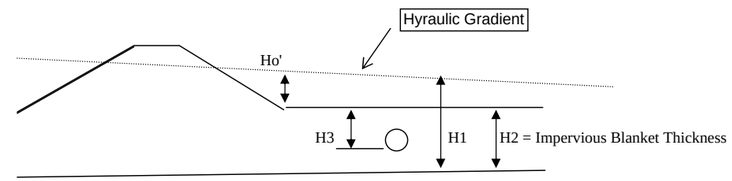


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 74+75 to 77+00
For pipe diam (in): 30
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 12 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	730.74	720	749	18.26	29	44.0	1730.3	54	49	1985	1730	0	1.21	1.18
25	14.55	730.74	720	749	18.26	29	43.6	1711.2	54	49	1985	1711	0	1.22	1.19
50	14.08	730.74	720	749	18.26	29	43.1	1692.7	54	49	1985	1693	0	1.23	1.20
100	13.19	730.74	720	749	18.26	29	42.2	1657.6	54	49	1985	1658	0	1.26	1.23
125	12.76	730.74	720	749	18.26	29	41.8	1640.8	54	49	1985	1641	0	1.27	1.24
150	12.35	730.74	720	749	18.26	29	41.3	1624.6	54	49	1985	1625	0	1.29	1.25
200	11.56	730.74	720	749	18.26	29	40.6	1593.8	54	49	1985	1594	0	1.31	1.28
300	10.14	730.74	720	749	18.26	29	39.1	1537.9	54	49	1985	1538	0	1.36	1.33
400	8.89	730.74	720	749	18.26	29	37.9	1488.9	54	49	1985	1489	0	1.40	1.37
500	7.80	730.74	720	749	18.26	29	36.8	1445.9	54	49	1985	1446	0	1.44	1.41

Ws Calc 12 -in VCP 1lf
54

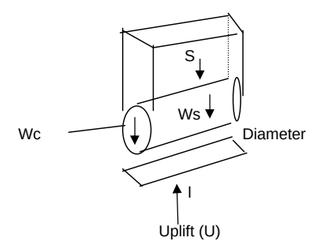
Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 54 lb/ft (12-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 749 | Distance from toe (ft) 0 | Ws = 54 | Wc = 49 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

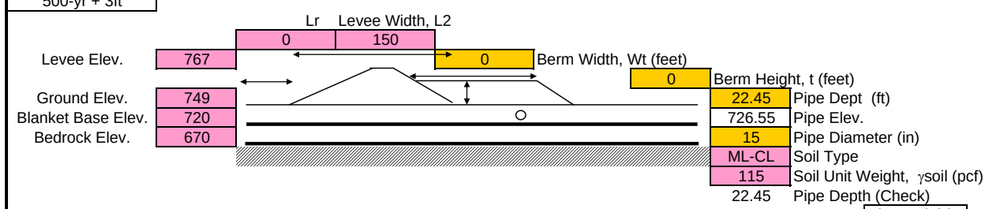
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		54	49			
18.26	730.74	1985	1730	54	49	1.21	1.18	-135.59
19.26	729.74	2100	1825	54	49	1.21	1.18	
20.26	728.74	2215	1920	54	49	1.21	1.18	
21.26	727.74	2330	2015	54	49	1.21	1.18	
22.26	726.74	2445	2109	54	49	1.21	1.18	
23.26	725.74	2560	2204	54	49	1.21	1.19	
24.26	724.74	2675	2299	54	49	1.21	1.19	
25.26	723.74	2790	2394	54	49	1.21	1.19	
26.26	722.74	2905	2488	54	49	1.21	1.19	

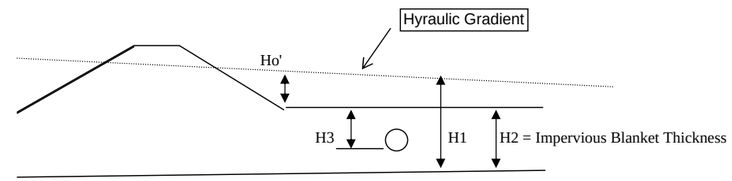


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 12
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 15 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	726.55	720	749	22.45	29	44.0	2127.3	90	77	3048	2659	0	1.21	1.18
25	14.55	726.55	720	749	22.45	29	43.6	2103.9	90	77	3048	2630	0	1.22	1.19
50	14.08	726.55	720	749	22.45	29	43.1	2081.2	90	77	3048	2601	0	1.24	1.21
100	13.19	726.55	720	749	22.45	29	42.2	2037.9	90	77	3048	2547	0	1.26	1.23
125	12.76	726.55	720	749	22.45	29	41.8	2017.4	90	77	3048	2522	0	1.27	1.24
150	12.35	726.55	720	749	22.45	29	41.3	1997.4	90	77	3048	2497	0	1.29	1.26
200	11.56	726.55	720	749	22.45	29	40.6	1959.5	90	77	3048	2449	0	1.31	1.28
300	10.14	726.55	720	749	22.45	29	39.1	1890.8	90	77	3048	2363	0	1.36	1.33
400	8.89	726.55	720	749	22.45	29	37.9	1830.5	90	77	3048	2288	0	1.40	1.37
500	7.80	726.55	720	749	22.45	29	36.8	1777.6	90	77	3048	2222	0	1.45	1.41

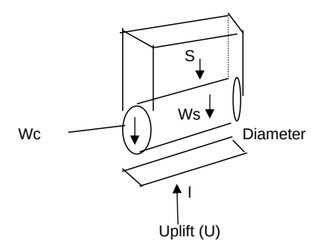
Ws Calc 15 -in VCP 1lf
90

Wc Calc
77

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 90 lb/ft (15-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

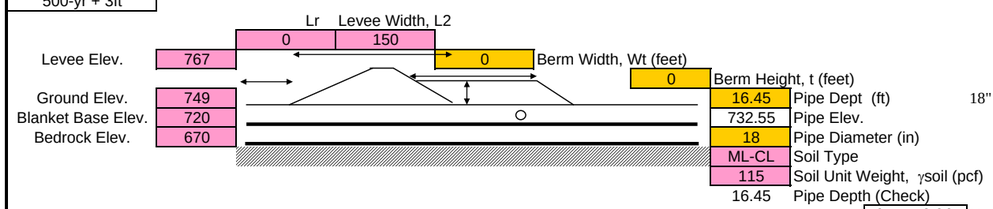
	Ground Elev 749		Distance from toe (ft) 0					
		Ws = 90		Wc = 77 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		90	77			
22.45	726.55	3048	2659	90	77	1.21	1.18	-212.44
23.45	725.55	3191	2778	90	77	1.21	1.18	
24.45	724.55	3335	2896	90	77	1.21	1.18	
25.45	723.55	3479	3014	90	77	1.21	1.18	
26.45	722.55	3623	3133	90	77	1.21	1.18	
27.45	721.55	3766	3251	90	77	1.21	1.19	
28.45	720.55	3910	3370	90	77	1.21	1.19	
29.45	719.55	4054	3488	90	77	1.21	1.19	
30.45	718.55	4198	3607	90	77	1.21	1.19	



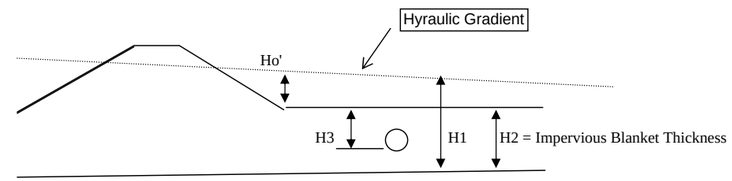
U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 15
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



18" VCP entering MH 11



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 18 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	732.55	720	749	16.45	29	44.0	1558.8	141	110	2579	2338	0	1.21	1.16
25	14.55	732.55	720	749	16.45	29	43.6	1541.6	141	110	2579	2312	0	1.22	1.18
50	14.08	732.55	720	749	16.45	29	43.1	1524.9	141	110	2579	2287	0	1.24	1.19
100	13.19	732.55	720	749	16.45	29	42.2	1493.3	141	110	2579	2240	0	1.26	1.21
125	12.76	732.55	720	749	16.45	29	41.8	1478.2	141	110	2579	2217	0	1.28	1.23
150	12.35	732.55	720	749	16.45	29	41.3	1463.6	141	110	2579	2195	0	1.29	1.24
200	11.56	732.55	720	749	16.45	29	40.6	1435.8	141	110	2579	2154	0	1.31	1.26
300	10.14	732.55	720	749	16.45	29	39.1	1385.5	141	110	2579	2078	0	1.36	1.31
400	8.89	732.55	720	749	16.45	29	37.9	1341.3	141	110	2579	2012	0	1.41	1.35
500	7.80	732.55	720	749	16.45	29	36.8	1302.5	141	110	2579	1954	0	1.45	1.39

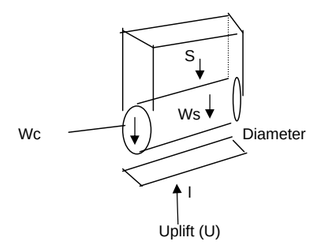
Ws Calc
18 -in VCP 1lf
141

Wc Calc
110

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 141 lb/ft (18-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

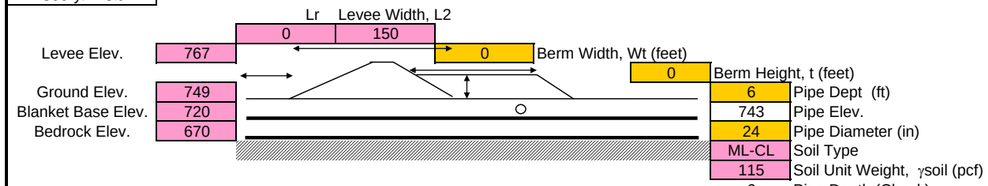
	Ground Elev 749		Distance from toe (ft) 0					
		Ws = 141		Wc = 110 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		141	110			
16.45	732.55	2579	2338	141	110	1.21	1.16	-147.91
17.45	731.55	2751	2480	141	110	1.21	1.17	
18.45	730.55	2924	2622	141	110	1.21	1.17	
19.45	729.55	3096	2765	141	110	1.21	1.17	
20.45	728.55	3269	2907	141	110	1.21	1.17	
21.45	727.55	3441	3049	141	110	1.21	1.17	
22.45	726.55	3614	3191	141	110	1.21	1.18	
23.45	725.55	3786	3333	141	110	1.21	1.18	
24.45	724.55	3959	3475	141	110	1.21	1.18	

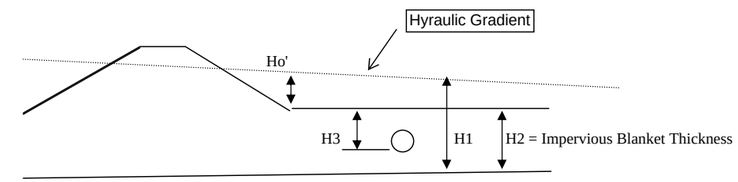


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 18
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





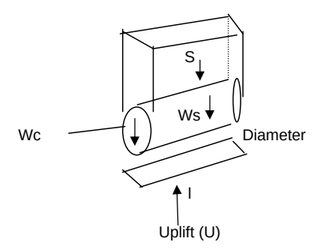
d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 24 -in CIP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	743	720	749	6	29	44.0	568.5	264	196	920	1137	0	1.21	1.04
25	14.55	743	720	749	6	29	43.6	562.3	264	196	920	1125	0	1.23	1.05
50	14.08	743	720	749	6	29	43.1	556.2	264	196	920	1112	0	1.24	1.06
100	13.19	743	720	749	6	29	42.2	544.7	264	196	920	1089	0	1.27	1.09
125	12.76	743	720	749	6	29	41.8	539.2	264	196	920	1078	0	1.28	1.10
150	12.35	743	720	749	6	29	41.3	533.8	264	196	920	1068	0	1.29	1.11
200	11.56	743	720	749	6	29	40.6	523.7	264	196	920	1047	0	1.32	1.13
300	10.14	743	720	749	6	29	39.1	505.3	264	196	920	1011	0	1.37	1.17
400	8.89	743	720	749	6	29	37.9	489.2	264	196	920	978	0	1.41	1.21
500	7.80	743	720	749	6	29	36.8	475.1	264	196	920	950	0	1.45	1.25

Ws Calc 24 -in CIP 1lf
264
Wc Calc 196

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 264 lb/ft (30-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

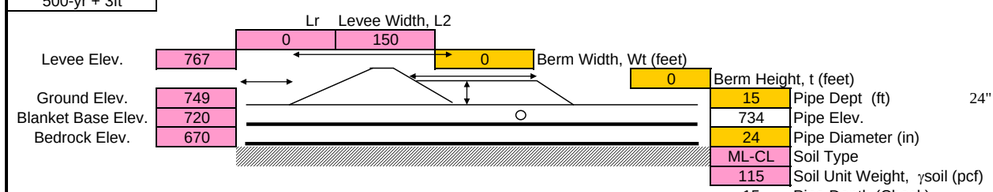
	Ground Elev 749		Distance from toe (ft) 0					
		Ws = 264		Wc = 196 Full		Uplift Safety Extreme Case (1.1 REQ'D)		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		264	196			
6	743	920	1137	264	196	1.21	1.04	66.80
7	742	1150	1327	264	196	1.21	1.07	
8	741	1380	1516	264	196	1.21	1.08	
9	740	1610	1706	264	196	1.21	1.10	
10	739	1840	1895	264	196	1.21	1.11	
11	738	2070	2085	264	196	1.21	1.12	
12	737	2300	2274	264	196	1.21	1.13	
13	736	2530	2464	264	196	1.21	1.13	
14	735	2760	2653	264	196	1.21	1.14	

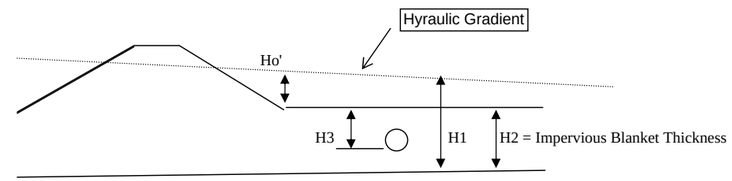


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 24
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 24 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	734	720	749	15	29	44.0	1421.4	230	196	2990	2843	0	1.20	1.13
25	14.55	734	720	749	15	29	43.6	1405.7	230	196	2990	2811	0	1.22	1.15
50	14.08	734	720	749	15	29	43.1	1390.5	230	196	2990	2781	0	1.23	1.16
100	13.19	734	720	749	15	29	42.2	1361.6	230	196	2990	2723	0	1.25	1.18
125	12.76	734	720	749	15	29	41.8	1347.9	230	196	2990	2696	0	1.27	1.19
150	12.35	734	720	749	15	29	41.3	1334.6	230	196	2990	2669	0	1.28	1.21
200	11.56	734	720	749	15	29	40.6	1309.3	230	196	2990	2619	0	1.30	1.23
300	10.14	734	720	749	15	29	39.1	1263.3	230	196	2990	2527	0	1.35	1.27
400	8.89	734	720	749	15	29	37.9	1223.1	230	196	2990	2446	0	1.40	1.32
500	7.80	734	720	749	15	29	36.8	1187.7	230	196	2990	2375	0	1.44	1.36

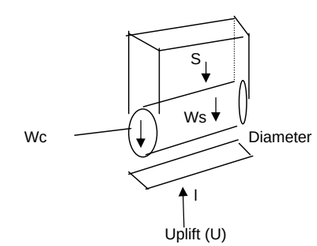
Ws Calc 24 -in VCP 1lf
230

Wc Calc
196

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 230 lb/ft (24-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

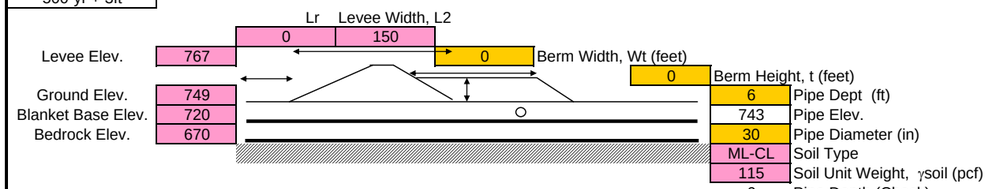
	Ground Elev 749		Distance from toe (ft) 0					
		Ws = 230		Wc = 196 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		230	196			
15	734	2990	2843	230	196	1.20	1.13	-92.99
16	733	3220	3032	230	196	1.20	1.14	
17	732	3450	3222	230	196	1.20	1.14	
18	731	3680	3411	230	196	1.20	1.15	
19	730	3910	3601	230	196	1.20	1.15	
20	729	4140	3790	230	196	1.20	1.15	
21	728	4370	3980	230	196	1.21	1.16	
22	727	4600	4169	230	196	1.21	1.16	
23	726	4830	4359	230	196	1.21	1.16	

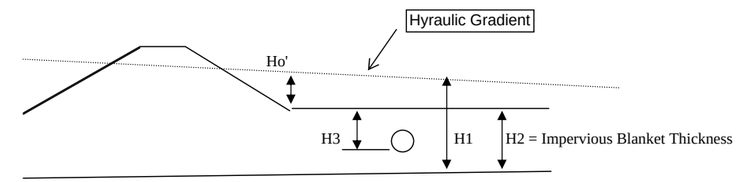


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 24
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





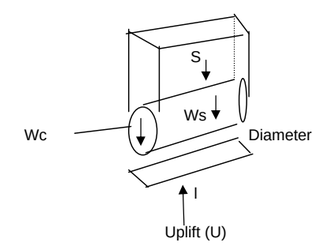
d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 30 -in CIP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	743	720	749	6	29	44.0	568.5	384	306	1006	1421	0	1.19	0.98
25	14.55	743	720	749	6	29	43.6	562.3	384	306	1006	1406	0	1.21	0.99
50	14.08	743	720	749	6	29	43.1	556.2	384	306	1006	1391	0	1.22	1.00
100	13.19	743	720	749	6	29	42.2	544.7	384	306	1006	1362	0	1.25	1.02
125	12.76	743	720	749	6	29	41.8	539.2	384	306	1006	1348	0	1.26	1.03
150	12.35	743	720	749	6	29	41.3	533.8	384	306	1006	1335	0	1.27	1.04
200	11.56	743	720	749	6	29	40.6	523.7	384	306	1006	1309	0	1.30	1.06
300	10.14	743	720	749	6	29	39.1	505.3	384	306	1006	1263	0	1.34	1.10
400	8.89	743	720	749	6	29	37.9	489.2	384	306	1006	1223	0	1.39	1.14
500	7.80	743	720	749	6	29	36.8	475.1	384	306	1006	1188	0	1.43	1.17

Ws Calc 30 -in CIP 1lf
384
Wc Calc 306

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 384 lb/ft (30-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

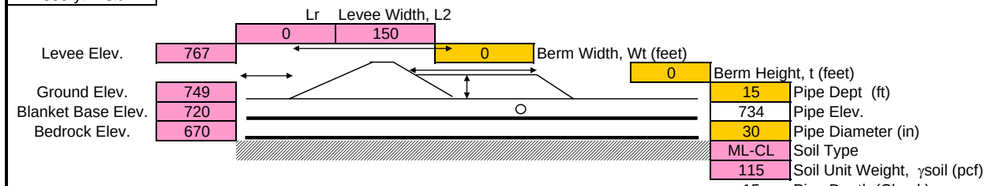
	Ground Elev 749		Distance from toe (ft) 140					
		Ws = 384		Wc = 306 Full		Uplift Safety Extreme Case (1.1 REQ'D)		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		384	306			
6	743	1006	1340	384	306	1.27	1.04	83.60
7	742	1294	1563	384	306	1.27	1.07	
8	741	1581	1786	384	306	1.27	1.10	
9	740	1869	2010	384	306	1.27	1.12	
10	739	2156	2233	384	306	1.27	1.14	
11	738	2444	2456	384	306	1.28	1.15	
12	737	2731	2680	384	306	1.28	1.16	
13	736	3019	2903	384	306	1.28	1.17	
14	735	3306	3126	384	306	1.28	1.18	

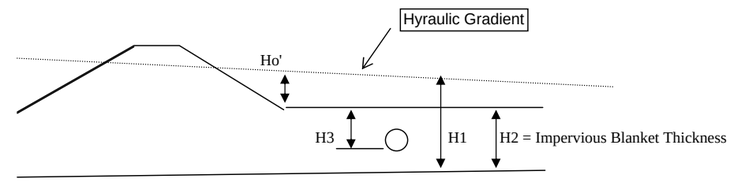


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 30
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 30 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	734	720	749	15	29	44.0	1421.4	333	306	3594	3553	0	1.19	1.11
25	14.55	734	720	749	15	29	43.6	1405.7	333	306	3594	3514	0	1.20	1.12
50	14.08	734	720	749	15	29	43.1	1390.5	333	306	3594	3476	0	1.22	1.13
100	13.19	734	720	749	15	29	42.2	1361.6	333	306	3594	3404	0	1.24	1.15
125	12.76	734	720	749	15	29	41.8	1347.9	333	306	3594	3370	0	1.26	1.17
150	12.35	734	720	749	15	29	41.3	1334.6	333	306	3594	3336	0	1.27	1.18
200	11.56	734	720	749	15	29	40.6	1309.3	333	306	3594	3273	0	1.29	1.20
300	10.14	734	720	749	15	29	39.1	1263.3	333	306	3594	3158	0	1.34	1.24
400	8.89	734	720	749	15	29	37.9	1223.1	333	306	3594	3058	0	1.38	1.28
500	7.80	734	720	749	15	29	36.8	1187.7	333	306	3594	2969	0	1.43	1.32

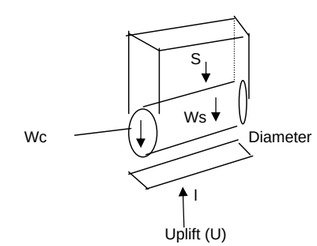
Ws Calc 30 -in VCP 1lf
333

Wc Calc
306

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 333 lb/ft (30-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

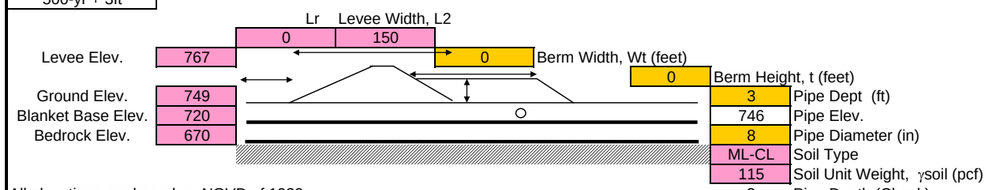
	Ground Elev 749		Distance from toe (ft) 0					
		Ws = 333		Wc = 306 Full		Uplift Safety Extreme Case **(1.1 REQ'D)**		
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		333	306			
15	734	3594	3553	333	306	1.19	1.11	-17.99
16	733	3881	3790	333	306	1.19	1.11	
17	732	4169	4027	333	306	1.19	1.12	
18	731	4456	4264	333	306	1.19	1.12	
19	730	4744	4501	333	306	1.20	1.13	
20	729	5031	4738	333	306	1.20	1.13	
21	728	5319	4975	333	306	1.20	1.14	
22	727	5606	5212	333	306	1.20	1.14	
23	726	5894	5449	333	306	1.20	1.14	



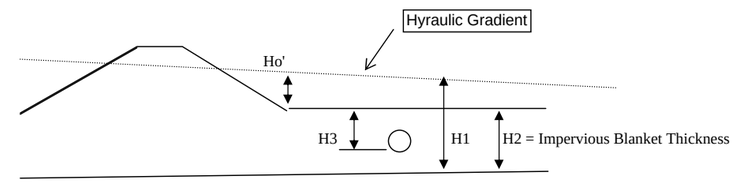
U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 30
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L6																							feet	
Stationing Range																								
77+00	400	400	29	29	29	50	18	0.84	0	0	1.63	0	150	762	912	912	15.04	15.04	15.04	0.52	762	762	0	0.000
97+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								



All elevations are based on NGVD of 1929.



No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 8 -in steel	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	15.04	746	720	749	3	29	44.0	284.3	29	22	179	190	0	1.21	1.09
25	14.55	746	720	749	3	29	43.6	281.1	29	22	179	187	0	1.22	1.11
50	14.08	746	720	749	3	29	43.1	278.1	29	22	179	185	0	1.24	1.12
100	13.19	746	720	749	3	29	42.2	272.3	29	22	179	182	0	1.26	1.14
125	12.76	746	720	749	3	29	41.8	269.6	29	22	179	180	0	1.28	1.15
150	12.35	746	720	749	3	29	41.3	266.9	29	22	179	178	0	1.29	1.17
200	11.56	746	720	749	3	29	40.6	261.9	29	22	179	175	0	1.31	1.19
300	10.14	746	720	749	3	29	39.1	252.7	29	22	179	168	0	1.36	1.23
400	8.89	746	720	749	3	29	37.9	244.6	29	22	179	163	0	1.41	1.27
500	7.80	746	720	749	3	29	36.8	237.5	29	22	179	158	0	1.45	1.31

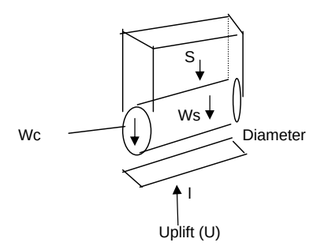
Ws Calc
8 -in steel 1lf
28.55
Wc Calc
22

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length = based on 8-inch Nom Diam Steel Pipe, OD 8.625" wall thickness .322")
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((4/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 749 | Distance from toe (ft) 0 | Ws = 29 | Wc = 22 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

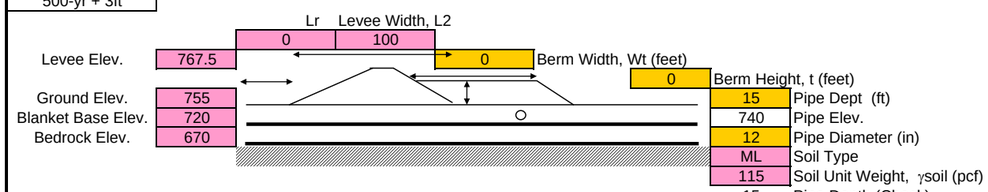
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	749	0		29	22			
3	746	179	190	29	22	1.21	1.09	1.02
4	745	256	253	29	22	1.21	1.12	
5	744	332	316	29	22	1.21	1.14	
6	743	409	379	29	22	1.21	1.15	
7	742	486	442	29	22	1.21	1.16	
8	741	562	505	29	22	1.21	1.17	
9	740	639	569	29	22	1.21	1.17	
10	739	716	632	29	22	1.21	1.18	
11	738	792	695	29	22	1.21	1.18	

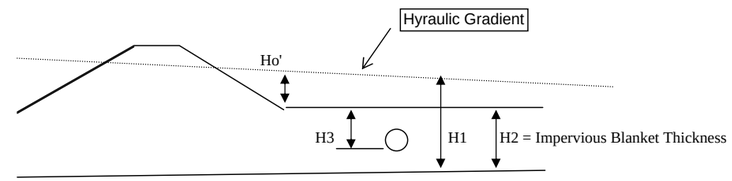


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 77+00 to 97+00
For pipe diam (in): 8
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L7																							feet	
Stationing Range																								
97+00	300	300	35	35	35	50	12.5	0.84	0	0	2.69	0	100	725	825	825	10.98	10.98	10.98	0.31	725	725	0	0.000
107+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 12 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	10.98	740	720	755	15	35	46.0	1229.7	54	49	1610	1230	0	1.39	1.35
25	10.61	740	720	755	15	35	45.6	1219.8	54	49	1610	1220	0	1.40	1.36
50	10.25	740	720	755	15	35	45.3	1210.2	54	49	1610	1210	0	1.42	1.38
100	9.57	740	720	755	15	35	44.6	1191.9	54	49	1610	1192	0	1.44	1.40
125	9.24	740	720	755	15	35	44.2	1183.2	54	49	1610	1183	0	1.45	1.41
150	8.93	740	720	755	15	35	43.9	1174.8	54	49	1610	1175	0	1.46	1.42
200	8.33	740	720	755	15	35	43.3	1158.9	54	49	1610	1159	0	1.48	1.44
300	7.26	740	720	755	15	35	42.3	1130.2	54	49	1610	1130	0	1.52	1.47
400	6.32	740	720	755	15	35	41.3	1105.1	54	49	1610	1105	0	1.55	1.51
500	5.51	740	720	755	15	35	40.5	1083.3	54	49	1610	1083	0	1.58	1.54

Ws Calc 12 -in VCP 1lf
54

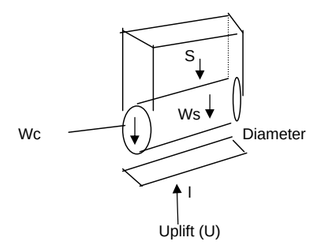
Wc Calc
49

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 54 lb/ft (36-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 755 | Distance from toe (ft) 0 | Ws = 54 | Wc = 49 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

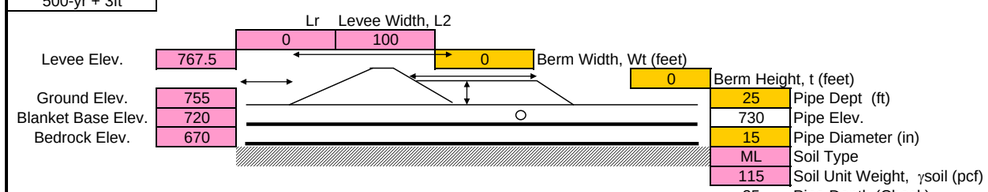
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	755	0		54	49			
15	740	1610	1230	54	49	1.39	1.35	-311.28
16	739	1725	1312	54	49	1.39	1.36	
17	738	1840	1394	54	49	1.39	1.36	
18	737	1955	1476	54	49	1.39	1.36	
19	736	2070	1558	54	49	1.40	1.36	
20	735	2185	1640	54	49	1.40	1.37	
21	734	2300	1722	54	49	1.40	1.37	
22	733	2415	1804	54	49	1.40	1.37	
23	732	2530	1886	54	49	1.40	1.37	

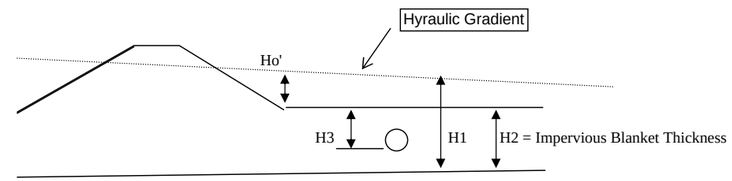


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 97+00 to 107+00
For pipe diam (in): 12
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L7																							feet	
Stationing Range																								
97+00	300	300	35	35	35	50	12.5	0.84	0	0	2.69	0	100	725	825	825	10.98	10.98	10.98	0.31	725	725	0	0.000
107+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





No Berm Calcs

d=Landside Distance from Toe Feet	Excess Head Feet, Ho'	Invert Elev of pipe 15 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	10.98	730	720	755	25	35	46.0	2049.6	90	77	3414	2562	0	1.40	1.37
25	10.61	730	720	755	25	35	45.6	2033.0	90	77	3414	2541	0	1.41	1.38
50	10.25	730	720	755	25	35	45.3	2016.9	90	77	3414	2521	0	1.42	1.39
100	9.57	730	720	755	25	35	44.6	1986.5	90	77	3414	2483	0	1.44	1.41
125	9.24	730	720	755	25	35	44.2	1972.0	90	77	3414	2465	0	1.45	1.42
150	8.93	730	720	755	25	35	43.9	1958.0	90	77	3414	2448	0	1.46	1.43
200	8.33	730	720	755	25	35	43.3	1931.5	90	77	3414	2414	0	1.48	1.45
300	7.26	730	720	755	25	35	42.3	1883.6	90	77	3414	2354	0	1.52	1.49
400	6.32	730	720	755	25	35	41.3	1841.9	90	77	3414	2302	0	1.56	1.52
500	5.51	730	720	755	25	35	40.5	1805.5	90	77	3414	2257	0	1.59	1.55

Ws Calc 15 -in VCP 1lf
90

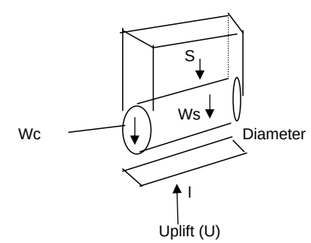
Wc Calc
77

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 90 lb/ft (15-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 755 | Distance from toe (ft) 0 | Ws = 90 | Wc = 77 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

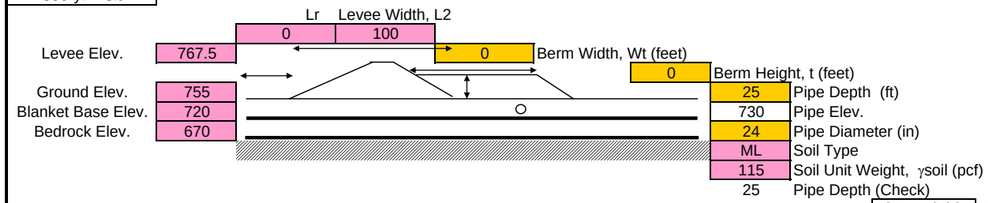
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	755	0		90	77			
25	730	3414	2562	90	77	1.40	1.37	-685.90
26	729	3558	2664	90	77	1.40	1.37	
27	728	3702	2767	90	77	1.40	1.37	
28	727	3845	2869	90	77	1.40	1.37	
29	726	3989	2972	90	77	1.40	1.37	
30	725	4133	3074	90	77	1.40	1.37	
31	724	4277	3177	90	77	1.40	1.37	
32	723	4420	3279	90	77	1.40	1.38	
33	722	4564	3382	90	77	1.40	1.38	

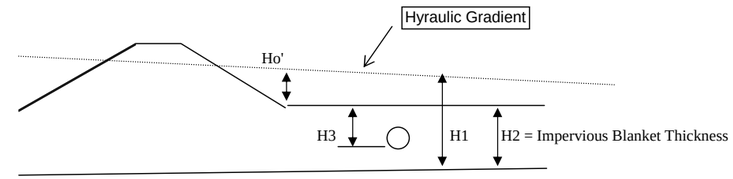


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 97+00 to 107+00
For pipe diam (in): 15
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

Armourdale Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L7																							feet	
Stationing Range																								
97+00	300	300	35	35	35	50	12.5	0.84	0	0	2.69	0	100	725	825	825	10.98	10.98	10.98	0.31	725	725	0	0.000
107+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 24 -in VCP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	10.98	730	720	755	25	35	46.0	2049.6	230	196	5290	4099	0	1.39	1.35
25	10.61	730	720	755	25	35	45.6	2033.0	230	196	5290	4066	0	1.41	1.36
50	10.25	730	720	755	25	35	45.3	2016.9	230	196	5290	4034	0	1.42	1.37
100	9.57	730	720	755	25	35	44.6	1986.5	230	196	5290	3973	0	1.44	1.39
125	9.24	730	720	755	25	35	44.2	1972.0	230	196	5290	3944	0	1.45	1.40
150	8.93	730	720	755	25	35	43.9	1958.0	230	196	5290	3916	0	1.46	1.41
200	8.33	730	720	755	25	35	43.3	1931.5	230	196	5290	3863	0	1.48	1.43
300	7.26	730	720	755	25	35	42.3	1883.6	230	196	5290	3767	0	1.52	1.47
400	6.32	730	720	755	25	35	41.3	1841.9	230	196	5290	3684	0	1.55	1.50
500	5.51	730	720	755	25	35	40.5	1805.5	230	196	5290	3611	0	1.58	1.53

Ws Calc 24 -in VCP 1lf
230

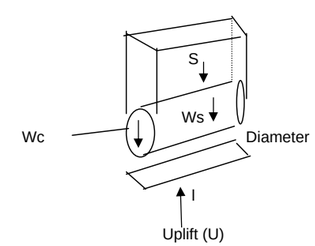
Wc Calc
196

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 230 lb/ft (24-inch Diameter, Standard Bell & Spigot VCP Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 755 | Distance from toe (ft) 0 | Ws = 230 | Wc = 196 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

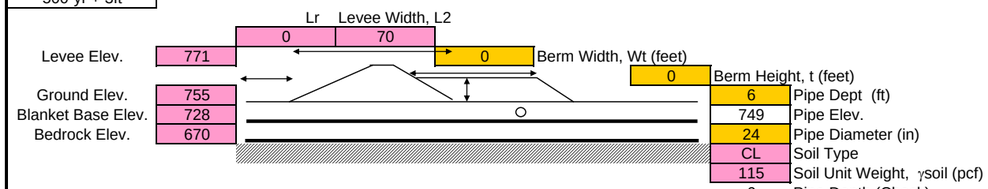
Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	755	0		230	196			
25	730	5290	4099	230	196	1.39	1.35	-1010.93
26	729	5520	4263	230	196	1.39	1.35	
27	728	5750	4427	230	196	1.40	1.35	
28	727	5980	4591	230	196	1.40	1.35	
29	726	6210	4755	230	196	1.40	1.35	
30	725	6440	4919	230	196	1.40	1.36	
31	724	6670	5083	230	196	1.40	1.36	
32	723	6900	5247	230	196	1.40	1.36	
33	722	7130	5411	230	196	1.40	1.36	

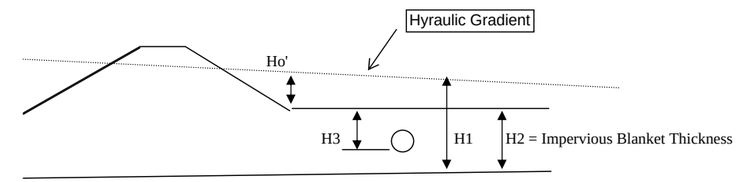


U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 97+00 to 107+00
For pipe diam (in): 24
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe

CID-KS Area	K-r	K-L	DbL	Dbo	Dbr	Df	H	i-c	Lr	Wt	Safety	L1	L2	Le	Lt	L't	Ho'	Hwt/2	Hwt	i-o	Cr	Cl	t	s
L10																							feet	
Stationing Range																								
127+00	500	500	27	27	27	58	16	0.84	0	0	1.54	0	70	885	955	955	11.50	14.83	14.83	0.55	885	885	0	0.000
168+00	Geotechnical data (above) presented in this spreadsheet was provided by Geotechnical Engineers and is used to develop the Hydraulic Gradient at various distances from the toe.																							
500-yr + 3ft																								





d=Landside Distance from Toe Feet	No Berm Calcs Excess Head Feet, Ho'	Invert Elev of pipe 24 -in CIP	Design Base Blanket Feet, MSL	Ground Elev Feet, MSL	H3 Feet	H2 Feet	H1 Feet	P3 Psf	Ws lb	Wc lb	S lb	U lb	Wg lb	SFf (Full)	SFf (Empty)
0	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
25	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
50	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
100	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
125	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
150	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
200	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
300	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
400	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11
500	11.50	749	728	755	6	27	38.5	533.9	264	196	920	1068	0	1.29	1.11

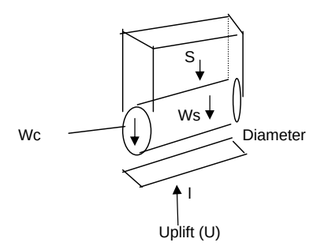
Ws Calc 24 -in CIP 1lf
264
Wc Calc 196

See Sample Calculations for list of abbreviations and sample calculations
Ws = weight of structure per foot of length 264 lb/ft (30-inch Diameter, Class B, based on Concrete Pipe Design Manual)
Wc = weight of water contained in the structure = pi * r^2 * 1 = 3.1416*((18/12)^2) *1*62.4
S = surcharge loads = weight of satuarted soils above = (H3-Pipe Diameter/12)*(Pipe Diameter/12)*1*γsoil
P3 = H3*(H1/H2)*γwater
U = Uplift force on the project area of structure = Area of pipe * P3 = (Pipe Diameter/12)'*1'*P3
Wg = weight of surcharge water above top surface of structure control by gravity flow
SFf = Flotation Safety Factor (Ws+Wc+S)/(U-Wg)
Ca = Weight of concrete anchor needed to prevent uplift per linear foot

Use this table to determine the distance from toe at which the Safety Factor is me
Enter the Distance from toe and change the value until the SFf is equal to that required

Ground Elev 755 | Distance from toe (ft) 0 | Ws = 264 | Wc = 196 Full | Uplift Safety Extreme Case **(1.1 REQ'D)**

Depth Below Ground	Pipe Inv Elev, Ft	Surcharge Load, S, lbs/ft	Uplift (U) Force, lbs/ft	Pipe Weight, Lbs/ft	Full water Wt, Lbs / ft	SFf Full	SFf Empty	Ca Lbs/ft
	755	0		264	196			
6	749	920	1068	264	196	1.29	1.11	-9.49
7	748	1150	1246	264	196	1.29	1.14	
8	747	1380	1424	264	196	1.29	1.15	
9	746	1610	1602	264	196	1.29	1.17	
10	745	1840	1780	264	196	1.29	1.18	
11	744	2070	1958	264	196	1.29	1.19	
12	743	2300	2135	264	196	1.29	1.20	
13	742	2530	2313	264	196	1.29	1.21	
14	741	2760	2491	264	196	1.29	1.21	



U = P3 * diameter * l
Using l = 1

Conclusions
For levee stretch: 127+00 to 168+00
For pipe diam (in): 24
There is uplift concern at a depth of 40 inches (3.3 feet) and less within 500 feet landward of the levee
There is uplift concern at a depth of 8.33 feet and less at the landward toe