A Trenchless Approach to Lift Station Elimination

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AGENDA

- Project Background
- Preliminary Investigations
- Final Design Approach
- Construction / Lessons Learned
- Conclusion / Status

PROJECT BACKGROUND

- Decommission Failing Garland Wynn Joyce Duplex Lift Station
- Original Study Completed in 2004
  - Required 4,250 LF of Pipeline
  - 3,500 LF Required Trenchless Installation Methods
  - Determined Current Trenchless Technology Could Not Meet Grade Requirements
  - City Chose to Shelf Project and Continue Lift Station Maintenance
- Revisited Study in 2014
  - Determined Trenchless Technology had Advanced and Proceeded with Alignment Study & Final Design

PRELIMINARY INVESTIGATIONS

Horizontal Alignment Analysis

- City Requested Installation within Wynn Joyce ROW
- Two Alignment Options
- Redirect Flow to Existing Downstream 15” Wastewater Main
- Protect Neighboring Development
- Provide Staging and Setup Areas

PRELIMINARY INVESTIGATIONS

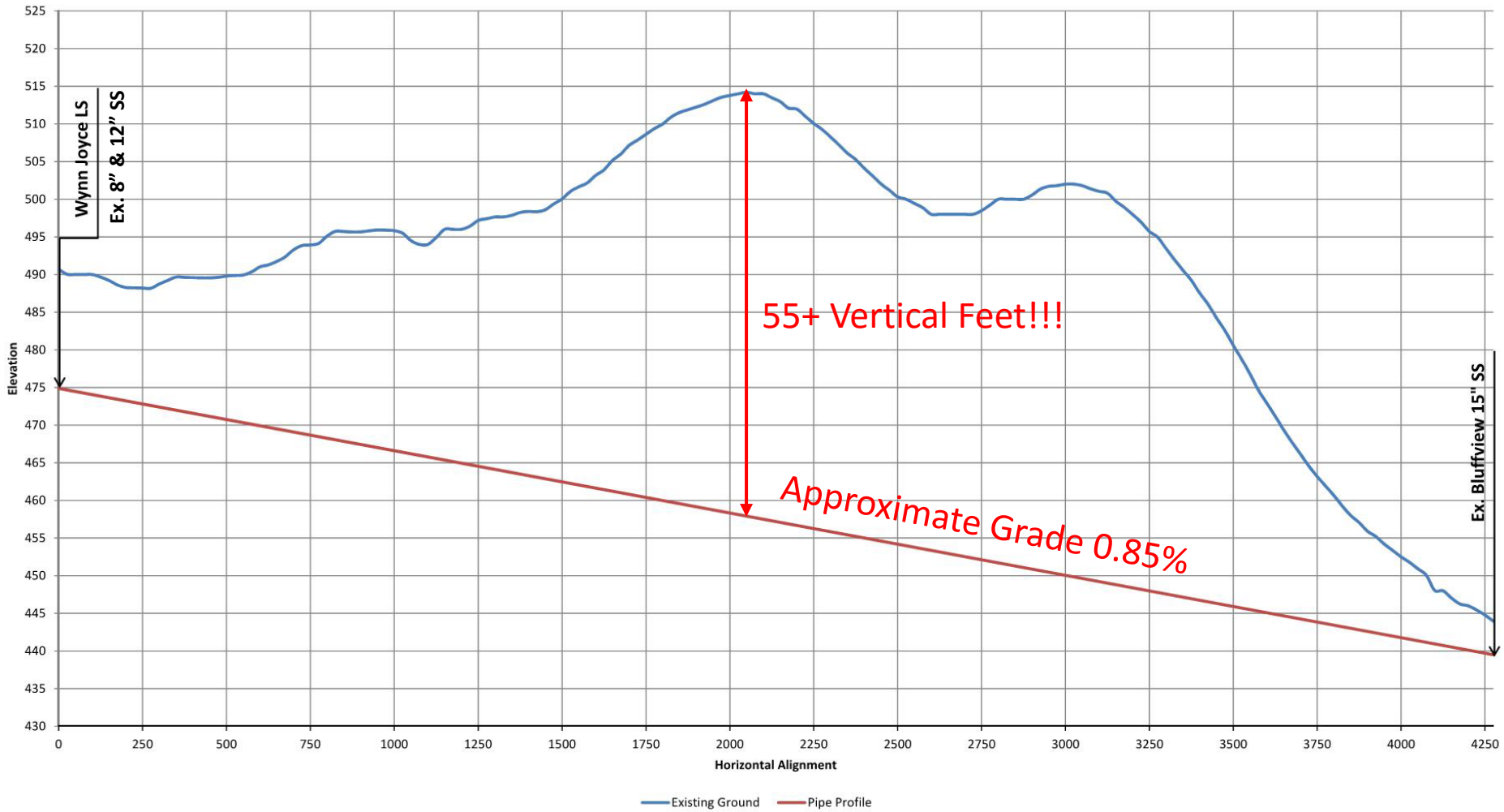
Horizontal Alignment Analysis

PRELIMINARY INVESTIGATIONS

Horizontal Alignment Analysis

PRELIMINARY INVESTIGATIONS

Vertical Alignment Analysis



Hydraulic Loading & Pipeline Sizing

- Average Day Flow (From City During Drought) = 0.044 MGD
- Lift Station Current Capacity = 0.474 MGD
- Lift Station Buildout Capacity (Per CIP) = 0.70 MGD
- Analyzed 8”, 10”, and 12” Diameter Pipelines

Table – Pipe Loading Characteristics

Diameter	Roughness Coef*	Slope	Flow Rate	Flow Rate	Velocity	Normal Depth	Full Pipe Capacity
(inches)	(Manning's n)	(%)	(GPM)	(MGD)	(ft/s)	(inches)	(MGD)
8	0.013	0.33	30.40	0.044	1.26	1.69	0.45
8	0.013	0.33	486.11	0.700	N/A	N/A	
8	0.013	0.80	30.40	0.044	1.73	1.36	0.70
8	0.013	0.80	486.11	0.700	3.53	6.57	
8	0.013	0.85	30.40	0.044	1.76	1.34	0.72
8	0.013	0.85	486.11	0.700	3.64	6.37	
10	0.013	0.25	30.40	0.044	1.12	1.69	0.71
10	0.013	0.25	486.11	0.700	2.29	8.1	
10	0.013	0.85	30.40	0.044	1.72	1.25	1.31
10	0.013	0.85	486.11	0.700	3.77	5.21	
12	0.013	0.20	30.40	0.044	1.01	1.69	1.03
12	0.013	0.20	486.11	0.700	2.18	7.26	
12	0.013	0.85	30.40	0.044	1.67	1.19	2.12
12	0.013	0.85	486.11	0.700	3.75	4.74	

Not Selected, No Grade Flexibility

Selected, Met Capacity & Highest Velocities

Not Selected, Exceeded Capacity

Trenchless Installation Methods

Horizontal Directional Drilling (HDD)

- Typical Accuracy +/- 1.0%
- Required Careful Selection of Guidance System, Limiting Back-Reaming Process, and Periodic Sight/Relief Holes
- Typical 200’ x 200’ Setup Staging Area
- Typical 100’ x 100’ Receiving Staging Area
- Large Area Required for Pipeline Fusing and Staging
- Common Pipes are Fusible Polyvinyl Chloride (PVC) and High Density Polyethylene (HDPE) Pipe

Trenchless Installation Methods

Pilot Tube Micro Tunneling

- Similar to Large Diameter Micro Tunneling
- Very Accurate Grade Performance
- Tunneling Rig Placed in 8’ to 12’ Diameter Vertical Shafts
- Rig Can Typically Travel Approximately 500 LF Between Vertical Shafts
- Carrier Pipe Pushed/Jacked into Place
- Most Common Pipe is Vitrified Clay Pipe (VCP) for it’s Strong Compressive Strength
- Fusible PVC and HDPE Can be Used, but Additional Installation Steps Required

PRELIMINARY INVESTIGATIONS

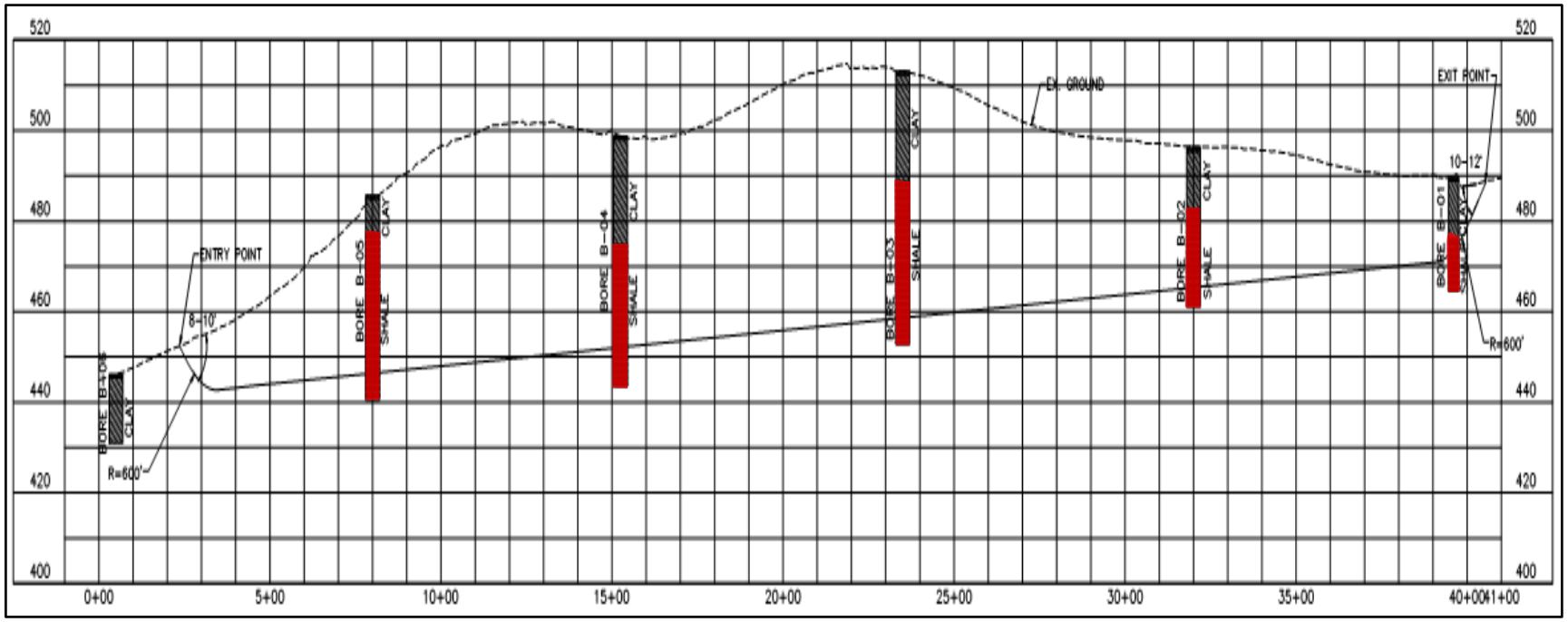
Selected Methods

- Option 2 – Southern Horizontal Alignment Selected
  - Provided Greatest Separation from Neighboring Development
  - Adequate Staging Room
  - Similar Construction Costs to Other Alignment
- Vertical Grade Determined by Upstream/Downstream Connections
- 10” Pipe Diameter Selected
  - Met Capacity Range
  - Best Velocity of Acceptable Size Options
- HDD Selected as Trenchless Installation Method
  - Both Options Capable of Installation
  - Pilot Tube Micro Tunneling Vertical Shafts Difficult for Deep Sections
- HDPE Selected as Pipe Material Due to City’s Familiarity

FINAL DESIGN APPROACH

Geotechnical Investigation

- Six Geotechnical Bores Taken
- Geotech Would Help Determine Achievable Accuracy
- HDD in Shale Layer Entire Route
- Critical Information for Contractor
  - Allows to Select Correct Drill Head, Proper Mud Parameters, and Overall Equipment Setup/Sizing



FINAL DESIGN APPROACH

Staging Areas

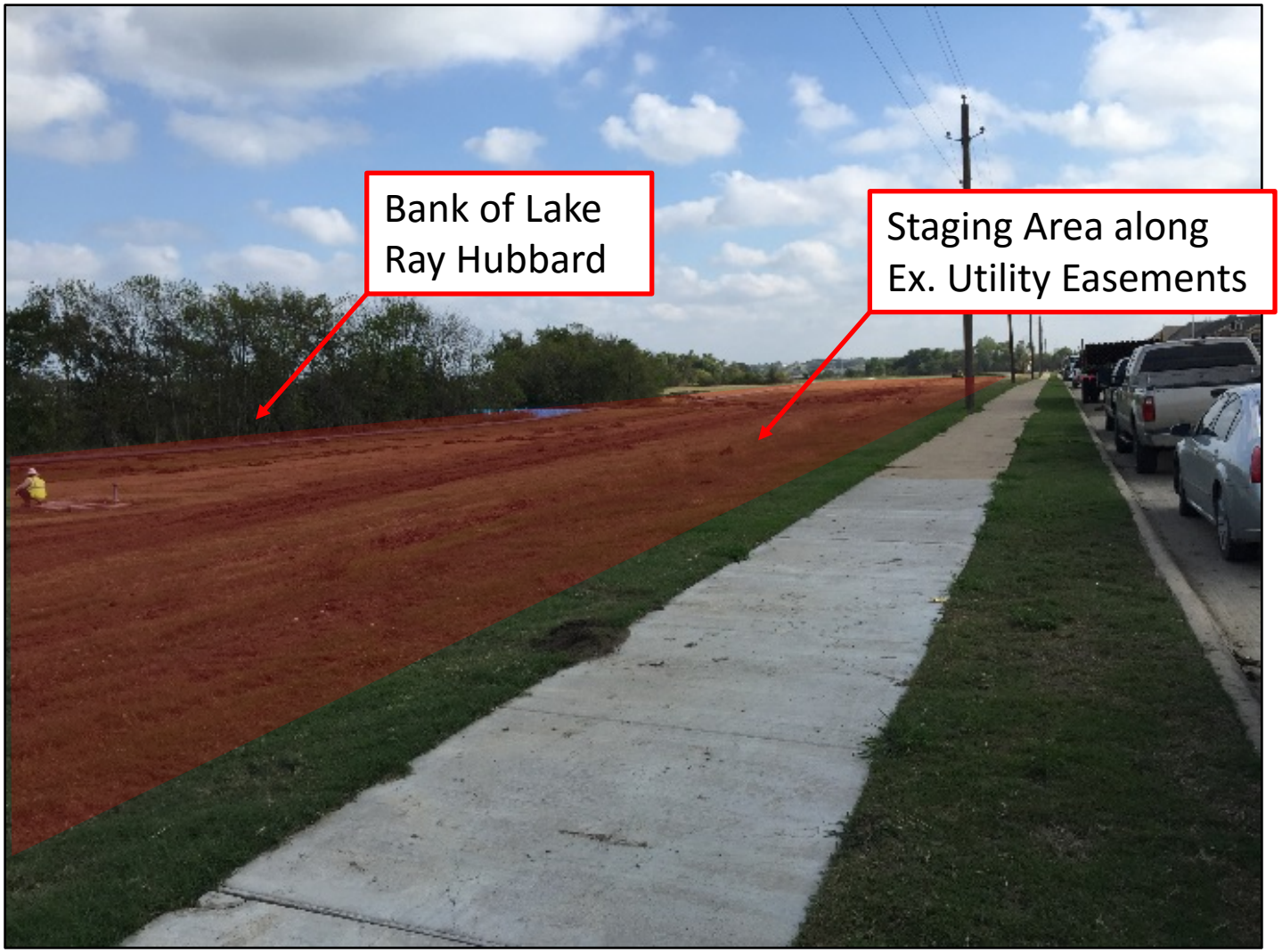
- All Staging Required to be Completed within Road ROW to Avoid Need for Easements

Traffic Control

- One Lane of Traffic Shut Down for Staging

FINAL DESIGN APPROACH

Staging Areas



FINAL DESIGN APPROACH

Staging Areas

FINAL DESIGN APPROACH

Pipe Calculations

- Dead/Live Loading
  - Live Loading Negligible at the Extreme Depths for Project
  - Dead Loading Calculations Resulted in Specifying AWWA C906, DR7 HDPE Pipe
  - Due to Wall Thickness, HDD Section Upsized to 14” Diameter Pipe (10” ID)
- Maximum Pulling Forces
  - Max Allowable Pull Force Provided by Plastic Pipes Institute
    - Factor of Diameter, Pressure Class, and HDPE Resin Properties
  - HDD Contractor Required to Monitor & Stay Within this Value During the Pipe Pull-back Phase
- Maximum Bending Radii
  - Maximum Radius Provided in Contract Documents to Ensure the Drill Stem Rod or Carrier Piping Does not Exceed Allowable Bending Parameters
- Entry / Exit Pit Angles
  - Typical Entry Pits: 8 to 10 Degrees
  - Typical Exit Pits: 10 to 12 Degrees

FINAL DESIGN APPROACH

HDD Subcontractor Coordination

- Coordinated with Six HDD Contractors During Design
- Discussed the Following Design and Constructability Aspects
  - Expected Equipment and Sizing
  - Proposed Staging Areas
  - Proposed Entry / Exit Bore Angles
  - Proposed Minimum Bending Radii
  - Geotechnical Findings
  - Is the Project Constructible?
- All Information Provided During Design Discussions was Provided to All Contractor at Bid Time
- Information Received was Analyzed and Consolidated to Ensure No Changes Would Exclude Potential Bidders

FINAL DESIGN APPROACH

<u>Additional Specification Language</u>

- Current FNI HDD Specification Was Geared Towards Pressure Pipe Applications
- Vertical Control
  - Originally Allowed Maximum 4% Deviation Horizontally <u>or Vertically</u>
  - Added the Following Statement, *"Vertical deflections for wastewater lines may be permitted as long as the slope is continuous (no sags), meets Texas Commission on Environmental Quality minimum slope requirements, and will flow by gravity with no surcharge and into existing or proposed downstream improvements."*
- Periodic Pressure Relief and Sight Holes
  - Vertical 12" to 18" Diameter Holes Required Every 500 LF
  - Used for Both Pressure Relief and Way for Vertical Measure Down Confirmation

FINAL DESIGN APPROACH

Additional Specification Language

- Mud Engineer Requirement
  - Required a Mud Engineer Onsite During All Drilling and Reaming Operations
  - Mud Engineer to Monitor Quality of Drill Mud to Prevent Potential Increase Friction Issues during Pullback
    - Daily Reports Consisting of 3 to 6 Samples
    - Tested for Viscosity, Density, Sand Content, PH, Hardness, Water Loss and Rheology (AV, PV, YP, 10 sec and 10 min gels)
  - Ultimate Goal to Avoid Overstressing Carrier Pipe
- TCEQ Manhole Spacing Variance Required
  - Pipeline Too Deep for Manholes
  - City's Pressure Wash Truck Capable of Flushing Line

HDD Equipment

HDD Equipment

CONSTRUCTION / LESSONS LEARNED

- Allow for Downstream Grade Flexibility
  - HDD Almost 1 VF Low on Downstream End
  - Required Additional Open-cutting and Upsizing of Downstream Pipe to Fix
- Monitor Drill Log
  - Enforce Contractor to Provide Live Drill Logs
- Vertical Sight Hole Shortcomings
  - Holes Could Never be Pumped Down Enough to Provide Accurate Measure Downs
- HDD Inadvertent Return Plan
  - Require Contractor to Provide Plan as a Part of Pre-Construction Documents
  - Enforce General Site Cleanup and Maintenance
- Testing Provisions
  - Standard Gravity Sewer Testing Procedures were Specified (i.e. mandrel, low pressure hydrostatic, air testing, etc.)
  - Standard Testing Methods Unachievable due to HDD Length/Depth
  - Required Contractor to Water Jet and TV Pipeline

CONCLUSION / STATUS

- Wynn Joyce Lift Station Decommissioned and Pipeline Put into Service Spring 2016
- To Date Pipeline Functioning as Designed
- Lessons Learned to be Applied to Future Projects

REFERENCES

- ASCE HDD design guideline task committee, “Pipeline Design for Installation by Horizontal Directional Drilling,” American Society of Civil Engineers, Reston, Virginia
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  - http://www.hdpipecalc.com/
- Najafi, Mohammed; Gokhale, Sanjiv, “Trenchless Technology,” McGraw Hill, New York, New York
- Bennett, David; Ariaratnam, Samuel; Como, Casey, “Horizontal Directional Drilling Good Practices Guidelines, Arlington, Virginia

CONCLUSION / STATUS

- Question & Answer

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