



From Underground to the Forefront of Innovation and Sustainability



Design of Utility Pipelines Through an Active, Urban Landslide

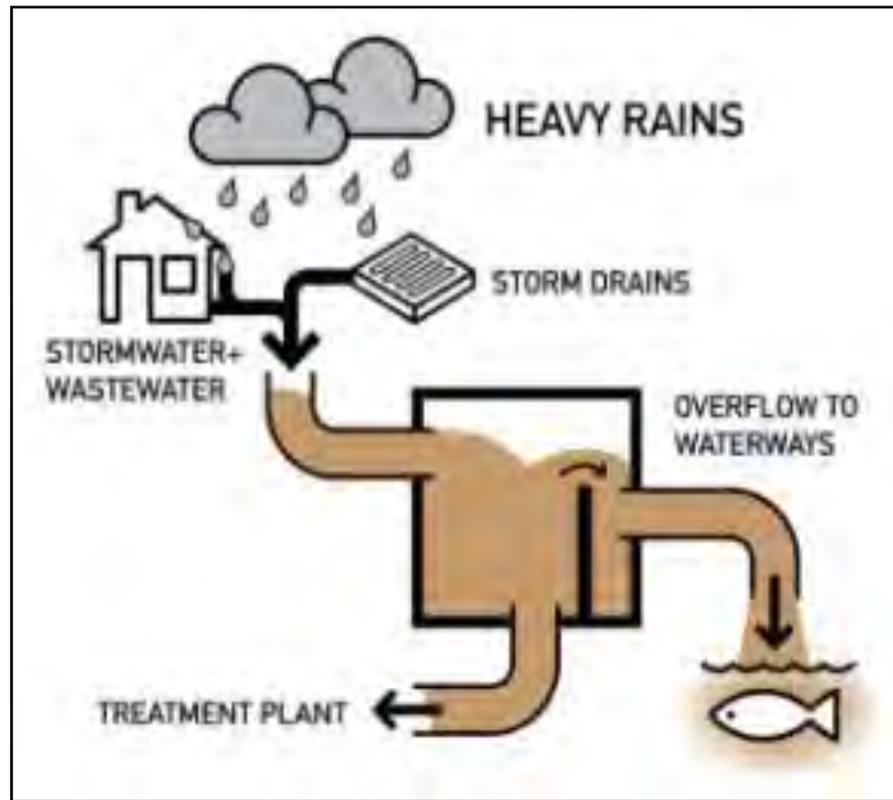
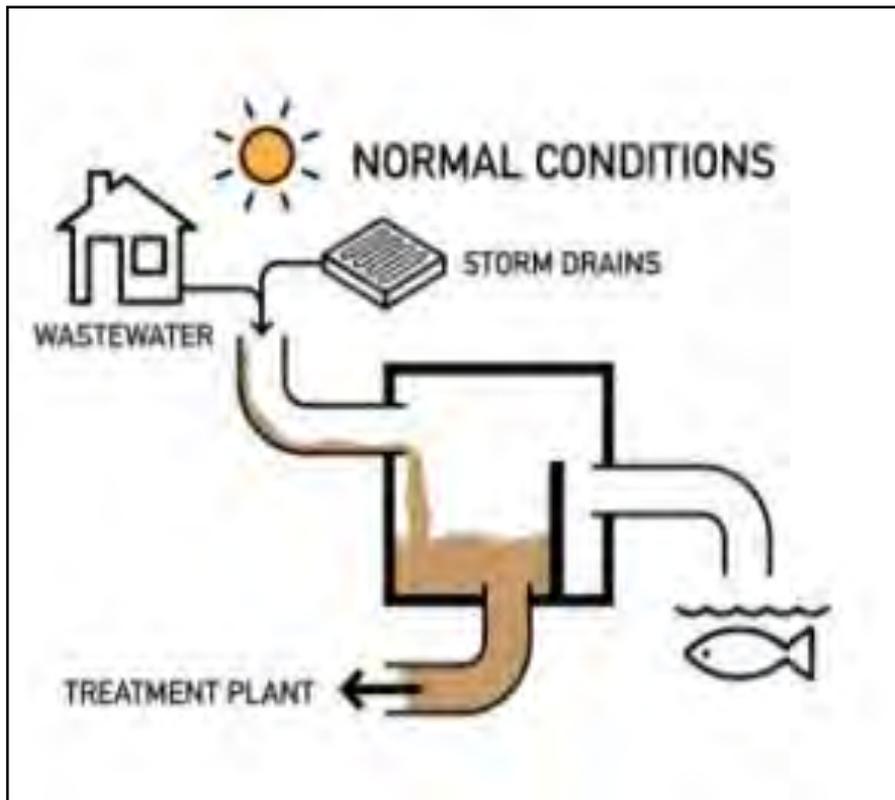
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Why Project Needed?



Project Area



Project Area

- 30 blocks of urban residential area within large active landslide



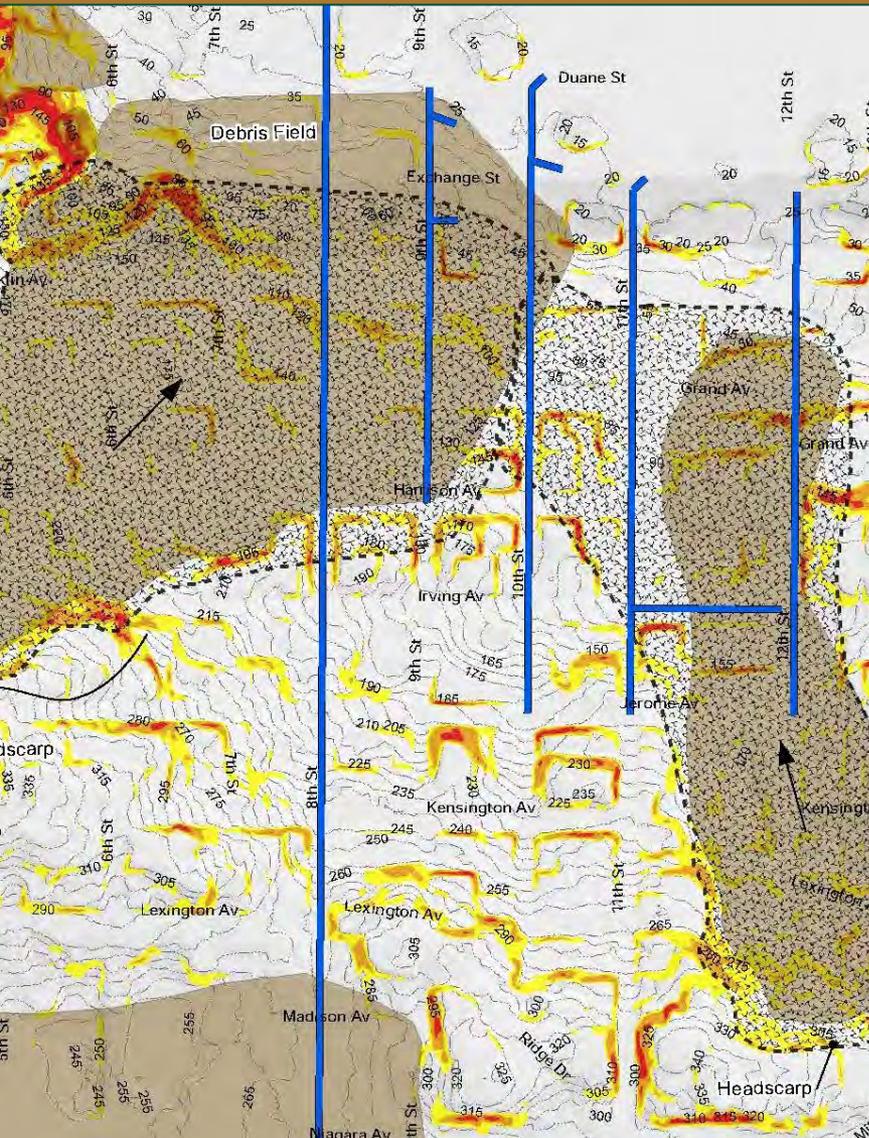
Existing Conditions - Piping



- terracotta w/ areas of corrugated metal and PVC
- Brittle gray cast iron



Unique Challenges



- Pipelines through two large, active landslides
- Creeping ground movements, variable rates and direction
- Extreme slopes up to 28 percent
- Shallow groundwater and groundwater springs

History and Background



- Residential hillside on top of ancient landslide complex
- Activity varies
- Surface and subsurface indicators of differential movement
- Occasional catastrophic failures

1st Phase – Geotechnical Mapping



- Performed preliminary geologic hazard evaluation
- Reviewed existing, documents, sewer video and other data
- Field visits to document existing conditions

1st Phase – Geotechnical Mapping



- Plotted GIS base maps
- Identified areas of tension, compression, and translation
- Determined dominant direction
- Assigned classification and rating system
- Developed boring plan

2nd Phase – Geotechnical Explorations



Photo 1: B-1, Box 1, Run 1 at 32.5' to Run 3 part at 43.1'



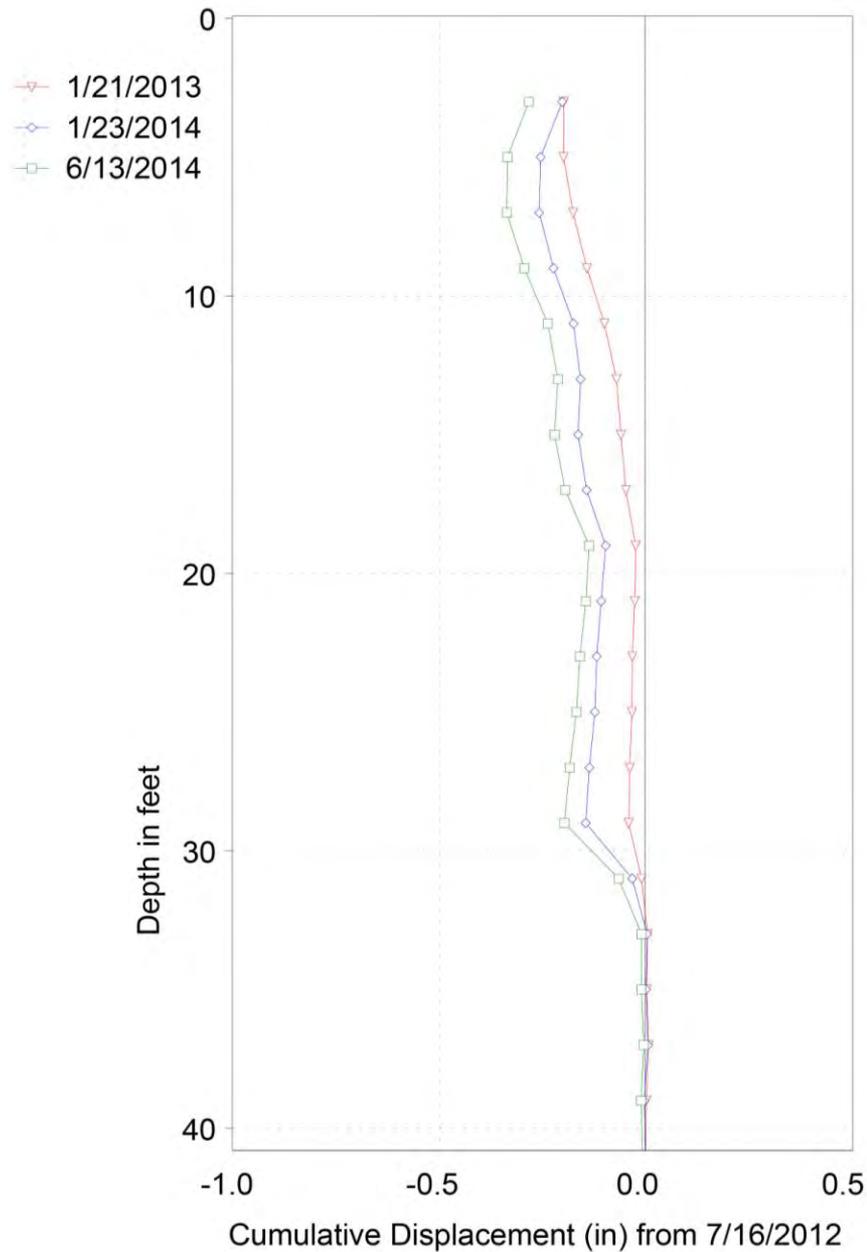
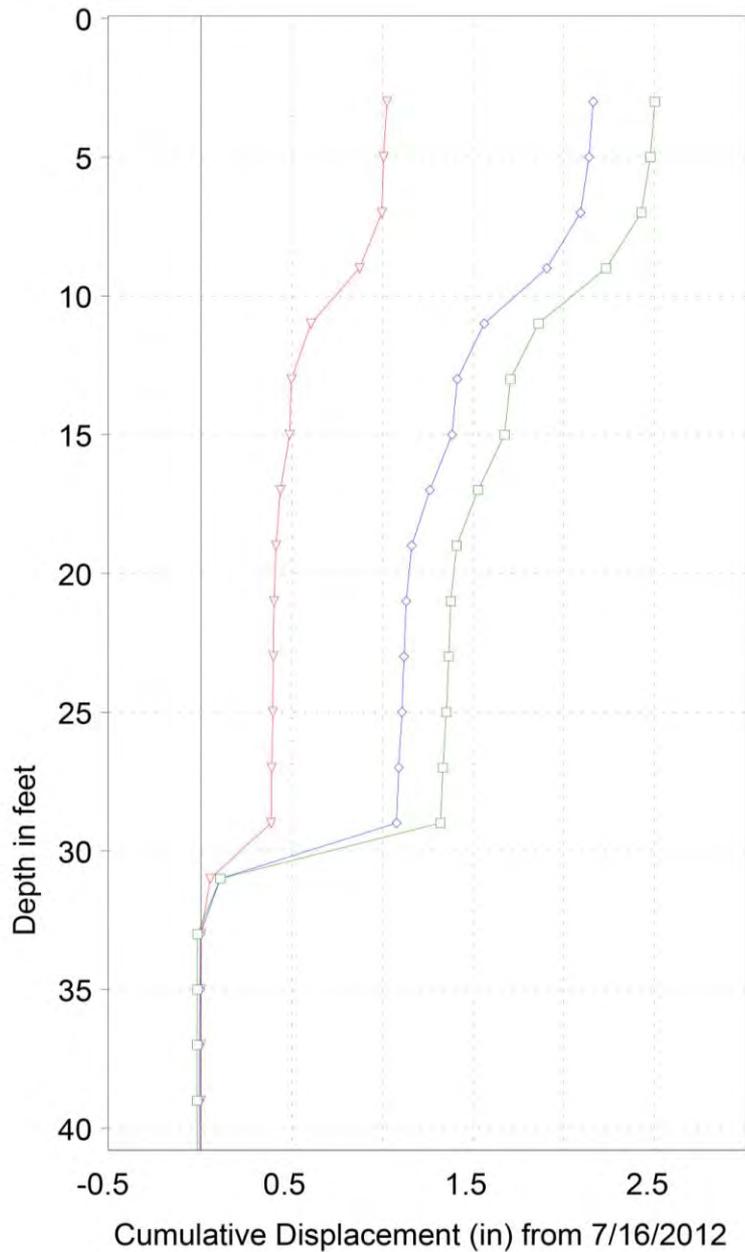
Photo 2: B-1, Box 1, Run 3 continued at 43.1' to Run 5 part at 52.4'

- 14 bore locations
- 5 observation wells
- 2 vibrating piezometers
- 2 inclinometer casing
- Other field and laboratory testing
- Follow up instrumentation monitoring

Slope Inclinometers



- 2.75 inch slope inclinometer casing installed to depth of 60 feet in two borings
- After initial reading , subsequent readings made to determine direction and magnitude of movement
- Recorded 2.5 inches of cumulative surface movement in a period of 23 months



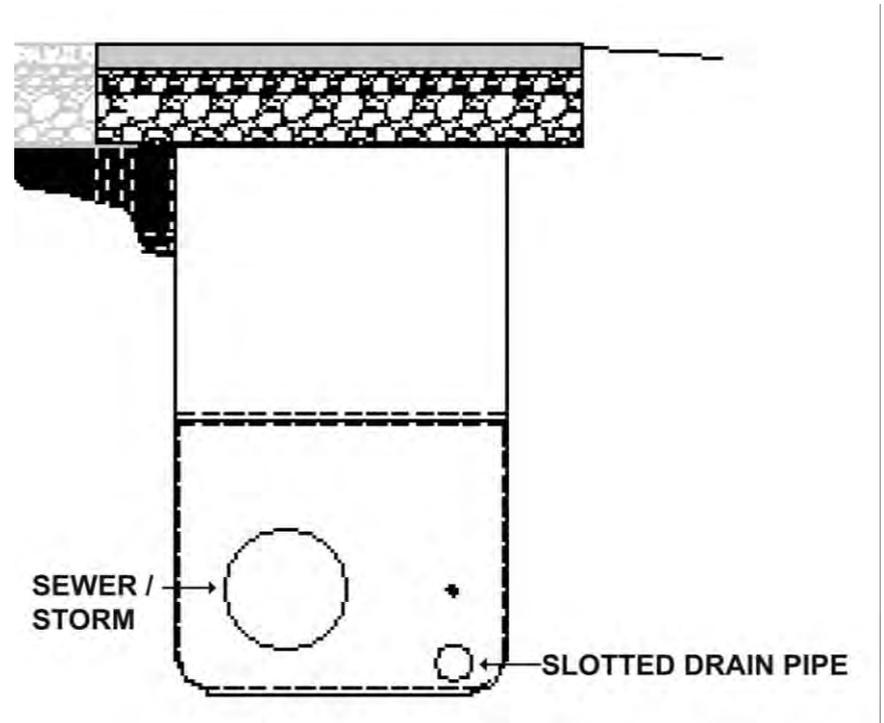
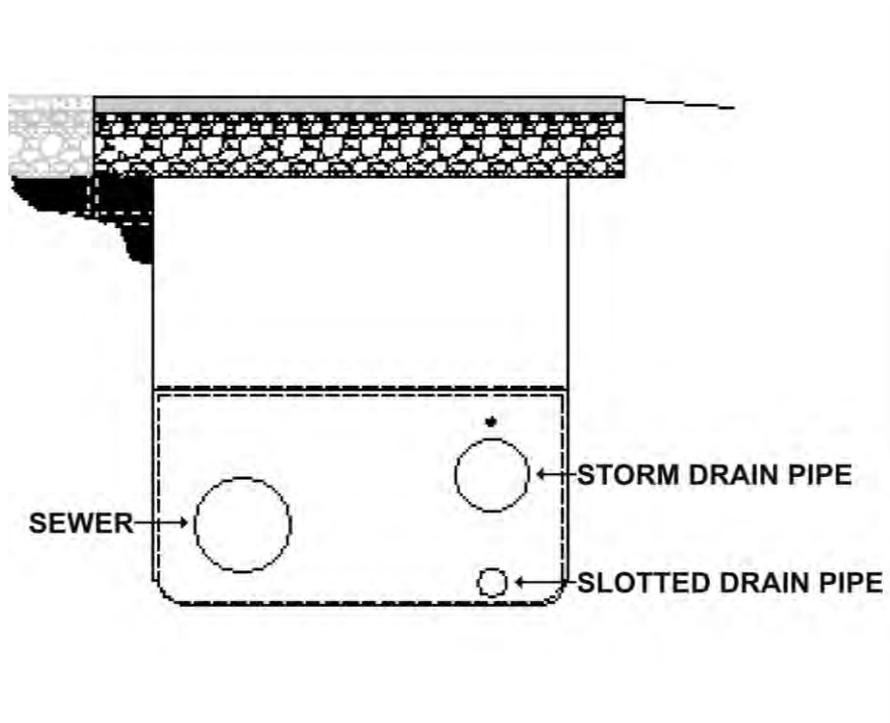
Pipeline Design

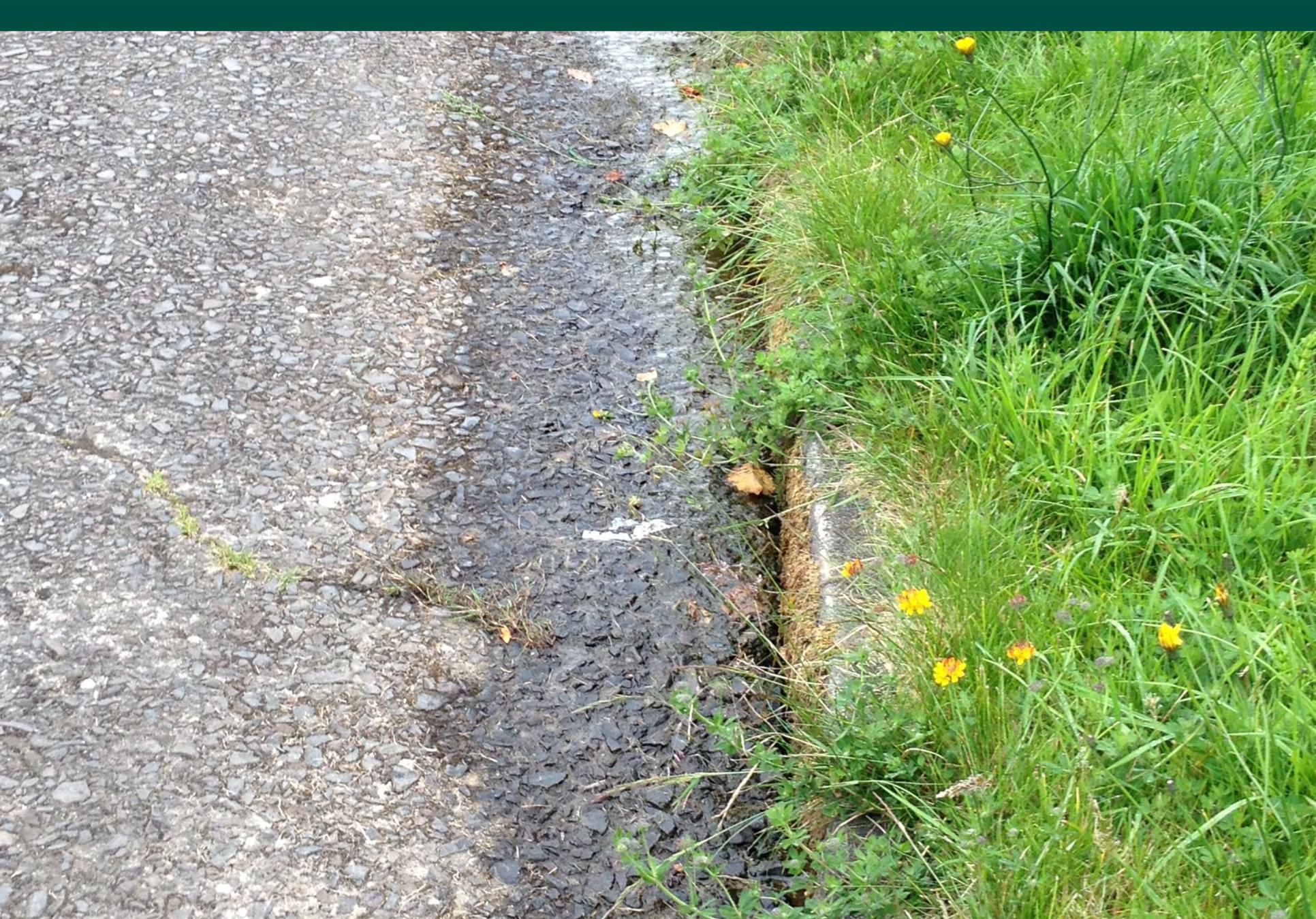


- Accommodate vertical & longitudinal movement
- Groundwater collection
- Vaulted/hallow sidewalk
- Steep slopes
- Joint trench for sewer/ storm
- Major vault on cross street



Pipeline Design



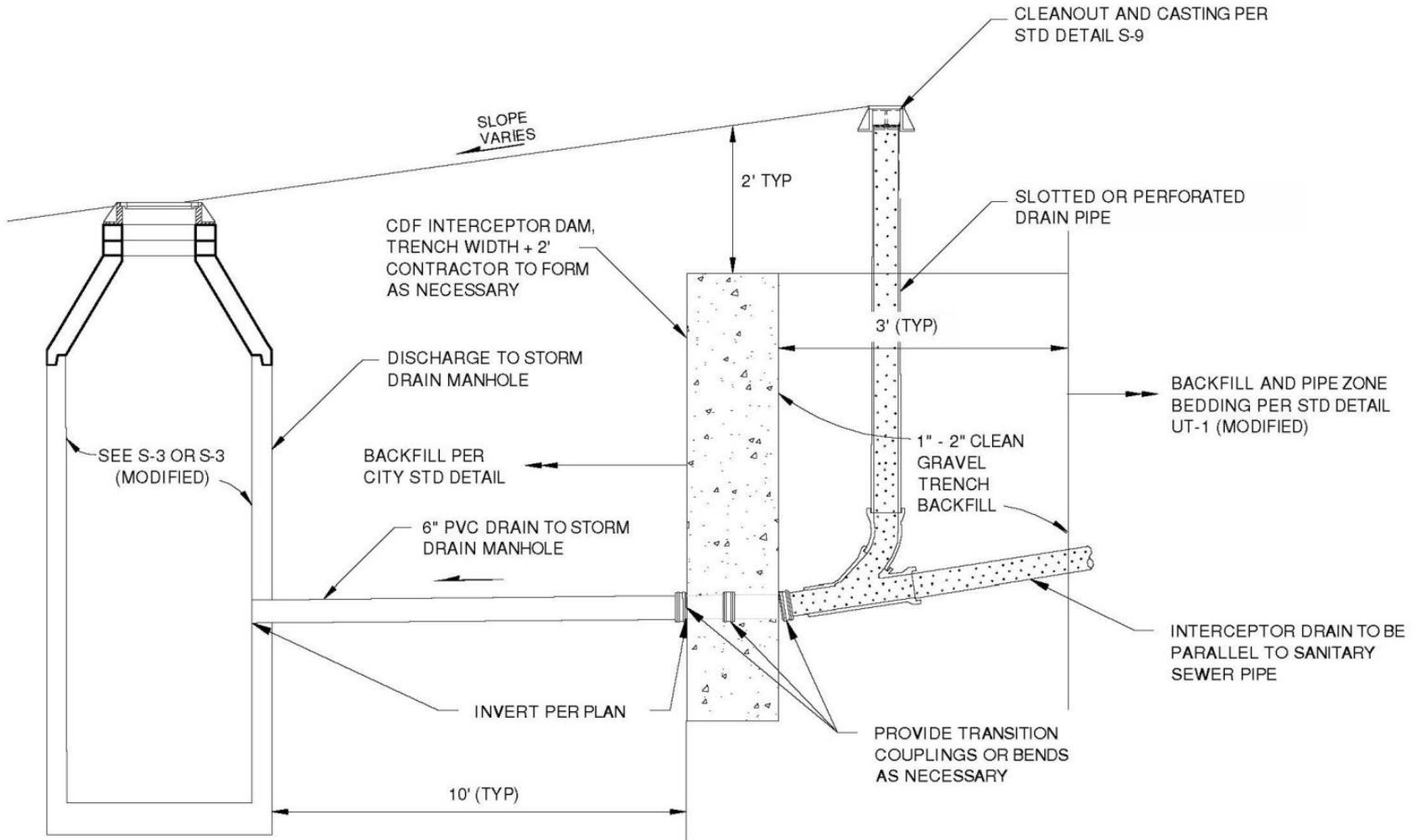


Collection & Redirection of Groundwater



- Two methods
 - Trench cutoff walls with slotted under drains
 - Interceptor drains in key locations using drywell structures

Trench Dam



TRENCH DAM AND INTERCEPTOR DRAIN DETAIL

N.T.S.







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Questions?