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Indian Creek Watershed (Cobbs Creek) Habitat Improvement
By Salman Babar & Alex Haptemariam, P.E., CFM



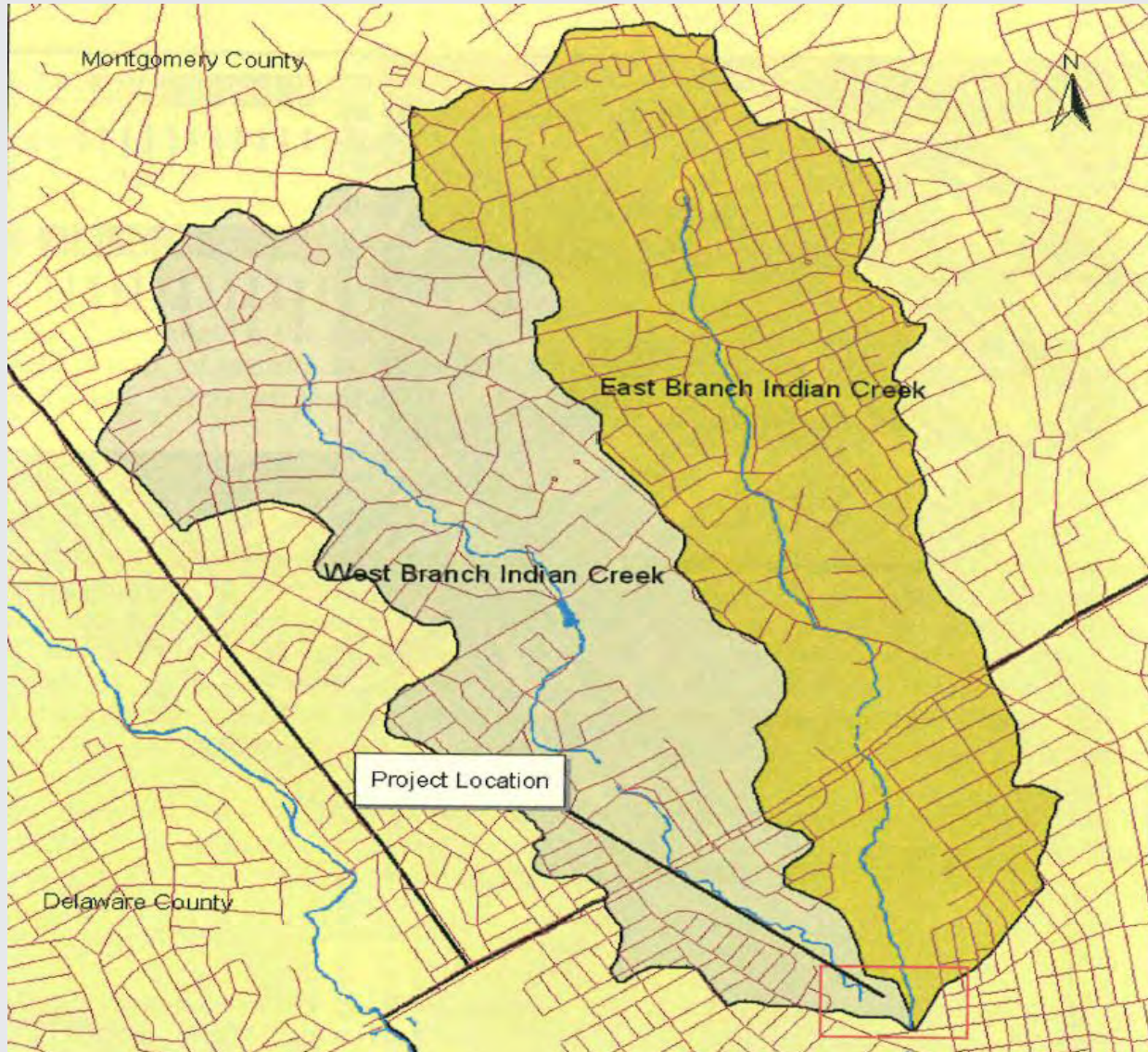
Project Location





Watershed Characterization

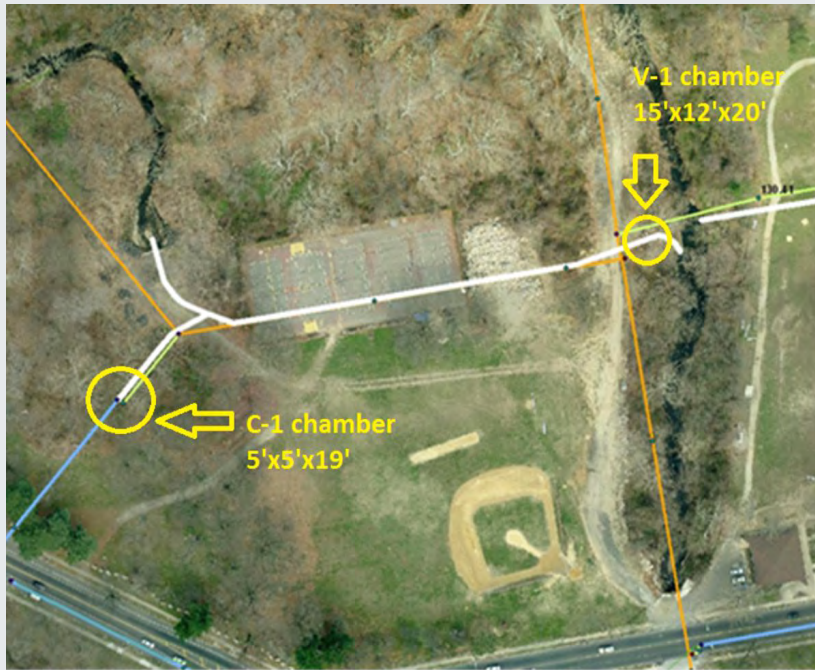
- ❖ Watershed is located in Southern Montgomery County & Western section of the City of Philadelphia along the eastern edge of Piedmont Physiographic province and is characterized by gently rolling to hilly topography.
- ❖ The total watershed area is 3.4 sq. miles.
- ❖ The upper portion of the watershed is characterized by hilly to steep topography with slopes ranging from 3% to 15% .
- ❖ Channel gradient varies from 1.4% to 3%.





Background:

- 20% of Cobbs Creek watershed is serviced by combined sewers.
- City of Philadelphia has 38 regulator structures within the watershed.
- CSO discharges are the major source of fecal coliform in Cobbs Creek Watershed.





Objective:

- Reduce and eliminate point source discharge
- Improve the Creeks water quality and reducing local overflow
- Stream bed and bank stabilization
- Wetland and habitat creation
- Elimination of debris accumulation



Problems & Issues

- Current conditions along East & West branch are characterized as very unstable.
- Sediment transport issues at downstream
- Stream bank erosion, lateral migration, channel blockages and stream bed aggradation & degradation are common throughout.
- CSO intake headwall clogging issues
- Accumulated sediment at CSO intake headwall
- Severe erosion at Haverford Avenue bridge



Debris accumulation



Intake head-wall of culvert (2000)



Accumulated sediment



Intake head-wall of culvert (2006)

Note opening is completely blocked by debris and accumulated sediment



Damages



Severe erosion at Haverford Avenue Bridge caused by August 1, 2004 storm



Urban Stream Restoration Challenges:

- Typically requires much greater degree of hydrologic & hydraulic analysis
- Sediment transport studies
- Bankfull indicator challenges
- Reduce base flow
- Increased flood flow
- Reduced Time of Concentration (T_c)



CSO Challenges:

- **Infrastructure:**
 - a) Aged Pipes
 - b) Aged Manholes
 - c) Existing infrastructure information
- **Maintenance:**
 - 4 chamber manhole
 - Fire hydrant
 - Manhole at upstream end of 6'x6' box culvert
 - Access manholes



Methods of Data Collection

- Existing data was collected, compiled and reviewed.
- Modeling and field studies were conducted to evaluate the current conditions along East & West branch.
- The data collected was utilized to determine structure type, size and location.
- Restoration and management recommendations, design concepts as well as preliminary cost estimates for restoration and management strategies were developed.
- The study included identification of significant plants and plantation of trees, HTRW studies and CSO inspection report



Achievements:

- Volume reduction:
- An average annual volume reduction from 2.9 to 1.2 million gallons (58% reduction) from regulator C_05
- CSO frequency reduction:
- An average annual reduction in CSO frequency reduction from 17 to 13 overflows per year from regulator C_05
- Pollutants removal
- Cost effective & Environment friendly:
- CSO reductions were achieved without the construction of new storage facilities
- Replaced aged infrastructure:
- New manhole C-1 and wellhole W-1



Hydrology

24-hour Peak Discharge

Storm Event	East Branch	West Branch
Design Flow	802 CFS	297 CFS
1.5-YR	1080 CFS	350 CFS
2-YR	1350 CFS	450 CFS
10-YR	2430 CFS	850 CFS
50-YR	3390 CFS	1300 CFS
100-YR	3610 CFS	1500 CFS



Hydrology (cont..)

- Bankfull discharge estimates: Three methods were used to estimate the bankfull discharge
 1. Regional regressions developed for use in urban watershed.
 2. USGS regional regressions
 3. Hydrologic model output provided by PWD
 4. Manning's equation and field data



Hydrology (cont..)

Bankfull Discharge Estimates (West branch)

Method	1-YR (cfs)	Bankfull (cfs)	2-YR (cfs)
Regional Regression	ND	296	ND
USGS	ND	ND	416
PWD	98	ND	450
Manning's Equation	ND	297.3	ND

Bankfull Discharge Estimates (East branch)

Method	1-YR (cfs)	Bankfull (cfs)	2-YR (cfs)
Regional Regression	ND	294	ND
USGS	ND	ND	408
PWD	365	ND	1350
Manning's Equation	ND	296	ND



Bankfull Channel Geometry Comparison

Reach ID (Drainage Area) Data Source	Cross-sectional Area (ft²)	Width (ft)	Depth (ft)
West Branch (1.71) Regional Regression	58.4	27.1	2.18
West Branch Measured	57.1 (55.0 – 59.1)	36.6 (25.4 – 48.1)	1.65 (1.1 – 2.3)
Upper East Branch (1.7) Regional Regression	58.2	27.0	2.17
Upper East Branch Measured	59.3 (58.9 – 60.1)	31.6 (27.5 - 34.1)	1.9 (1.8 – 2.2)
Lower East Branch (3.41) Regional Regression	94.5	38.3	2.54
Lower East Branch Measured	98.6 (94.5 – 102.3)	40.8 (35.7 – 45.9)	2.5 (2.1 – 2.9)

Table 5 – Indian Creek Bankfull Channel Geometry Comparison of Predicted Values to Field Data



Classification Summary Table

Reach	Bankfull Width (ft)	Bankfull Mean Depth (ft)	Bankfull XS Area (ft ²)	Width/Depth Ratio	Entrenchment Ratio	Slope (ft/ft)	D50 (mm)	Stream Type
West Branch 1	48.1	1.1	55.0	42	2.1	0.021	39	C4
West Branch 2	37.5	1.5	55.6	25.3	2.9	0.021	39	D4
West Branch 3	35.2	1.7	58.7	21.1	1.6	0.01	39	B4c
West Branch 4	25.4	2.3	59.1	10.9	5.2	0.01	39	E4
Upper East Branch 1	32.4	1.8	58.9	17.9	1.85	0.01	76	B3c
Upper East Branch 2	32.5	1.8	58.3	18.1	1.4	0.01	76	F3
Lower East Branch	45.9	2.1	94.9	22.2	1.1	0.01	76	F3

Table 6 – Indian Creek Reach Classification Summary Table



Hydraulic Analysis

- Analyze existing water surface elevations, channel velocities and other pertinent hydraulic parameters associated with the channel.
- US Army Corps of Engineers Hec-RAS computer modeling program was used to perform hydraulic analysis.



Functions of In-stream Structures

- Maintain stable W/D ratio
- Maintain necessary shear stress to move large particles
- Decrease near bank velocity, shear stress or stream power
- Ensure stability of structure during high flows (floods)
- Maintain fish passage at all flows
- Improves fish habitat and fish spawning
- Visibly compatible with natural channels
- Less costly than traditional structures



Considerations for In-stream structures

- Rock size is based on bankfull shear stress and stream size
- Footers are used in absence of bedrock
- Location of these structures is finalized after proper design of dimension, pattern and profile for the restored channel

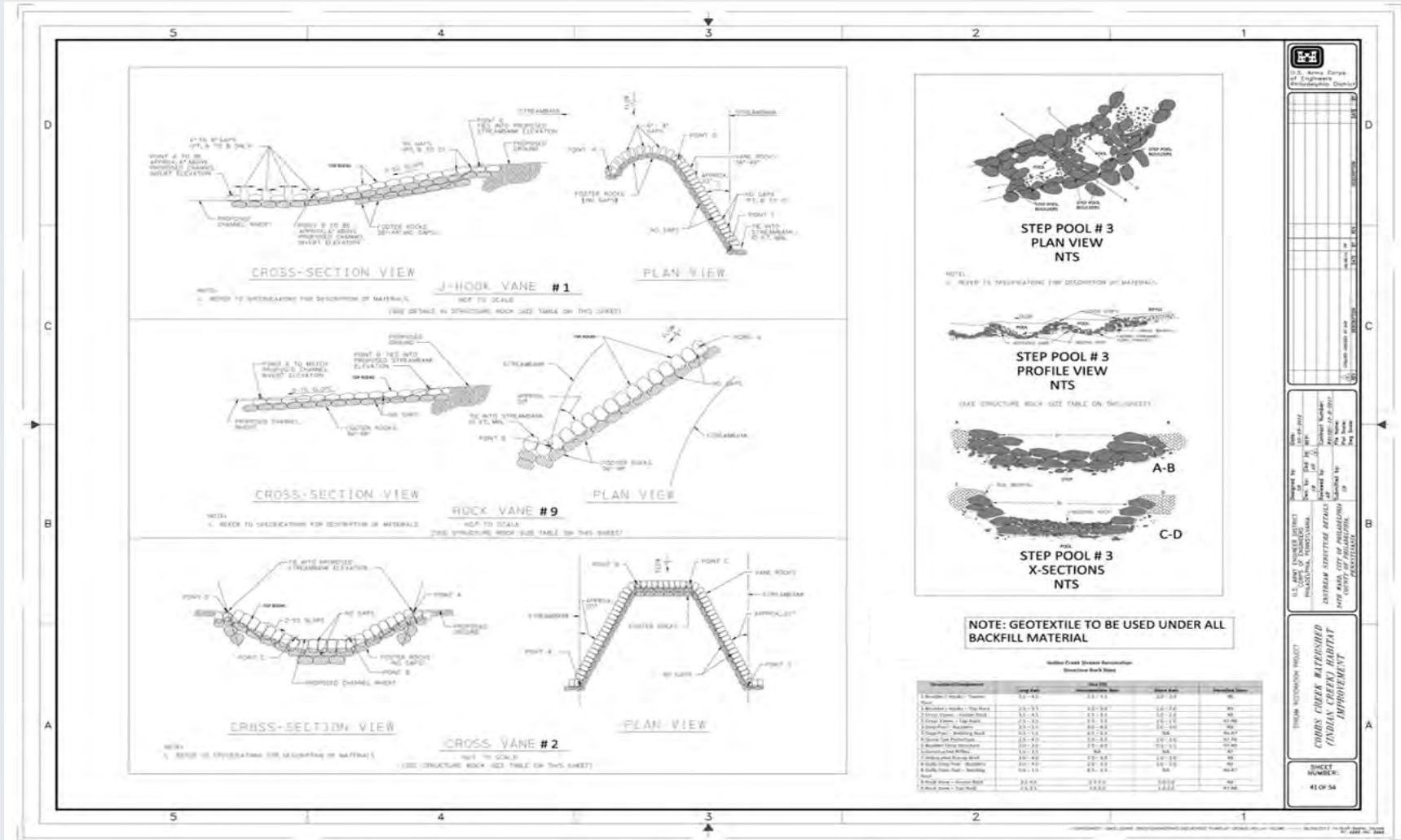


Types of In-stream structures used

- Cross vanes
- Rock vanes
- J-hook vanes:
- Imbricated riprap wall
- Step pools

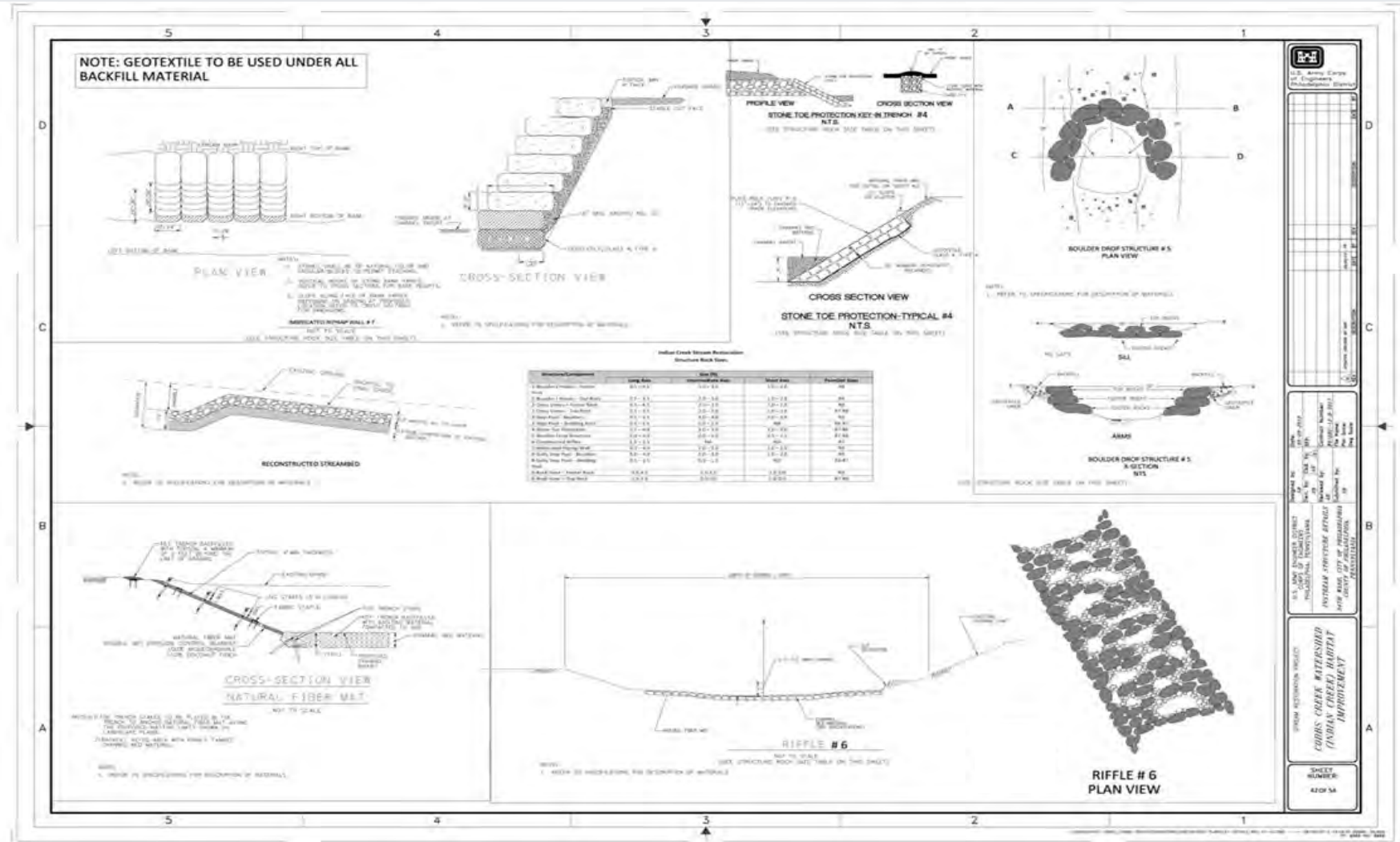


Instream Structure Details





Instream Structure Details





Under cutting in West branch





Eroding banks



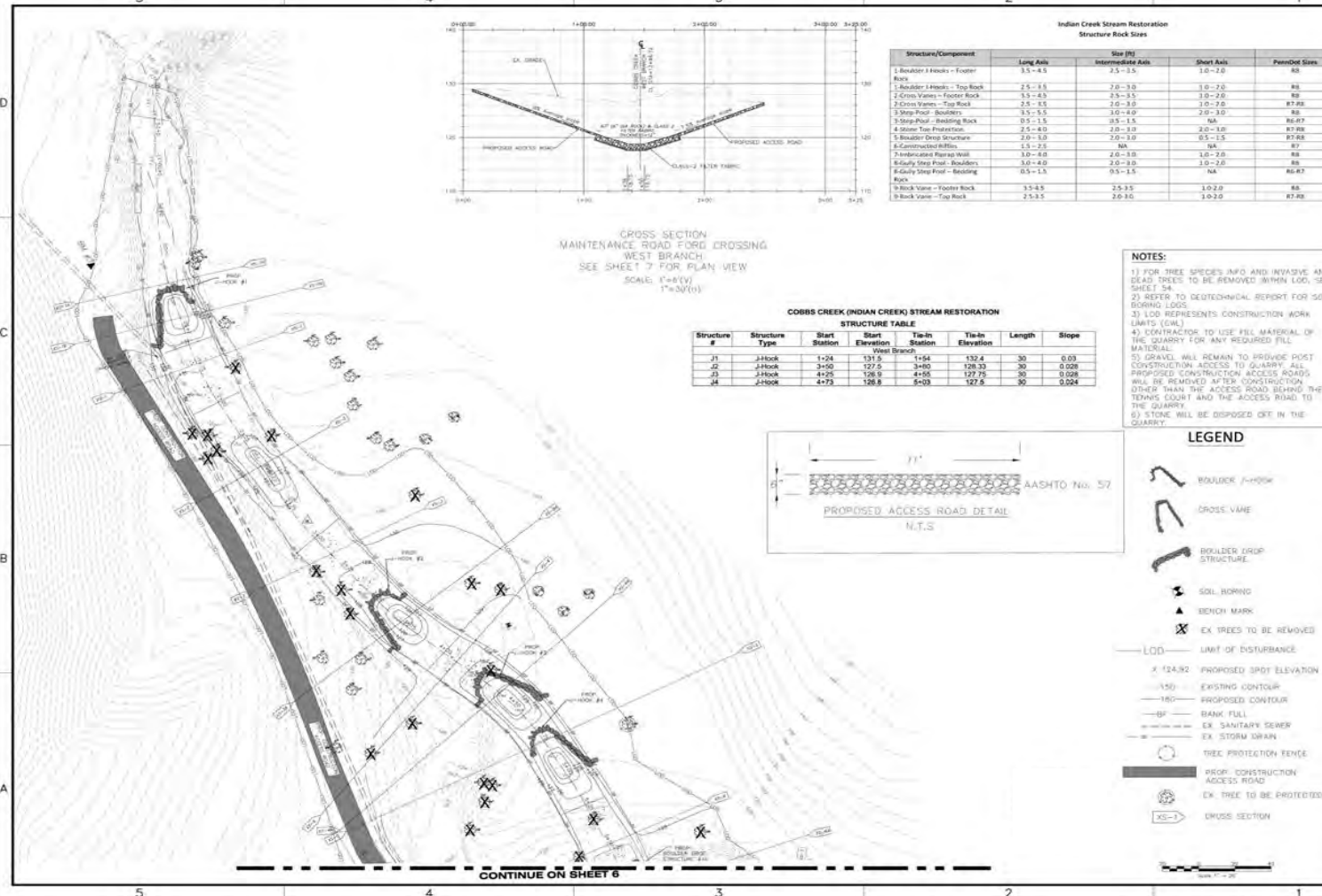
Eroding bank, exposed manhole, old support columns along upstream end of Reach 1



Stormdrain relocation

- To ensure natural design
- Taking out hardened infrastructure such as RCP and headwall
- 18" RCP exposed along West branch will be reconstructed and relocated.





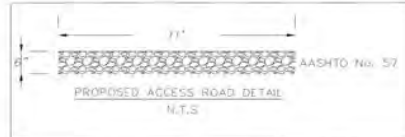
Indian Creek Stream Restoration Structure Rock Sizes

Structure/Component	Long Axis	Size (ft)		Paved Size
		Intermediate Axis	Short Axis	
1 Boulder I Hook - Footer Rock	3.5 - 4.5	2.5 - 3.5	1.0 - 2.0	88
1 Boulder I Hook - Top Rock	2.5 - 3.5	2.0 - 3.0	1.0 - 2.0	88
2 Cross Vane - Footer Rock	3.5 - 4.5	2.5 - 3.5	1.0 - 2.0	88
2 Cross Vane - Top Rock	2.5 - 3.5	2.0 - 3.0	1.0 - 2.0	87.98
3 Step Pool - Boulder	3.5 - 5.5	1.0 - 4.0	2.0 - 3.0	88
3 Step Pool - Jetting Rock	0.5 - 1.5	0.5 - 1.5	NA	86.87
4 Glider Top Protection	2.5 - 4.0	2.0 - 3.0	2.0 - 3.0	87.98
5 Boulder Drop Structure	2.0 - 3.0	2.0 - 3.0	0.5 - 1.5	87.88
6 Concrete Dribble	1.5 - 2.5	NA	NA	87
7 Reinforced Parapet Wall	3.0 - 4.0	2.0 - 3.0	1.0 - 2.0	88
8 Galley Step Pool - Boulder	3.0 - 4.0	2.0 - 3.0	1.0 - 2.0	88
8 Galley Step Pool - Bedding Rock	0.5 - 1.5	0.5 - 1.5	NA	86.87
9 Rock Vane - Footer Rock	3.5 - 4.5	2.5 - 3.5	1.0 - 2.0	88
9 Rock Vane - Top Rock	2.5 - 3.5	2.0 - 3.0	1.0 - 2.0	87.98

CROSS SECTION MAINTENANCE ROAD FORD CROSSING WEST BRANCH SEE SHEET 7 FOR PLAN VIEW
SCALE: 1"=30'(H)
1"=30'(V)

COBS CREEK (INDIAN CREEK) STREAM RESTORATION STRUCTURE TABLE

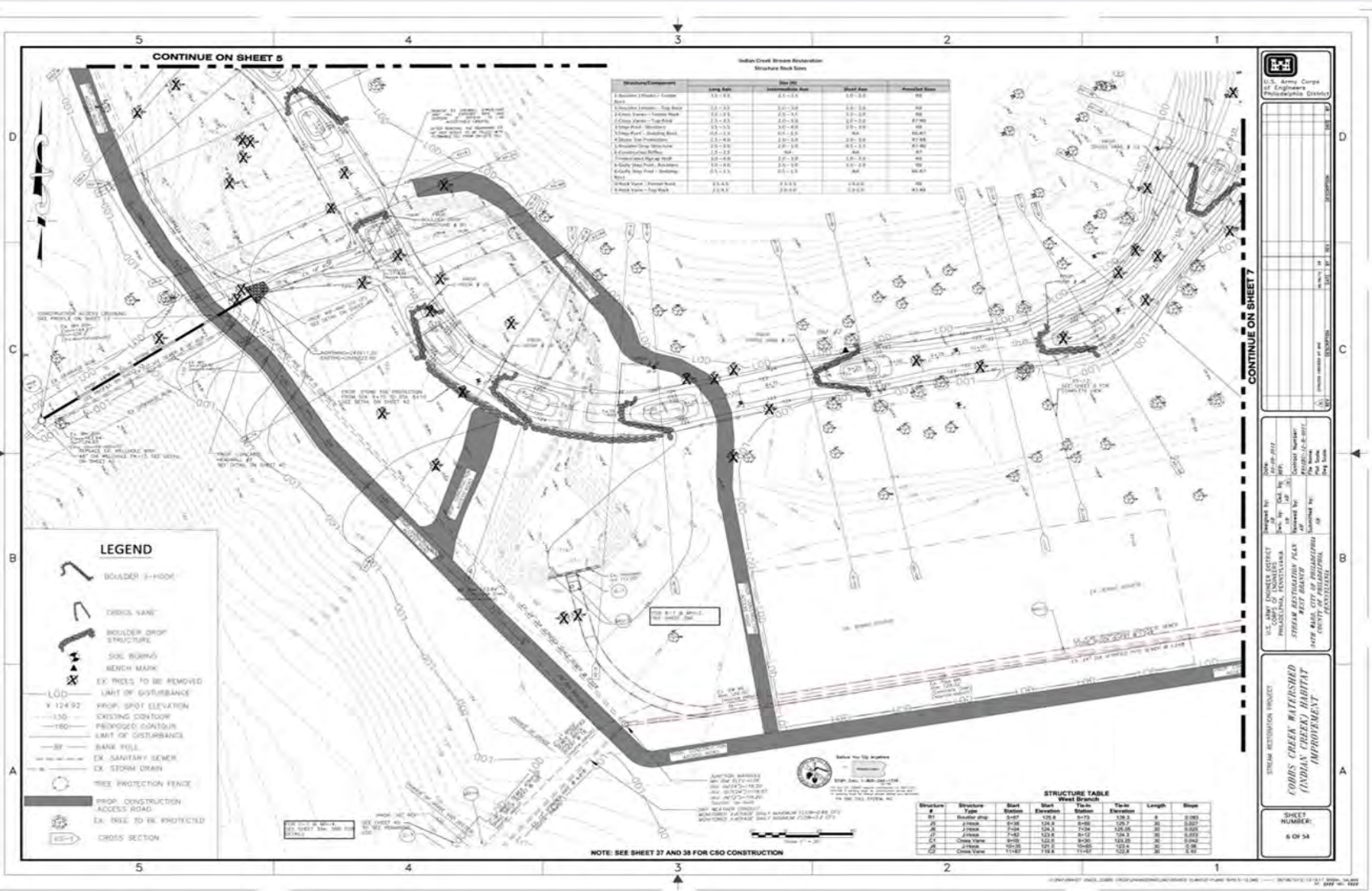
Structure #	Structure Type	Start Station			Length	Slope
		Start Elevation	End Elevation	End Station		
J1	J-Hook	1+24	131.5	1+64	132.4	30 0.03
J2	J-Hook	3+50	127.5	3+80	128.35	30 0.028
J3	J-Hook	4+25	126.9	4+55	127.75	30 0.028
J4	J-Hook	4+73	126.8	5+03	127.5	30 0.024



- NOTES:**
- 1) FOR TREE SPECIES INFO AND INVASIVE AND DEAD TREES TO BE REMOVED (WHEN LOD), SEE SHEET 54
 - 2) REFER TO GEOTECHNICAL REPORT FOR SOIL BORING LOGS
 - 3) LOD REPRESENTS CONSTRUCTION WORK LIMITS (LWL)
 - 4) CONTRACTOR TO USE FILL MATERIAL OF THE QUARRY FOR ANY REQUIRED FILL MATERIAL
 - 5) GRAVEL WILL REMAIN TO PROVIDE POST CONSTRUCTION ACCESS TO QUARRY ALL PROPOSED CONSTRUCTION ACCESS ROADS WILL BE REMOVED AFTER CONSTRUCTION OTHER THAN THE ACCESS ROAD BEHIND THE TENNIS COURT AND THE ACCESS ROAD TO THE QUARRY
 - 6) STONE WILL BE DISPOSED OFF IN THE QUARRY

- LEGEND**
- BOULDER /-HOOK
 - CROSS VANE
 - BOULDER DROP STRUCTURE
 - SOIL BORING
 - BENCH MARK
 - EX TREES TO BE REMOVED
 - LOD LIMIT OF DISTURBANCE
 - PROPOSED SPOT ELEVATION
 - EXISTING CONTOUR
 - PROPOSED CONTOUR
 - BANK FULL
 - EX SANITARY SEWER
 - EX STORM DRAIN
 - TREE PROTECTION FENCE
 - PROPRIETARY CONSTRUCTION ACCESS ROAD
 - EX TREE TO BE PROTECTED
 - CROSS SECTION

	U.S. Army Corps of Engineers Philadelphia District	Project / Sheet Number	Scale	Date
	Project / Sheet Number			
	U.S. Army District Engineer Philadelphia District Stream Restoration Plan West Branch Cobs Creek City of Philadelphia Philadelphia	Project / Sheet Number	Scale	Date
	Project / Sheet Number			
STREAM RESTORATION PROJECT COBS CREEK WATERSHED (INDIAN CREEK) HABITAT IMPROVEMENT		SHEET NUMBER	5 OF 54	



Indian Creek Stream Restoration
Structure Rock Size

Structure/Component	Start Elev.	Structure Elev.	End Elev.	Proposed Size
Structure 1 (Pond) - Center	121.15	121.15	121.15	10
Structure 1 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 1 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 2 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 2 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 3 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 3 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 4 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 4 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 5 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 5 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 6 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 6 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 7 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 7 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 8 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 8 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 9 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 9 (Pond) - Bottom Bank	121.15	121.15	121.15	10
Structure 10 (Pond) - Top Bank	121.25	121.25	121.25	10
Structure 10 (Pond) - Bottom Bank	121.15	121.15	121.15	10

- LEGEND**
- BOULDER 3-HOOK
 - CIRCLE VANE
 - BOULDER DROP STRUCTURE
 - SIDE BERM
 - BENCH MARK
 - EX. TREES TO BE REMOVED
 - LIMIT OF DISTURBANCE 124.92
 - PROP. SPOT ELEVATION
 - EXISTING CONTOUR 150
 - PROPOSED CONTOUR 160
 - LIMIT OF DISTURBANCE 160
 - BANK HILL
 - S.S. SANITARY SEWER
 - S.D. STORM DRAIN
 - TREE PROTECTION FENCE
 - PROP. CONSTRUCTION ACCESS ROAD
 - EX. TREE TO BE PROTECTED
 - CROSS SECTION

U.S. Army Corps of Engineers
Philadelphia District

PROJECT NO.	100-000-000
DRAWING NO.	100-000-000
DATE	10/1/10
SCALE	AS SHOWN
DESIGNED BY	J. J. [Name]
CHECKED BY	[Name]
APPROVED BY	[Name]

PROJECT BY: U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
PROJECT NO. 100-000-000
DRAWING NO. 100-000-000
DATE 10/1/10
SCALE AS SHOWN
DESIGNED BY J. J. [Name]
CHECKED BY [Name]
APPROVED BY [Name]

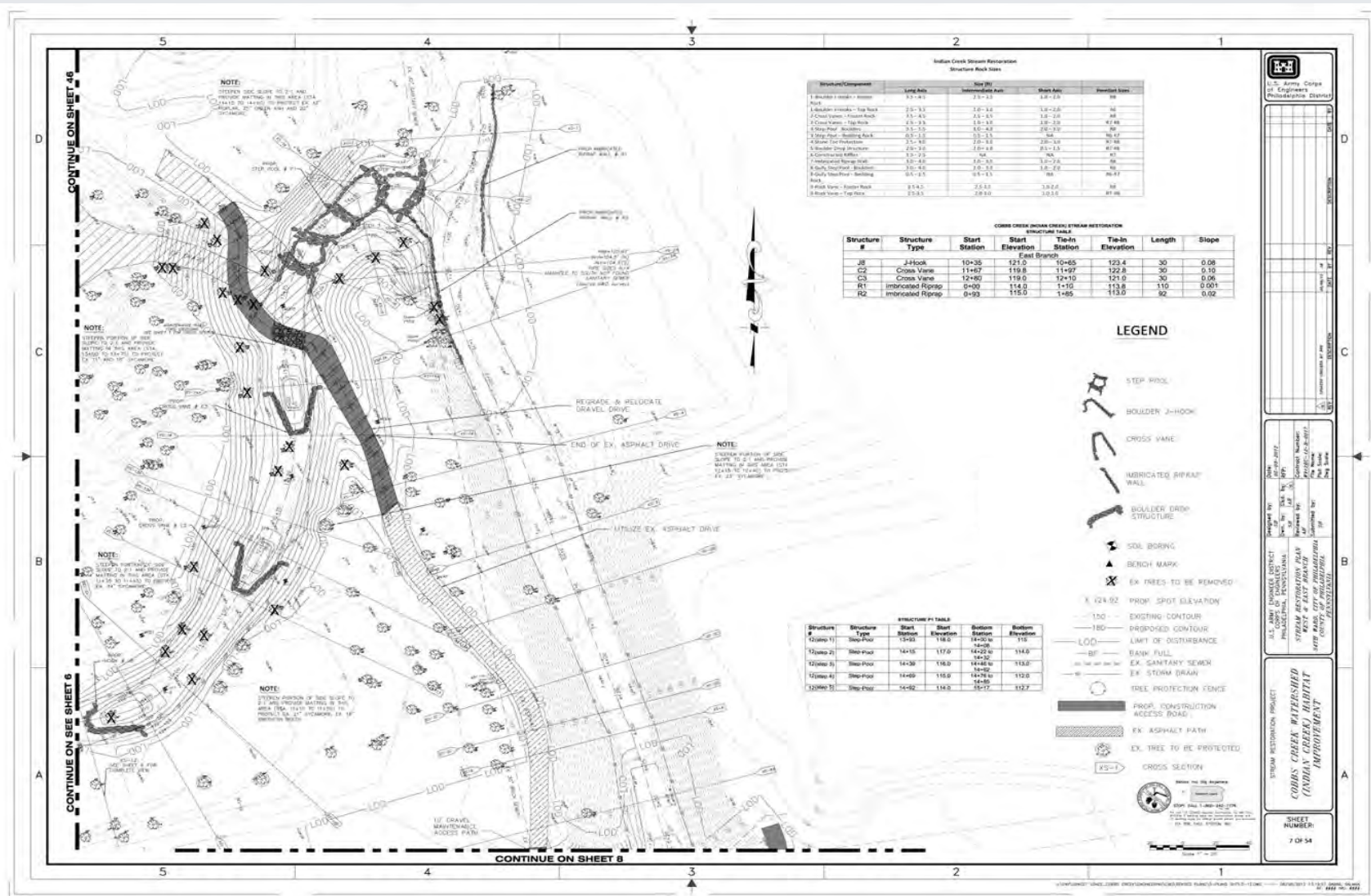
STREAM RESTORATION PROJECT
COBBS CREEK WATERSHED
(INDIAN CREEK) HABITAT
IMPROVEMENT

SHEET NUMBER:
6 OF 54

STRUCTURE TABLE

Structure	Structure Type	Start Station	End Station	Start Elevation	End Elevation	Length	Notes
1	Structure 1	1+00.0	1+05.0	121.15	121.15	5	10' dia
2	Structure 2	1+10.0	1+15.0	121.25	121.25	5	10' dia
3	Structure 3	1+20.0	1+25.0	121.15	121.15	5	10' dia
4	Structure 4	1+30.0	1+35.0	121.25	121.25	5	10' dia
5	Structure 5	1+40.0	1+45.0	121.15	121.15	5	10' dia
6	Structure 6	1+50.0	1+55.0	121.25	121.25	5	10' dia
7	Structure 7	1+60.0	1+65.0	121.15	121.15	5	10' dia
8	Structure 8	1+70.0	1+75.0	121.25	121.25	5	10' dia
9	Structure 9	1+80.0	1+85.0	121.15	121.15	5	10' dia
10	Structure 10	1+90.0	1+95.0	121.25	121.25	5	10' dia

NOTE: SEE SHEET 37 AND 38 FOR CSO CONSTRUCTION



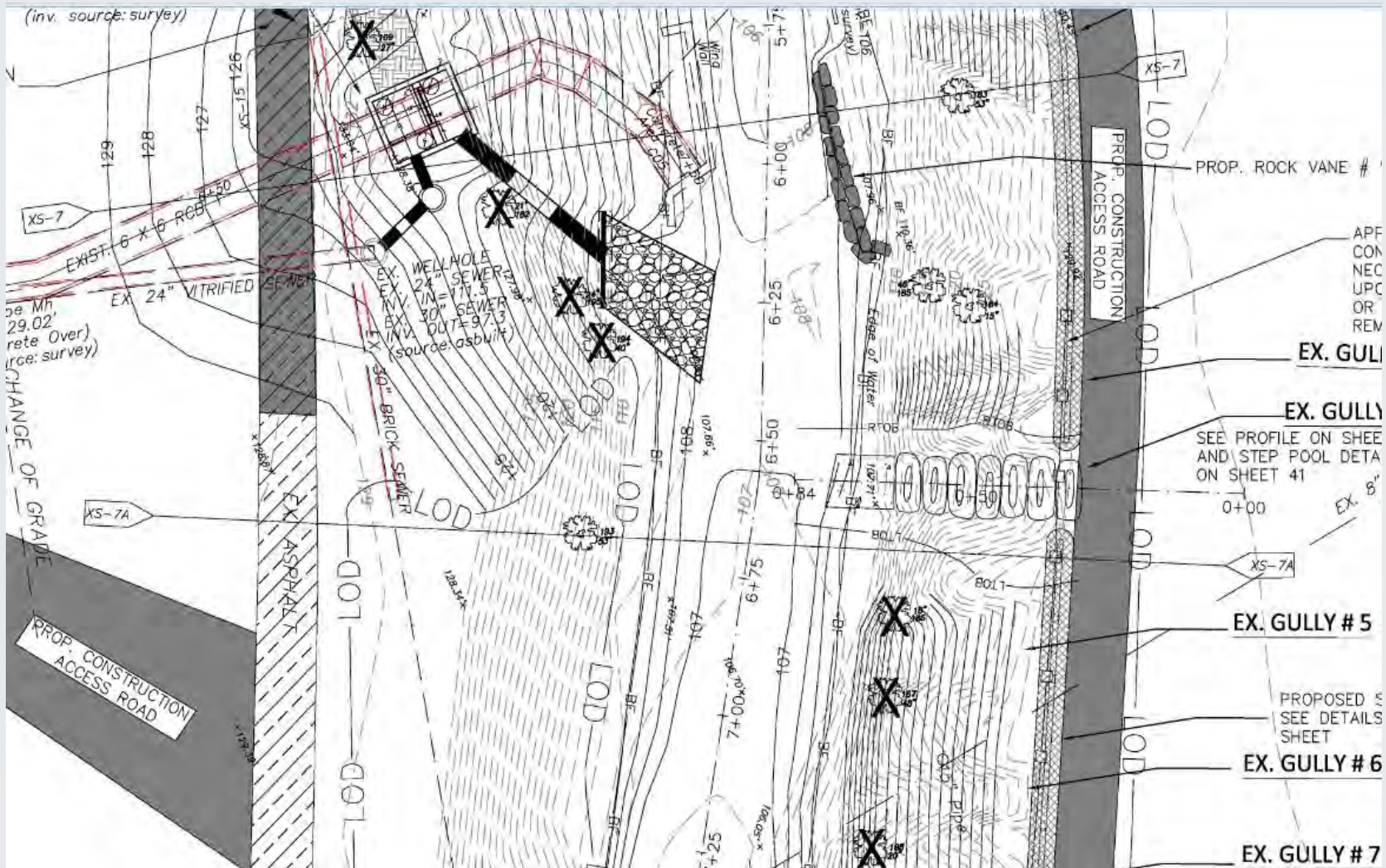
U.S. Army Corps of Engineers
Civil Works Division
Philadelphia District
Project No. 11-001-001
Sheet No. 7 OF 54

PROJECT NO. 11-001-001
SHEET NO. 7 OF 54
DATE: 11/11/11

STREAM RESTORATION PROJECT
COBB CREEK WATERSHED
(INDIAN CREEK) HABITAT
IMPROVEMENT
SHEET NUMBER:
7 OF 54

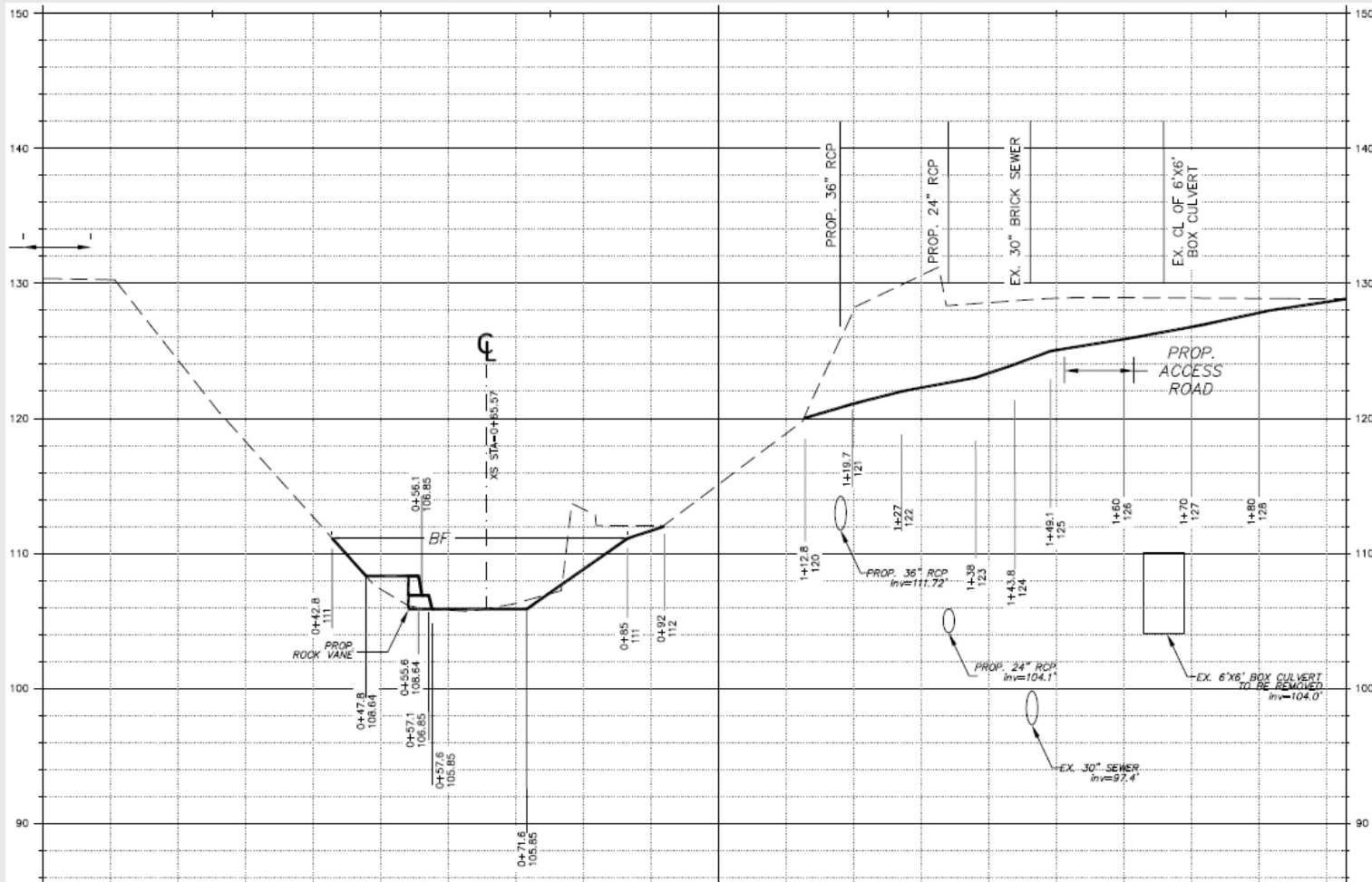


Bankfull benches





Bankfull benches





East branch

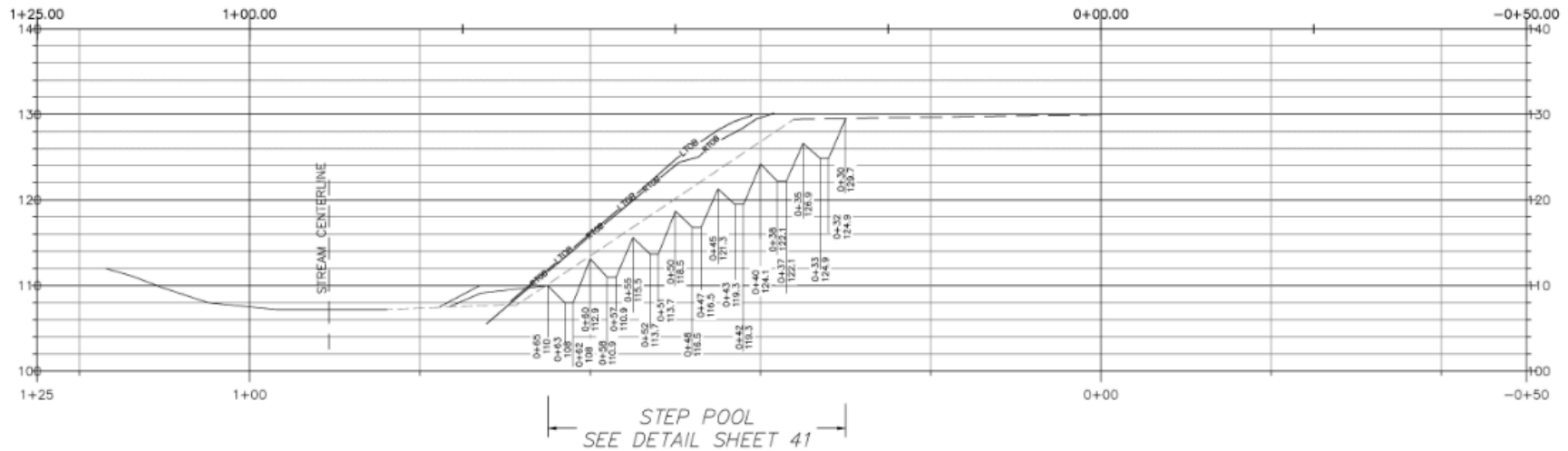








Boulders dumped over slope to repair gully erosion along Reach 1

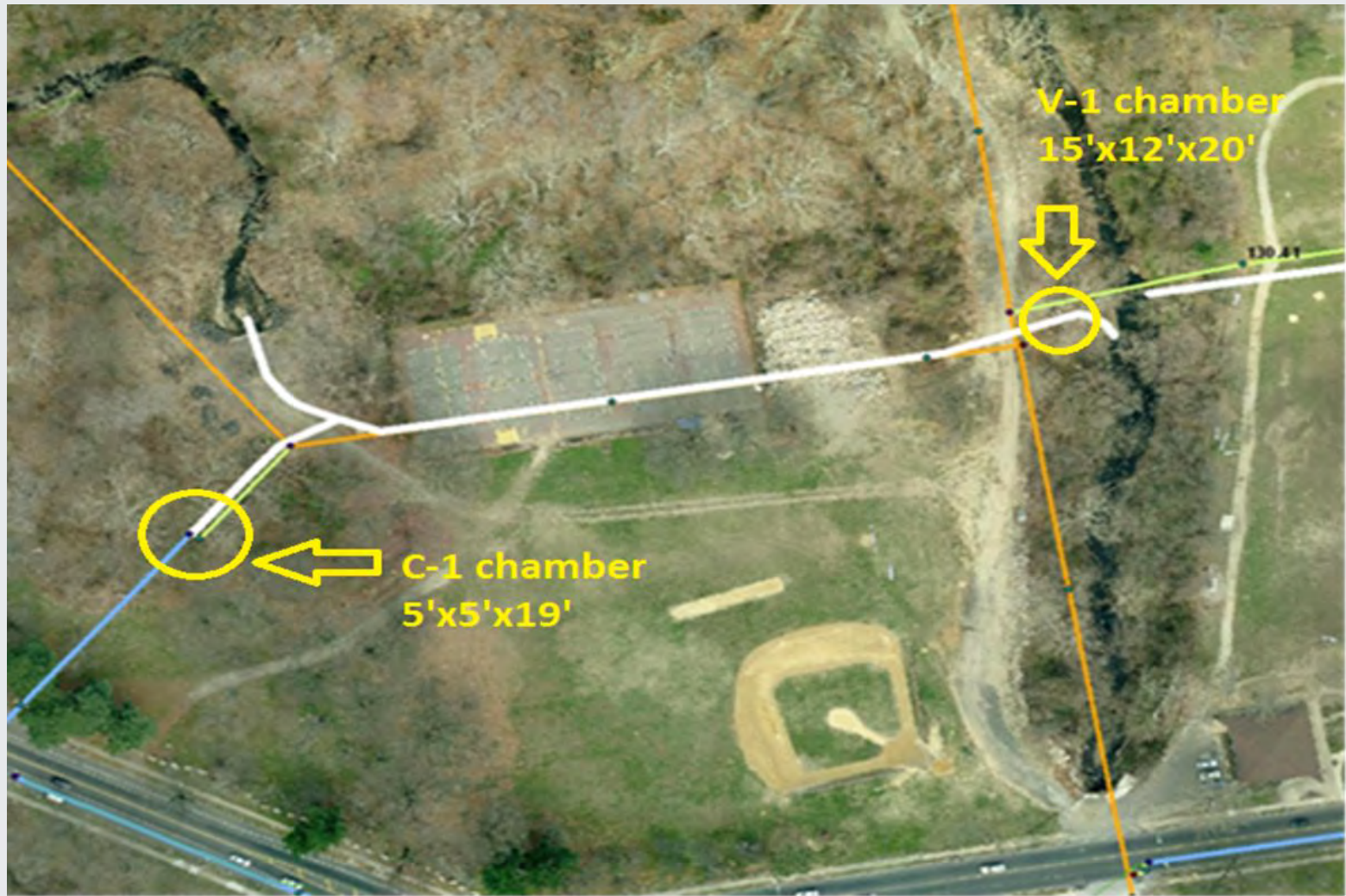


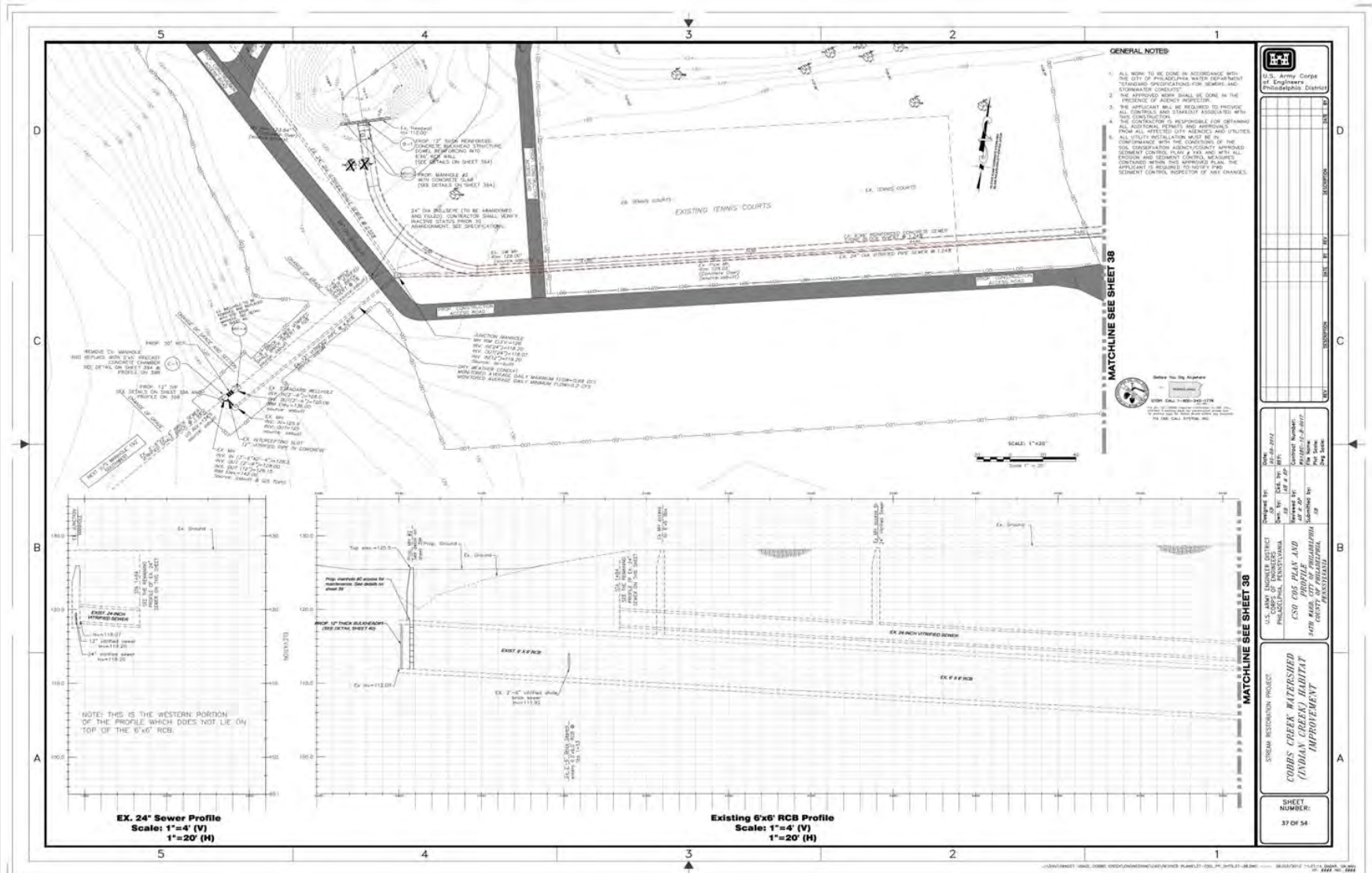
EAST BRANCH GULLY NO. 4 PROFILE

SEE PLAN SHEET 8

Scale: 1"=10' (V)

1"=10' (H)





U.S. Army Corps of Engineers
Philadelphia District

PROJECT: STREAM RESTORATION PROJECT
CODS CREEK WATERSHED (LINDEN CREEK) ILLUMINAT IMPROVEMENT

U.S. ARMY ENGINEER DISTRICT
PHILADELPHIA, PENNSYLVANIA

DESIGNED BY: [Name]
DRAWN BY: [Name]
CHECKED BY: [Name]
DATE: [Date]

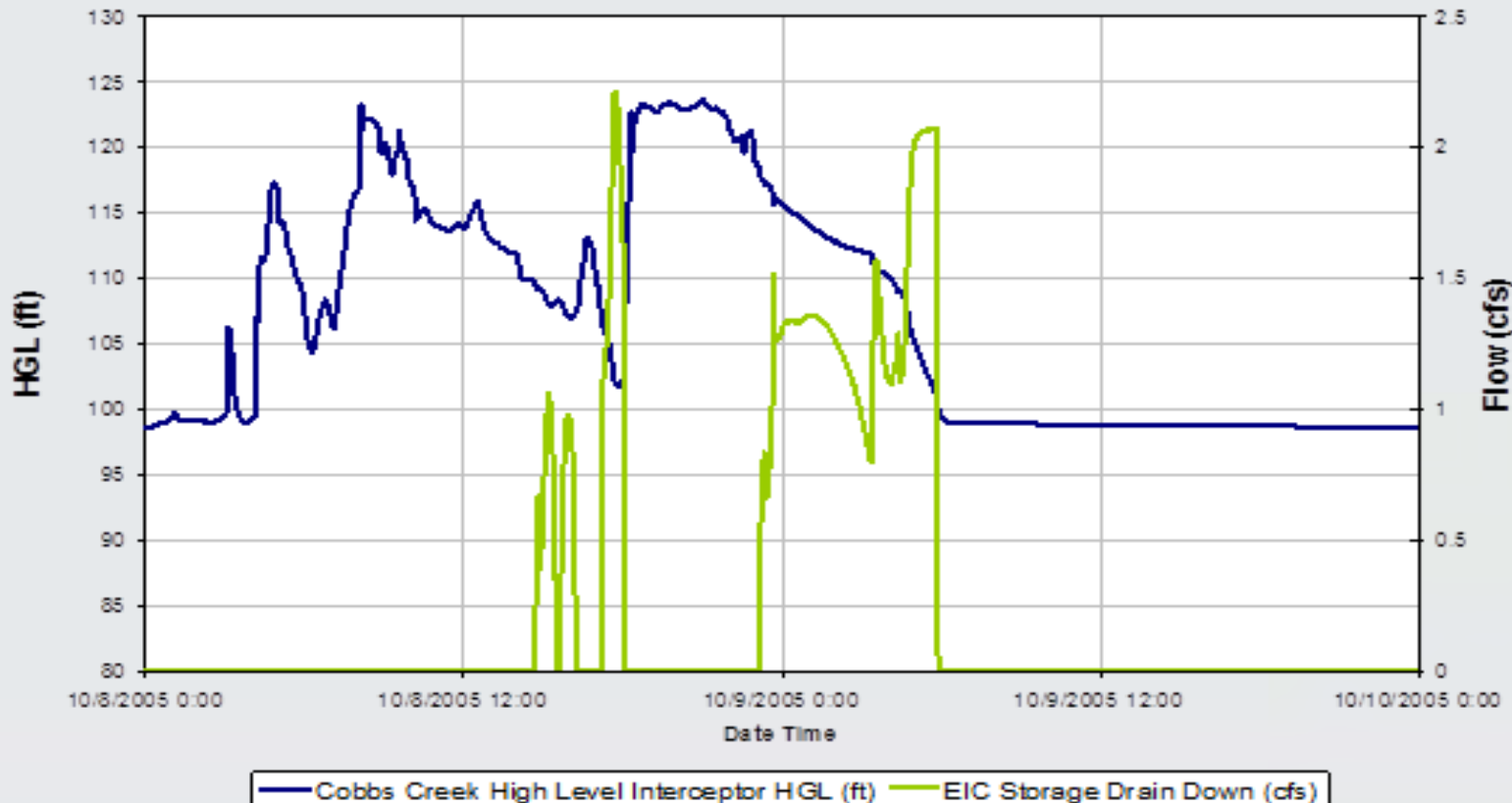
CSD 005 PLAN AND PROFILE
WITH MAIN COURSE OF CHANGES/REVISIONS

SHEET NUMBER: 37 OF 54



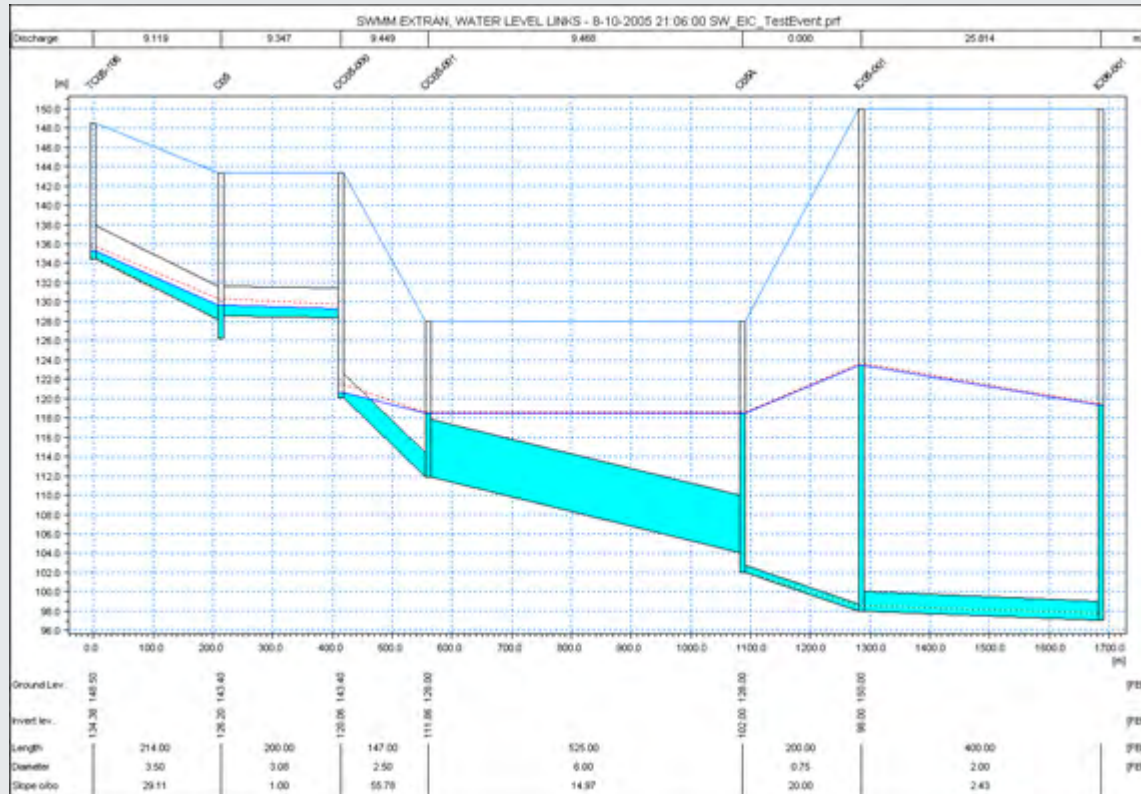
Routing between sewer interceptor & regulator:

East Indian Creek Storage Tank Drain Down
SWMM Simulation





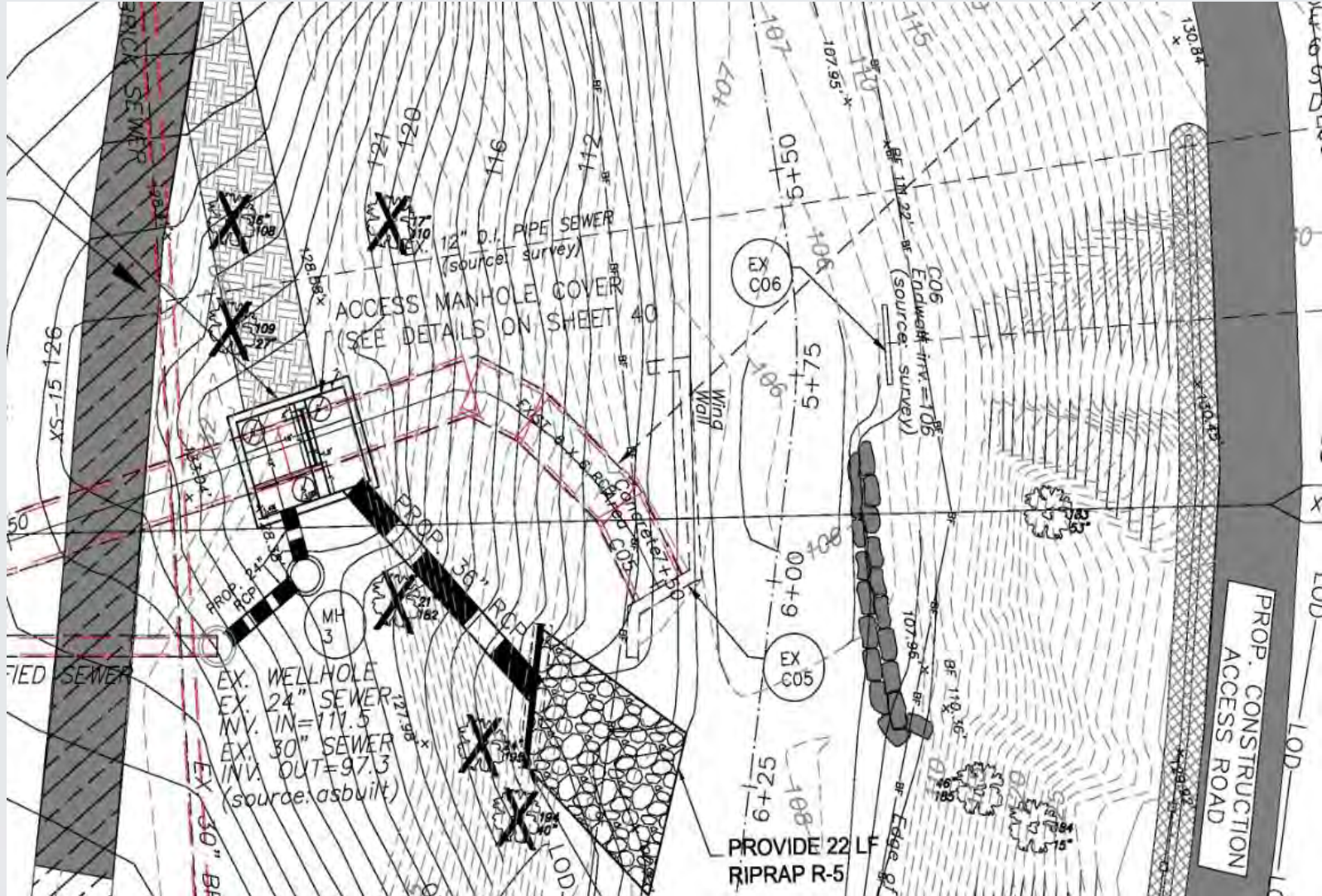
Representation of drainage connection to Interceptor





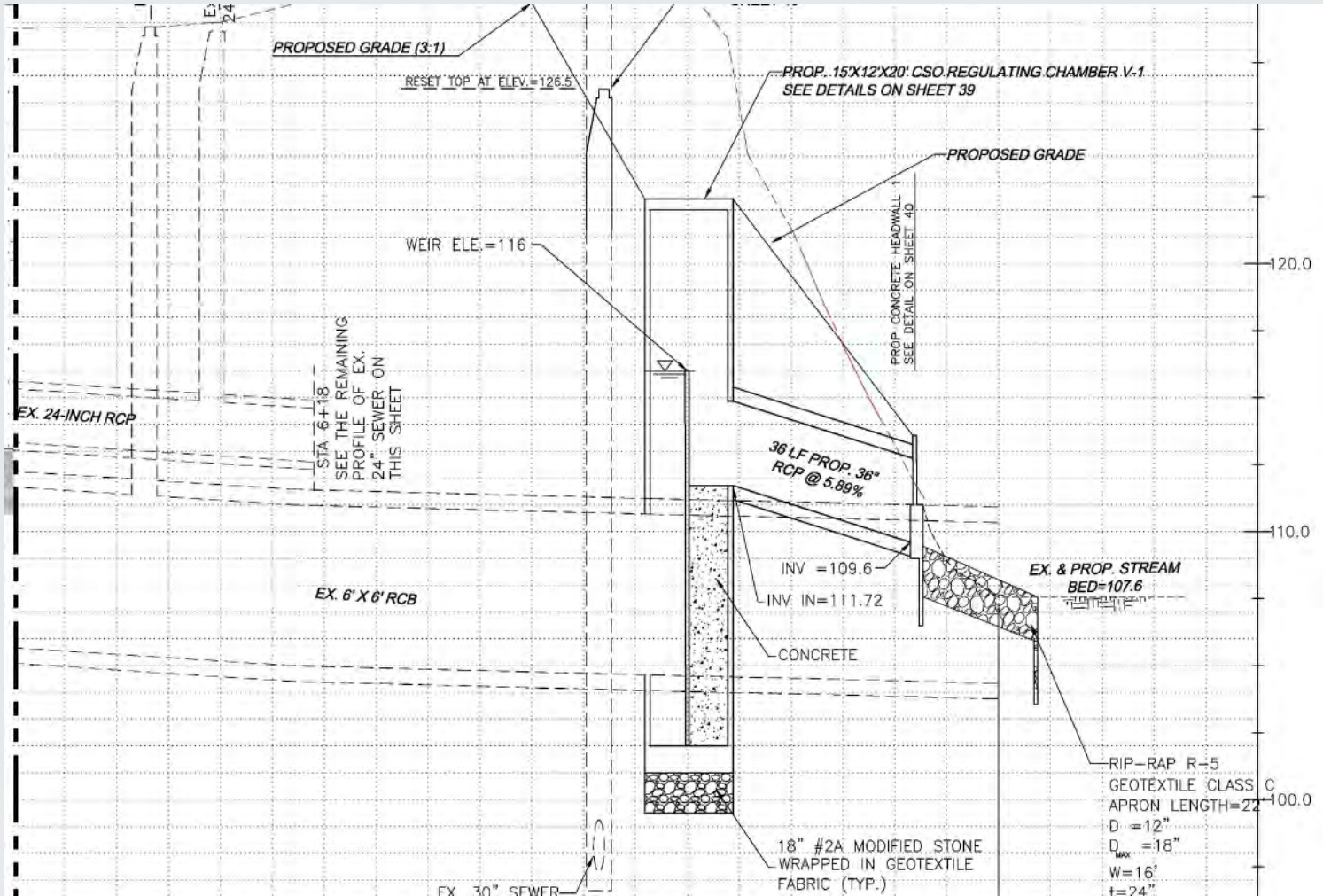
CSO Design

- CSO design includes a weir wall with 24" orifice inside concrete vault structure.
- The 24" orifice is used to divert the flow from the vault into the existing sewer interceptor.
- The 24" orifice size was selected to reduce the likelihood of clogging.
- The existing 700LF of underground reinforced concrete box (RCB) serves as storage during large storm events.
- The downstream portion of the existing reinforced concrete box (RCB) will be removed.



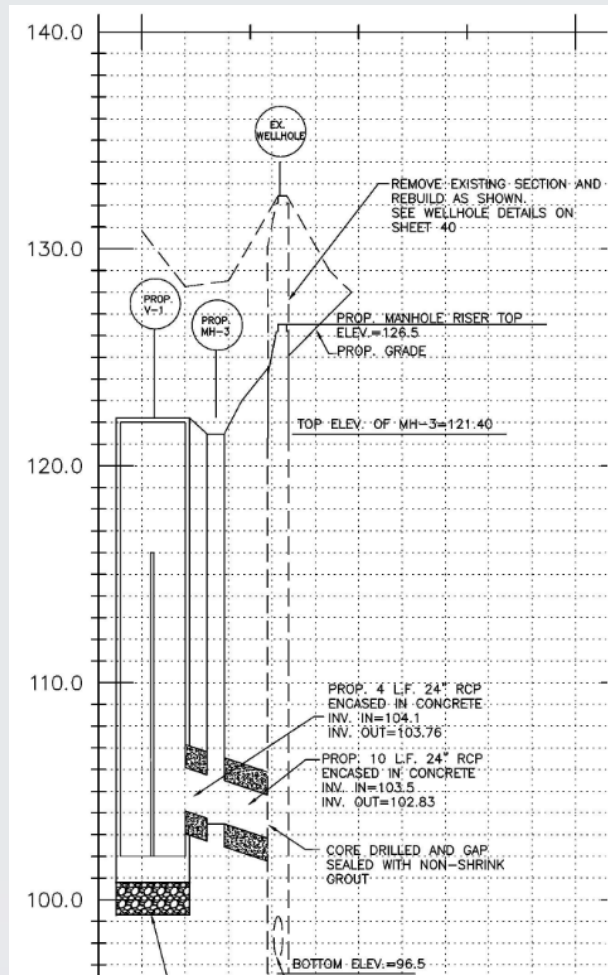


Connection between regulator & overflow



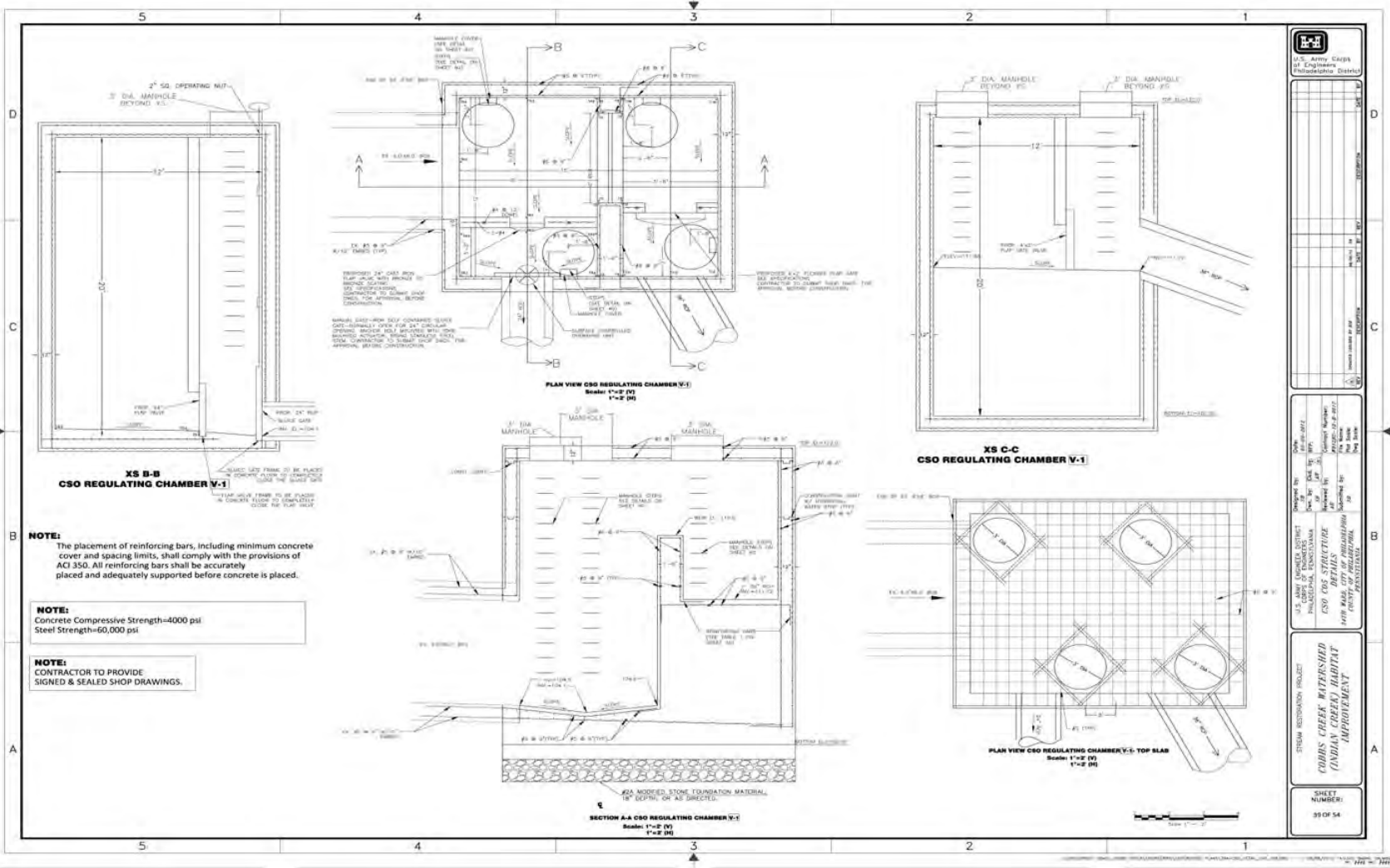


Connection between Interceptor and regulator



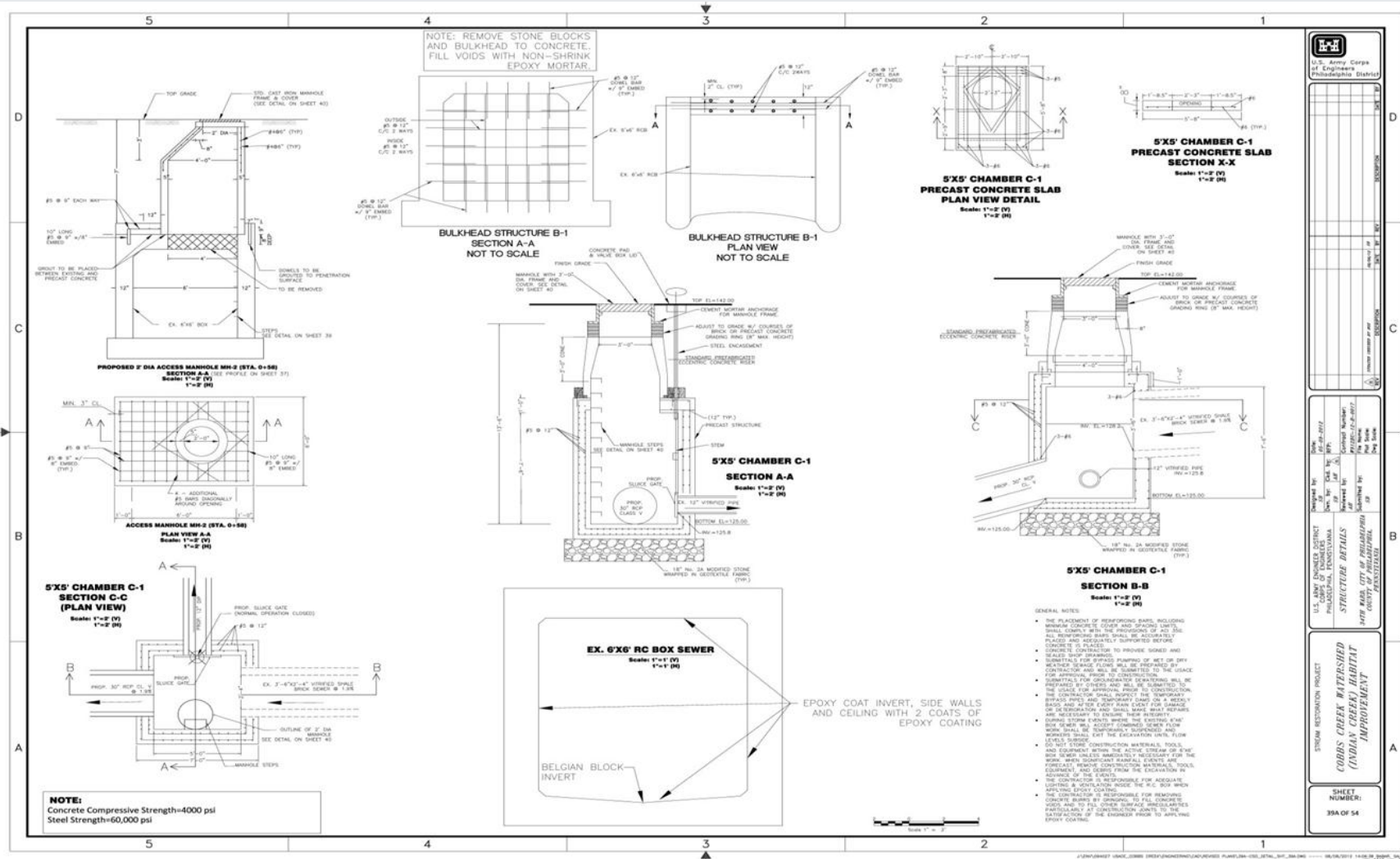


CSO regulating chamber V-1 details





CSO regulating chamber C-1 details



H-E-H
U.S. Army Corps of Engineers
Philadelphia District

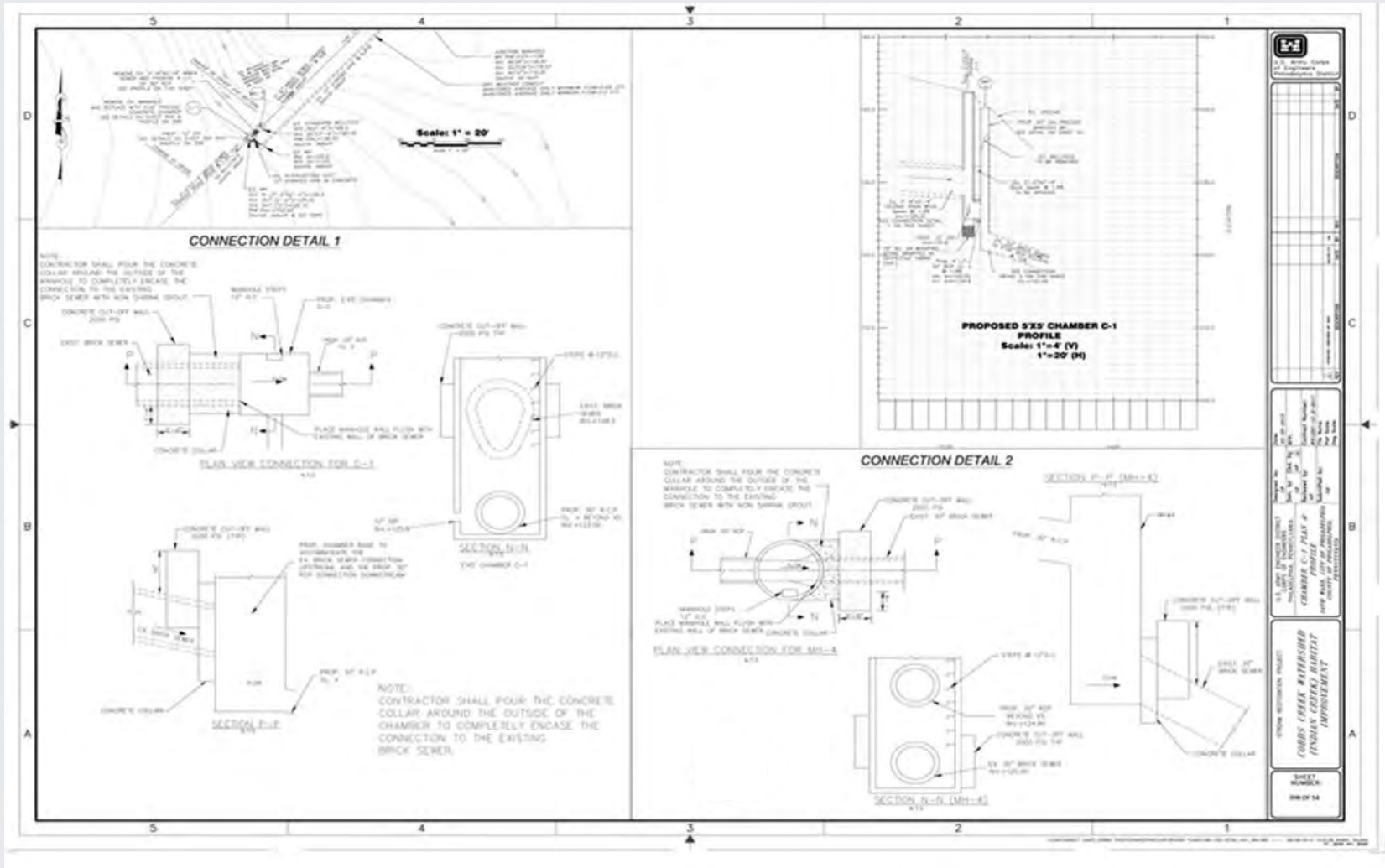
DESIGNED BY: [Name]
CHECKED BY: [Name]
DATE: [Date]

STRUCTURE DETAILS
SITE: [Location]

SHEET NUMBER:
39A OF 54



Connection details



Thank You!



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