North Dakota Department of Transportation

Ronald J. Henke, P.E.
Interim Director

Doug Burgum
Governor

July 27, 2017

Dionne Haynes
State NFIP Coordinator
Office of the State Engineer
608 East Boulevard
Bismarck, ND 58505-0850

PROJECT: SS-7-023(050)910 - PCN 21172
WATFORD CITY-CHERRY CREEK
FLOODWAY AUTHORIZATION REQUEST

The North Dakota Department of Transportation is requesting a Floodway Authorization for the above referenced project. This project is on Highway 23A on the SE side of Watford City from the Junction of US 85B to ND 23B. The project is scheduled for the 2018 construction season. The proposed improvements include reconstruction, widening, and structure replacement utilizing a temporary traffic bypass. There will be no loss of conveyance with the proposed work. Modeling was conducted for the permanent work include the new roadway profile and slopes along with the new structure. NDDOT proposes no modeling for the temporary traffic bypass since any impact would be temporary.

Attached is the Floodway Review Application, with the floodplain administrator's signature, no rise certification, hydraulic analysis, and sheets from the project plan set.

If you have any questions concerning this permit request, please contact Steve Kessler at (701) 328-3736.

Matt Linneman

for MARK S. GAYDOS, P.E., DIRECTOR – ENVIRONMENTAL AND TRANSPORTATION SERVICES DIVISION

19:msg:sek
Enclosures

APPLICATION FOR THE STATE ENGINEER'S FLOODWAY REVIEW

OFFICE OF THE STATE ENGINEER
REGULATORY - FLOODPLAIN
SFN 61171 (1/2017)

FOR STATE USE ONLY

Project Number	1721-05
Date Received	

N.D.C.C. § 61-16.2-14 requires that the community responsible for permitting or authorizing a use in a regulatory floodway must notify the state engineer of the proposed use before issuing the permit or authorization.

1. PERMITTING COMMUNITY

Community Name	Floodplain Administrator's Name		
Watford City, City of	Rick Jore		
Address	**City**	**State**	**ZIP Code**
200 2nd Avenue NE	Watford City	ND	58854
Telephone Number	**Email Address**		
701-444-8453	rjore@nd.gov		

2. APPLICANT (if different than Permitting Community)

Company/Agency	Contact Name		
North Dakota Department of Transportation	Mark S. Gaydos, P.E.		
Address	**City**	**State**	**ZIP Code**
608 East Boulevard Avenue	Bismarck	ND	58505-0700
Telephone Number	**Email Address**		
701-328-4417	mgaydos@nd.gov		

3. DEVELOPMENT INFORMATION

Location	
ND Hwy 23A from Jct US 85B to Jct ND 23B; Sections 19 & 20 of T-150-N, R-98-W	
FIRM Panel	**FIRM Date**
380344 0917 D	September 2, 2015
Flood Source (stream name)	
Tributaries of Cherry Creek & Cherry Creek	
Purpose	
The reconstruction of a rural section of 23A and improving it to a combination rural/urban street section.	
Development Description (attach additional documents as needed)	
See attached supplemental information.	
Anticipated Construction Start Date	**Anticipated Construction Completion Date**
04/01/2018	11/01/2018

4. FLOODWAY ANALYSIS

Floodway Development Federal and State Regulations:
44 CFR 60.3(d)(3) requires that communities must prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge.

N.D.C.C. § 61-16.2-6 requires that upon delineation of the floodway under the National Flood Insurance Program [42 U.S.C. 4001 et seq.], uses shall be permitted within the floodway to the extent that they do not cause any measurable decrease in the hydraulic conveyance in the affected area.

Please provide the following documentation (note that additional documentation may be required).	
✓	A map showing the proposed development location, compensatory storage, and all hydraulic cross sections used in the analysis.
✓	A description of the mitigation measures taken to restore conveyance. Provide volumetric calculations demonstrating compensatory storage, if applicable.
✓	Completed "No-Rise" Certificate.
✓	The hydraulic analysis results, including calculated conveyance and any other properties that may be pertinent. Please include at least one cross section both upstream and downstream of the development site, as well as all cross sections used at the development site (at least one). These are needed for both pre-and post-development conditions.

5. SIGNATURES

Submit this document and all attachments to the Office of the State Engineer to request a floodway review as required by North Dakota Century Code § 61-16.2-14. Furthermore, I understand a permit issued from the local floodplain Administrator is required before any development may commence.

Applicant's Signature (if not Floodplain Administrator)	Date
Matt Zimmerman	7-27-17

Before issuing a permit or authorization to allow a use in a regulatory floodway, the community responsible for permitting or authorizing such development shall notify the State Engineer of the proposed development. With a signature from the local floodplain administrator, this form will serve as official notification.

Floodplain Administrator's Signature	Date
Rich M. Love	7/20/17

Mail this application & supplemental forms to:

Office of the State Engineer
North Dakota State Water Commission
Floodplain Management Division
900 E Boulevard Ave, Dept 770
Bismarck, ND 58505-0850

SUPPLEMENTAL INFORMATION

Project Development Description

The project location is Highway 23A from the Junction of US 85B to ND 23B; lying on the SE side of Watford City, ND.

The purpose of the project is to improve the load capacity, extend the service life and improve the level of service at various access points along the route. The improvements will provide increased safety and mobility to the traveling public.

This reconstruction project consists of widening, grading, intersection reconfiguration, structure replacement (Cherry Creek crossing), curb & gutter, storm sewer, lighting, shared use path, aggregate base, concrete and/or asphalt surfacing and incidentals. The roadway will be widened to a 42' wide urban section (back of curb to back of curb), consisting of two 12' driving lanes and a 14' center turning lane. Curb and gutter shall be installed on both sides of the roadway. Lighting and storm sewer will also be updated and improved. A shared use path will be constructed along ND 23A to enhance the safety and recreational use for pedestrians and bicyclists. The driving surface will be either Hot Mix Asphalt or Concrete Pavement placed upon aggregate base course.

The project includes the replacement of an existing 27'x19' Structural Steel Plate Pipe Ellipse with a reinforced concrete box culvert (RCBC). The proposed RCBC has a triple 14' wide by 12' high opening and 151' long barrel with flared wingwalls.

Jurisdictional Information

A Solicitation of Views letter was sent to the North Dakota State Water Commission on December 29, 2015; to which a response letter was sent on January 11, 2016. The response identified the project affects two types of floodplain determinations with explanations as follows:

1. Areas are designated to be in Zone AE. North Dakota has no formal "permitting" authority as a state entity in National Flood Insurance Program (NFIP) identified floodplain areas. The permitting is always done by the local entity, which has jurisdiction in the area in question.
    - **Watford City's Floodplain Development Permit has been completed and submitted to the floodplain administrator.**

2. Portions of this project also take place in the regulatory floodway (Structure Replacement). Additional regulations exist for any development in the regulatory floodway and this project would be subject to floodway review by the State Engineer. The floodway review should be requested by Watford City, or on the City's behalf.
    - **Watford City's floodplain administrator has reviewed this Application for the State Engineer's Floodway Review and signed this request.**

Floodplain Information (Zone AE)

The project will impact a large portion of the floodplain as the existing Zone AE extends from Cherry creek in to the ditch section of the roadway. As stated in the description above, the roadway will be widened and a shared use path added. The floodplain was considered when modifying the existing typical section and pipe selection, assuring not to negatively impact the conveyance of the existing flow pattern. All existing and proposed mainline and approach pipe were analyzed using HY-8 7.30 computer modeling software. The existing and proposed mainline pipe, approach pipe and proposed typical sections were then analyzed with the use of HydroCAD, by HydroCAD Software Solutions, Inc.; the report and results can be found in the *Hydraulic Analysis of Mainline Pipe, Approach Pipe and Drop Inlet/Manhole Selection Report (July 2017)* for the North Dakota Department of Transportation.

Regulatory Floodway Information

The project includes the replacement of an existing 27'x19' Structural Steel Plate Pipe Ellipse with a reinforced concrete box culvert (RCBC). The proposed RCBC has a triple 14' wide by 12' high opening and 151' long barrel with flared wingwalls. The structure replacement lies within the limits of the floodway thus was analyzed basing the hydrology on USGS Regression Equations for North Dakota and hydraulic analysis for both the existing structure and proposed structure were performed using both HEC-RAS and HY-8 7.30 computer modeling software.

The computer modeling software requires the input of the structure size, channel slopes, channel cross sections and the overtopping profile; which in this typical section is not the center of the roadway, but the northern edge of the shared use path. The report and results can be found in the *Hydraulic Analysis and Structure Selection Report – Bridge No. 23-910.691 Cherry Creek (October 2016)* for the North Dakota Department of Transportation.

The installation of the proposed box culvert will require the use of a temporary bypass on the upstream side of the roadway. The temporary bypass will be installed after construction commences and will be removed prior to project completion, thus making all associated impacts temporary in nature.

FLOODWAY "NO-RISE" CERTIFICATION

OFFICE OF THE STATE ENGINEER
REGULATORY - FLOODPLAIN
SFN 61173 (1/2017)

This document is to certify that I am a duly qualified, registered professional engineer, licensed to practice in the State of North Dakota.

This document is to further certify that the attached technical data supports the fact that the proposed

Name of Development
ND Hwy 23A from Jct US 85B to Jct ND 23B

will not impact the base flood elevations, floodway elevations, or floodway widths on

Name of Stream
Cherry Creek

at the published cross sections in the Flood Insurance Study for

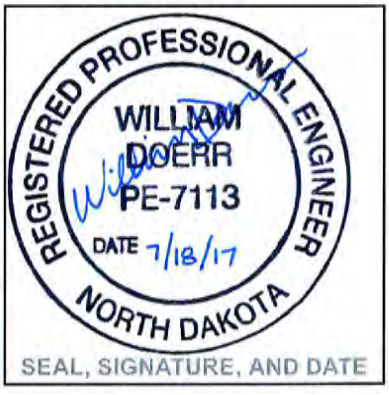
Name of Community	Study Date
Watford City, City of	October 14th, 2016

and will not impact the base flood elevations, floodway elevations, or floodway widths at unpublished cross-sections in the vicinity of the proposed development.

Attached are the following documents to support my findings:

* Hydraulic Analysis and Structure Selection
* Hydraulic Analysis of Mainline Pipe, Approach Pipe and Drop Inlet/Manhole Selection

Name		
William Doerr, P.E.		
Title		
Engineer		
Address		
109 S. Main Street		
Address		
City	State	ZIP Code
Bowman	ND	58623



SEAL, SIGNATURE, AND DATE

HYDRAULIC ANALYSIS AND STRUCTURE SELECTION

BRIDGE NO. 23-910.691

CHERRY CREEK

PROJECT NO. SS-7-023(050)910

PCN 21172

MCKENZIE COUNTY

PREPARED BY

BROSZ ENGINEERING, INC.

FOR THE

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

BRIDGE DIVISION

OCTOBER 14, 2016

SS-7-023(050)910

Hydraulic Report for Cherry Creek Structure

ND Highway 23A
US 85B to ND 23B

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Gary Brennan, Registration number PE-4513 on 10/14/16 and the original document is stored at the North Dakota Department of Transportation.

This document was originally issued and sealed by Gary Brennan Registration Number PE-4513 on 10/14/16 and the original document is stored at the North Dakota Department of Transportation

/s/ 10/14/16

Gary Brennan, P.E. Date

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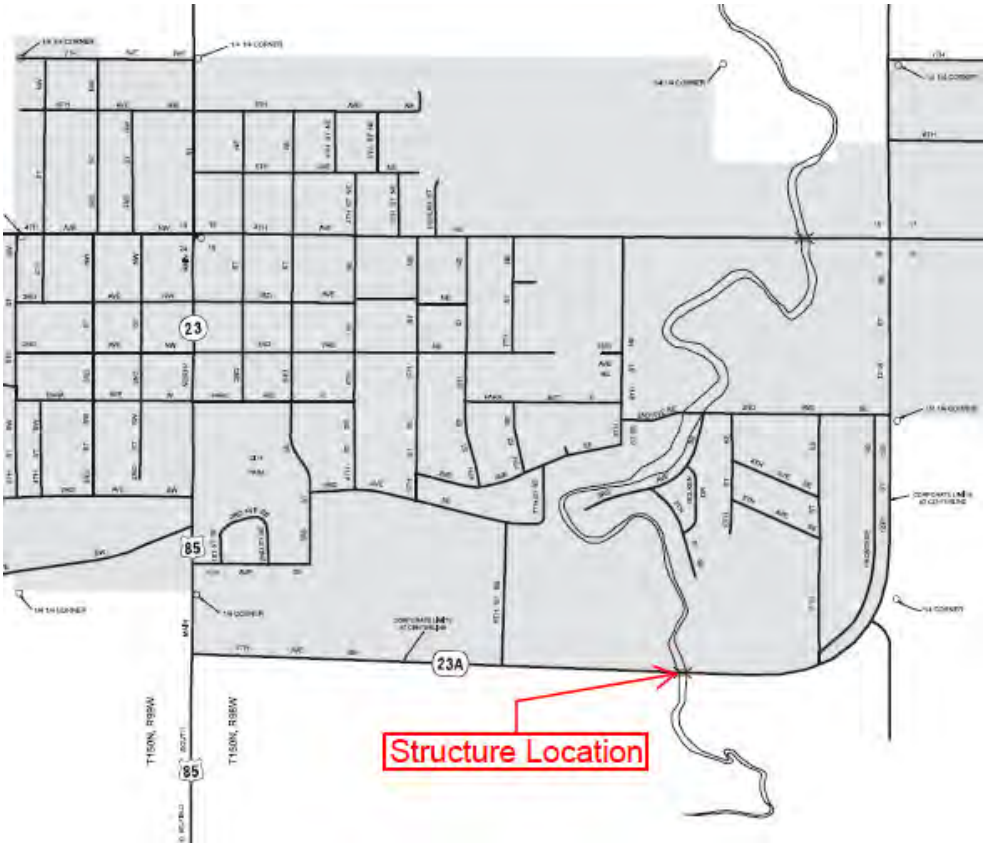
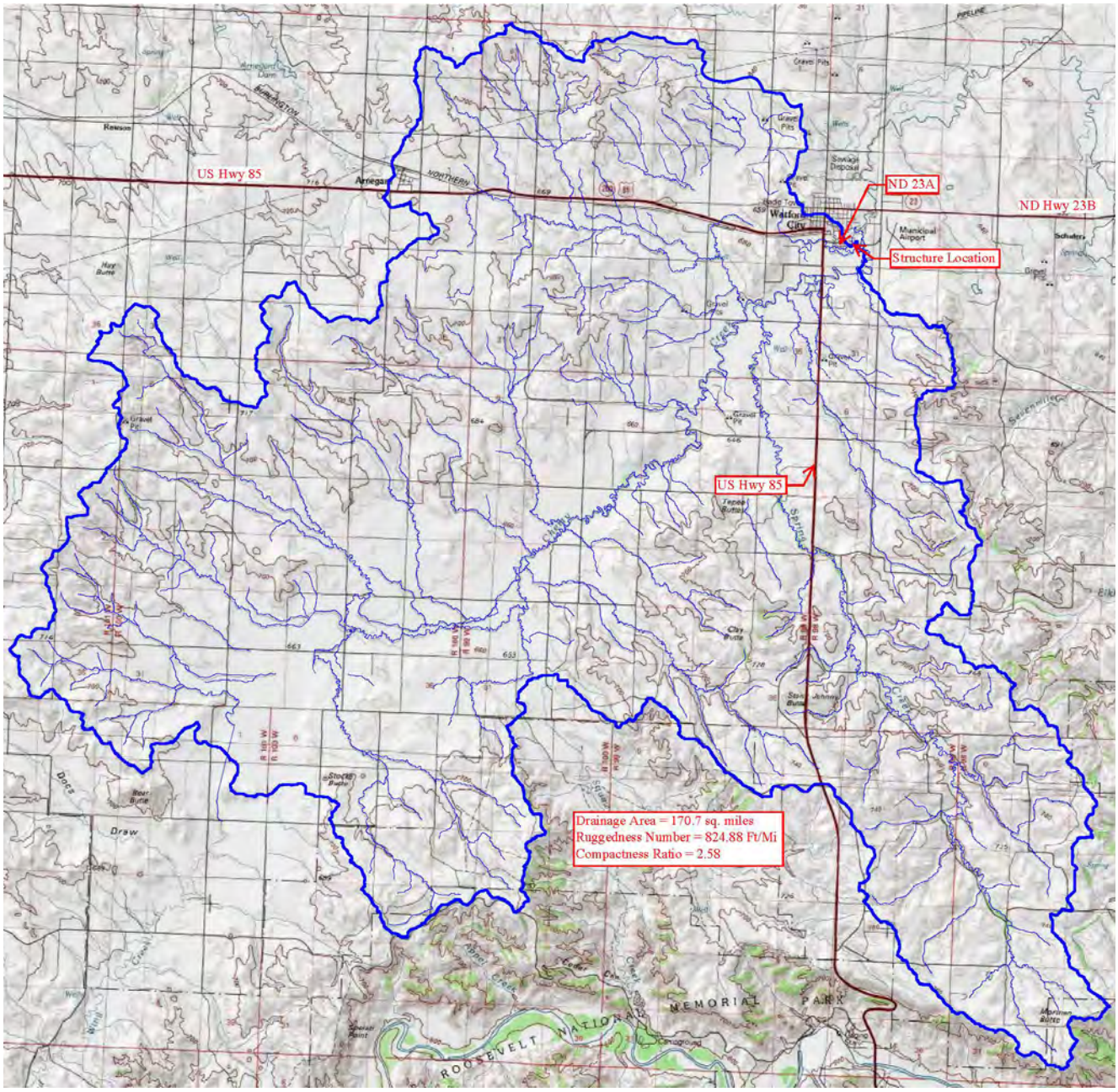
APPENDICES

Project Location
RP 910.69
BRIDGE NO. 23-910.691



Hydrologic and Hydraulic Study
for
Proposed Box Culvert
Cherry Creek



Cherry Creek Watershed

I. PURPOSE

The purpose of this report is to determine the hydraulic requirements for Bridge Number 23-910.691. This structure conveys the flows of Cherry Creek from south to north through ND 23 A at RP 910.691 in Watford City, ND.

II. EXISTING STRUCTURE

A single 27'x19'x62' Structural Steel Plate Pipe Ellipse culvert was built normal to the roadway at this location in 1977. Cherry Creek flows directly through this culvert. The culvert empties on the north side of ND Highway 23A.

III. HYDROLOGY

Hydrology is based on USGS Regression Equations for North Dakota, Scientific Investigations Report, 2015-5096. There are approximately 170.7 square miles of drainage area upstream of the subject crossing. After a review of the overall basin, water bodies within the basin were inspected for outlet conditions that would contribute to the direct runoff into Cherry Creek. The slope of the contributing portion of this drainage basin is approximately 6.9 feet per mile. The structural replacement options were sized based on the 50-year design discharge.

Table 1 – USGS Regression Equation Results

2015 USGS REGRESSION RESULTS

Location 23-910.691	**Hydrologic Zone** Zone B	**Contributing DrainageArea (Square Mile)** 170.70
Maximum Elevation 2430.00	**Basin Relief** 373.00	**Minimum Elevation** 2057.00
Stream Length (NHD) (Miles) 377.50	**Stream Density (Mile per Square Mile)** 2.21	**Ruggedness Number (Feet per Mile)** 824.88
Basin Perimeter (Miles) 119.36		**Compactness Ratio** 2.58

RESULTS

Recurrence Interval (years)	Peak Flow Q (CFS)
2	302
5	794
10	1212
25	1835
50	2321
100	2829
500	3998

A hydraulic analysis for both the existing pipe and the proposed box culvert were performed using the computer program HY-8 7.30. The results of this analysis are shown in **EXHIBIT 1-4**.

IV. STRUCTURE ANALYSIS

The new roadway will consist of two 12' driving lanes and one 14' center median. Per the AASHTO Roadside Design Guide, for a 40 MPH design speed and ADT over 6000 vpd, the clear zone is 18 feet from the edge of the driving lane or 37 feet from the centerline of the highway. The typical section was continued over the proposed structure and the shared use path contributed to additional length of the box culvert on the north side of the road.

Two new box culvert sizes were analyzed and the computations for headwater and outlet velocities are shown on the structure comparison sheet in **EXHIBIT 4**.

Alternative 1 is a triple 14' x 12' x 118' RCB culvert. Alternative 2 is a triple 14' x 14' x 110' RCB culvert. The cost estimates for these alternatives are shown in Table 2.

TABLE 2 – COST ESTIMATES (CAST-IN-PLACE)

ALTERNATIVE	COST
Alternative No. 1 (Triple 14' x 12' x 118')	**$814,564.90**
Alternative No. 2 (Triple 14' x 14' x 110')	**$817,225.50**

The desired limit for the outlet velocity through the structure is 10 feet per second for the design stage. The design outlet velocity for Alternative 1 and Alternative 2 are 5.67 fps and 5.67 fps respectively. The 100-year outlet velocities for Alternative 1 and Alternative 2 are 6.35 fps and 6.35 fps respectively. Given that this structure is in the regulatory floodway, the proposed structures must also be analyzed to ensure that FEMA's 100-year discharge (8700 cfs) will not cause an increase in the 100-year base flood elevation. It was also a priority that the conveyance of the new structure be equal to or greater than the conveyance provided by the existing structure. The box culverts listed in the two alternatives above were sized based on this criterion.

Alternative No. 1 is the least expensive option. Therefore, Alternative 1 is recommended as a replacement structure for this site.

Consideration was given to a Bridge option; however, the cost to construct a bridge would be considerably higher than a box culvert and a bridge would require more maintenance in the future resulting in additional expense over the life of the structure as compared to a box culvert. The estimated cost of a bridge is approximately $1,408,000.00.

The design load for this structure is HL-93.

V. MISCELLANEOUS

The box culvert lengths shown in this report are based on two 12’ driving lanes and a 14’ center median and 18’ clear zone (4:1 inslope) for a 40 mph design speed.

Scour computations were not performed for the alternatives. To control potential scour, riprap extending 10’ upstream and 20’ downstream is recommended. Riprap is recommended to be placed to a depth of 18”. These recommendations should be discussed at the TS&L inspection.

ITEMS FOR TS&L INSPECTION

1. Structure location
2. Temporary Traffic Bypass
3. Riprap recommendations
4. Possible utility conflicts

APPENDIX A

Hydraulic Calculations – HY-8

Cherry Creek

Existing 27’ x 19’ x 62’ Elliptical Pipe

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 302 cfs

Design Flow: 2321 cfs

Maximum Flow: 2829 cfs

Table 1 - Summary of Culvert Flows at Crossing: Existing

Headwater Elevation (ft)	Total Discharge (cfs)	Existing 27'x19' Ellipse Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2050.94	302.00	302.00	0.00	1
2052.60	554.70	554.70	0.00	1
2053.90	807.40	807.40	0.00	1
2055.03	1060.10	1060.10	0.00	1
2056.01	1312.80	1312.80	0.00	1
2056.82	1565.50	1565.50	0.00	1
2057.54	1818.20	1818.20	0.00	1
2058.20	2070.90	2070.90	0.00	1
2058.77	2321.00	2321.00	0.00	1
2059.30	2576.30	2576.30	0.00	1
2059.82	2829.00	2829.00	0.00	1
2060.78	3457.37	3457.37	0.00	Overtopping

Rating Curve Plot for Crossing: Existing

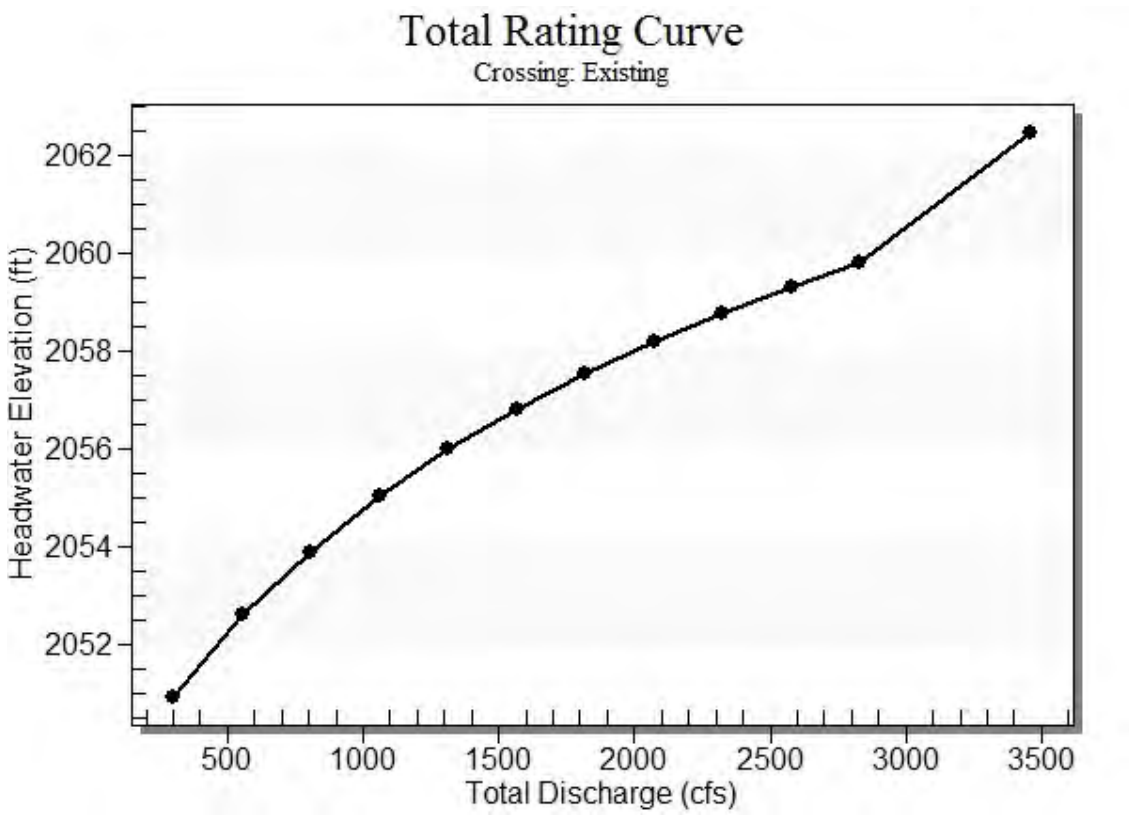


Table 2 - Culvert Summary Table: Existing 27'x19' Ellipse

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
302.00	302.00	2050.94	4.077	7.892	3-M1t	4.311	2.915	7.930	7.830	1.906	1.820
554.70	554.70	2052.60	5.603	9.551	3-M1t	5.852	3.962	9.470	9.370	2.771	2.500
807.40	807.40	2053.90	6.807	10.849	3-M1t	7.107	4.790	10.640	10.540	3.482	3.040
1060.10	1060.10	2055.03	7.860	11.982	3-M1t	8.173	5.489	11.640	11.540	4.098	3.510
1312.80	1312.80	2056.01	8.787	12.958	3-M1t	9.184	6.115	12.470	12.370	4.681	3.950
1565.50	1565.50	2056.82	9.709	13.767	3-M1t	10.147	6.683	13.110	13.010	5.274	4.390
1818.20	1818.20	2057.54	10.818	14.493	3-M1t	11.092	7.214	13.650	13.550	5.860	4.830
2070.90	2070.90	2058.20	11.775	15.149	3-M1t	12.031	7.709	14.100	14.000	6.447	5.270
2321.00	2321.00	2058.77	12.602	15.721	3-M1t	13.015	8.177	14.440	14.340	7.050	5.720
2576.30	2576.30	2059.30	13.348	16.255	3-M1t	14.071	8.628	14.710	14.610	7.680	6.200
2829.00	2829.00	2059.82	14.012	16.769	3-M2t	15.359	9.061	14.940	14.840	8.305	6.670

****

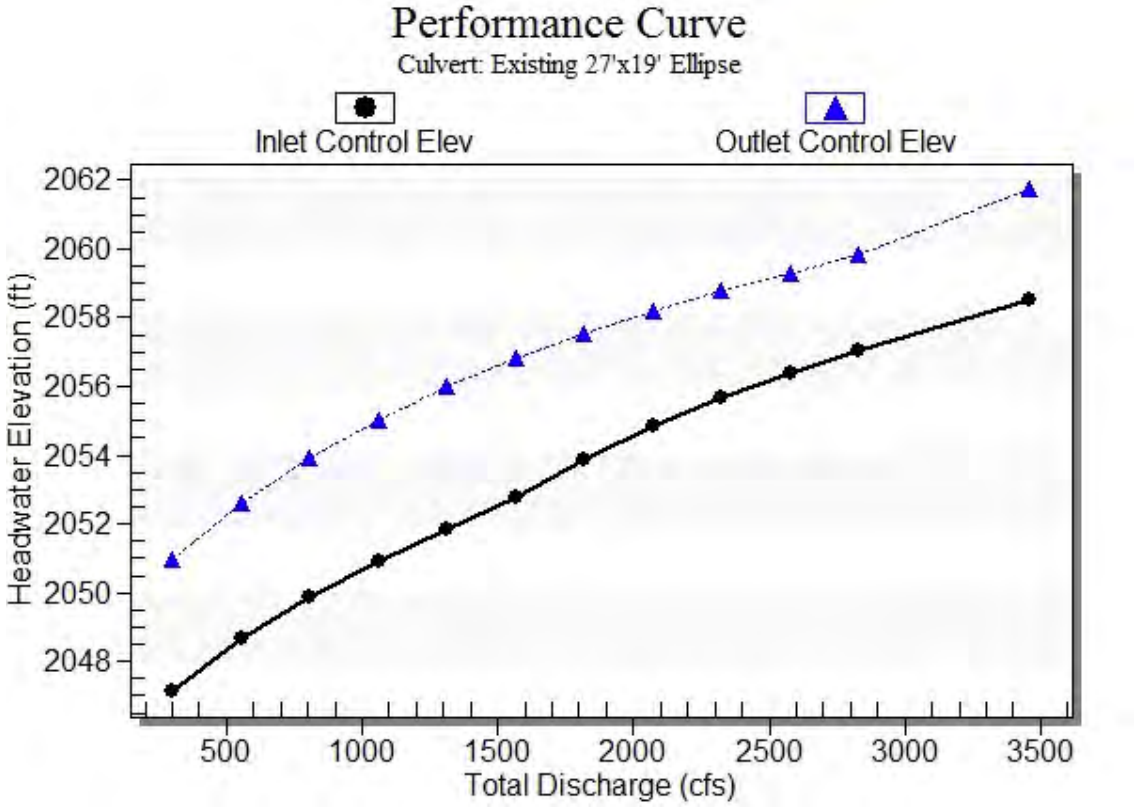
Straight Culvert

Inlet Elevation (invert): 2043.05 ft, Outlet Elevation (invert): 2042.90 ft

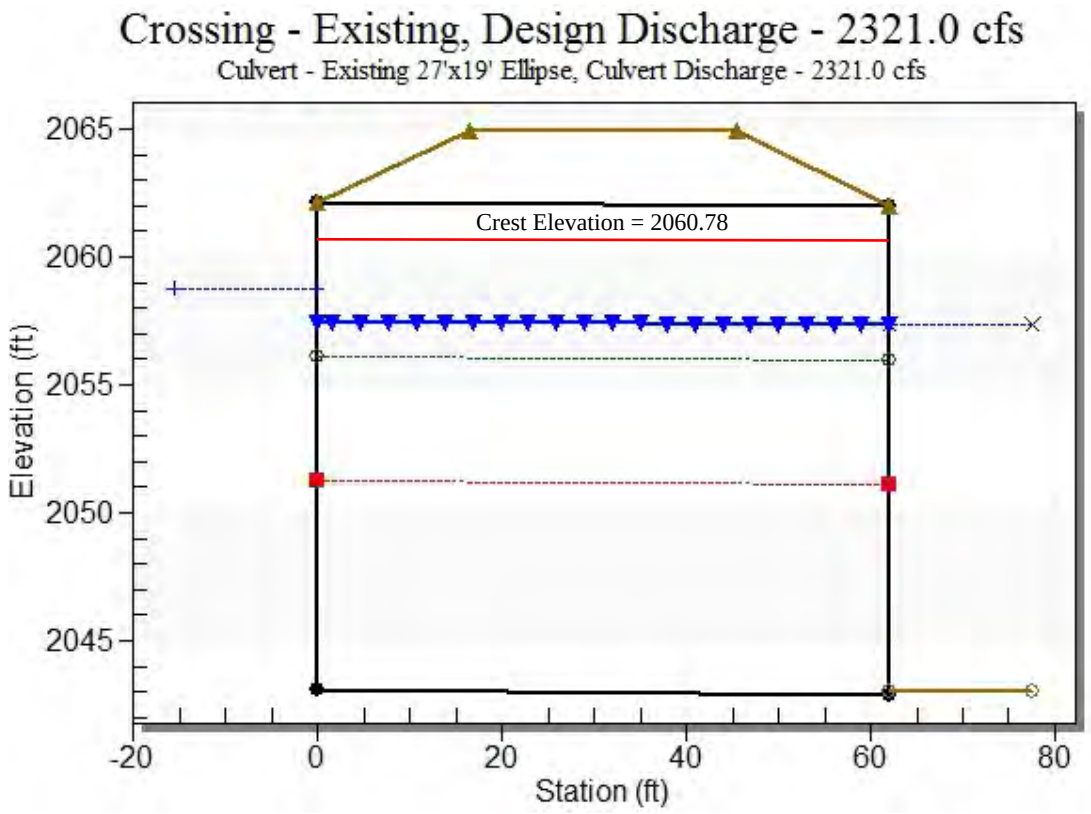
Culvert Length: 62.00 ft, Culvert Slope: 0.0024

****

Culvert Performance Curve Plot: Existing 27'x19' Ellipse



Water Surface Profile Plot for Culvert: Existing 27'x19' Ellipse



Site Data - Existing 27'x19' Ellipse

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2043.05 ft

Outlet Station: 62.00 ft

Outlet Elevation: 2042.90 ft

Number of Barrels: 1

Culvert Data Summary - Existing 27'x19' Ellipse

Barrel Shape: Elliptical

Barrel Span: 326.00 in

Barrel Rise: 229.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0330

Culvert Type: Straight

Inlet Configuration: Mitered

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Existing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
302.00	2050.83	7.83	1.82
554.70	2052.37	9.37	2.50
807.40	2053.54	10.54	3.04
1060.10	2054.54	11.54	3.51
1312.80	2055.37	12.37	3.95
1565.50	2056.01	13.01	4.39
1818.20	2056.55	13.55	4.83
2070.90	2057.00	14.00	5.27
2321.00	2057.34	14.34	5.72
2576.30	2057.61	14.61	6.20
2829.00	2057.84	14.84	6.67

Tailwater Channel Data - Existing

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: 2043.00 ft

Roadway Data for Crossing: Existing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	54400.00	2064.96
1	54500.00	2064.83
2	55000.00	2062.83
3	55100.00	2062.67
4	55200.00	2062.49
5	55300.00	2062.06
6	55500.00	2061.85
7	55700.00	2061.25
8	55800.00	2061.07
9	55900.00	2060.78
10	56000.00	2060.84
11	56100.00	2061.81
12	56200.00	2063.28
13	56400.00	2068.33
14	56600.00	2074.97

Roadway Surface: Paved

Roadway Top Width: 29.00 ft

APPENDIX B

Hydraulic Calculations – HY-8

Cherry Creek

Alternative 1

Triple 14’ X 12’ X 118’ RCB

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 302 cfs

Design Flow: 2321 cfs

Maximum Flow: 2829 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box Alt 1

Headwater Elevation (ft)	Total Discharge (cfs)	(3) 14x12 Proposed Box Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2050.86	302.00	302.00	0.00	1
2052.43	554.70	554.70	0.00	1
2053.64	807.40	807.40	0.00	1
2054.67	1060.10	1060.10	0.00	1
2055.58	1312.80	1312.80	0.00	1
2056.31	1565.50	1565.50	0.00	1
2056.95	1818.20	1818.20	0.00	1
2057.52	2070.90	2070.90	0.00	1
2057.99	2321.00	2321.00	0.00	1
2058.42	2576.30	2576.30	0.00	1
2058.81	2829.00	2829.00	0.00	1
2060.17	4376.90	4376.90	0.00	Overtopping

Rating Curve Plot for Crossing: Box Alt 1

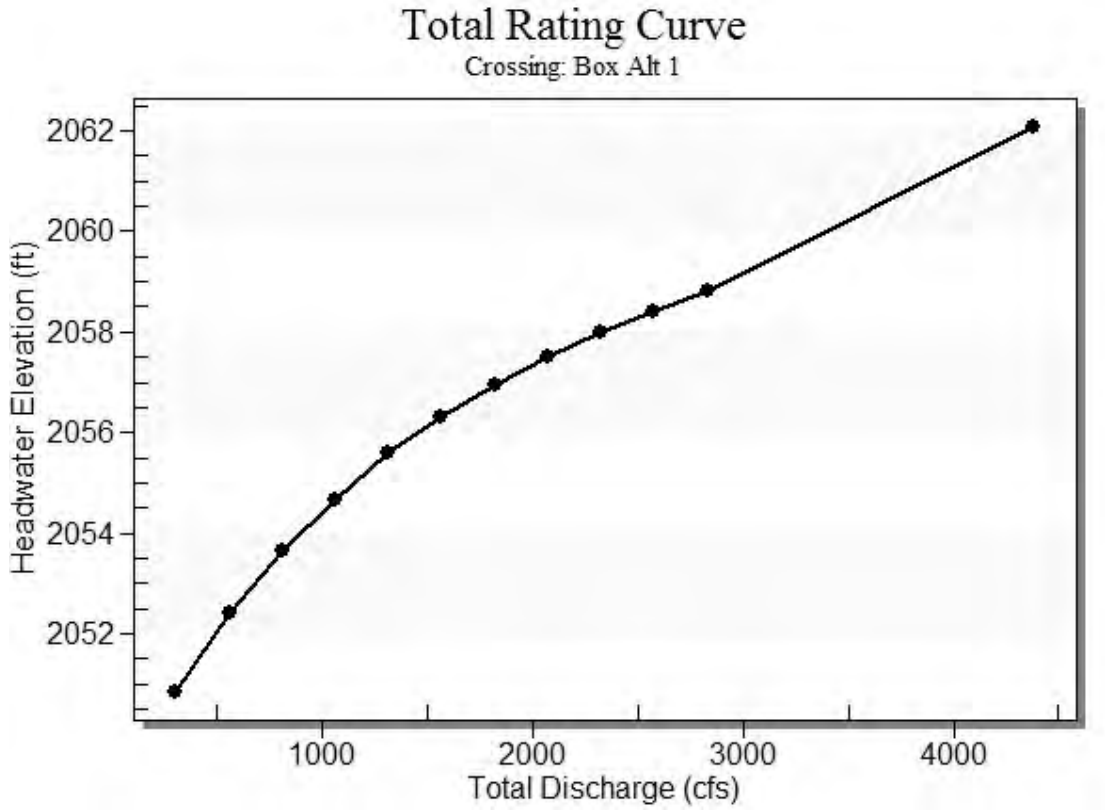


Table 2 - Culvert Summary Table: (3) 14x12 Proposed Box

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
302.00	302.00	2050.86	1.716	6.860	3-M1t	2.750	1.163	7.030	6.830	1.023	1.820
554.70	554.70	2052.43	2.574	8.432	3-M1t	4.027	1.746	8.570	8.370	1.541	2.500
807.40	807.40	2053.64	3.307	9.637	3-M1t	5.078	2.264	9.740	9.540	1.974	3.040
1060.10	1060.10	2054.67	3.965	10.673	3-M1t	5.983	2.711	10.740	10.540	2.350	3.510
1312.80	1312.80	2055.58	4.572	11.580	4-FFf	6.795	3.124	11.000	11.370	3.126	3.950
1565.50	1565.50	2056.31	5.142	12.308	4-FFf	7.550	3.513	11.000	12.010	3.727	4.390
1818.20	1818.20	2056.95	5.670	12.952	4-FFf	8.264	3.881	11.000	12.550	4.329	4.830
2070.90	2070.90	2057.52	6.169	13.521	4-FFf	8.941	4.232	11.000	13.000	4.931	5.270
2321.00	2321.00	2057.99	6.663	13.995	4-FFf	9.568	4.565	11.000	13.340	5.526	5.720
2576.30	2576.30	2058.42	7.167	14.417	4-FFf	11.000	4.897	11.000	13.610	6.134	6.200
2829.00	2829.00	2058.81	7.649	14.813	4-FFf	11.000	5.212	11.000	13.840	6.736	6.670

****

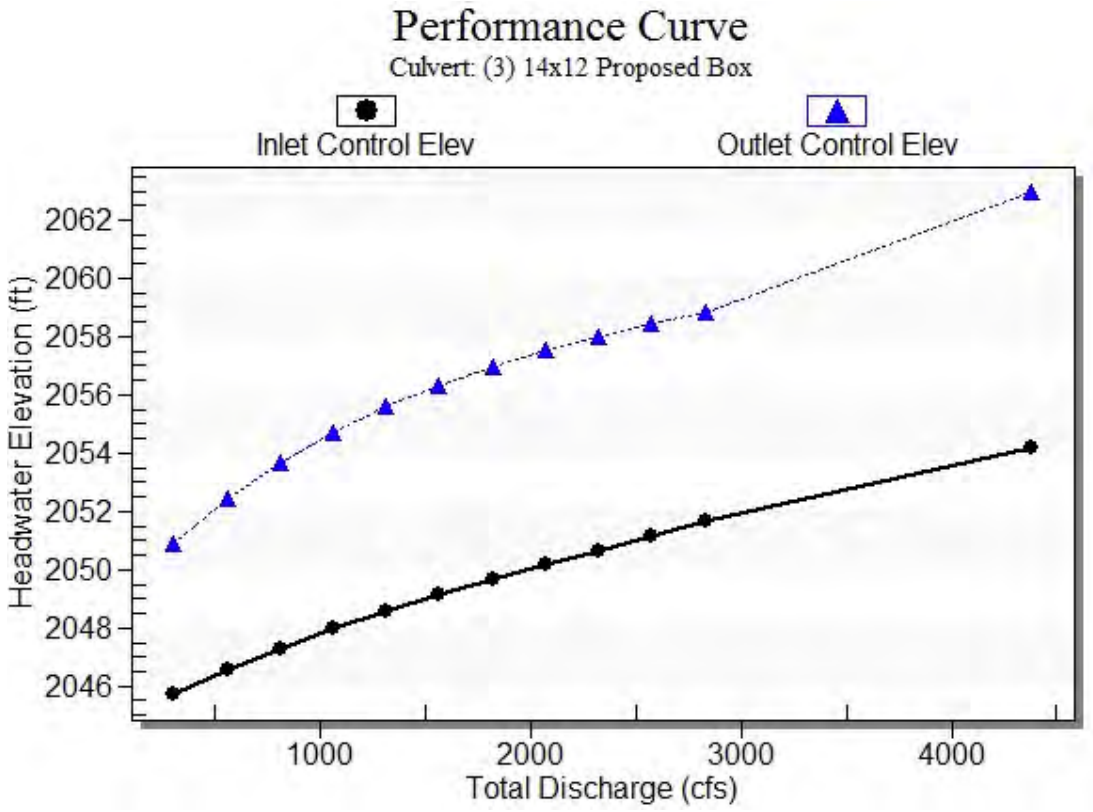
Straight Culvert

Inlet Elevation (invert): 2044.00 ft, Outlet Elevation (invert): 2043.80 ft

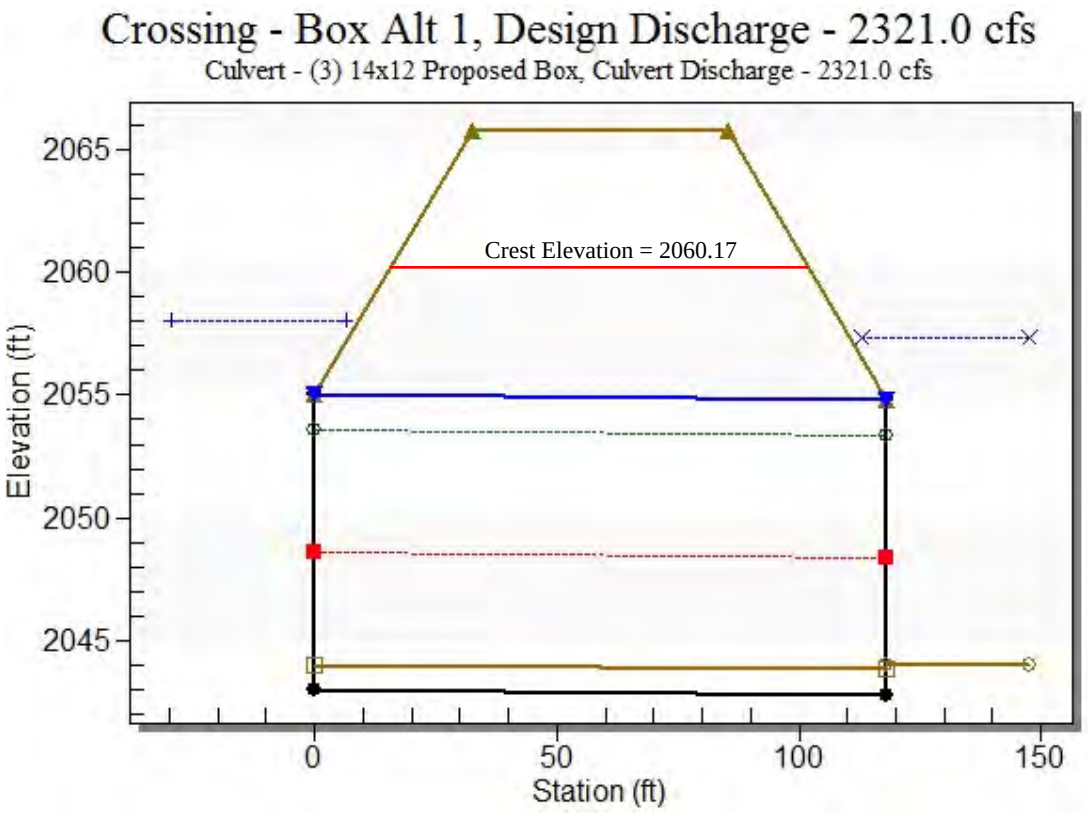
Culvert Length: 118.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: (3) 14x12 Proposed Box



Water Surface Profile Plot for Culvert: (3) 14x12 Proposed Box



Site Data - (3) 14x12 Proposed Box

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2043.00 ft

Outlet Station: 118.00 ft

Outlet Elevation: 2042.80 ft

Number of Barrels: 3

Culvert Data Summary - (3) 14x12 Proposed Box

Barrel Shape: Concrete Box

Barrel Span: 14.00 ft

Barrel Rise: 12.00 ft

Barrel Material: Concrete

Embedment: 12.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0450 (bottom)

Culvert Type: Straight

Inlet Configuration: Beveled Edge

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Box Alt 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
302.00	2050.83	6.83	1.82
554.70	2052.37	8.37	2.50
807.40	2053.54	9.54	3.04
1060.10	2054.54	10.54	3.51
1312.80	2055.37	11.37	3.95
1565.50	2056.01	12.01	4.39
1818.20	2056.55	12.55	4.83
2070.90	2057.00	13.00	5.27
2321.00	2057.34	13.34	5.72
2576.30	2057.61	13.61	6.20
2829.00	2057.84	13.84	6.67

Tailwater Channel Data - Box Alt 1

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: 2044.00 ft

Roadway Data for Crossing: Box Alt 1

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	54100.00	2065.81
1	54900.00	2063.43
2	55300.00	2061.55
3	55600.00	2060.17
4	55900.00	2061.18
5	56300.00	2065.42
6	56400.00	2068.32

Roadway Surface: Paved

Roadway Top Width: 53.00 ft

APPENDIX C

Hydraulic Calculations – HY-8

Cherry Creek

Alternative 2

Triple 14’ X 14’ X 110’ RCB

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 302 cfs

Design Flow: 2321 cfs

Maximum Flow: 2829 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box Alt 2

Headwater Elevation (ft)	Total Discharge (cfs)	(3) 14x14 Proposed Box Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2050.86	302.00	302.00	0.00	1
2052.43	554.70	554.70	0.00	1
2053.64	807.40	807.40	0.00	1
2054.67	1060.10	1060.10	0.00	1
2055.54	1312.80	1312.80	0.00	1
2056.22	1565.50	1565.50	0.00	1
2056.81	1818.20	1818.20	0.00	1
2057.36	2070.90	2070.90	0.00	1
2057.80	2321.00	2321.00	0.00	1
2058.17	2576.30	2576.30	0.00	1
2058.52	2829.00	2829.00	0.00	1
2060.17	5250.39	5250.39	0.00	Overtopping

Rating Curve Plot for Crossing: Box Alt 2

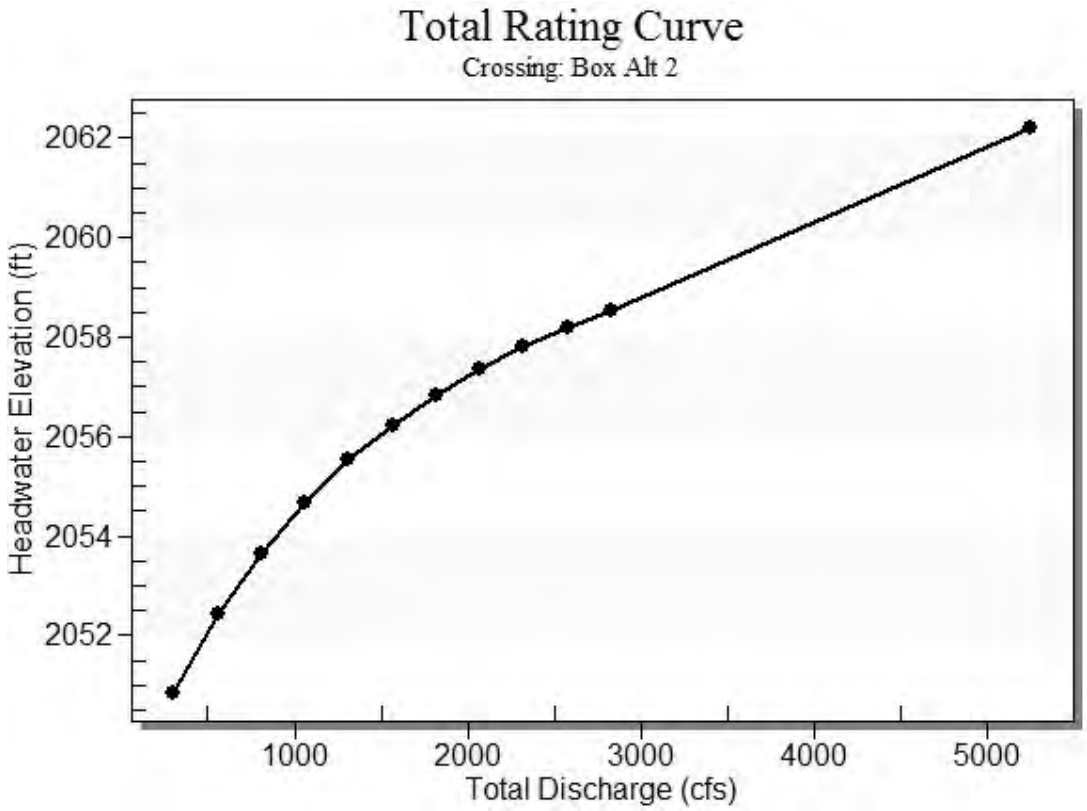


Table 2 - Culvert Summary Table: (3) 14x14 Proposed Box

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
302.00	302.00	2050.86	1.680	6.859	3-M1t	2.682	1.165	7.030	6.830	1.023	1.820
554.70	554.70	2052.43	2.574	8.431	3-M1t	3.920	1.751	8.570	8.370	1.541	2.500
807.40	807.40	2053.64	3.306	9.636	3-M1t	4.963	2.249	9.740	9.540	1.974	3.040
1060.10	1060.10	2054.67	3.964	10.672	3-M1t	5.896	2.710	10.740	10.540	2.350	3.510
1312.80	1312.80	2055.54	4.572	11.540	3-M1t	6.692	3.126	11.570	11.370	2.702	3.950
1565.50	1565.50	2056.22	5.141	12.224	3-M1t	7.443	3.513	12.210	12.010	3.053	4.390
1818.20	1818.20	2056.81	5.680	12.812	3-M1t	8.151	3.882	12.750	12.550	3.395	4.830
2070.90	2070.90	2057.36	6.195	13.362	4-FFf	8.806	4.234	13.000	13.000	4.172	5.270
2321.00	2321.00	2057.80	6.673	13.795	4-FFf	9.443	4.568	13.000	13.340	4.676	5.720
2576.30	2576.30	2058.17	7.137	14.171	4-FFf	10.042	4.896	13.000	13.610	5.190	6.200
2829.00	2829.00	2058.52	7.596	14.516	4-FFf	10.634	5.210	13.000	13.840	5.699	6.670

****

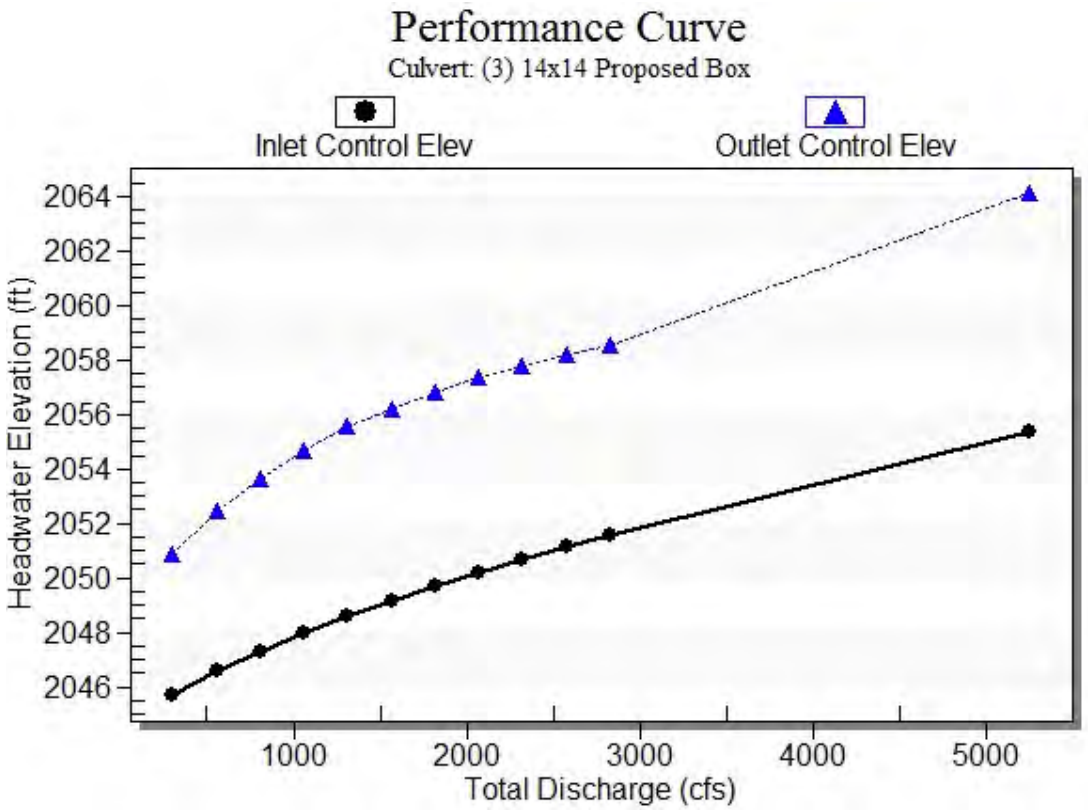
Straight Culvert

Inlet Elevation (invert): 2044.00 ft, Outlet Elevation (invert): 2043.80 ft

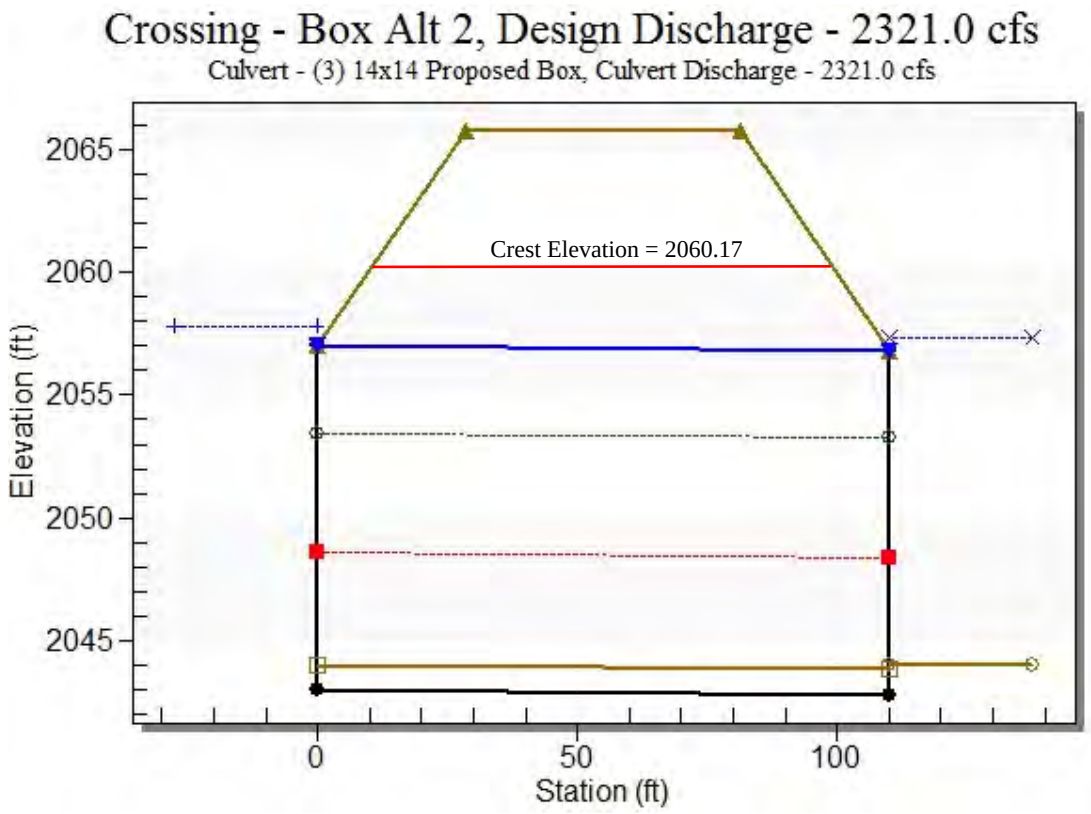
Culvert Length: 110.00 ft, Culvert Slope: 0.0018

****

Culvert Performance Curve Plot: (3) 14x14 Proposed Box



Water Surface Profile Plot for Culvert: (3) 14x14 Proposed Box



Site Data - (3) 14x14 Proposed Box

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2043.00 ft

Outlet Station: 110.00 ft

Outlet Elevation: 2042.80 ft

Number of Barrels: 3

Culvert Data Summary - (3) 14x14 Proposed Box

Barrel Shape: Concrete Box

Barrel Span: 14.00 ft

Barrel Rise: 14.00 ft

Barrel Material: Concrete

Embedment: 12.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0450 (bottom)

Culvert Type: Straight

Inlet Configuration: Beveled Edge

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Box Alt 2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
302.00	2050.83	2050.83	1.82
554.70	2052.37	2052.37	2.50
807.40	2053.54	2053.54	3.04
1060.10	2054.54	2054.54	3.51
1312.80	2055.37	2055.37	3.95
1565.50	2056.01	2056.01	4.39
1818.20	2056.55	2056.55	4.83
2070.90	2057.00	2057.00	5.27
2321.00	2057.34	2057.34	5.72
2576.30	2057.61	2057.61	6.20
2829.00	2057.84	2057.84	6.67

Tailwater Channel Data - Box Alt 2

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: 2044.00 ft

Roadway Data for Crossing: Box Alt 2

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	54100.00	2065.81
1	54900.00	2063.43
2	55300.00	2061.55
3	55600.00	2060.17
4	55900.00	2061.18
5	56300.00	2065.42
6	56400.00	2068.32

Roadway Surface: Paved

Roadway Top Width: 53.00 ft

APPENDIX D

Structure Comparison Summary

STRUCTURE COMPARISON SUMMARY

North Dakota Department of Transportation, Bridge
SFN 18323 (7-2016)

Structure Data

ITEM	EXISTING	ALT. NUMBER 1	ALT. NUMBER 2	ALT. NUMBER 3
Type or Description	27'x19' Elliptical Pipe	(3) 14'x12' RCBC	(3) 14'x14' RCBC	---
Number of Spans, Barrels, etc.	1	3	3	---
Overall Length	62	118	110	---
Total Waterway Area (FT ^{2})	403.89	504.00	588.00	---
Clearance Elevation	2062.05	2056.22	2058.22	---
Roadway Overtopping Elevation	2060.78	2060.17	2060.17	---

Hydraulic Comparison

50-Year Frequency Q= 2,321 CFS

ITEM	EXISTING	ALT. NUMBER 1	ALT. NUMBER 2	ALT. NUMBER 3
Discharge Through Structure (CFS)	2,321	2,321	2,321	---
Discharge Over Roadway (CFS)	0	0	0	---
Upstream Stage	2058.77	2057.99	2057.80	---
Downstream Stage	2057.39	2057.14	2057.14	---
Avg Velocity Through Structure (FT/SEC)	7.05	5.53	4.68	---

Hydraulic Comparison

100-Year Frequency Q= 2,829 CFS

ITEM	EXISTING	ALT. NUMBER 1	ALT. NUMBER 2	ALT. NUMBER 3
Discharge Through Structure (CFS)	2,829	2,829	2,829	---
Discharge Over Roadway (CFS)	0	0	0	---
Upstream Stage	2059.82	2058.81	2058.52	---
Downstream Stage	2057.89	2057.64	2057.64	---
Avg Velocity Through Structure (FT/SEC)	8.31	6.74	5.70	---

Hydraulic Comparison

500-Year Frequency Q= 3,998 CFS

ITEM	EXISTING	ALT. NUMBER 1	ALT. NUMBER 2	ALT. NUMBER 3
Discharge Through Structure (CFS)	3,457	3,998	3,998	---
Discharge Over Roadway (CFS)	541	0	0	---
Upstream Stage	2061.54	2060.85	2060.42	---
Downstream Stage	2059.00	2058.90	2058.90	---
Avg Velocity Through Structure (FT/SEC)	10.23	9.03	8.05	---

Comments
FIS 100 year (8700 CFS) Upstream Stage 2062.93 2062.49 2062.30

APPENDIX E

Hydraulic Design Data for Bridges

(Box Culverts)

HYDRAULIC DESIGN DATA FOR CULVERTS

North Dakota Department of Transportation, Bridge
SFN 9636 (7-2016)

Project Control Number	Project Number	Bridge Number
21172	SS-7-023(050)910	23-910.691

Drainage Area	170.7	Square Miles
Stream Gradient	0.0013	ft/ft
Design Frequency	50	- Year
Design Discharge	2,321	cfs
Design Headwater Stage	2,057.99	ft
Design Tailwater Stage	2,057.14	ft
Velocity Through Culvert	5.53	ft/sec
100-year Frequency Discharge	2,829	cfs
100-year Frequency Headwater	2,058.81	ft
Overtopping Stage	2,060.17	ft
Overtopping Discharge	4,376.90	cfs
Structure Selection	Triple 14'x12'x118' RCBC	

Comments
Inlet elevation = 2043.00
Outlet elevation = 2042.80

APPENDIX F

Cost Estimate for Structure Options

109 S. Main • Box 357
Bowman, ND 58623
Ph: 701.523.3340
Brosz ENGINEERING, INC.
ARCHITECTURE ENGINEERING SURVEYING

Project Name: ND 23A Reconstruction
Project # SS-7-023(050)910
File Task: Engineer's Cost Opinion
Date: 10/3/2016

Triple 14' X 12' X 118' Cast In Place RCBC Cost Opinion

Bid Item	Quantity	Unit	Cost/Unit	Cost/Item
Mobilization	1	LS	$30,000.00	$30,000.00
Class 2 Excavation-Box Culvert	1	EA	$50,000.00	$50,000.00
Foundation Preparation	1	EA	$15,000.00	$15,000.00
Foundation Fill	800.0	CY	$40.00	$32,000.00
Class AE-3 Concrete-Box Culvert	736.0	CY	$550.00	$404,800.00
Reinforcing Steel - Grade 60 - Box Culvert	104,523	LBS	$1.25	$130,653.75
Riprap Grade I	170	CY	$225.00	$38,250.00
Geotextile Fabric - Type RR	250	SY	$3.00	$750.00
Geotextile Fabric - Type R1	1,060	SY	$3.00	$3,180.00
Temporary Bypass	1	EA	$79,980.00	$79,980.00

Total Construction Cost Opinion = **$784,613.75**

Triple 14' X 14' X 110' Cast In Place RCBC Cost Opinion

Bid Item	Quantity	Unit	Cost/Unit	Cost/Item
Mobilization	1	LS	$30,000.00	$30,000.00
Class 2 Excavation-Box Culvert	1	EA	$50,000.00	$50,000.00
Foundation Preparation	1	EA	$15,000.00	$15,000.00
Foundation Fill	800.0	CY	$40.00	$32,000.00
Class AE-3 Concrete-Box Culvert	775.0	CY	$550.00	$426,250.00
Reinforcing Steel - Grade 60 - Box Culvert	112,505	LBS	$1.25	$140,631.25
Riprap Grade I	170	CY	$225.00	$38,250.00
Geotextile Fabric - Type RR	250	SY	$3.00	$750.00
Geotextile Fabric - Type R1	1,060	SY	$3.00	$3,180.00
Temporary Bypass	1	EA	$79,980.00	$79,980.00

Total Construction Cost Opinion = **$816,041.25**

APPENDIX G

Hydraulic Calculations – HEC-RAS

Cherry Creek

Existing 27’ x 19’ x 62’ Elliptical Pipe

Plan: CherryCreekFIS Cherry Creek Cherry Creek RS: 25708 Culv Group: Culvert #1 Profile: 50

Q Culv Group (cfs)	2321.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	7.77
Q Barrel (cfs)	2321.00	Culv Vel DS (ft/s)	7.39
E.G. US. (ft)	2058.74	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2058.27	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2057.84	Culv Frctn Ls (ft)	0.08
W.S. DS (ft)	2057.34	Culv Exit Loss (ft)	0.35
Delta EG (ft)	0.90	Culv Entr Loss (ft)	0.47
Delta WS (ft)	0.93	Q Weir (cfs)	
E.G. IC (ft)	2055.59	Weir Sta Lft (ft)	
E.G. OC (ft)	2058.74	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2057.33	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2057.34	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	7.43	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	8.14	Min El Weir Flow (ft)	2060.59

Plan: CherryCreekFIS Cherry Creek Cherry Creek RS: 25708 Culv Group: Culvert #1 Profile: 100

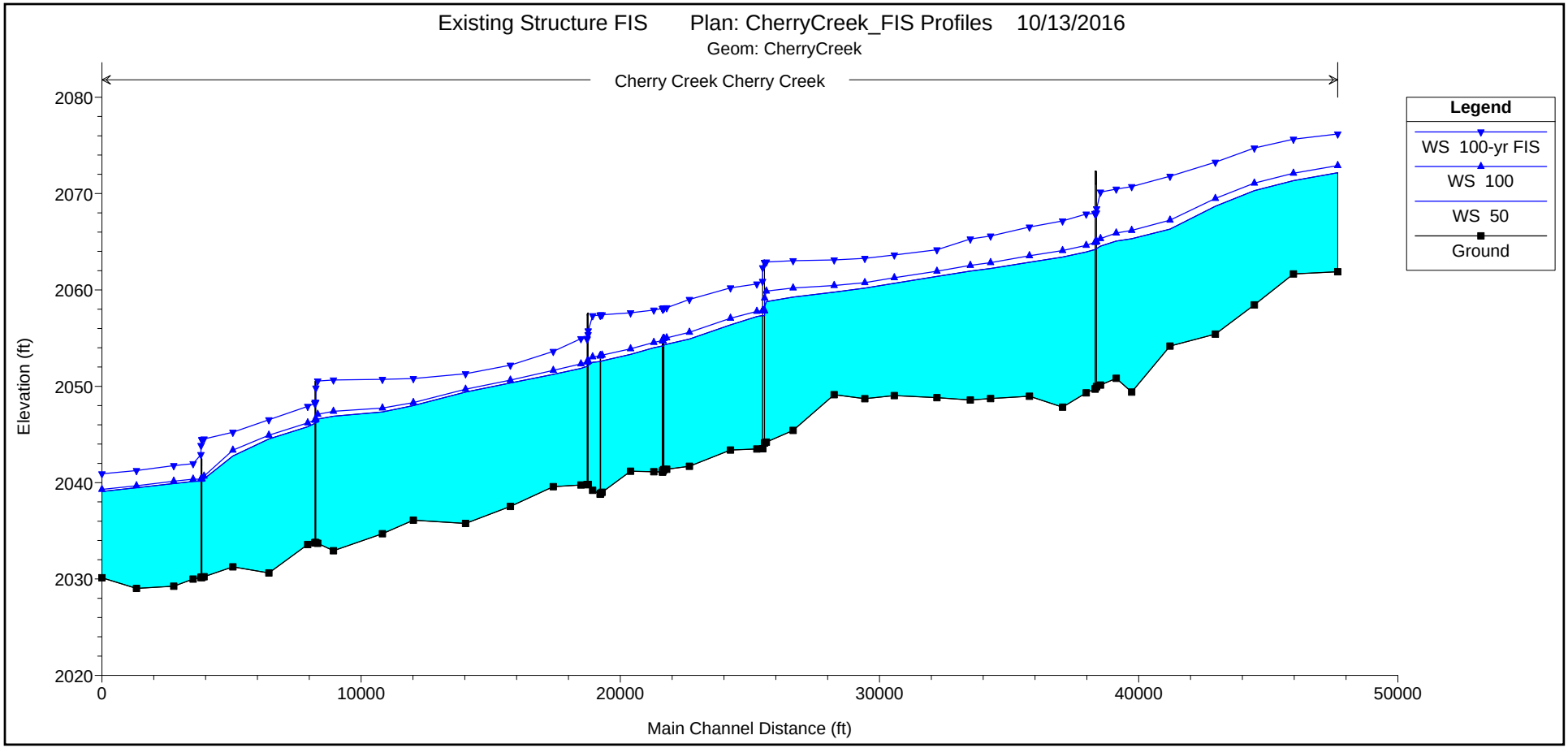
Q Culv Group (cfs)	2829.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	9.09
Q Barrel (cfs)	2829.00	Culv Vel DS (ft/s)	8.68
E.G. US. (ft)	2059.76	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2059.17	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2058.52	Culv Frctn Ls (ft)	0.11
W.S. DS (ft)	2057.84	Culv Exit Loss (ft)	0.49
Delta EG (ft)	1.24	Culv Entr Loss (ft)	0.64
Delta WS (ft)	1.32	Q Weir (cfs)	
E.G. IC (ft)	2057.06	Weir Sta Lft (ft)	
E.G. OC (ft)	2059.76	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2057.84	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2057.84	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	8.26	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	9.03	Min El Weir Flow (ft)	2060.59

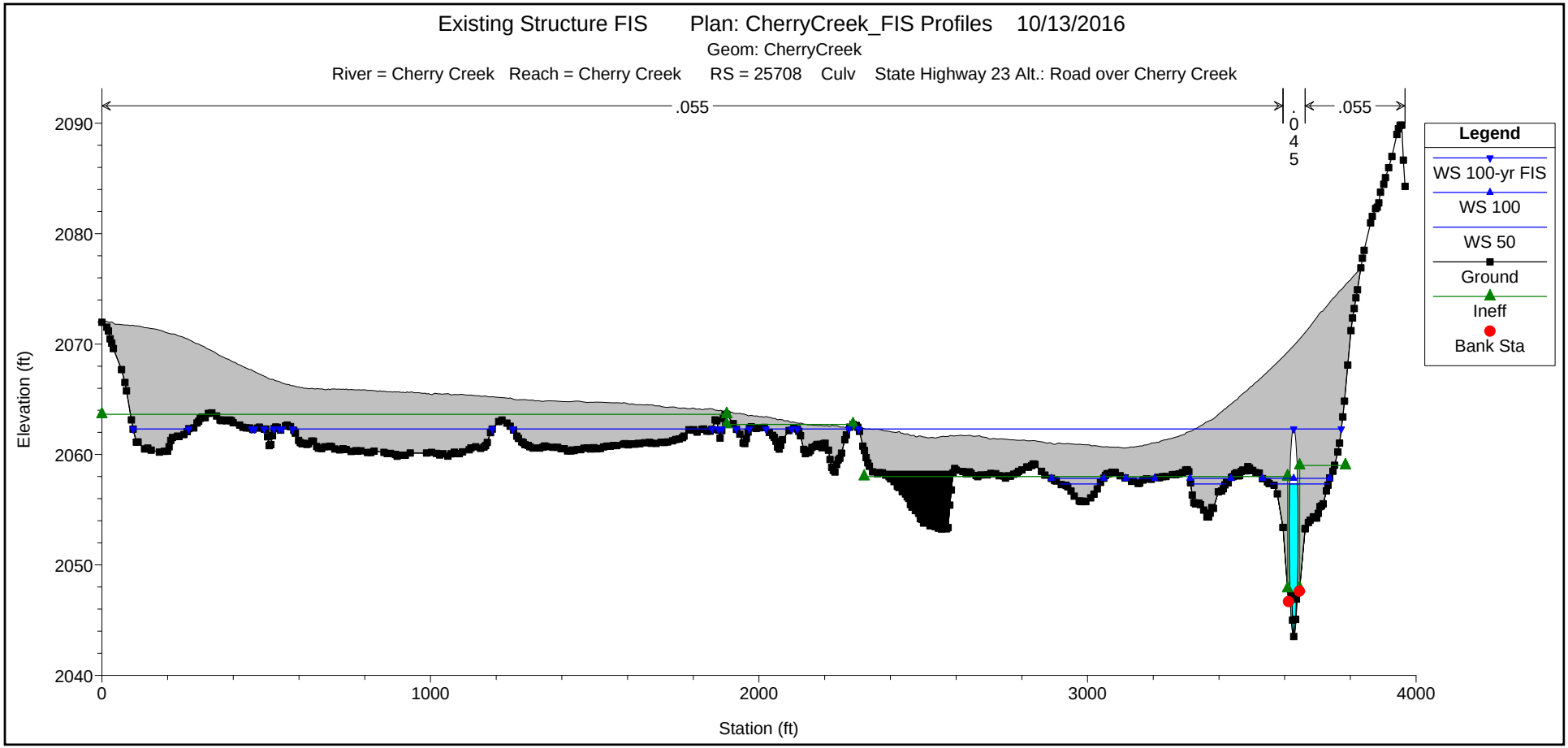
Plan: CherryCreekFIS Cherry Creek Cherry Creek RS: 25708 Culv Group: Culvert #1 Profile: 100-yr FIS

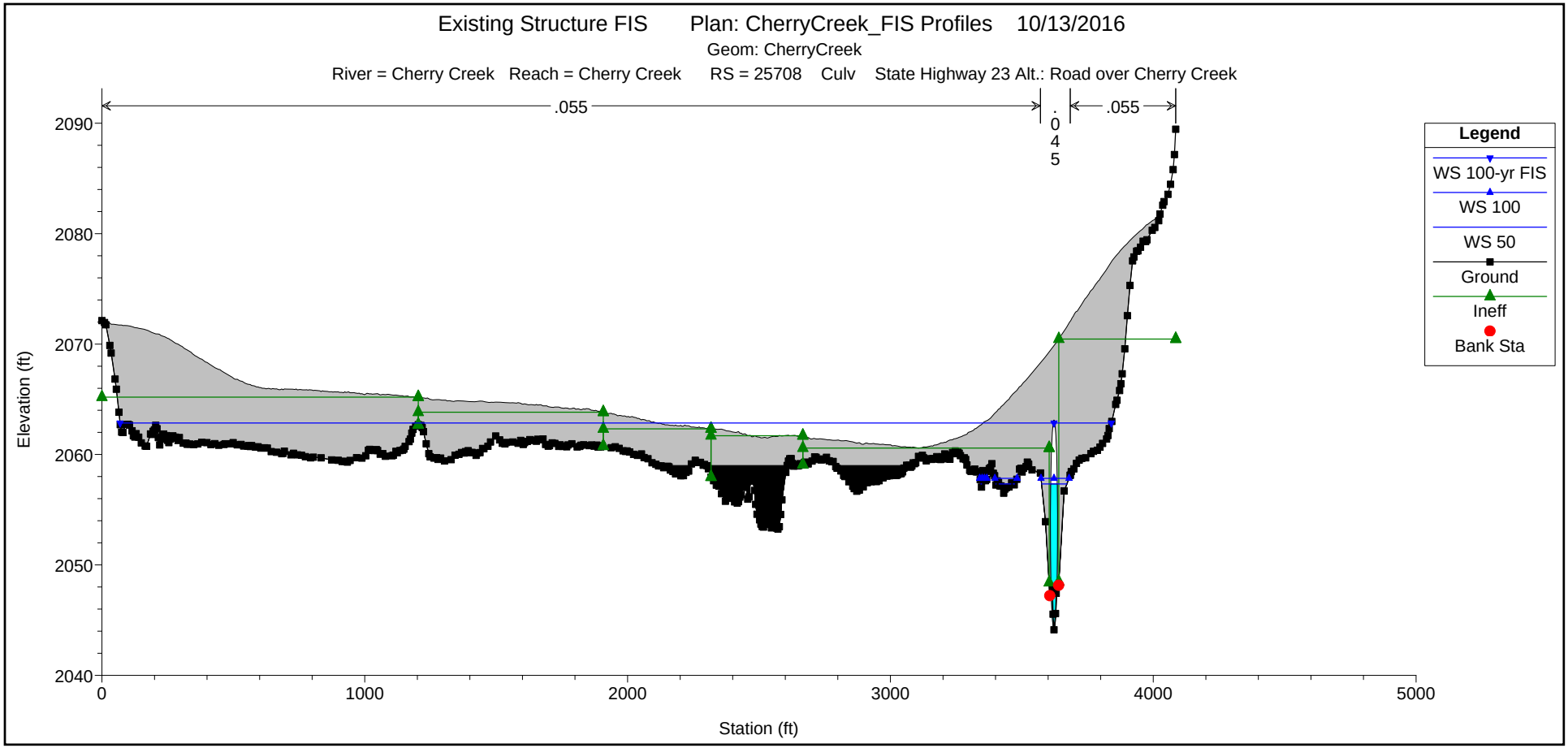
Q Culv Group (cfs)	3457.37	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	9.17
Q Barrel (cfs)	3457.37	Culv Vel DS (ft/s)	8.95
E.G. US. (ft)	2062.90	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2062.86	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2060.97	Culv Frctn Ls (ft)	0.11
W.S. DS (ft)	2060.89	Culv Exit Loss (ft)	1.16
Delta EG (ft)	1.93	Culv Entr Loss (ft)	0.65
Delta WS (ft)	1.97	Q Weir (cfs)	5242.63
E.G. IC (ft)	2062.63	Weir Sta Lft (ft)	2103.78
E.G. OC (ft)	2062.90	Weir Sta Rgt (ft)	3354.01
Culvert Control	Outlet	Weir Submerg	0.02
Culv WS Inlet (ft)	2060.94	Weir Max Depth (ft)	2.32
Culv WS Outlet (ft)	2060.89	Weir Avg Depth (ft)	1.29
Culv Nml Depth (ft)	9.22	Weir Flow Area (sq ft)	1613.78
Culv Crt Depth (ft)	10.03	Min El Weir Flow (ft)	2060.59

HEC-RAS Plan: CherryCreekFIS River: Cherry Creek Reach: Cherry Creek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Cherry Creek	25708 Culvert #1	10	2055.65	2055.42	2052.04	2055.65	2060.59	1212.00		0.35	5.05	4.73
Cherry Creek	25708 Culvert #1	25	2057.57	2057.21	2054.12	2057.57	2060.59	1835.00		0.63	6.56	6.22
Cherry Creek	25708 Culvert #1	50	2058.74	2058.27	2055.59	2058.74	2060.59	2321.00		0.93	7.77	7.39
Cherry Creek	25708 Culvert #1	100	2059.76	2059.17	2057.06	2059.76	2060.59	2829.00		1.32	9.09	8.68
Cherry Creek	25708 Culvert #1	100-yr FIS	2062.90	2062.86	2062.63	2062.90	2060.59	3457.37	5242.63	1.97	9.17	8.95


Existing Structure FIS Plan: CherryCreek_FIS Profiles 10/13/2016
Geom: CherryCreek
Cherry Creek Cherry Creek
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Elevation (ft)
2080
2070
2060
2050
2040
2030
2020
0
10000
20000
30000
40000
50000
Main Channel Distance (ft)


Existing Structure FIS Plan: CherryCreek_FIS Profiles 10/13/2016
Geom: CherryCreek
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Ineff
Bank Sta
Elevation (ft)
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
Station (ft)


Existing Structure FIS Plan: CherryCreek_FIS Profiles 10/13/2016
Geom: CherryCreek
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Ineff
Bank Sta
Elevation (ft)
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
5000
Station (ft)

APPENDIX H

Hydraulic Calculations – HEC-RAS

Cherry Creek

Alternative 1

Triple 14’ X 12’ X 118’ RCB

Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x12 Profile: 50

Q Culv Group (cfs)	2321.00	Culv Full Len (ft)	69.50
# Barrels	3	Culv Vel US (ft/s)	5.02
Q Barrel (cfs)	773.67	Culv Vel DS (ft/s)	5.02
E.G. US. (ft)	2058.21	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2057.69	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2057.84	Culv Frctn Ls (ft)	0.10
W.S. DS (ft)	2057.34	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.37	Culv Entr Loss (ft)	0.27
Delta WS (ft)	0.36	Q Weir (cfs)	
E.G. IC (ft)	2052.84	Weir Sta Lft (ft)	
E.G. OC (ft)	2058.21	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2056.13	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2055.52	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	5.56	Min El Weir Flow (ft)	2060.59

Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x12 Profile: 100

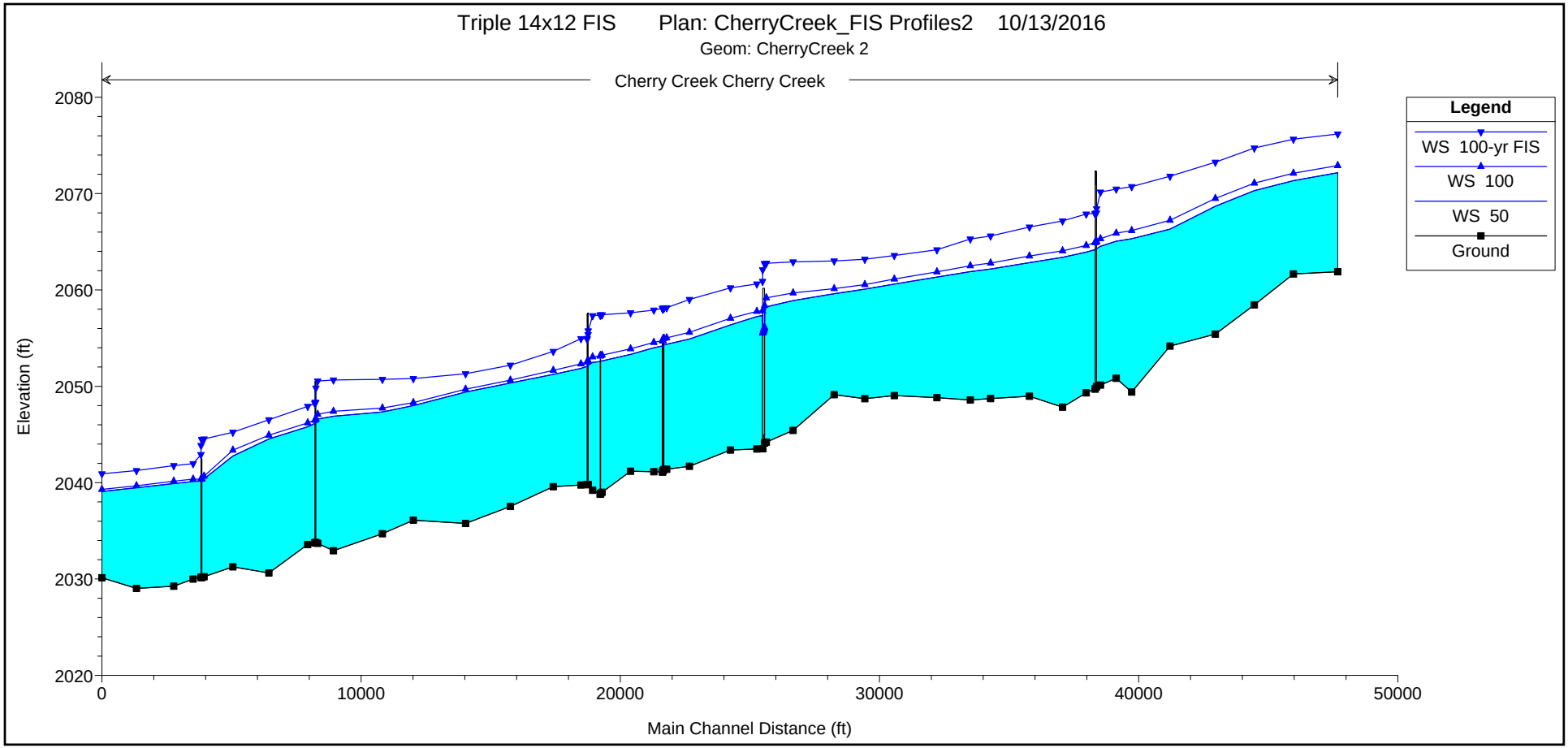
Q Culv Group (cfs)	2829.00	Culv Full Len (ft)	69.50
# Barrels	3	Culv Vel US (ft/s)	6.12
Q Barrel (cfs)	943.00	Culv Vel DS (ft/s)	6.12
E.G. US. (ft)	2059.08	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2058.40	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2058.52	Culv Frctn Ls (ft)	0.15
W.S. DS (ft)	2057.84	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.55	Culv Entr Loss (ft)	0.41
Delta WS (ft)	0.56	Q Weir (cfs)	
E.G. IC (ft)	2053.95	Weir Sta Lft (ft)	
E.G. OC (ft)	2059.08	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2056.13	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2055.52	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	6.20	Min El Weir Flow (ft)	2060.59

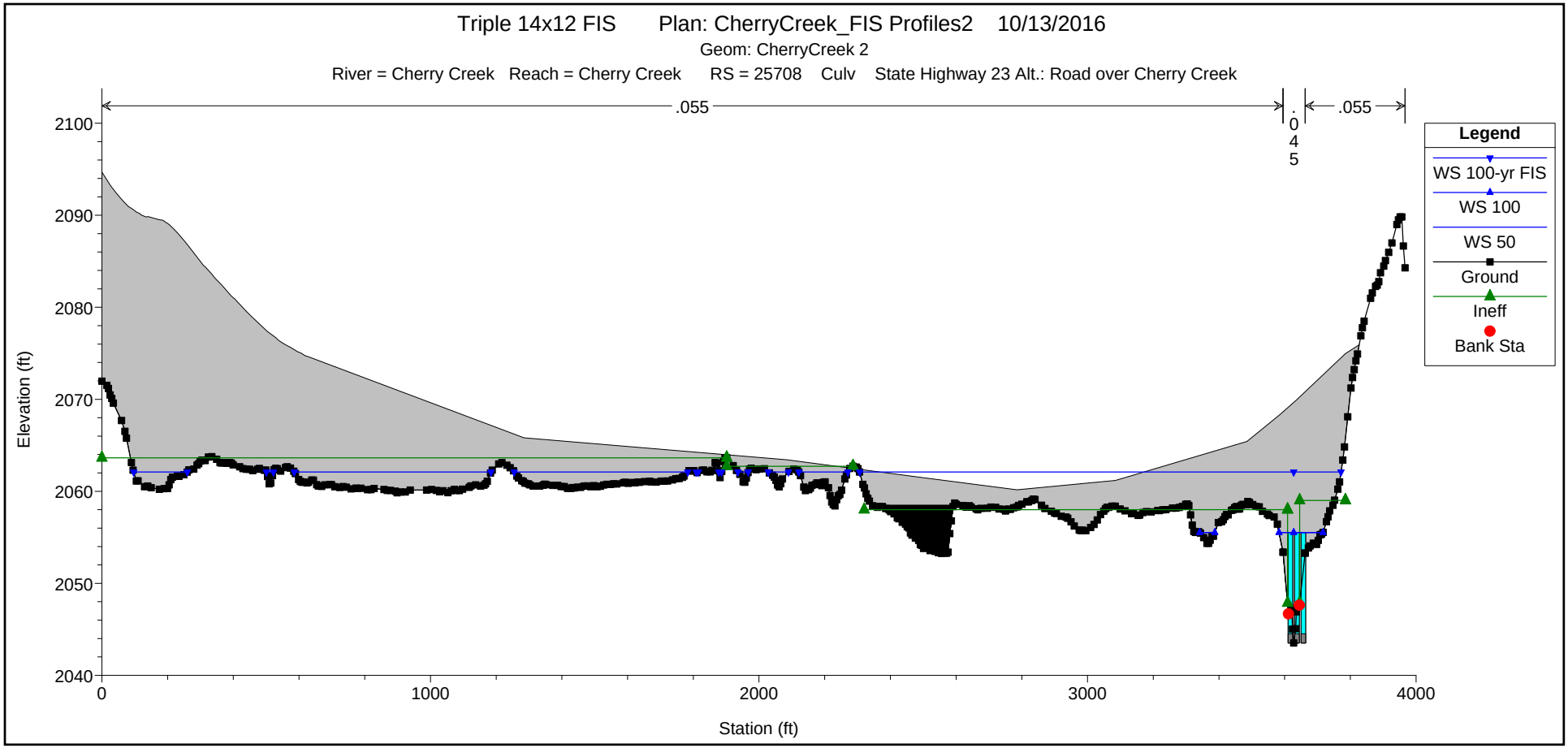
Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x12 Profile: 100-yr FIS

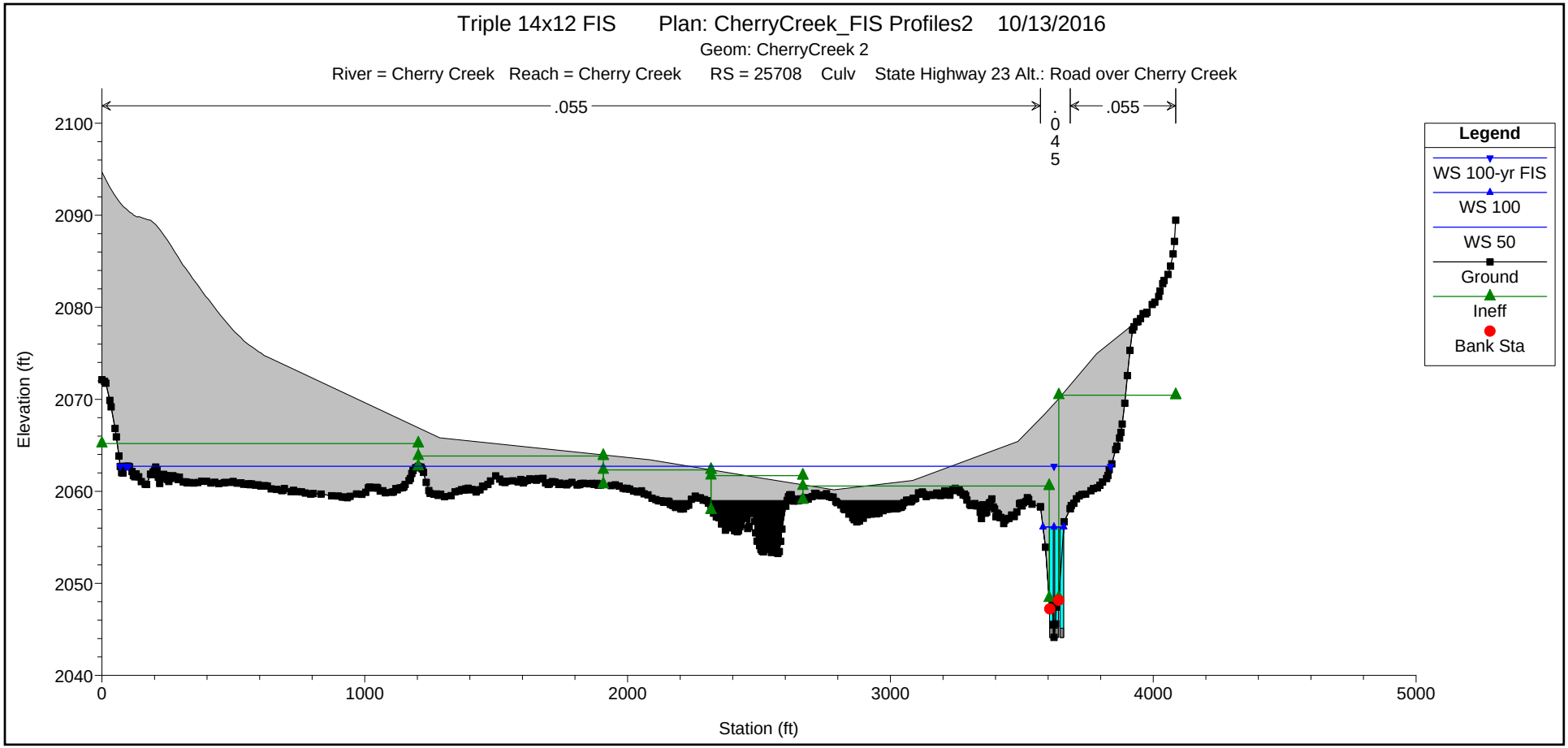
Q Culv Group (cfs)	3640.41	Culv Full Len (ft)	69.50
# Barrels	3	Culv Vel US (ft/s)	7.88
Q Barrel (cfs)	1213.47	Culv Vel DS (ft/s)	7.88
E.G. US. (ft)	2062.77	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2062.72	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2060.97	Culv Frctn Ls (ft)	0.24
W.S. DS (ft)	2060.89	Culv Exit Loss (ft)	0.88
Delta EG (ft)	1.80	Culv Entr Loss (ft)	0.67
Delta WS (ft)	1.83	Q Weir (cfs)	5059.59
E.G. IC (ft)	2062.06	Weir Sta Lft (ft)	2223.65
E.G. OC (ft)	2062.77	Weir Sta Rgt (ft)	3235.79
Culvert Control	Outlet	Weir Submerg	0.05
Culv WS Inlet (ft)	2056.13	Weir Max Depth (ft)	2.61
Culv WS Outlet (ft)	2055.52	Weir Avg Depth (ft)	1.47
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1487.66
Culv Crt Depth (ft)	7.16	Min El Weir Flow (ft)	2060.59

HEC-RAS Plan: Cherry Creek 2 River: Cherry Creek Reach: Cherry Creek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Cherry Creek	25708 TRPL 14x12	10	2055.40	2055.16	2050.08	2055.40	2060.59	1212.00		0.09	2.87	2.71
Cherry Creek	25708 TRPL 14x12	25	2057.17	2056.78	2051.70	2057.17	2060.59	1835.00		0.20	3.97	3.97
Cherry Creek	25708 TRPL 14x12	50	2058.21	2057.69	2052.84	2058.21	2060.59	2321.00		0.36	5.02	5.02
Cherry Creek	25708 TRPL 14x12	100	2059.08	2058.40	2053.95	2059.08	2060.59	2829.00		0.56	6.12	6.12
Cherry Creek	25708 TRPL 14x12	100-yr FIS	2062.77	2062.72	2062.06	2062.77	2060.59	3640.41	5059.59	1.83	7.88	7.88


Triple 14x12 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
Cherry Creek Cherry Creek
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Elevation (ft)
2080
2070
2060
2050
2040
2030
2020
0
10000
20000
30000
40000
50000
Main Channel Distance (ft)


Triple 14x12 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Ineff
Bank Sta
Elevation (ft)
2100
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
Station (ft)


Triple 14x12 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Ineff
Bank Sta
Elevation (ft)
2100
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
5000
Station (ft)

APPENDIX I

Hydraulic Calculations – HEC-RAS

Cherry Creek

Alternative 2

Triple 14’ X 14’ X 110’ RCB

Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x14 Profile: 50

Q Culv Group (cfs)	2321.00	Culv Full Len (ft)	64.53
# Barrels	3	Culv Vel US (ft/s)	4.44
Q Barrel (cfs)	773.67	Culv Vel DS (ft/s)	4.25
E.G. US. (ft)	2058.10	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2057.57	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2057.84	Culv Frctn Ls (ft)	0.05
W.S. DS (ft)	2057.34	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.26	Culv Entr Loss (ft)	0.21
Delta WS (ft)	0.23	Q Weir (cfs)	
E.G. IC (ft)	2052.81	Weir Sta Lft (ft)	
E.G. OC (ft)	2058.10	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2057.58	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2057.56	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	6.90	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	5.56	Min El Weir Flow (ft)	2060.59

Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x14 Profile: 100

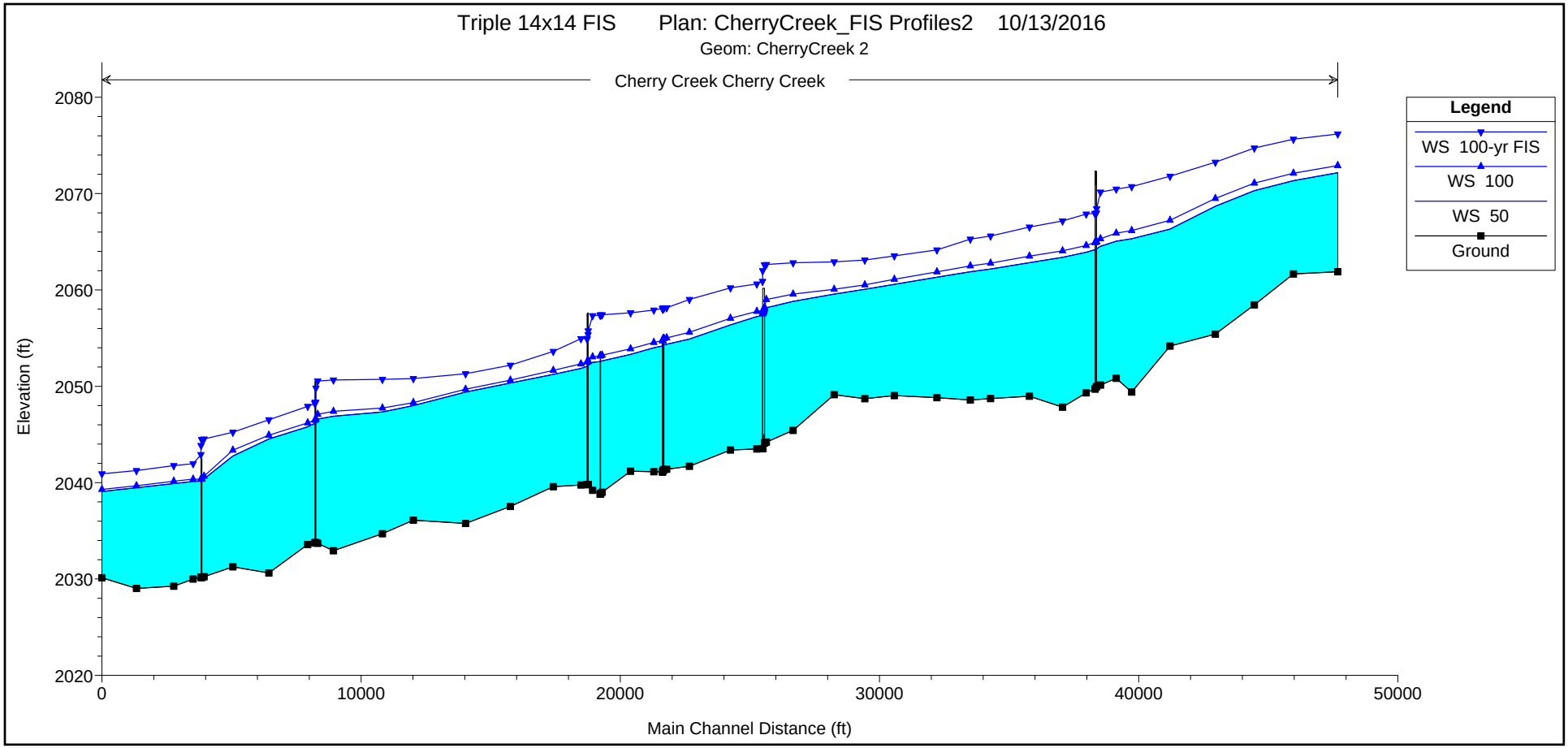
Q Culv Group (cfs)	2829.00	Culv Full Len (ft)	69.50
# Barrels	3	Culv Vel US (ft/s)	5.18
Q Barrel (cfs)	943.00	Culv Vel DS (ft/s)	5.18
E.G. US. (ft)	2058.90	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2058.20	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2058.52	Culv Frctn Ls (ft)	0.09
W.S. DS (ft)	2057.84	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.38	Culv Entr Loss (ft)	0.29
Delta WS (ft)	0.36	Q Weir (cfs)	
E.G. IC (ft)	2053.92	Weir Sta Lft (ft)	
E.G. OC (ft)	2058.90	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	2058.13	Weir Max Depth (ft)	
Culv WS Outlet (ft)	2057.52	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	6.20	Min El Weir Flow (ft)	2060.59

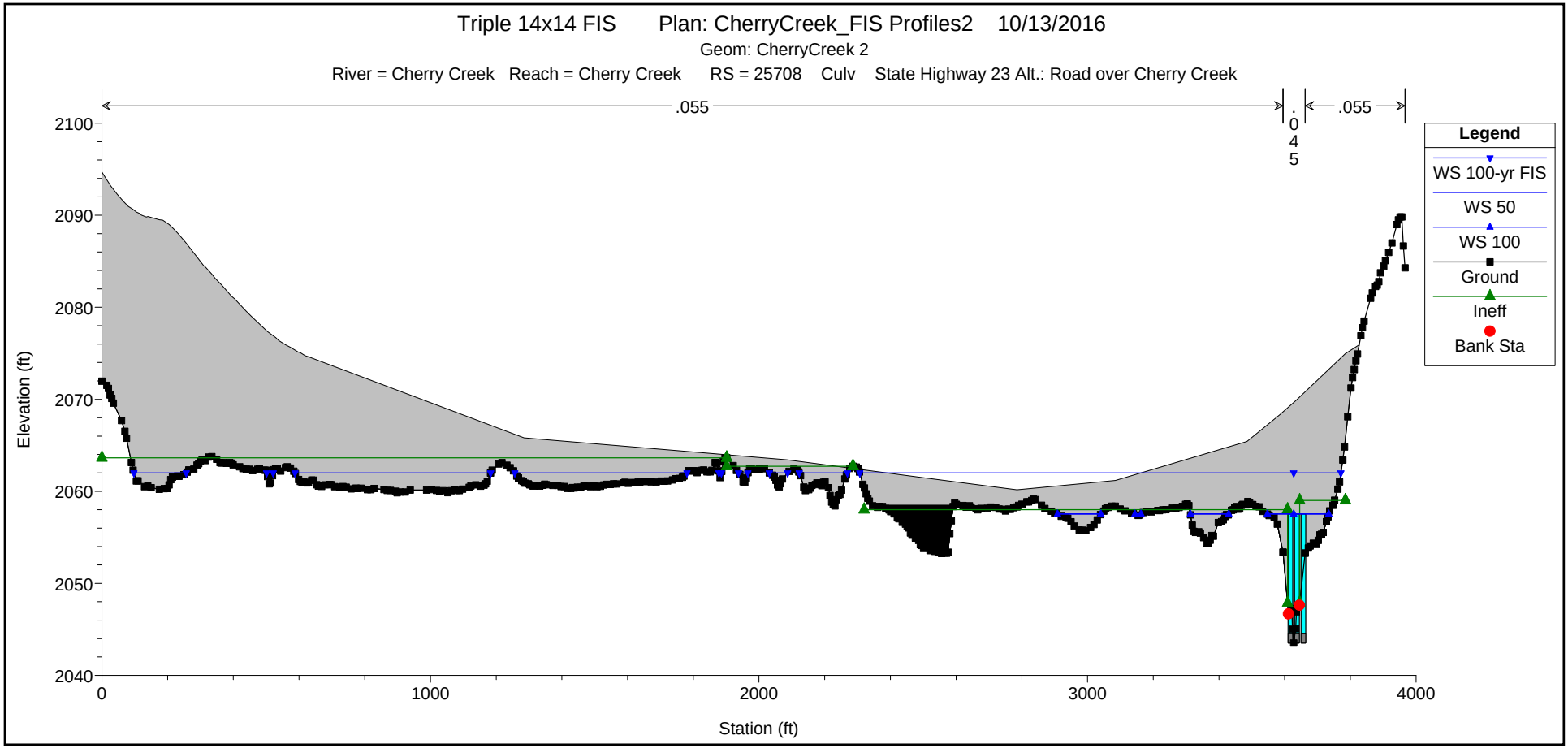
Plan: Cherry Creek 2 Cherry Creek Cherry Creek RS: 25708 Culv Group: TRPL 14x14 Profile: 100-yr FIS

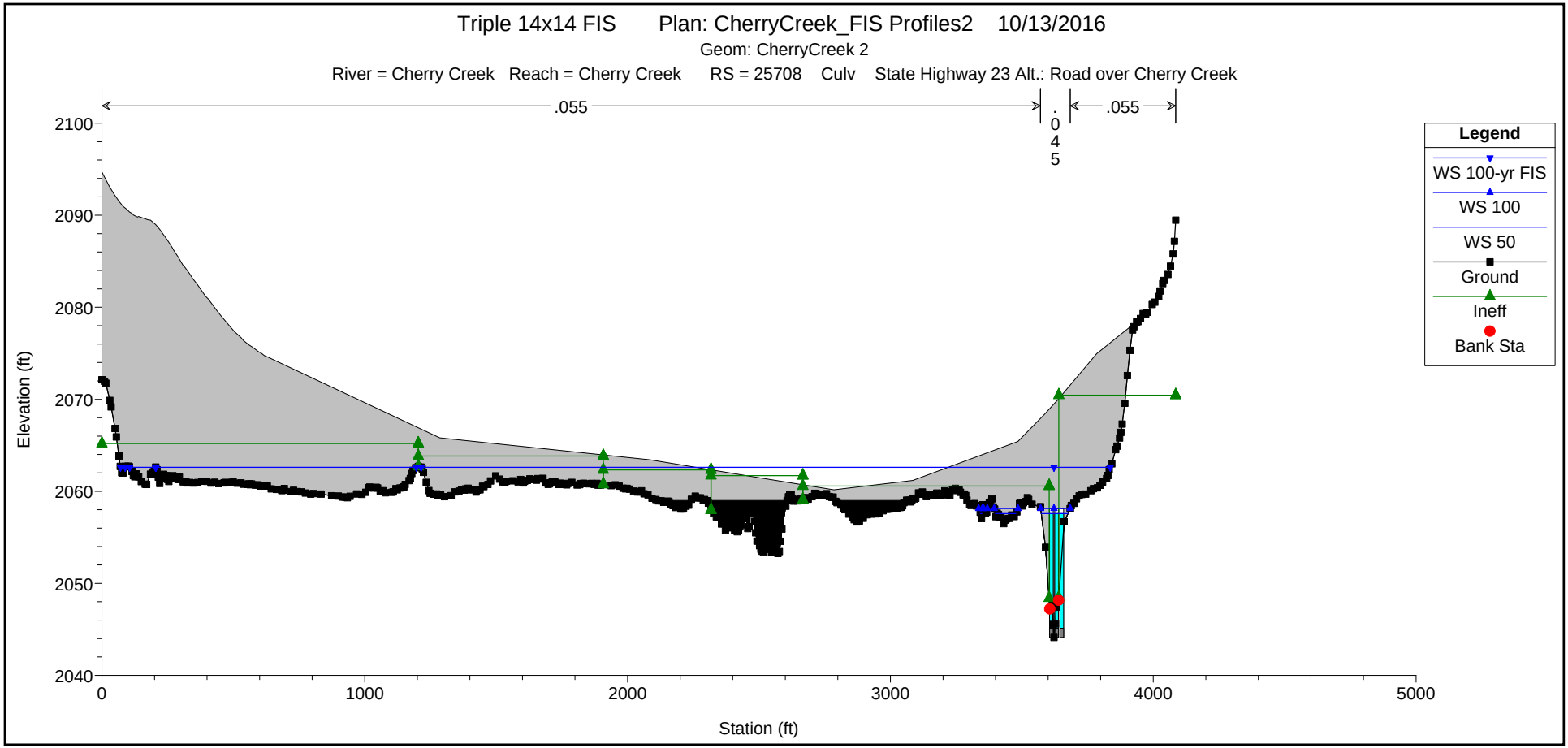
Q Culv Group (cfs)	4213.70	Culv Full Len (ft)	69.50
# Barrels	3	Culv Vel US (ft/s)	7.72
Q Barrel (cfs)	1404.57	Culv Vel DS (ft/s)	7.72
E.G. US. (ft)	2062.65	Culv Inv El Up (ft)	2044.13
W.S. US. (ft)	2062.60	Culv Inv El Dn (ft)	2043.52
E.G. DS (ft)	2060.97	Culv Frctn Ls (ft)	0.19
W.S. DS (ft)	2060.89	Culv Exit Loss (ft)	0.84
Delta EG (ft)	1.68	Culv Entr Loss (ft)	0.65
Delta WS (ft)	1.71	Q Weir (cfs)	4486.30
E.G. IC (ft)	2061.77	Weir Sta Lft (ft)	2252.12
E.G. OC (ft)	2062.65	Weir Sta Rgt (ft)	3223.17
Culvert Control	Outlet	Weir Submerg	0.06
Culv WS Inlet (ft)	2058.13	Weir Max Depth (ft)	2.47
Culv WS Outlet (ft)	2057.52	Weir Avg Depth (ft)	1.40
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1354.99
Culv Crt Depth (ft)	7.79	Min El Weir Flow (ft)	2060.59

HEC-RAS Plan: Cherry Creek 2 River: Cherry Creek Reach: Cherry Creek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Cherry Creek	25708 TRPL 14x14	10	2055.40	2055.16	2050.06	2055.40	2060.59	1212.00		0.09	2.87	2.71
Cherry Creek	25708 TRPL 14x14	25	2057.14	2056.74	2051.67	2057.14	2060.59	1835.00		0.16	3.76	3.57
Cherry Creek	25708 TRPL 14x14	50	2058.10	2057.57	2052.81	2058.10	2060.59	2321.00		0.23	4.44	4.25
Cherry Creek	25708 TRPL 14x14	100	2058.90	2058.20	2053.92	2058.90	2060.59	2829.00		0.36	5.18	5.18
Cherry Creek	25708 TRPL 14x14	100-yr FIS	2062.65	2062.60	2061.77	2062.65	2060.59	4213.70	4486.30	1.71	7.72	7.72

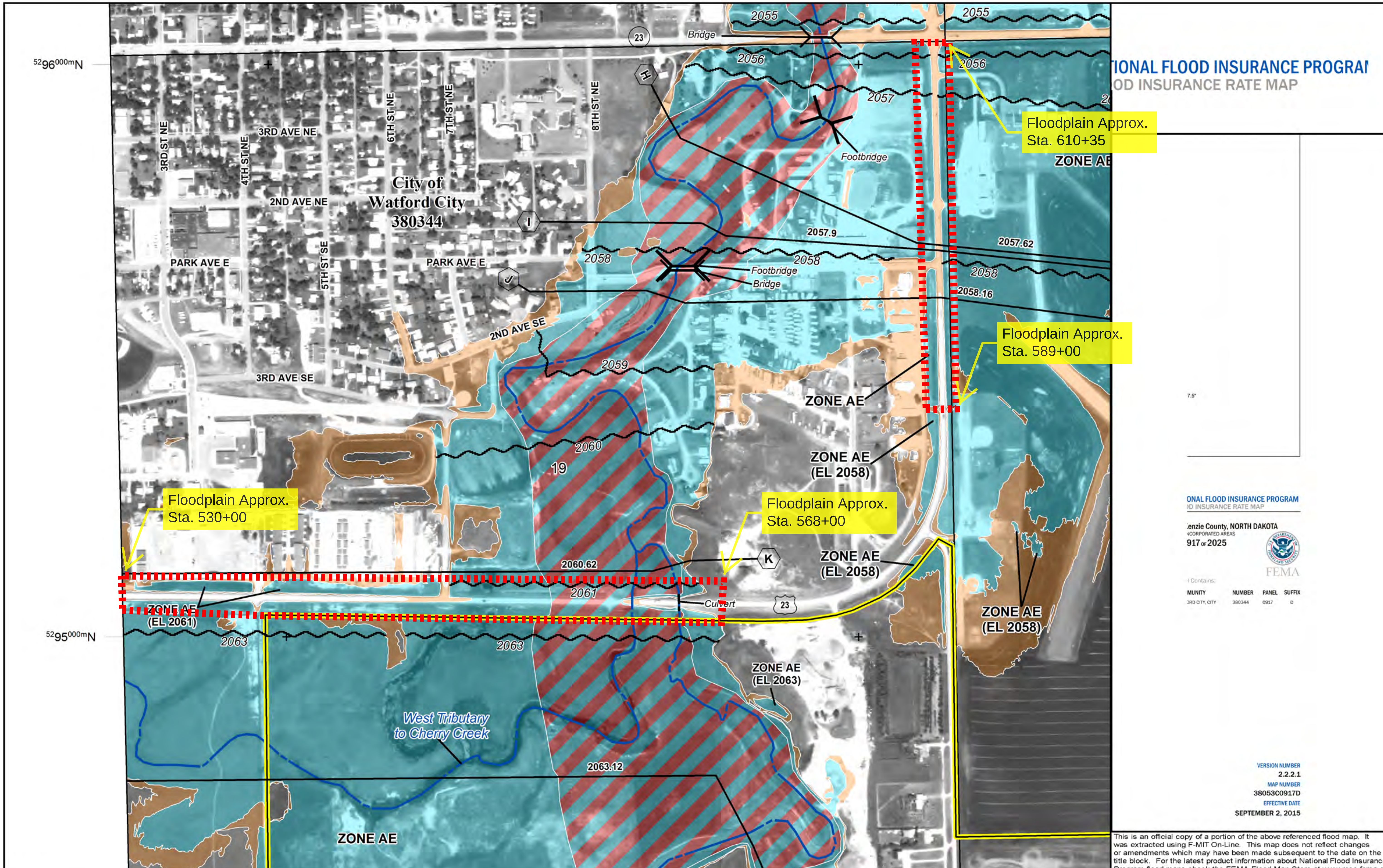

Triple 14x14 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
Cherry Creek Cherry Creek
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Elevation (ft)
2080
2070
2060
2050
2040
2030
2020
0
10000
20000
30000
40000
50000
Main Channel Distance (ft)


Triple 14x14 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 50
WS 100
Ground
Ineff
Bank Sta
Elevation (ft)
2100
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
Station (ft)

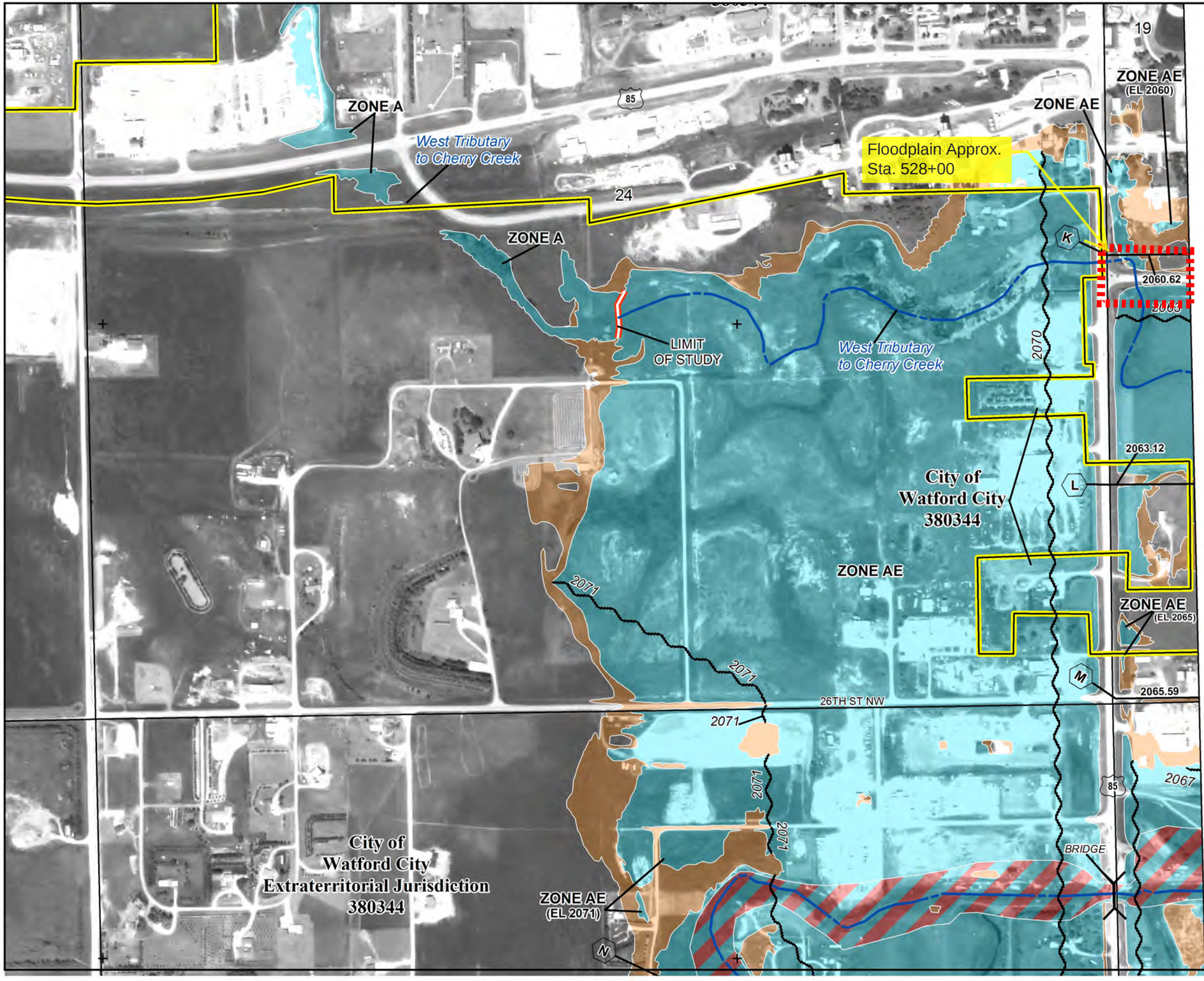

Triple 14x14 FIS Plan: CherryCreek_FIS Profiles2 10/13/2016
Geom: CherryCreek 2
River = Cherry Creek Reach = Cherry Creek RS = 25708 Culv State Highway 23 Alt.: Road over Cherry Creek
.055
.045
.055
Legend
WS 100-yr FIS
WS 100
WS 50
Ground
Ineff
Bank Sta
Elevation (ft)
2100
2090
2080
2070
2060
2050
2040
0
1000
2000
3000
4000
5000
Station (ft)

109 S. Main • Box 357
Bowman, ND 58623
Ph: 701.523.3340

BROSZ
ENGINEERING, INC.
ARCHITECTURE ENGINEERING SURVEYING



Floodplain Approx.
Sta. 610+35
Floodplain Approx.
Sta. 589+00
Floodplain Approx.
Sta. 530+00
Floodplain Approx.
Sta. 568+00
City of
Watford City
380344
3RD AVE NE
2ND AVE NE
PARK AVE E
PARK AVE E
2ND AVE SE
3RD AVE SE
3RD ST NE
4TH ST NE
5TH ST SE
6TH ST NE
7TH ST NE
8TH ST NE
Bridge
Footbridge
Footbridge
Bridge
Culvert
2055
2056
2057
2057.9
2057.62
2058
2058.16
2059
2060
2060.62
2061
2063
2063.12
ZONE AE
ZONE AE
(EL 2058)
ZONE AE
(EL 2061)
ZONE AE
(EL 2063)
West Tributary
to Cherry Creek
19
5296000mN
5295000mN
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP
McKenzie County, NORTH DAKOTA
AND INCORPORATED AREAS
917 OF 2025
FEMA
VERSION NUMBER
2.2.2.1
MAP NUMBER
38053C0917D
EFFECTIVE DATE
SEPTEMBER 2, 2015
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



TIONAL FLOOD INSURANCE PROGRAM
OD INSURANCE RATE MAP

ONAL FLOOD INSURANCE PROGRAM
OD INSURANCE RATE MAP

enzie County, NORTH DAKOTA
NCORPORATED AREAS
916 OF 2025

FEMA

Contains:

MUNITY	NUMBER	PANEL	SUFFIX
NZIE COUNTY	380054	0916	D
ORD CITY, CITY	380344	0916	D

VERSION NUMBER
2.2.2.1
MAP NUMBER
38053C0916D
EFFECTIVE DATE
SEPTEMBER 2, 2015

3RD ST NE
4TH ST NE
3RD AVE NE
6TH ST NE
7TH ST NE
8TH ST NE
2ND AVE NE
PARK AVE E
5TH ST SE
2ND AVE SE
3RD AVE SE
City of
Watford City
380344
H
I
J
K
23
Bridge
Footbridge
PROJECT LIMITS
2055
2056
2057
2057.9
2057.6
2058
2058.16
2059
2060
2060.62
2061
2063
19
ZONE AE
(EL 2060)
ZONE AE
(EL 2061)
ZONE AE
(EL 2058)
ZONE AE
(EL 2063)
Culvert
West Tributary

DESIGN DATA				
Traffic	Average Daily			
Current 2015	Pass: 6985	Trucks: 890	Total: 7875	
Forecast 2035	Pass: 10410	Trucks: 1330	Total: 11740	
Clear Zone Distance: 18		Design Speed: 40		
Minimum Sight Dist. for Stopping: 305'		Bridges: HL-93		
Sight Dist. for No Passing Zone: 600'				
Pavement Design Life 30 (years)				
Design Accumulated One-way Rigid ESALs: 5,583,120				

STATE	PROJECT NO.	PCN	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	21172	1	1

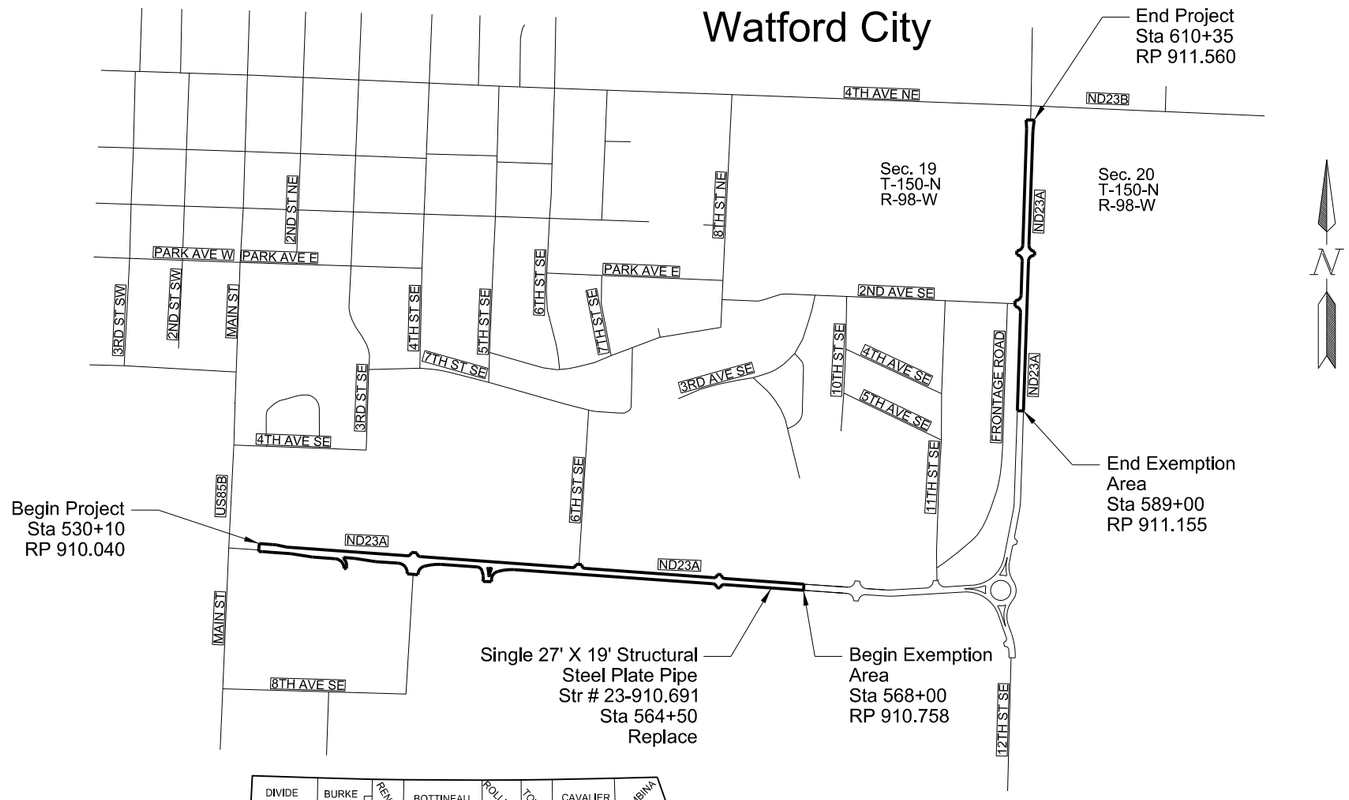
JOB
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

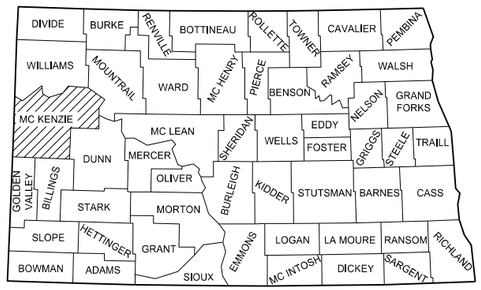
SS-7-023(050)910

McKenzie County
ND Hwy 23A from Jct US85B to Jct ND23B
Grading, Concrete / HMA Option, Curb & Gutter,
Shared Use Path, Storm Drain, Lighting

GOVERNING SPECIFICATIONS:
2014 Standard Specifications adopted by the North Dakota Department of Transportation and the Supplemental Specifications effective on the date the project is advertised.

PROJECT NUMBER \ DESCRIPTION	NET MILES	GROSS MILES
SS-7-023(050)910	1.123	1.520





STATE COUNTY MAP

DESIGNERS

APPROVED DATE _____

OFFICE OF PROJECT DEVELOPMENT
ND DEPARTMENT OF TRANSPORTATION

I hereby certify that the attached plans were prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the state of ND.

APPROVED DATE _____

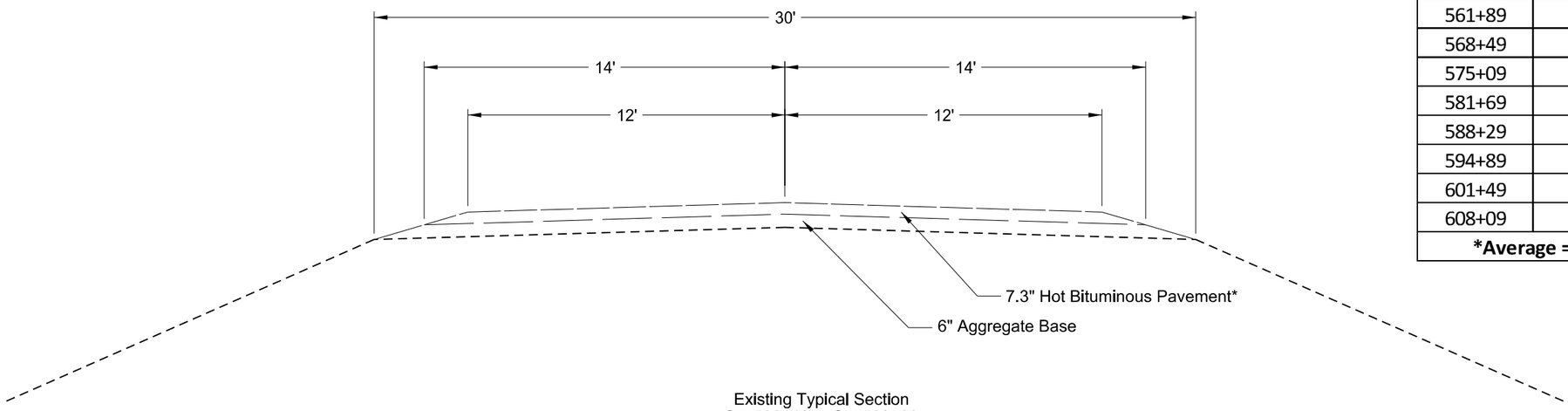
BROSZ ENGINEERING, INC.

This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	30	1

Existing Core Data		
Station (SCL23A Alignment)	Offset	Depth (Inches)
529+27	RT	8.5
535+49	LT	7.5
542+09	RT	6.5
578+69	LT	7.3
555+29	RT	7.5
561+89	LT	5.5
568+49	RT	7.3
575+09	LT	8.0
581+69	RT	7.5
588+29	LT	7.5
594+89	RT	7.5
601+49	LT	7.5
608+09	RT	7.0
***Average =**		**7.3**



Existing Typical Section
Sta 530+10 to Sta 568+00
Sta 589+00 to Sta 610+35

This document is preliminary and not for construction or implementation purposes.

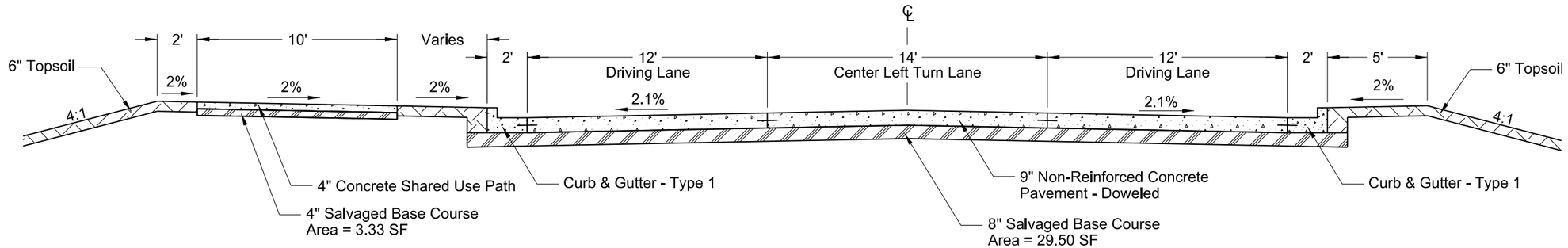
PRELIMINARY

Existing Typical Section

ND23A

US85B to ND23B

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	30	2



Proposed Typical Section
Sta 530+10 to Sta 568+00
Sta 589+00 to Sta 610+35

This document is preliminary and not for construction or implementation purposes.

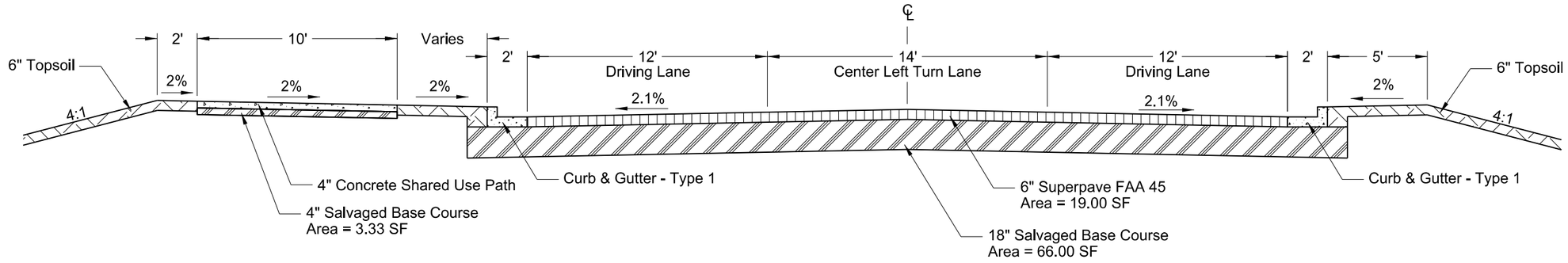
PRELIMINARY

Proposed Typical Section
Option 1 - Non-Reinforced Concrete Pavement

ND23A

US85B to ND23B

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	30	3



Proposed Typical Section
Sta 530+10 to Sta 568+00
Sta 589+00 to Sta 610+35

This document is preliminary and not for construction or implementation purposes.

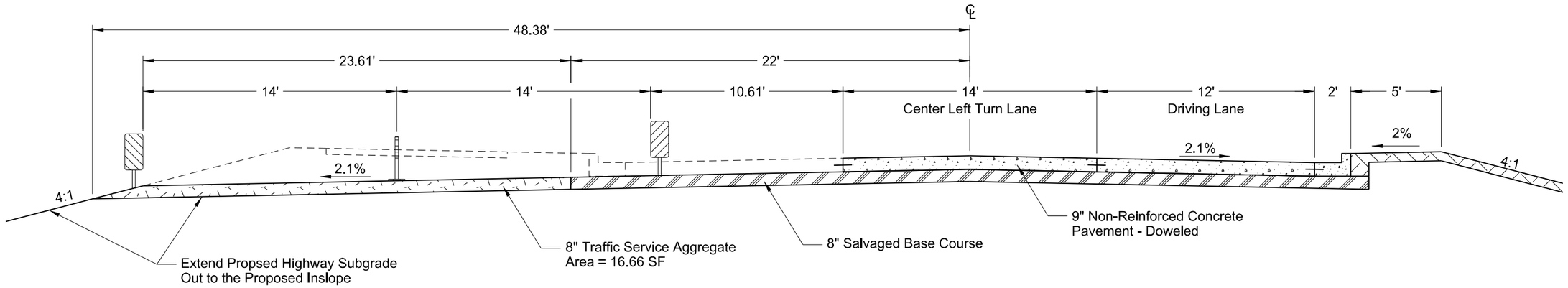
PRELIMINARY

Proposed Typical Section
Option 2 - Hot Mix Asphalt

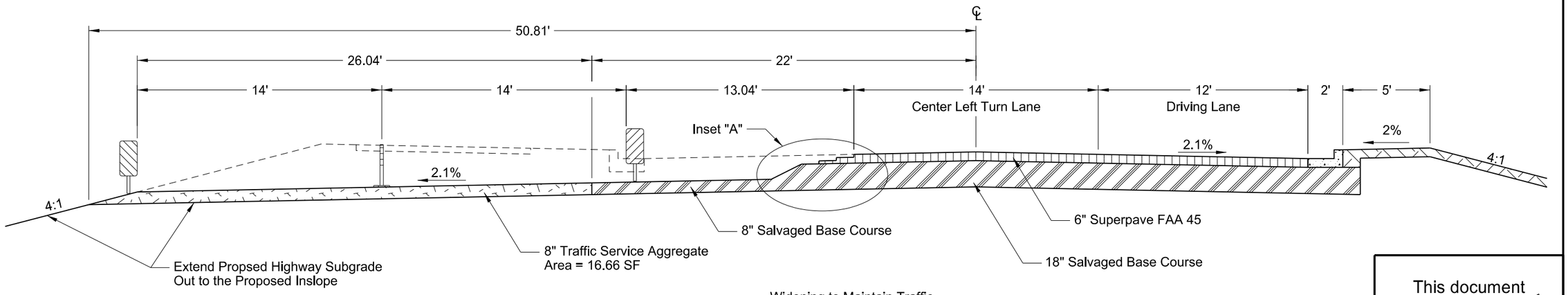
ND23A

US85B to ND23B

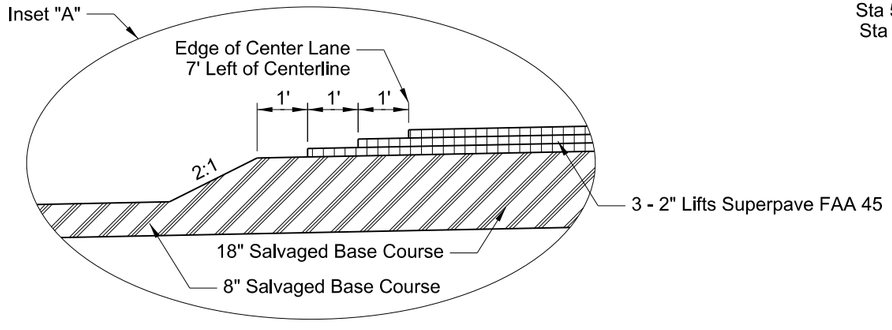
	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	30	4



Widening to Maintain Traffic
Option 1 - Concrete Pavement
Phase I and II of the Traffic Control Phasing Plan
Sta 530+10 to Sta 568+60*
Sta 589+00 to Sta 610+35



Widening to Maintain Traffic
Option 2 - Asphalt Pavement
Phase I and II of the Traffic Control Phasing Plan
Sta 530+10 to Sta 568+60*
Sta 589+00 to Sta 610+35



*Tie into the Temporary Bypass at Sta 568+60

This document is preliminary and not for construction or implementation purposes.

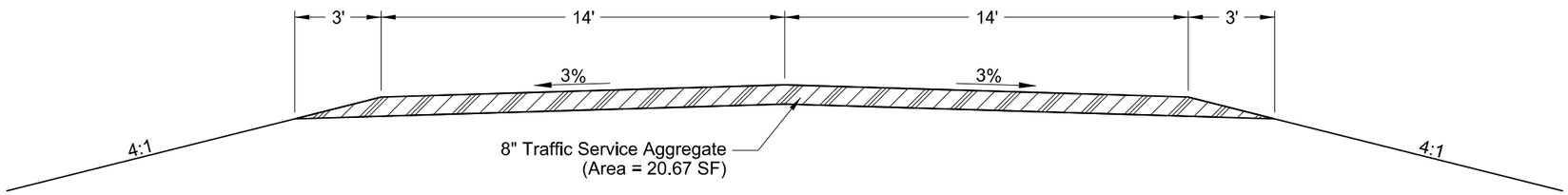
PRELIMINARY

Proposed Typical Section
Widening to Maintain Traffic

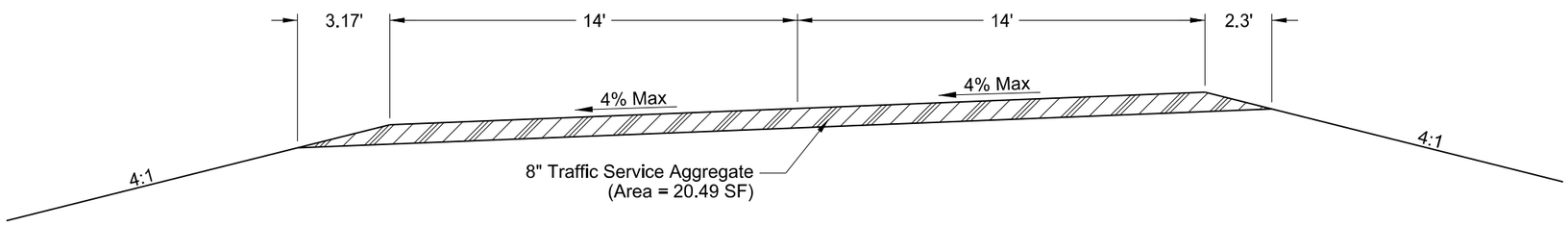
ND23A

US85B to ND23B

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	30	5



Normal Crown



Superelevation

This document is preliminary and not for construction or implementation purposes.

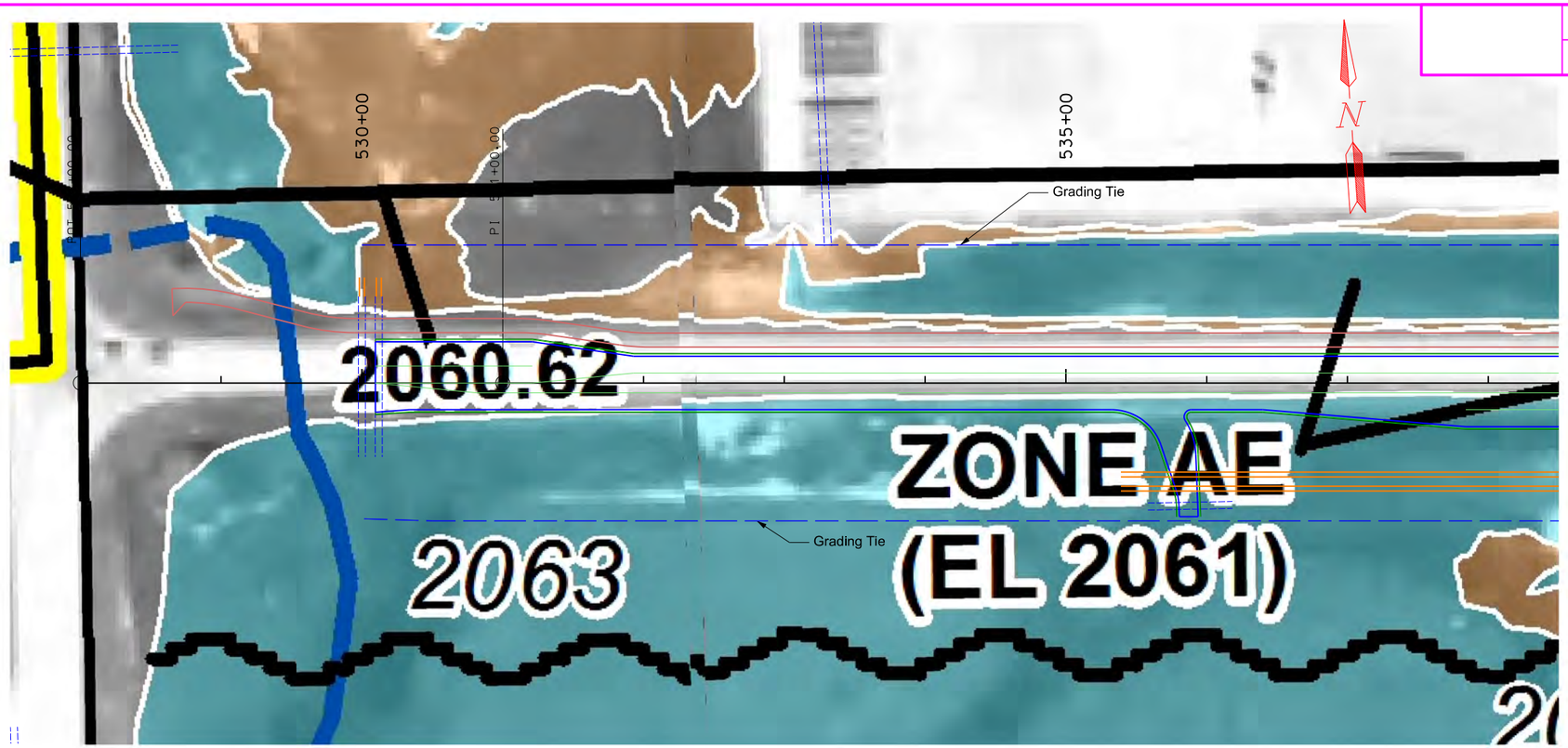
PRELIMINARY

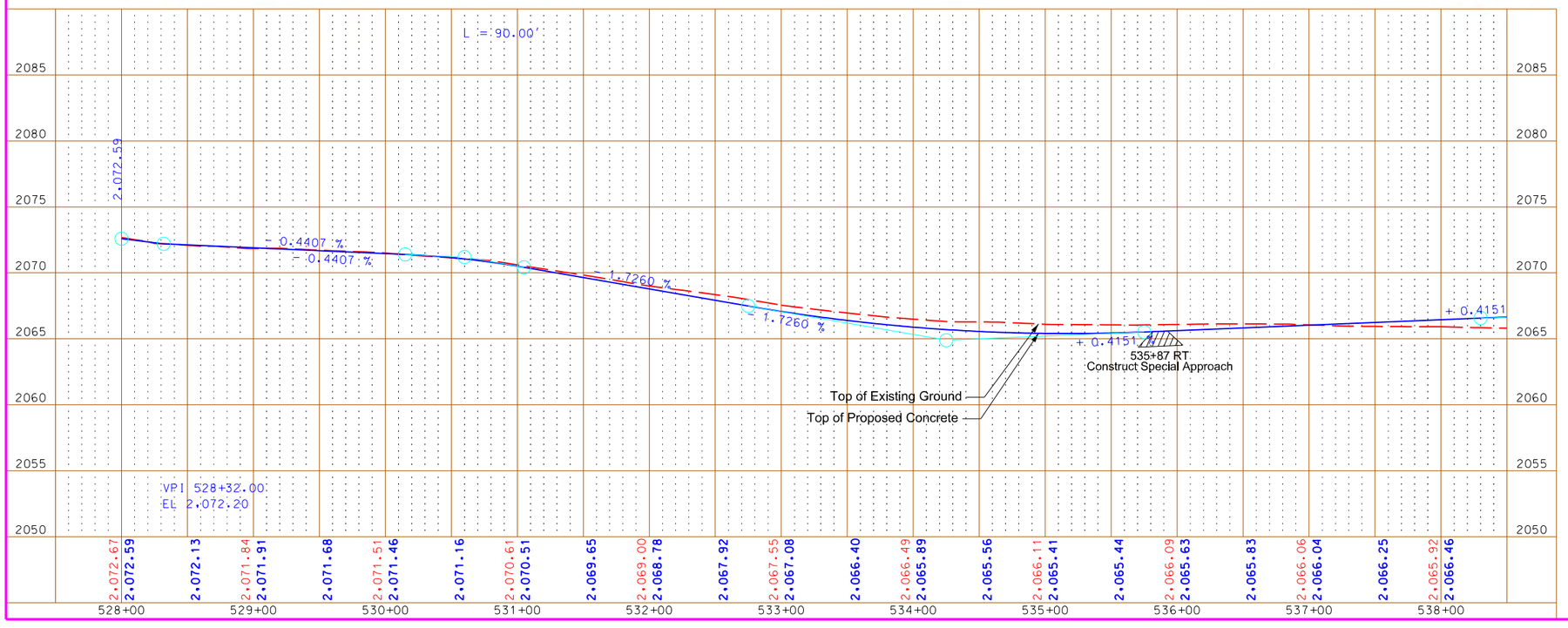
Proposed Typical Section
Temporary Bypass

ND23A

US85B to ND23B

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	1





This document is preliminary and not for construction or implementation purposes.

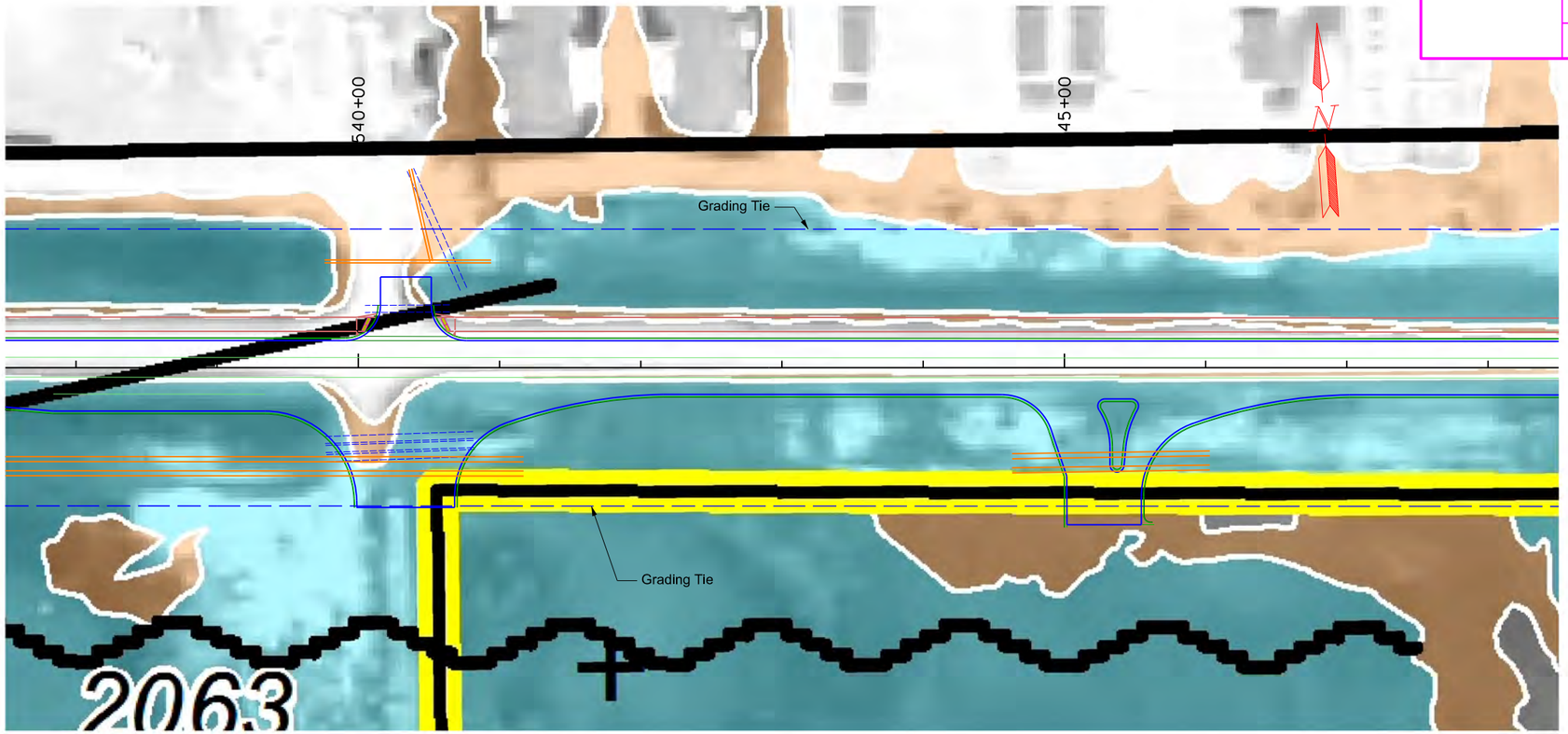
PRELIMINARY

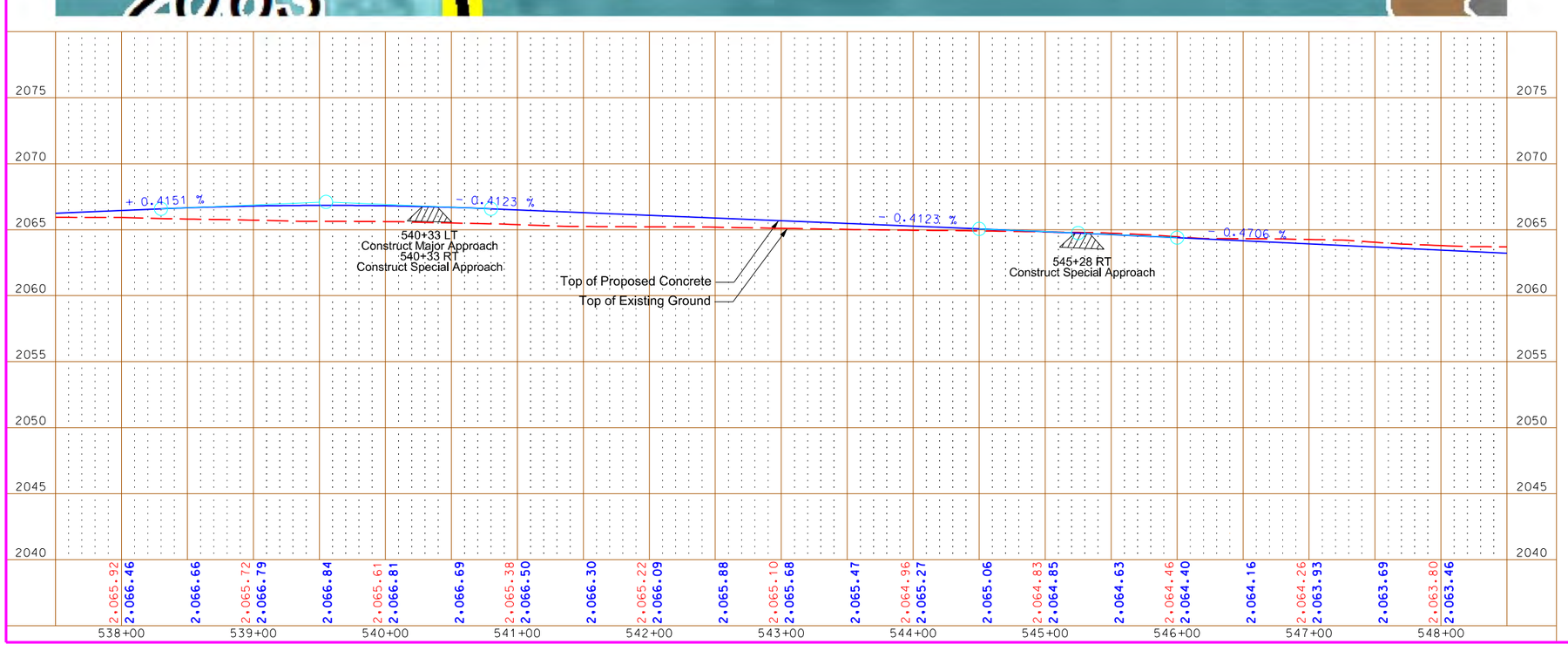
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	2





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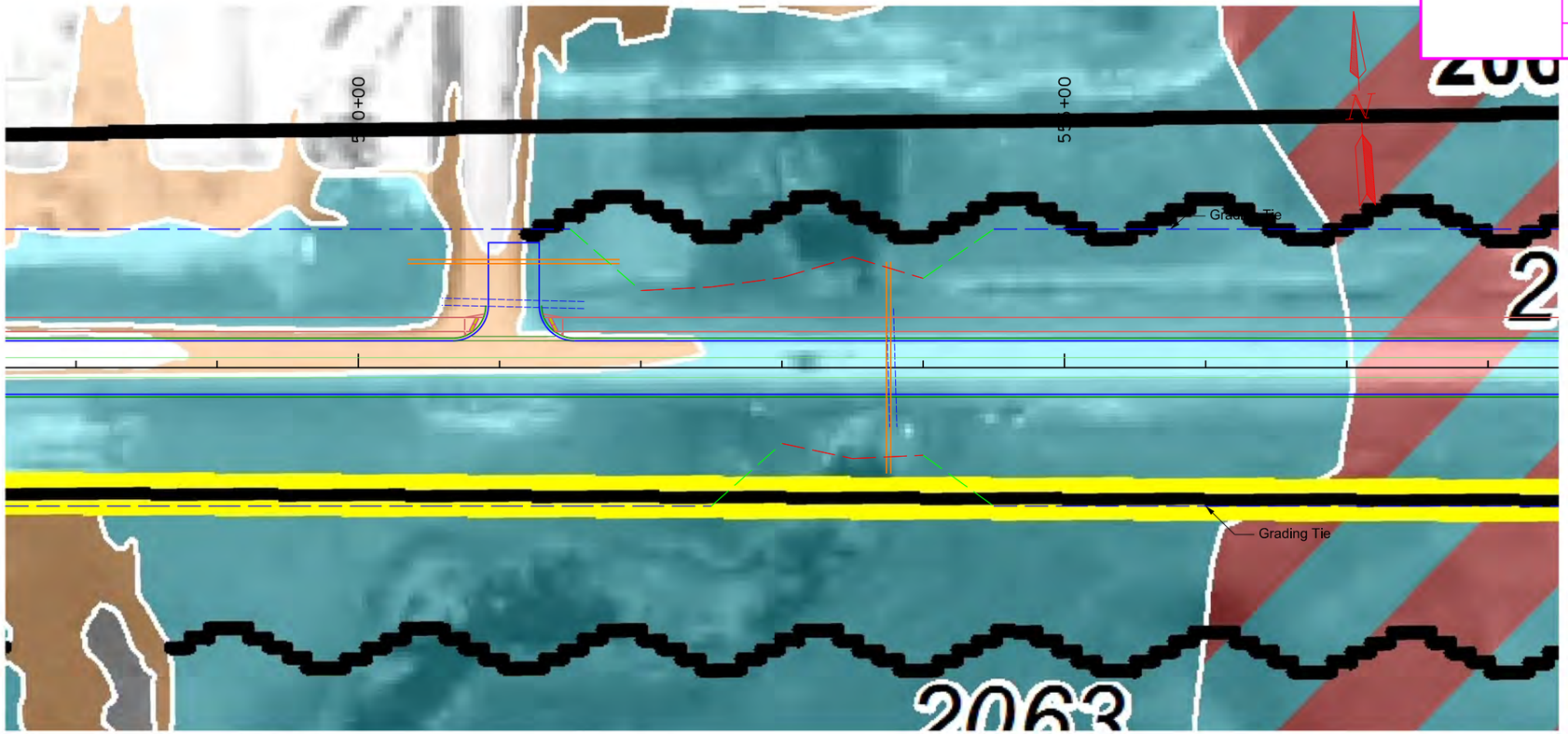
PRELIMINARY

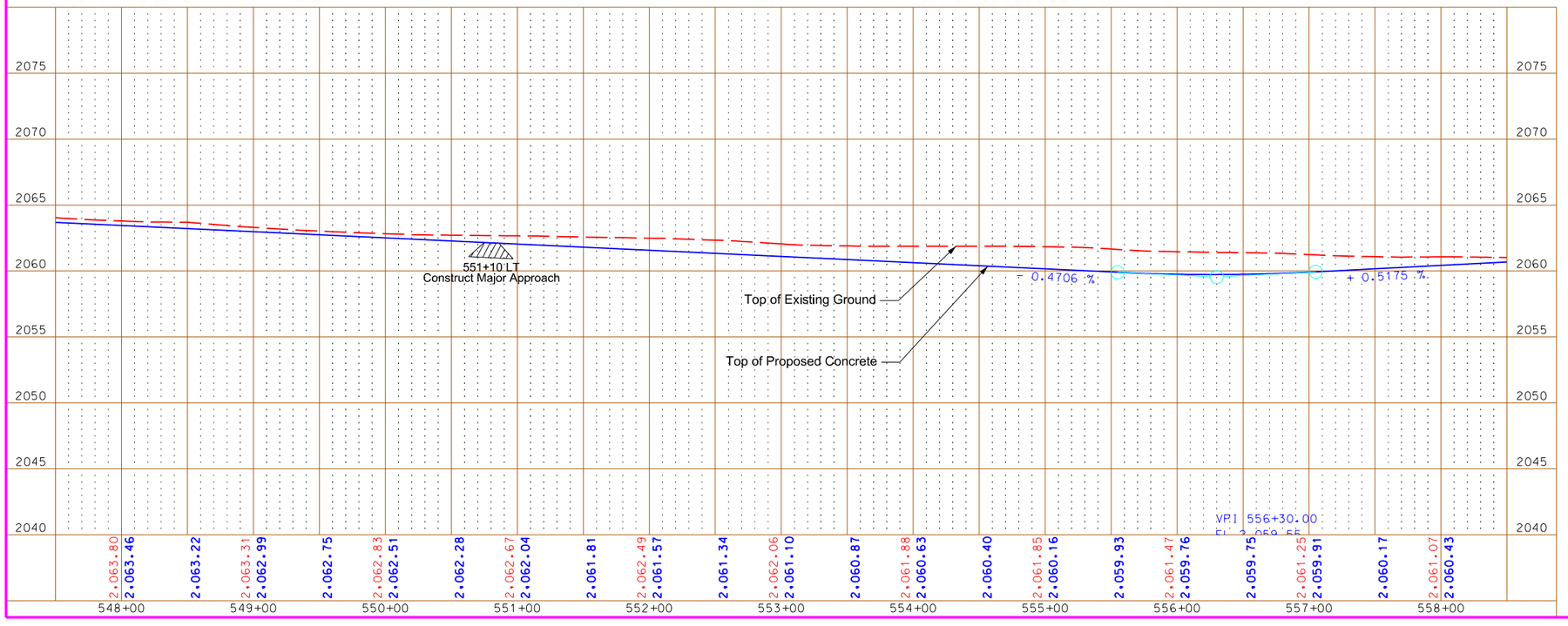
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	3





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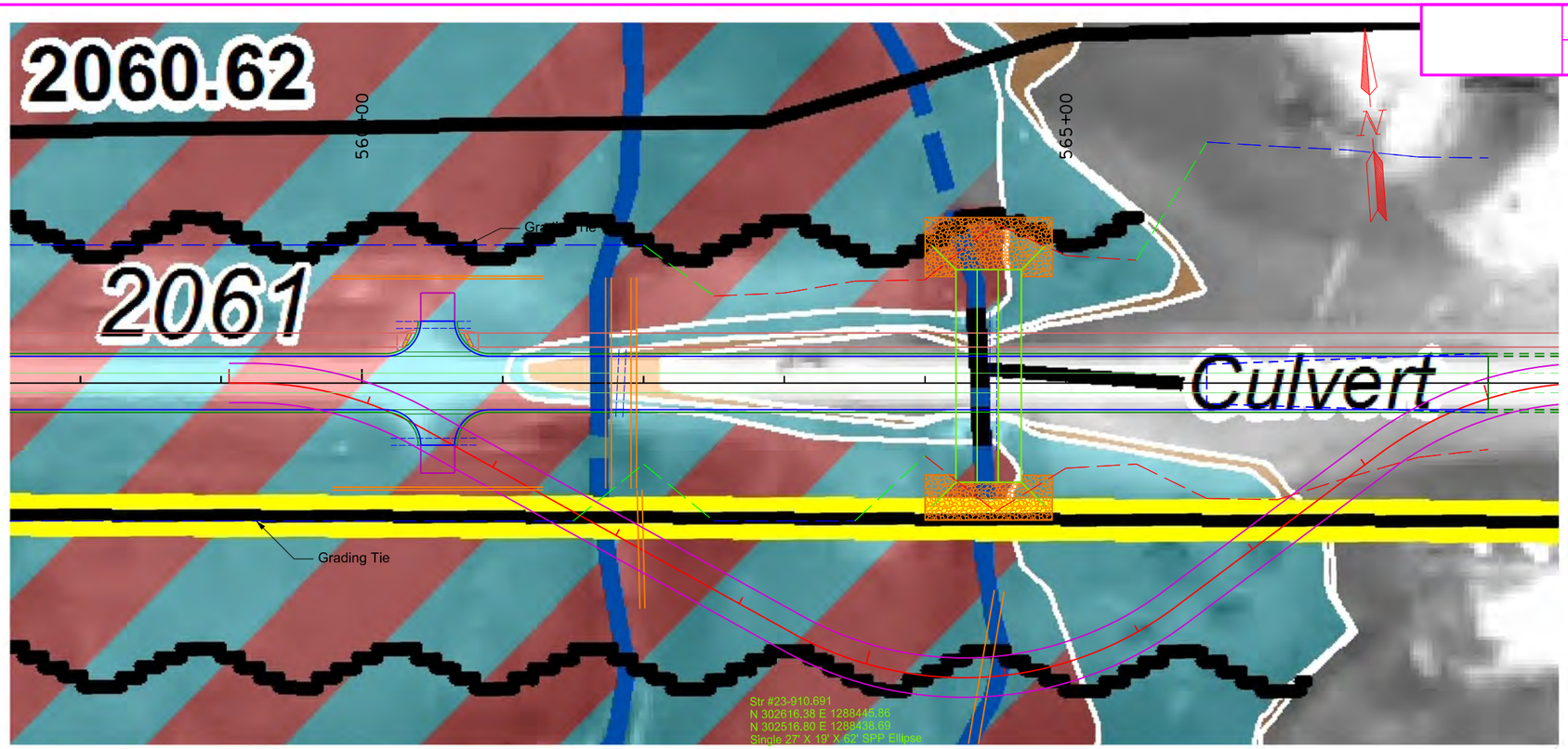
PRELIMINARY

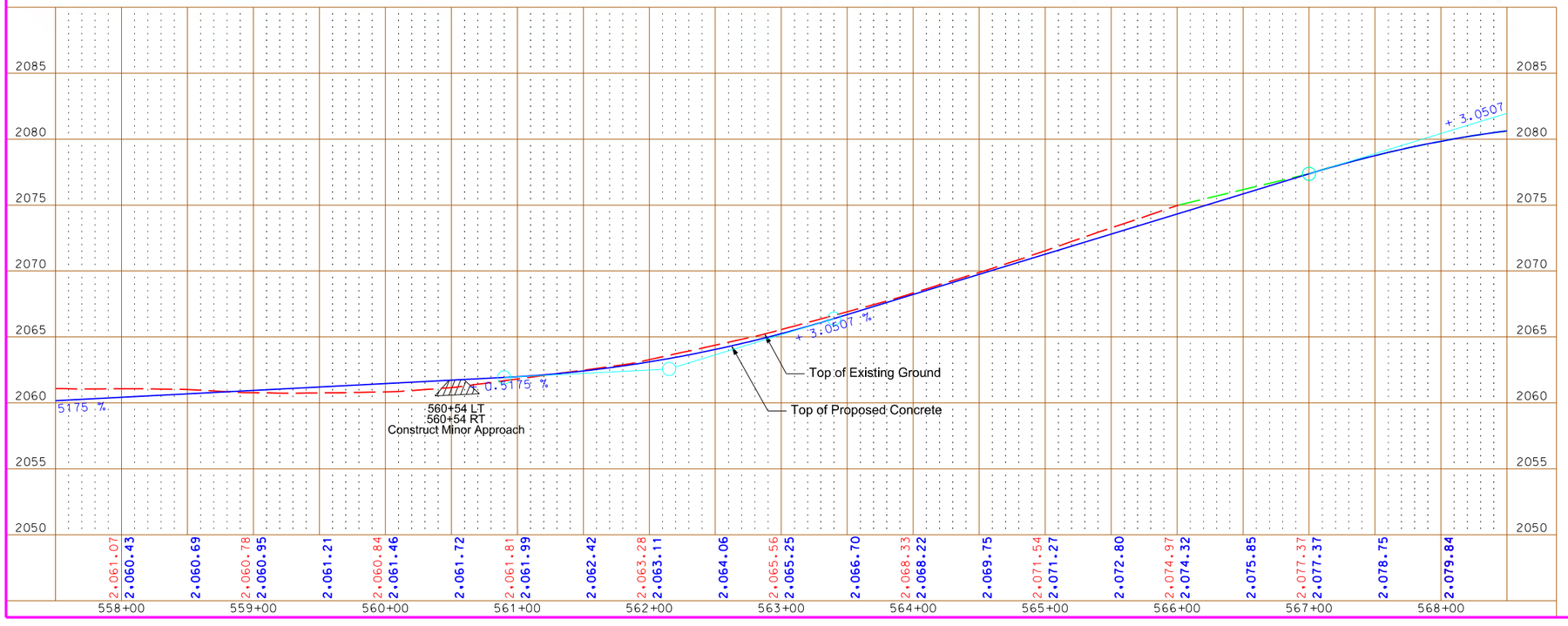
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	4





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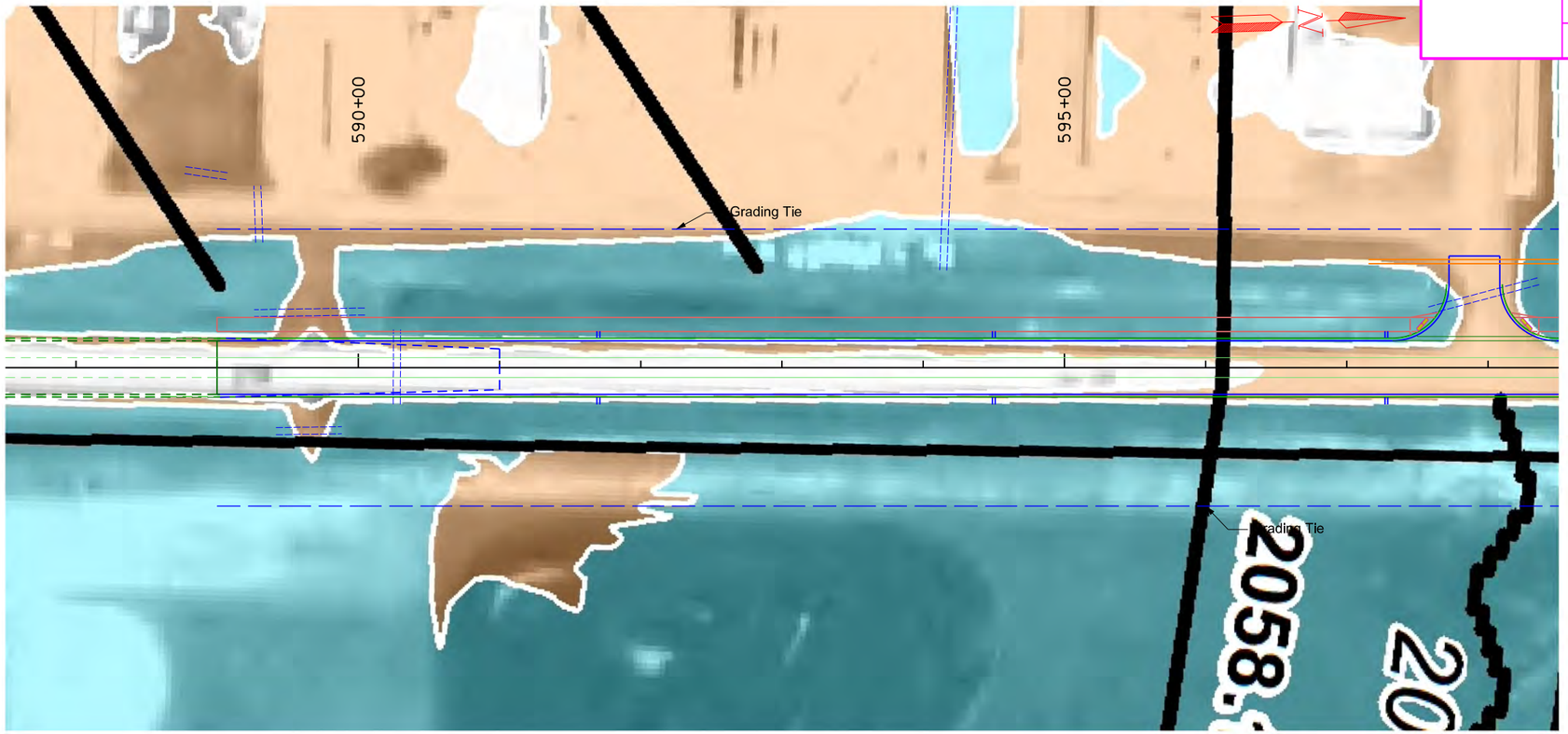
PRELIMINARY

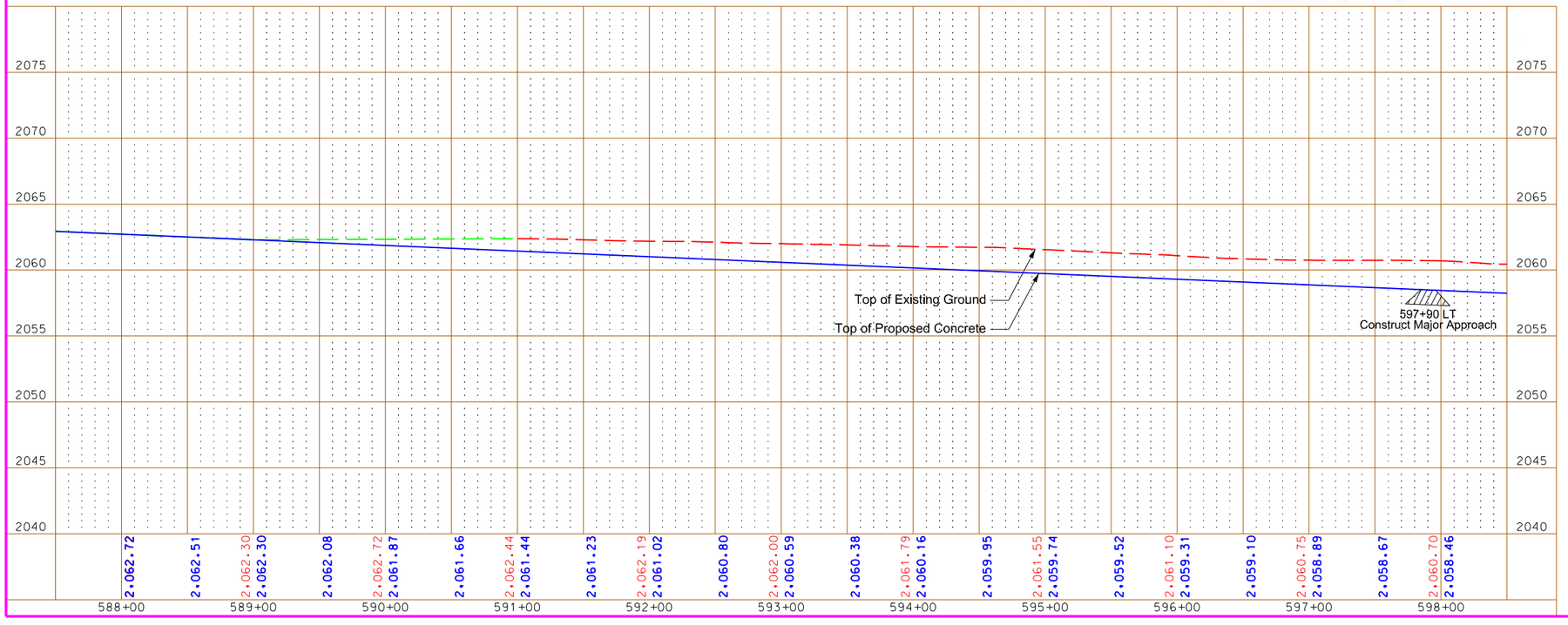
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	5





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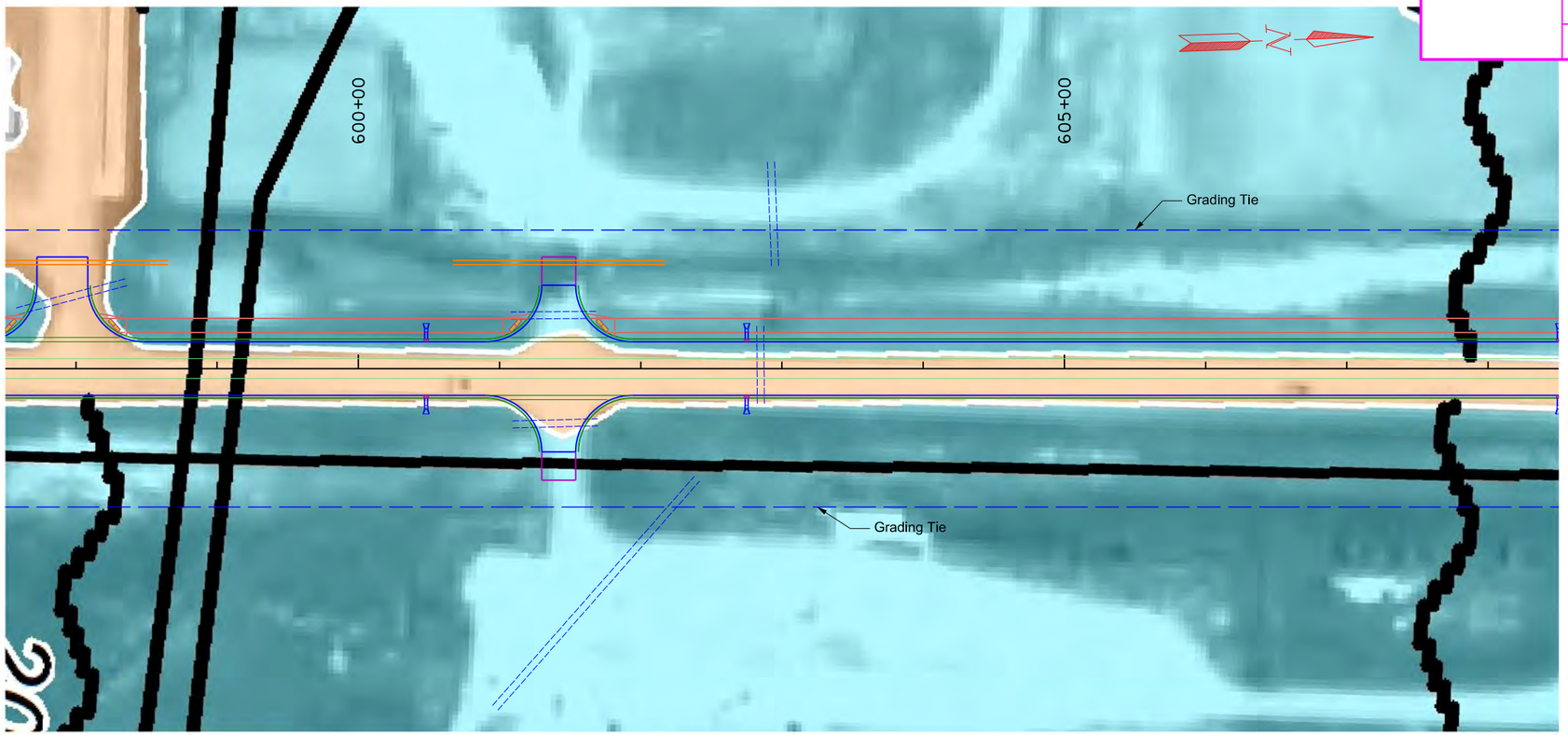
PRELIMINARY

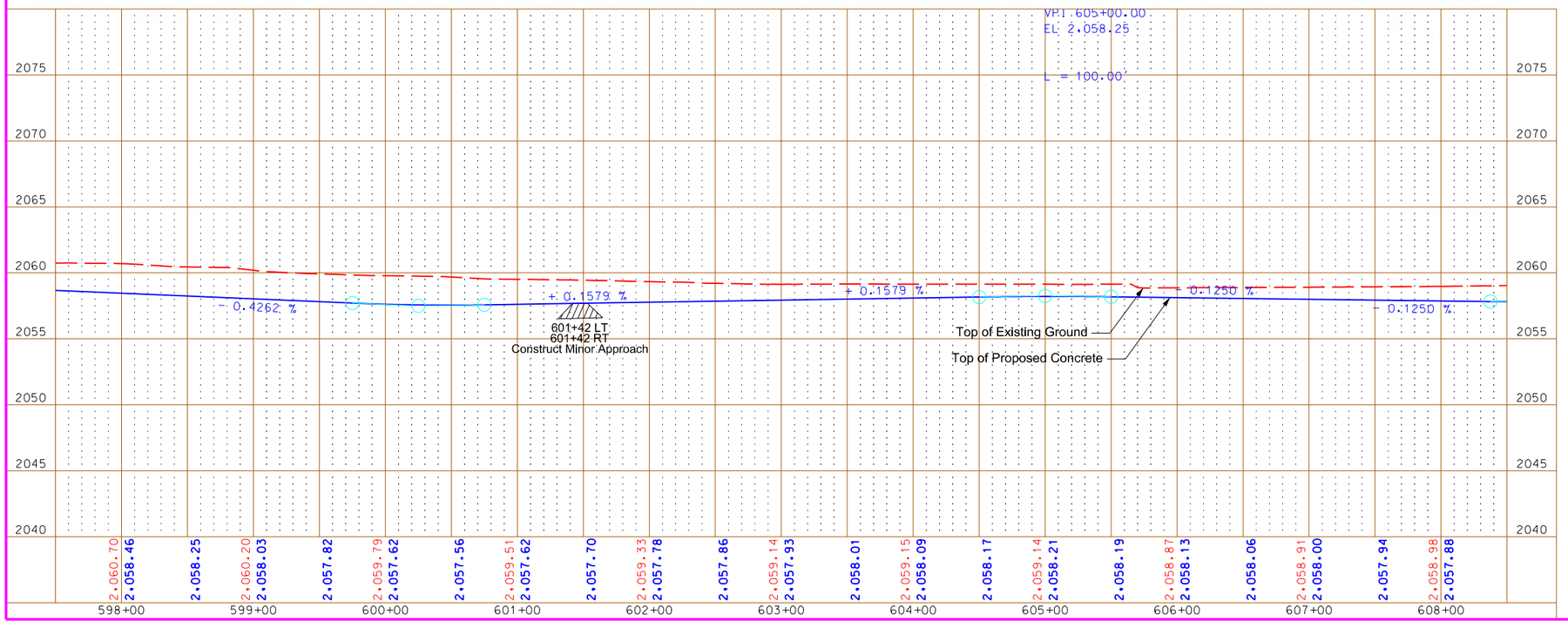
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	6



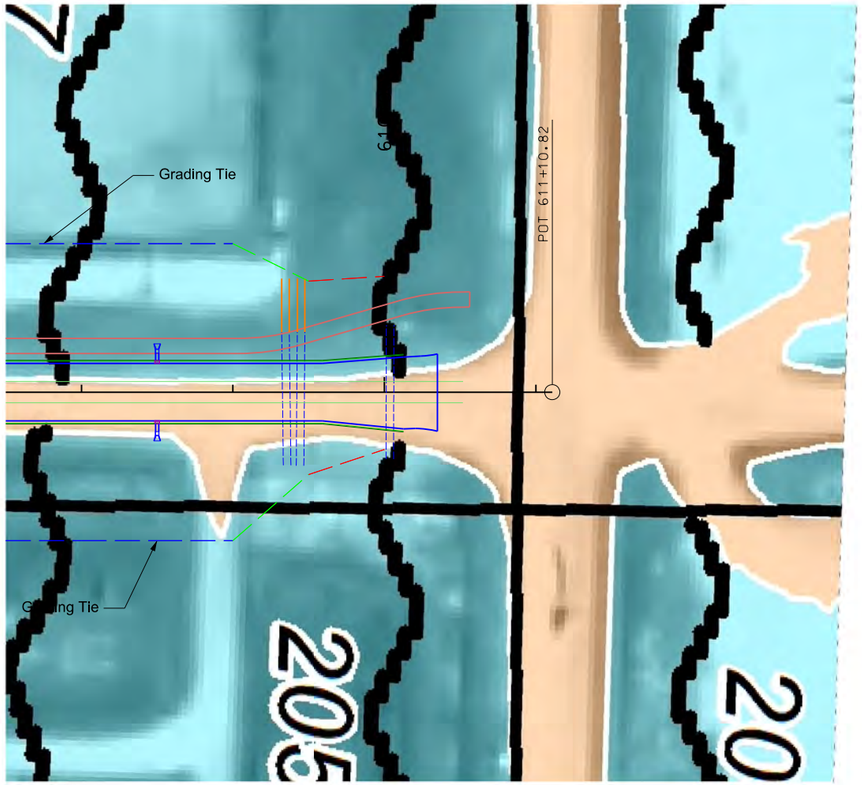


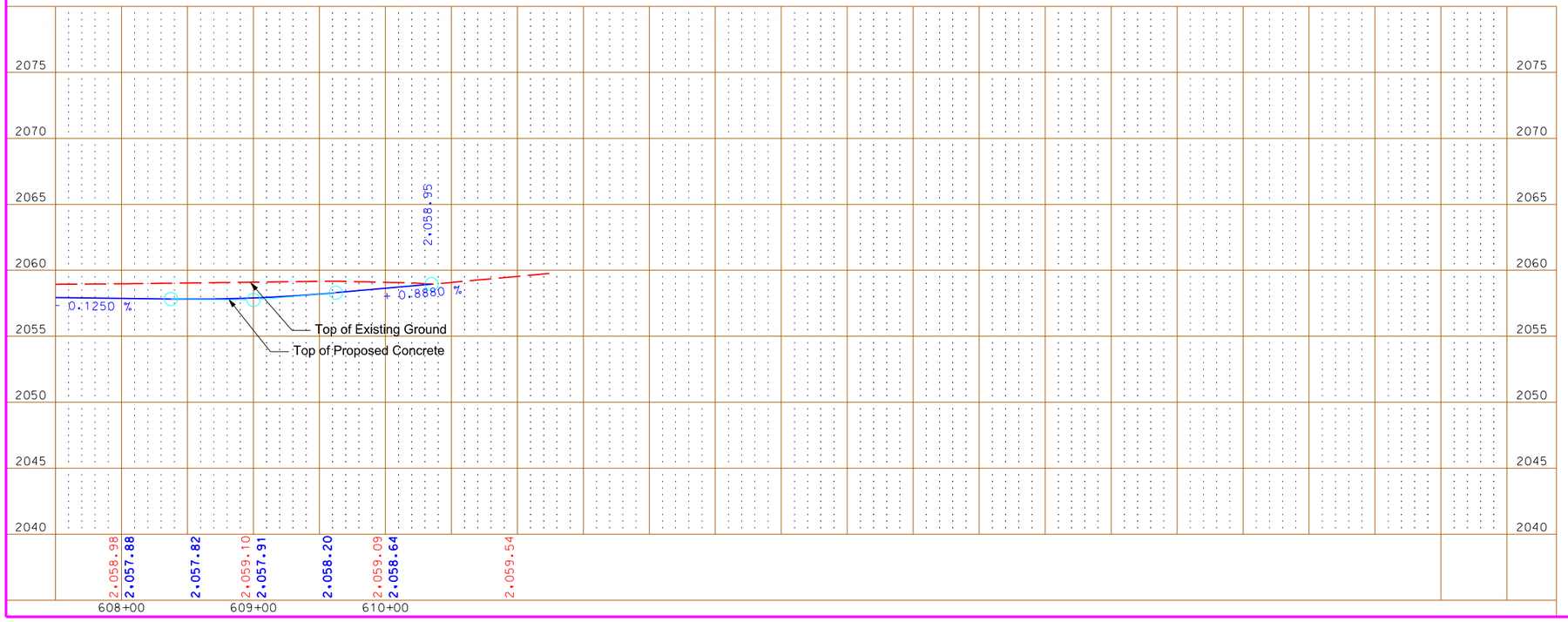
Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	60	7





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PRELIMINARY

Plan and Profile

ND23A

US85B to ND23A

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SOIB-7-023(054)910	75	1

Wetland Impact Table

Wetland Number	Location	Wetland Feature	USACE Jurisdictional Wetlands[1]	Wetland Impacts Acre(s)		USFWS Easement Impacts Acre(s)		Wetland Mitigation												
								Mitigation Required			USACE/11990 Bank		11990 Bank		USFWS Bank		Onsite			
				Temp.	Perm.	Temp.	Perm.	EO 11990	USACE	USFWS	Location	Acre(s)	Location	Acre(s)	Location	Acre(s)	Mitigation Location; Ratio	Acre(s)	Constructed Site #	Constructed Size Acre(s)
1a	Sec.19, T150N, R98W	Artificial	No	0.00	0.03			N	N	N										
1b	Sec.19, T150N, R98W	Artificial	No	0.00	0.18			N	N	N										
2a	Sec.20, T150N, R98W	Artificial	No	0.00	0.00			N	N	N										
2b	Sec.20, T150N, R98W	Artificial	No	0.00	0.00			N	N	N										
2c	Sec.19, T150N, R98W	Artificial	No	0.00	0.12			N	N	N										
3a	Sec.19, T150N, R98W	Natural	Yes	0.23	0.00			Y	N	N										
3b	Sec.19, T150N, R98W	Natural	Yes	0.08	0.00			Y	N	N										
3c	Sec.19, T150N, R98W	Natural	Yes	0.01	0.02			Y	N	N										
3d	Sec.19, T150N, R98W	Natural	Yes	0.13	0.08			Y	N	N										
3e	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.01			Y	N	N										

This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

Wetlands Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

3f	Sec.19, T150N, R98W	Natural	Yes	0.04	0.25			Y	Y	N										
3g	Sec.19, T150N, R98W	Natural	Yes	0.05	0.13			Y	Y	N										
3h	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.04			Y	N	N										
3i	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.37			Y	N	N										
3j	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.60			Y	N	N										
3k	Sec.19, T150N, R98W	Natural	Yes	0.03	0.13			Y	N	N										
3l	Sec.19, T150N, R98W	Natural	Yes	0.04	0.43			Y	Y	N										
3m	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.15			Y	N	N										
3n	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.43			Y	N	N										
3o	Sec.19, T150N, R98W	Artificial	Yes	0.00	0.49			Y	N	N										
4	Sec.19, T150N, R98W	Artificial	No	0.00	0.12			N	N	N										
				0.61	**3.58**	**0.00**	**0.00**					**0.00**		**0.00**		**0.00**		**0.00**		**0.00**

[1] A wetland Jurisdictional Determination was issued by the USACE on 4/22/2016; NWO-2016-0223-BIS.

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PRELIMINARY

Wetlands Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SOIB-7-023(054)910	75	3

[2] 1199 Mitigation requirements - All impacts to natural wetlands (natural/jurisdictional and natural/non-jurisdictional), regardless of size, as well as impacts greater than 0.10 acre to wetlands require mitigation.
USACE Mitigation Requirements – All jurisdictional impacts greater than 0.10 acre to each resource (cumulative. eg 1a ,1b,1c..etc.) requires mitigation. Other Water impact greater than 300 linear feet requires mitigation.
[3] All artificial/non-jurisdictional, deep water (impacts greater than 6.6 feet), Other Waters less than 300 linear feet (determined by the USACE on a case by case), and temporary impacts do not require mitigation.

Impact Summary Table

Permanent Impact Summary		Temporary Impacts and additional information	
Wetland Type	**Total (Acres)**	**Wetland Type**	**Total (Acres/Lf)**
Natural/JD	0.00	**Temporary JD**	0.00
Natural/Non-JD	0.00	**Non-JD Temporary**	0.00
Artificial/JD	0.00	**Permanent JD > 0.10**	0.00
Artificial /Non-JD	0.19	**Permanent OW**	0.00 ac/00 ft.
Total	**0.19**	**Temporary OW**	0.00/00

Mitigation Summary Table

	Location	Onsite Acre(s)	11990 Bank Acre(s)	USACE/11990 Bank Acre(s)	USFWS Bank Acre(s)
USACE Only	NA	0.00		0.00	
EO 11990 Only	NA	0.00	0.00		
USACE/11990	NA	0.00		0.00	
USFWS	NA				0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**

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PRELIMINARY

Wetlands Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	75	4

WETLAND 3k
0.13 ACRES OF
PERMANENT IMPACTS
0.03 ACRES OF
TEMPORARY IMPACTS

WETLAND 3j
0.60 ACRES OF
PERMANENT IMPACTS

WETLAND 3l
0.43 ACRES OF
PERMANENT IMPACTS
0.04 ACRES OF
TEMPORARY IMPACTS

WETLAND 3m
0.15 ACRES OF
PERMANENT IMPACTS

WETLAND 3n
0.43 ACRES OF
PERMANENT IMPACTS

WETLAND 3i
0.37 ACRES OF
PERMANENT IMPACTS

WETLAND 3o
0.49 ACRES OF
PERMANENT IMPACTS

Legend

- Permanent Wetland Impact
- Temporary Wetland Impact
- Flow Arrow

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PRELIMINARY

Wetland Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

2/28/2017 10:37:37 AM lucas S:\2015proj\151024W\Project\7-023(050)910\Design\Plan Sheets\075WL_004.dgn

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	75	5

550+00
555+00
7th St SE
¼ Line
Road
Grading Tie
Wetland #3g
WETLAND 3g
0.13 ACRES OF
PERMANENT IMPACTS
0.05 ACRES OF
TEMPORARY IMPACTS
Existing ROW
WETLAND 4
0.12 ACRES OF
PERMANENT IMPACTS
Sec 19
T-150-N
R-98-W
N
Wetland #3i
Wetland #3h
WETLAND 3h
0.04 ACRES OF
PERMANENT IMPACTS
Wetland #4
ND 23A
Wetland #3e
Wetland #3o
WETLAND 3e
0.01 ACRES OF
PERMANENT IMPACTS
Wetland #3f
Grading Tie
Existing ROW
WETLAND 3f
0.25 ACRES OF
PERMANENT IMPACTS
0.04 ACRES OF
TEMPORARY IMPACTS
Sec 19
T-150-N
R-98-W

0+00
560+00
WETLAND 3c
0.02 ACRES OF
PERMANENT IMPACTS
0.01 ACRES OF
TEMPORARY IMPACTS
WETLAND 3b
0.08 ACRES OF
TEMPORARY IMPACTS
Temp Easement
565+00
Proposed ROW
Wetland #3b
10+00
Curve C851
PI Grading Tie 79.37 Simple Curve (RT)
Delta = 28° 58' 12.16"
Da = 22° 55' 05.92"
R = 250.00
T = 64.58
L = 126.41
Wetland #3c
Wetland #4
Curve C853
PI Existing ROW 83.87 Simple Curve (RT)
Delta = 36° 52' 04.45"
Da = 22° 55' 05.92"
R = 250.00
T = 83.33
L = 160.87
ND 23A
Wetland #3d
5+00
Wetland #3a
PC 4+44.11
Existing ROW
Grading Tie
PC 0+14.19
PT 1+41.19
PC 9+13.54
0+74.41
Sec 19
T-150-N
R-98-W
WETLAND 3d
0.08 ACRES OF
PERMANENT IMPACTS
0.13 ACRES OF
TEMPORARY IMPACTS
Curve C852
PI 0.25 ACRES OF 16.62" (LT)
Delta = 22° 55' 05.92"
Da = 250.00
R
WETLAND 3a
TEMPORARY IMPACTS
Temp Easement
Temp Easement

Legend
Permanent Wetland Impact
Temporary Wetland Impact
Flow Arrow

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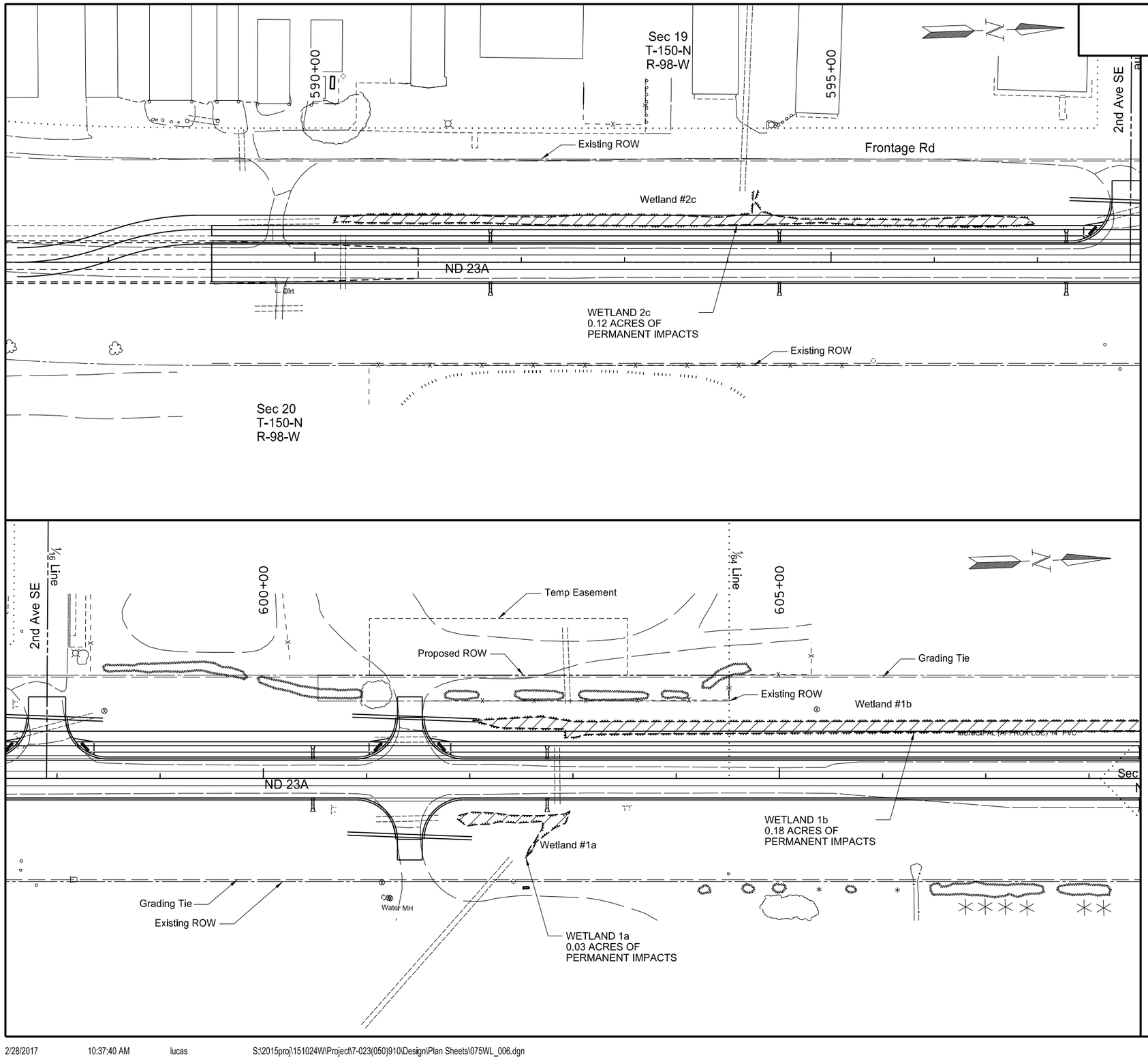
PRELIMINARY

Wetland Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)910	75	6



Legend

- Permanent Wetland Impact
- Temporary Wetland Impact
- Flow Arrow

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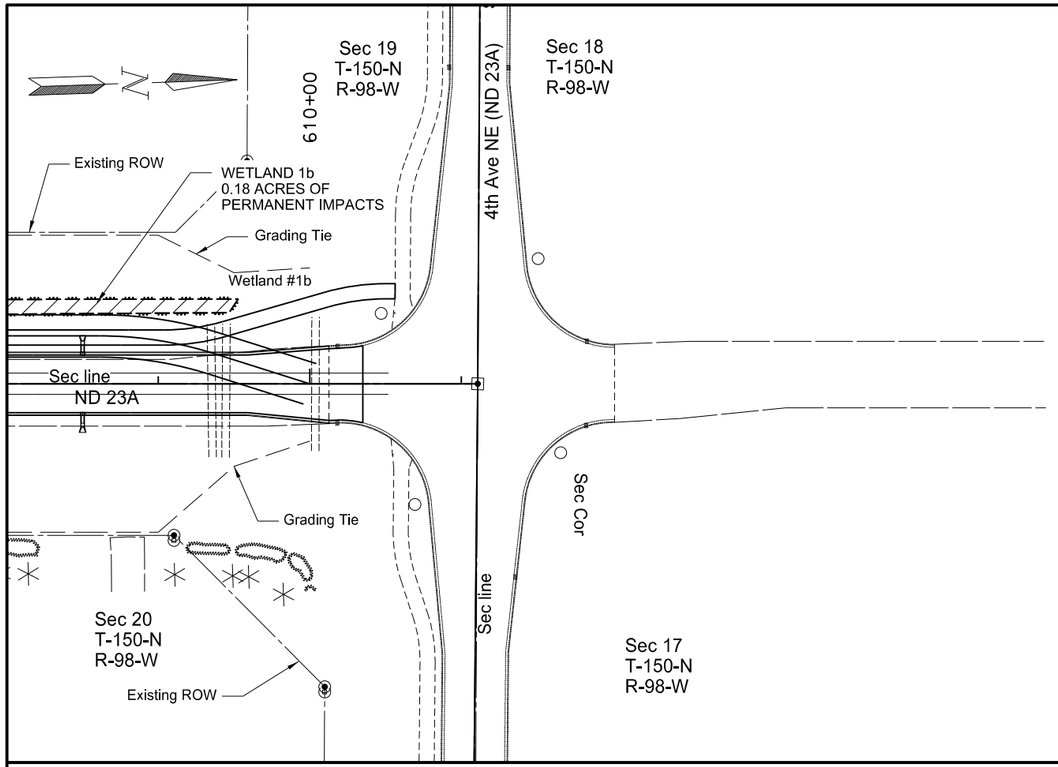
PRELIMINARY

Wetland Mitigation and Environmental

ND23A

Intersection of ND23A and 12th St SE

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	75	7



Legend

- Permanent Wetland Impact
- Temporary Wetland Impact
- Flow Arrow

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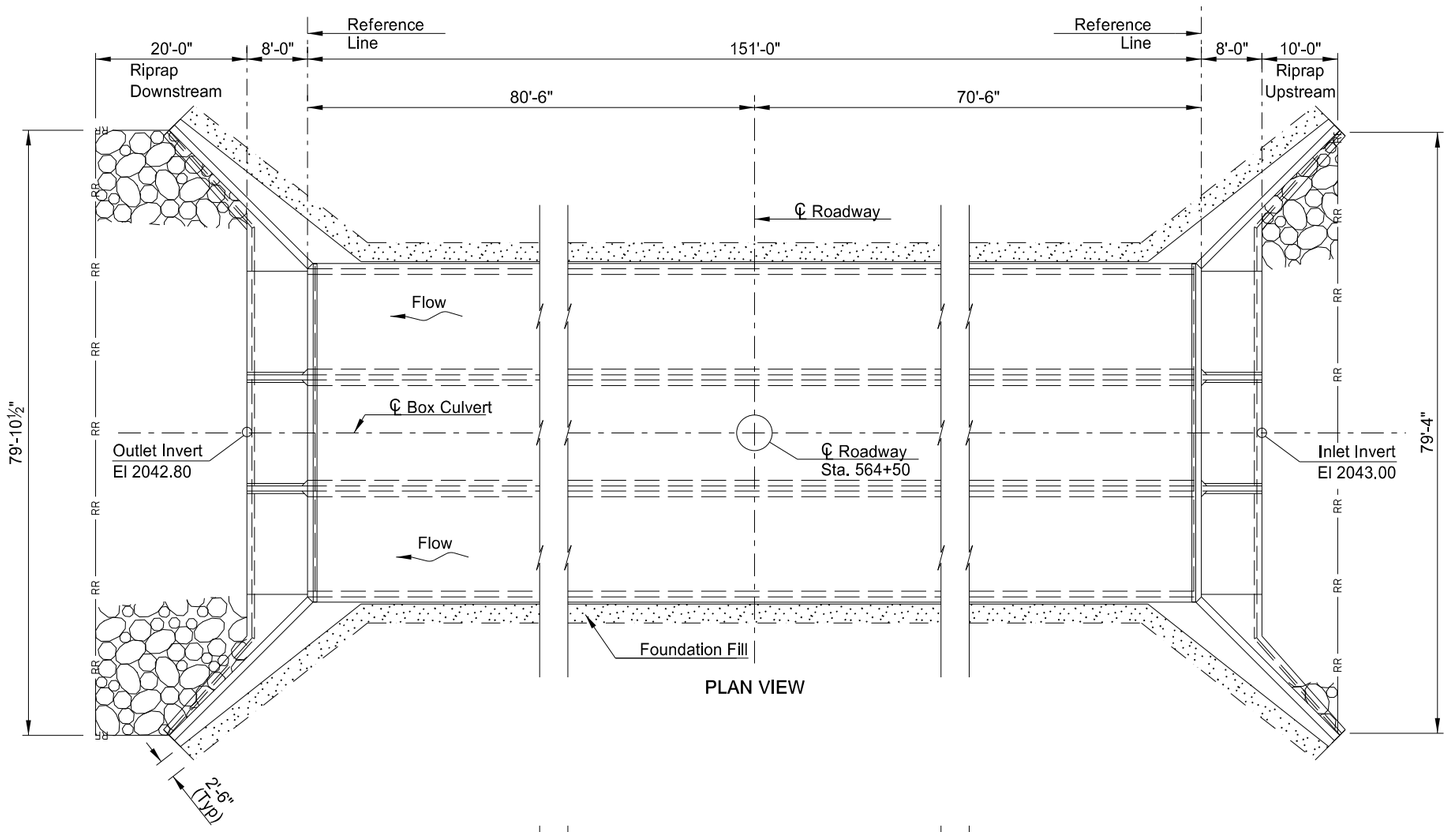
PRELIMINARY

Wetland Mitigation and Environmental

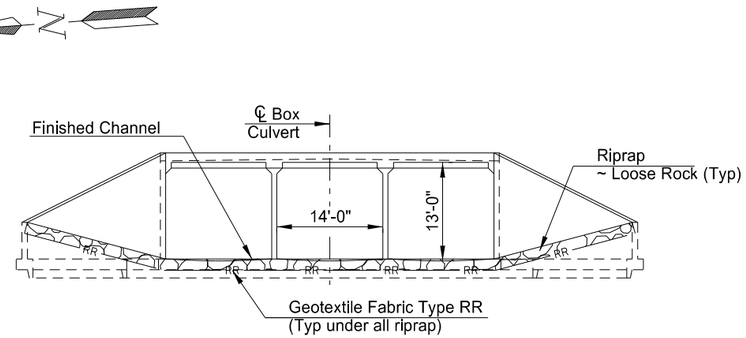
ND23A

Intersection of ND23A and 12th St SE

	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)019	170	1

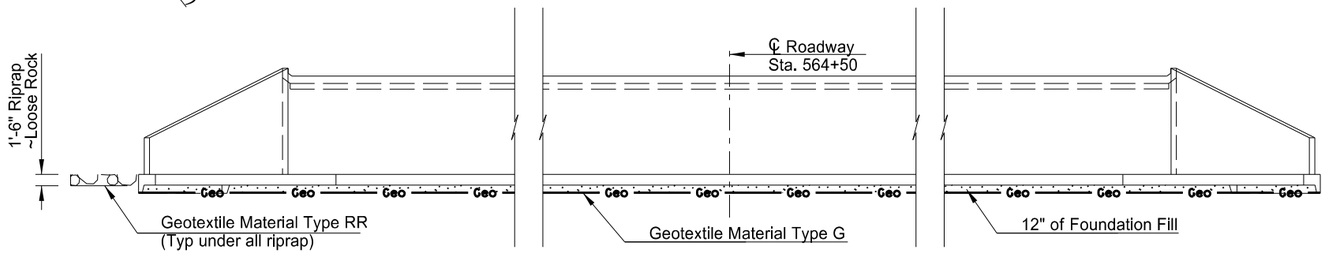


PLAN VIEW



(SHOWING FINISHED SECTION)

END VIEW



ELEVATION

DESIGN STRENGTHS:

f'c = 4,500 psi ~ Class AAE-3 Concrete
fy = 60,000 psi ~ Reinforcing Steel

Load & Resistance Factor Design

This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

HYDRAULIC DATA:

Drainage Area	170.7	sq mi
Stream Gradient	0.0013	ft/ft
Design Frequency	50	yr
Design Discharge	2321.0	cfs
Design Headwater Stage	2058.0	ft
Design Tailwater Stage	2057.6	ft
Velocity Through Culvert	5.53	fps
100-Year Frequency Discharge	2829.0	cfs
100-Year Frequency Headwater	2058.8	ft
Overtopping Stage	2060.2	ft
Overtopping Discharge	4376.9	cfs

BOX CULVERT BID ITEMS

SPEC	CODE	ITEM DESCRIPTION	UNIT	QUANTITY
202	0105	REMOVAL OF STRUCTURE	L SUM	1
210	0050	BOX CULVERT EXCAVATION	EA	1
210	0210	FOUNDATION FILL	CY	2,072
210	0405	FOUNDATION PREPARATION-BOX CULVERT	EA	1
256	0200	RIPRAP GRADE II	CY	116.3
602	0130	CLASS AAE-3 CONCRETE	CY	937
612	0114	REINFORCING STEEL-GRADE 60-BOX CULVERT	LBS	156,058
709	0100	GEOSYNTHETIC MATERIAL TYPE "G"	SY	931
709	0155	GEOSYNTHETIC MATERIAL TYPE RR	SY	294

HL-93 DESIGN LOADING

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

0.7 MILES EAST OF JCT ND23A

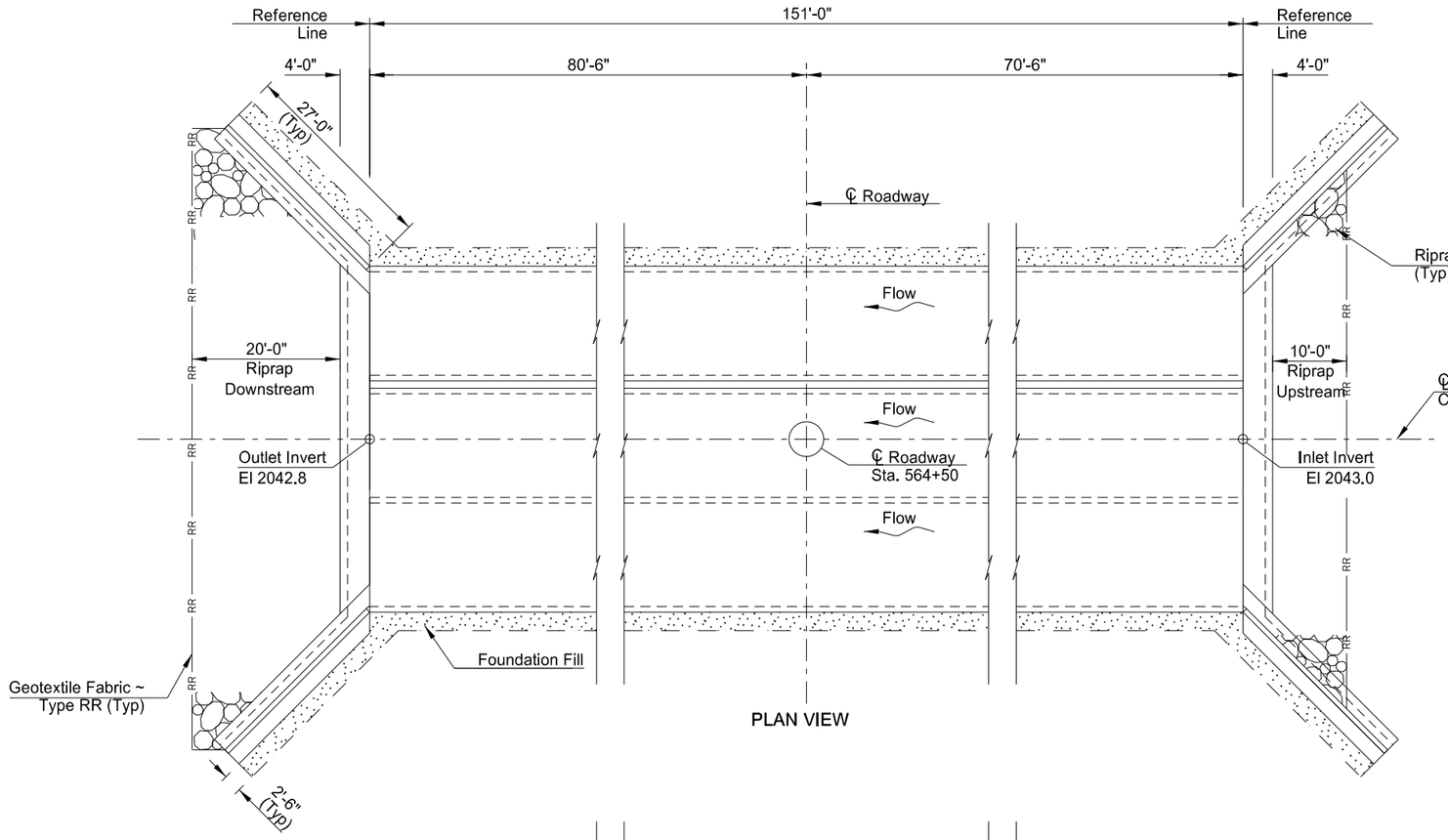
REINFORCED CONCRETE
TRIPLE BOX CULVERT LAYOUT

CLEAR SPAN 3 x 14' CLEAR HEIGHT 12'
MAXIMUM FILL 14'

PROJECT: SS-7-023(050)910 - PCN 21172
STATION: 564+50
MCKENZIE COUNTY

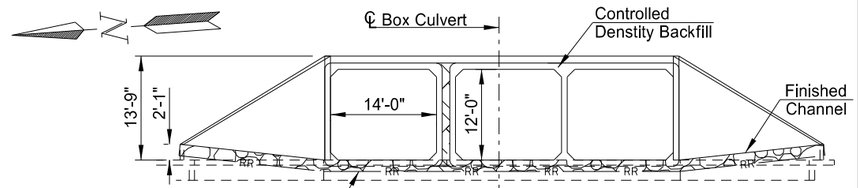
DATE BRIDGE ENGINEER

	BRIDGE CODE	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	X081	ND	SS-7-023(050)019	170	1P



PLAN VIEW

ELEVATION



END VIEW
(SHOWING FINISHED SECTION)

For a single barrel box culvert with 10" thick roof, 10" floor and 9" walls, the following total factored moments and shears would result from the application of the required loads:

FACTORED DESIGN MOMENTS (SINGLE)		FACTORED DESIGN SHEARS (SINGLE)	
WALL MOMENT	6,006 ft-lbs	WALL SHEAR	8,400 lbs
ROOF MOMENTS		ROOF SHEARS	
CORNER	-31,464 ft-lbs	CORNER	17,155 lbs
BOTTOM	49,869 ft-lbs	WALL	19,275 lbs
TOP	-59,027 ft-lbs	FLOOR SHEARS	
FLOOR MOMENTS		CORNER	21,353 lbs
CORNER	-37,019 ft-lbs	WALL	20,807 lbs
TOP	52,935 ft-lbs		
BOTTOM	-61,209 ft-lbs		

For a double barrel box culvert with 10" thick roof, 10" floor and 9" walls, the following total factored moments and shears would result from the application of the required loads:

FACTORED DESIGN MOMENTS (DOUBLE)		FACTORED DESIGN SHEARS (DOUBLE)	
WALL MOMENT	2,037 ft-lbs	WALL SHEAR	8,317 lbs
ROOF MOMENTS		ROOF SHEARS	
CORNER	-26,146 ft-lbs	CORNER	14,329 lbs
BOTTOM	35,065 ft-lbs	WALL	19,982 lbs
TOP	-67,598 ft-lbs	FLOOR SHEARS	
FLOOR MOMENTS		CORNER	18,170 lbs
CORNER	-30,660 ft-lbs	WALL	23,713 lbs
TOP	36,273 ft-lbs		
BOTTOM	-71,311 ft-lbs		

HYDRAULIC DATA:

Drainage Area	170.7	sq mi
Stream Gradient	0.0013	ft/ft
Design Frequency	50	yr
Design Discharge	2321.0	cfs
Design Headwater Stage	2058.0	ft
Design Tailwater Stage	2057.6	ft
Velocity Through Culvert	5.53	fps
100-Year Frequency Discharge	2829.0	cfs
100-Year Frequency Headwater	2058.8	ft
Overtopping Stage	2060.2	ft
Overtopping Discharge	4376.9	cfs

BOX CULVERT BID ITEMS

SPEC	CODE	ITEM DESCRIPTION	UNIT	QUANTITY
202	0105	REMOVAL OF STRUCTURE	L SUM	1
210	0050	BOX CULVERT EXCAVATION	EA	1
210	0210	FOUNDATION FILL	CY	1,853
210	0405	FOUNDATION PREPARATION-BOX CULVERT	EA	1
256	0200	RIPRAP GRADE II	CY	116.3
606	1412	14FT X 12FT PRECAST RCB CULVERT	LF	151
606	3412	DBL 14FT X 12FT PRECAST RCB CULVERT	LF	151
606	5412	14FT X 12FT PRECAST RCB END SECTION	EA	2
606	7412	DBL 14FT X 12FT PRECAST RCB END SECTION	EA	2
709	0100	GEOSYNTHETIC MATERIAL TYPE G	SY	914
709	0155	GEOSYNTHETIC MATERIAL TYPE RR	SY	294

This document is preliminary and not for recording or implementation purposes.

PRELIMINARY

HL-93 DESIGN LOADING

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

0.7 MILES EAST OF JCT ND23A

REINFORCED CONCRETE TRIPLE PRECAST BOX CULVERT LAYOUT

CLEAR SPAN 3' x 14' CLEAR HEIGHT 12'
MAXIMUM FILL 14'

PROJECT: SS-7-023(050)910 - PCN 21172
STATION: 564+50
MCKENZIE COUNTY

DATE BRIDGE ENGINEER

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)019	170	2

NOTES

100 SCOPE OF WORK: Work at this site consists of removing an existing structure and building a new triple barrel 14' x 12' x 118'-0" reinforced concrete box culvert.

202 REMOVAL OF STRUCTURE: The existing structure is a 27’x19’ elliptical structural plate pipe, 62'-0" long with a clear roadway width of 28'-0", with cable guardrail. Include all work required to remove the bridge in the contract unit price for “Removal of Structure”.

Submit SFN 17987 Asbestos Notification of Demolition and Renovation to the North Dakota Department of Health 10 days before beginning removal of concrete.

210 ORDINARY BACKFILL: Compact material as specified in Section 203.04 E.2.a, “ND T 180.”

602 CONCRETE: Provide aggregate for concrete that meets the requirements of Section 802.01C.2, “Course Aggregate” and Section 802.01C.3, “Fine Aggregate”.

All concrete shall be Class AAE-3, with a minimum 28 day f’c = 4,500 psi.

602 CONCRETE: Cast the following elements of each section in one continuous run:

1. Floor slab and wing footings
2. Each intermediate wall up to the bottom of fillets
3. Each sidewall up to the bottom of fillets with its adjacent wings complete to the top
4. Roof slab and parapets

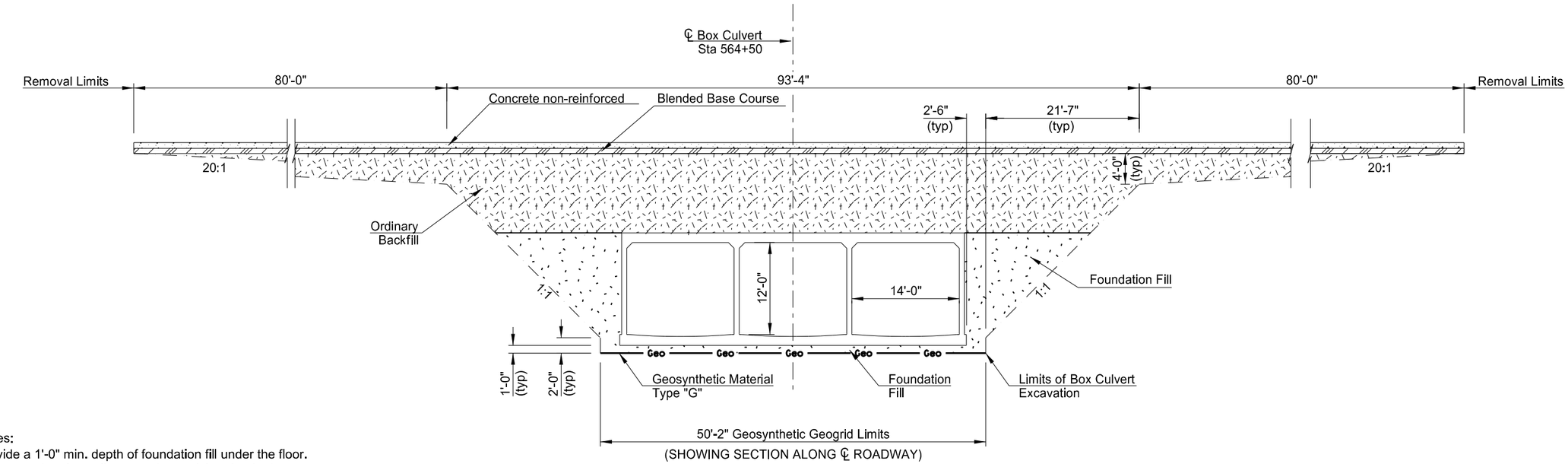
Allow the concrete in the walls to set at least two hours before the roof slab is poured.

602 CURING CONCRETE: Wet cure all concrete surfaces not covered by forms. Cover the concrete with a double thickness of burlap. Maintain surface moisture between the final finish and placement of burlap by periodic applications of a light fog spray of water. Keep the burlap continuously moist until the end of the curing period.

612 REINFORCING STEEL: When the distance between end bars is not evenly divisible by bar spacing, adjust the odd distance by a few irregular spaces near the center, not at the ends of the culvert.

Dimensions of bent bars are given out to out.

	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)019	170	3



GEOSYNTHETIC GEOGRID PLACEMENT AND FOUNDATION FILL
THROUGH EXISTING EMBANKMENT

Notes:
Provide a 1'-0" min. depth of foundation fill under the floor. remove and replace all unsound material under the box with foundation fill. The engineer will determine the depth required.

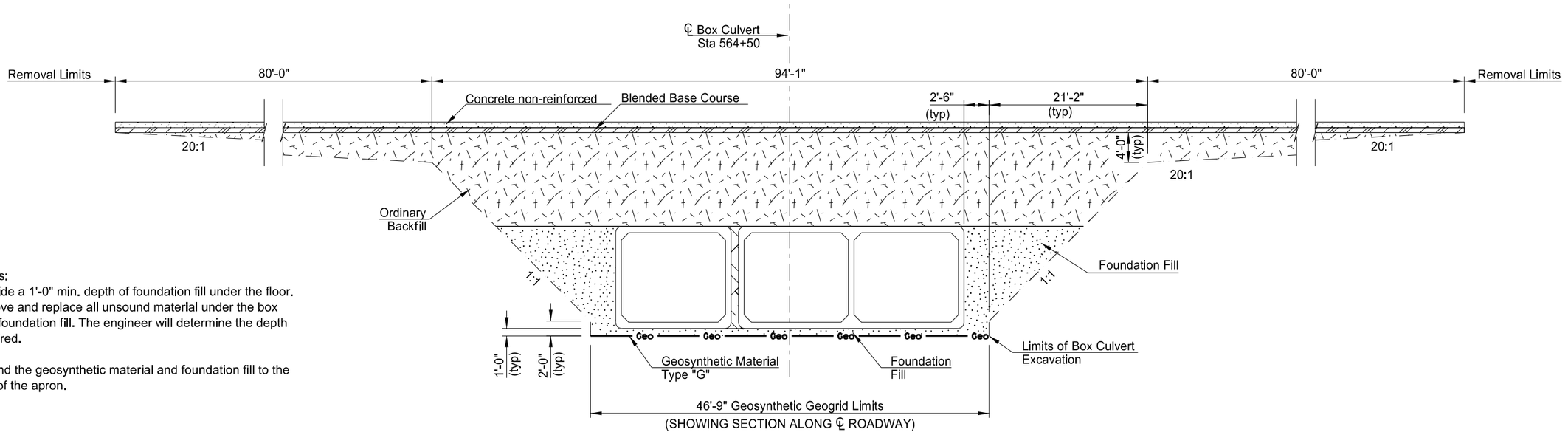
Extend the geosynthetic material and foundation fill to the end of the apron.

Cherry Creek
Cherry Creek Box Culvert

0.7 MILES EAST OF JCT ND23A

EXCAVATION & FOUNDATION
FILL DETAIL

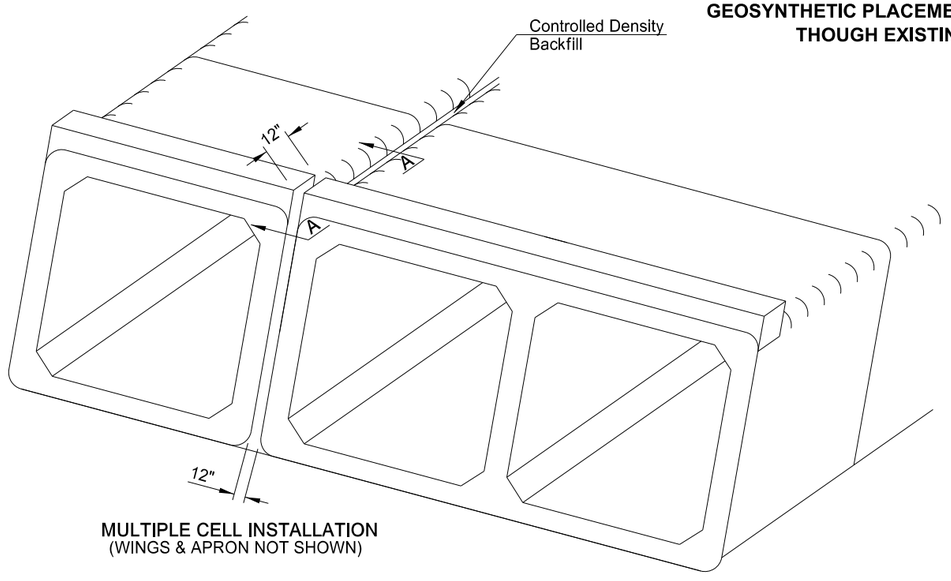
	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)019	170	3P



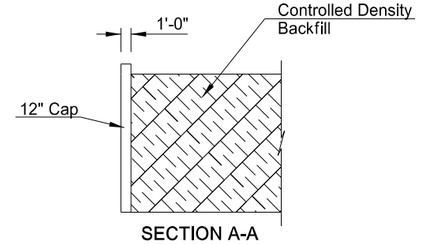
GEOSYNTHETIC PLACEMENT AND FOUNDATION FILL THOUGH EXISTING EMBANKMENT

Notes:
Provide a 1'-0" min. depth of foundation fill under the floor. remove and replace all unsound material under the box with foundation fill. The engineer will determine the depth required.

Extend the geosynthetic material and foundation fill to the end of the apron.



MULTIPLE CELL INSTALLATION
(WINGS & APRON NOT SHOWN)



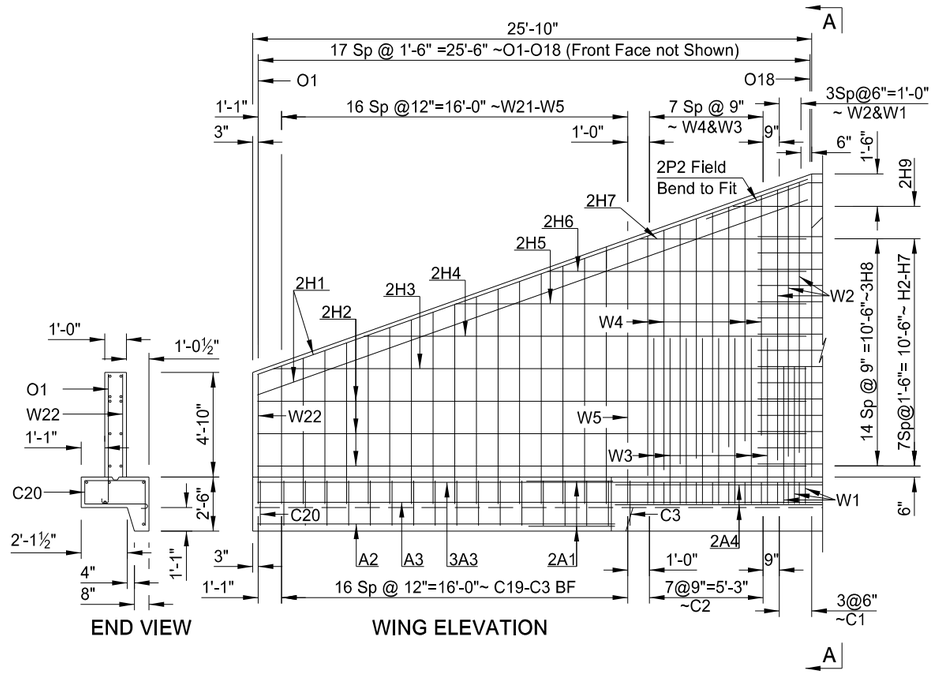
SECTION A-A

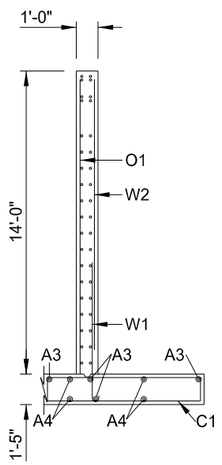
The intent of this drawing is to show only the placement of the controlled density backfill between adjacent barrels. The representation of the number of barrels is arbitrary.

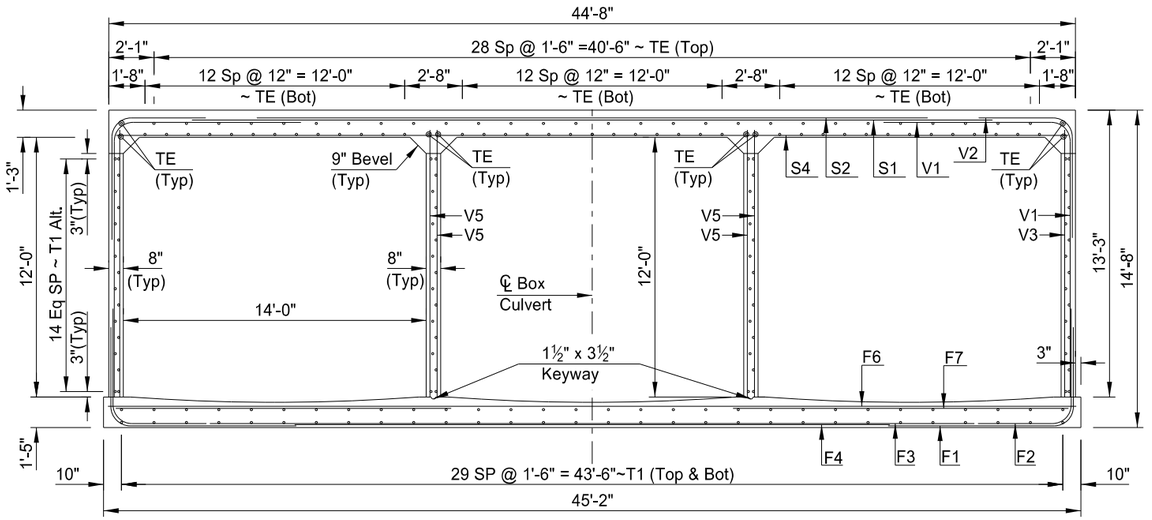
Cherry Creek
Cherry Creek Box Culvert

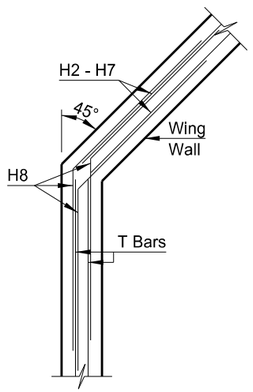
EXCAVATION & FOUNDATION FILL DETAIL

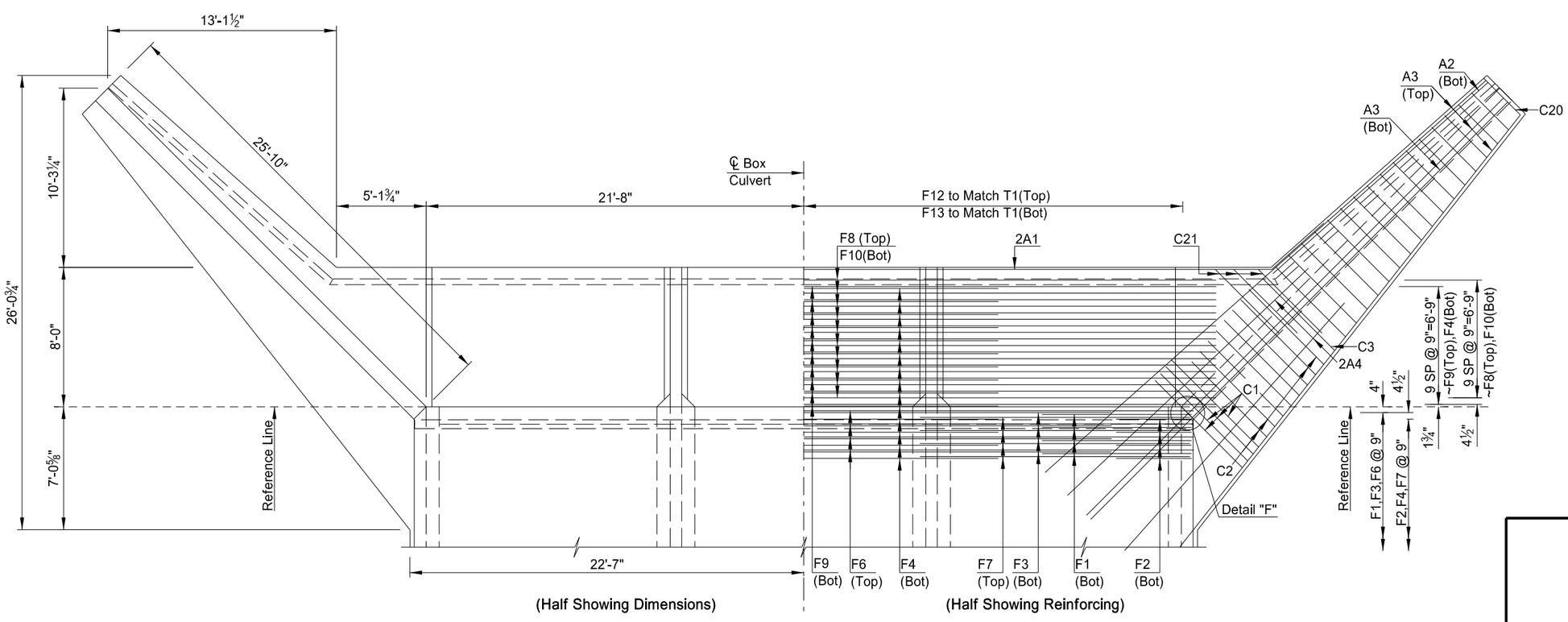
STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
ND	SS-7-023(050)019	170	4











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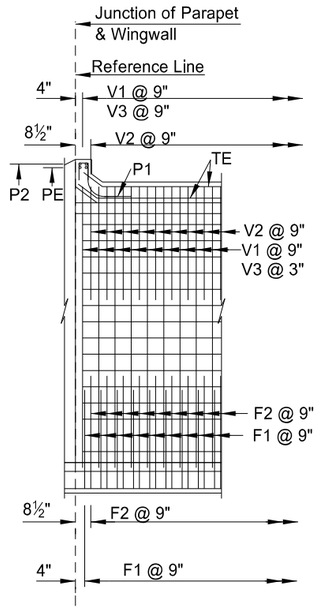
PRELIMINARY

Cherry Creek
Cherry Creek Box Culvert

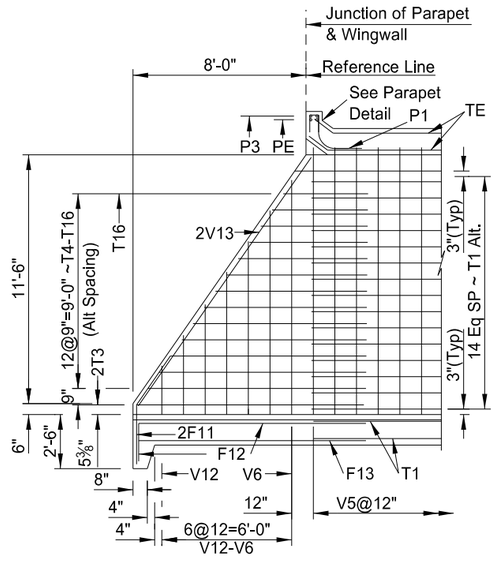
0.7 MILES EAST OF JCT ND23A

FLOOR, BARREL SECTION & WING DETAILS

	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)019	170	5

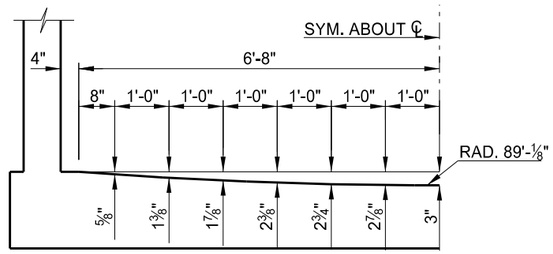


OUTER WALL

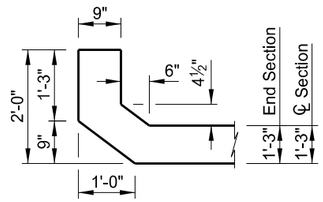


INNER WALL

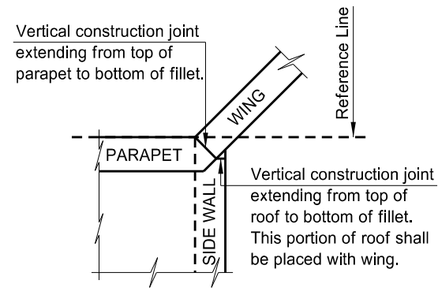
LONGITUDINAL SECTIONS



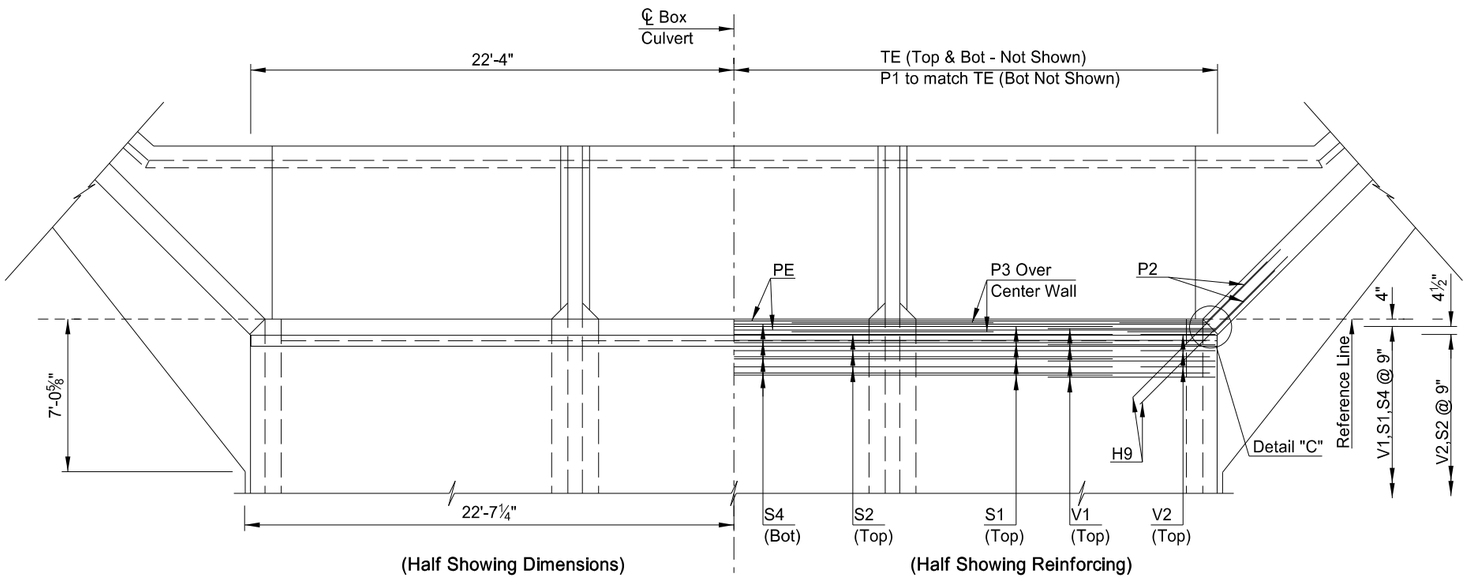
CURVED FLOOR OFF-SETS



PARAPET DETAIL



DETAIL "C"



ROOF-PLAN

Cherry Creek
Cherry Creek Box Culvert

0.7 MILES EAST OF JCT ND23A

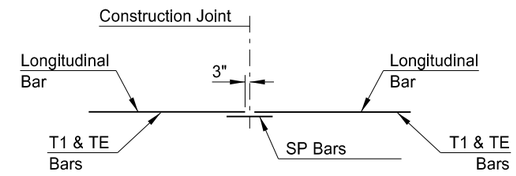
FLOOR, BARREL SECTION & WINGE DETAILS

BAR LIST (Constant)				
MARK	SIZE	NO.	LENGTH	SHAPE
A 1	6	8	32'-10"	BENT
A 2	6	4	16'-6"	STR.
A 3	6	16	33'-10"	STR.
A 4	6	16	19'-0"	STR.
C 1	6	16	16'-10"	BENT
C 2	6	32	14'-10"	BENT
C 3	5	4	15'-4"	BENT
C 4	5	4	15'-0"	BENT
C 5	5	4	14'-8"	BENT
C 6	5	4	14'-4"	BENT
C 7	5	4	14'-0"	BENT
C 8	5	4	13'-8"	BENT
C 9	5	4	13'-4"	BENT
C10	5	4	13'-0"	BENT
C11	4	4	12'-5"	BENT
C12	4	4	12'-1"	BENT
C13	4	4	11'-9"	BENT
C14	4	4	11'-5"	BENT
C15	4	4	11'-1"	BENT
C16	4	4	10'-9"	BENT
C17	4	4	10'-5"	BENT
C18	4	4	9'-11"	BENT
C19	4	4	9'-7"	BENT
C20	4	4	9'-3"	BENT
C21	4	12	7'-3"	BENT
F 8	5	20	47'-4"	STR.
F 9	6	20	47'-4"	STR.
F10	6	20	47'-4"	STR.
F11	6	8	5'-6"	BENT
F12	4	60	12'-3"	BENT
F13	4	60	10'-6"	STR.
H 1	7	16	26'-11"	STR.
H 2	4	24	25'-4"	STR.
H 3	4	8	24'-10"	STR.
H 4	4	8	20'-8"	STR.
H 5	4	8	16'-5"	STR.
H 6	4	8	12'-2"	STR.
H 7	4	8	7'-11"	STR.
H 8	4	180	6'-0"	BENT
H 9	6	8	9'-8"	STR.
O1 - O18	4	4 SETS	167'-3"	STR.
P 1	4	90	4'-7"	BENT
P 2	6	8	8'-0"	BENT
P 3	6	8	9'-4"	STR.
P E	6	8	24'-2"	STR.
T 3	4	8	10'-6"	STR.
T4 - T16	4	4 SETS	91'-0"	STR.

BAR LIST (Constant)				
MARK	SIZE	NO.	LENGTH	SHAPE
V 6	4	8	10'-10"	STR.
V 7	4	8	9'-5"	STR.
V 8	4	8	8'-0"	STR.
V 9	4	8	6'-7"	STR.
V10	4	8	5'-1"	STR.
V11	4	8	3'-8"	STR.
V12	4	8	2'-3"	STR.
V13	6	8	14'-0"	STR.
W 1	7	12	7'-2"	BENT
W 2	6	12	13'-3"	STR.
W 3	7	32	8'-5"	BENT
W 4	6	32	11'-1"	STR.
W 5	7	4	12'-9"	BENT
W 6	7	4	12'-5"	BENT
W 7	7	4	12'-0"	BENT
W 8	7	4	11'-8"	BENT
W 9	7	4	11'-4"	BENT
W10	7	4	11'-0"	BENT
W11	6	4	10'-6"	BENT
W12	6	4	10'-2"	BENT
W13	5	4	9'-9"	BENT
W14	5	4	9'-4"	BENT
W15	5	4	9'-0"	BENT
W16	4	4	8'-7"	BENT
W17	4	4	8'-3"	BENT
W18	4	4	7'-10"	BENT
W19	4	4	7'-6"	BENT
W20	4	4	7'-2"	BENT
W21	4	4	6'-10"	BENT
W22	4	4	6'-5"	BENT

BAR LIST (Variable)				
MARK	SIZE	NO.	LENGTH	SHAPE
F 1	5	404	12'-9"	BENT
F 2	6	402	9'-3"	BENT
F 3	6	202	35'-4"	STR.
F 4	6	201	27'-6"	STR.
F 6	5	202	44'-9"	STR.
F 7	6	402	15'-6"	STR.
S 1	6	202	37'-0"	STR.
S 2	7	201	31'-0"	STR.
S 4	7	202	44'-0"	STR.
SP	4	612	5'-6"	STR.
TE	4	76	149'-8"	BENT
T 1	4	128	149'-4"	STR.
V 1	5	404	21'-0"	BENT
V 2	6	402	9'-6"	BENT
V 3	6	404	12'-4"	STR.
V 5	4	608	12'-4"	STR.

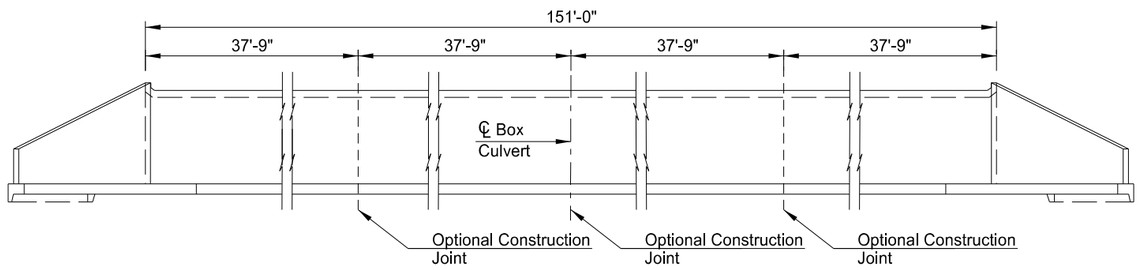
STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
ND	SS-7-023(050)019	170	6



T1, TE, & SP BAR PLACEMENT AT CONSTRUCTION JOINTS

OPTIONAL CONSTRUCTION JOINTS

Unless construction requirements dictate otherwise, the Contractor has the option to construct the box culvert using the construction joints as shown or as one continuous unit. The 5'-6" SP Bars shall be used for either option.



CONCRETE QUANTITY FORMULAS			
ENTIRE FLOOR	"L" X 2.12506 + 70.35110	=	CY
TWO OUTSIDE WALLS & FOUR WINGS	"L" X 0.57292 + 35.64553	=	CY
INSIDE WALLS	"L" X 0.55556 + 4.93827	=	CY
ENTIRE ROOF	"L" X 2.20447 + 1.69147	=	CY
TOTAL	"L" X 5.26305 + 112.18061	=	CY

CONCRETE QUANTITIES	
ENTIRE FLOOR	391.2 CY
TWO OUTSIDE WALLS & FOUR WINGS	122.2 CY
INSIDE WALLS	88.8 CY
ENTIRE ROOF	334.6 CY
TOTAL	936.8 CY

This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

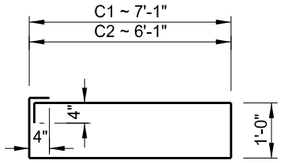
QUANTITIES	
CLASS AAE-3 CONCRETE	937.0 CY
REINFORCING STEEL-GRADE 60	156,058 LBS

Cherry Creek
Cherry Creek Box Culvert

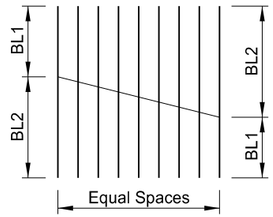
0.7 MILES EAST OF JCT ND23A

REINFORCING BAR LIST

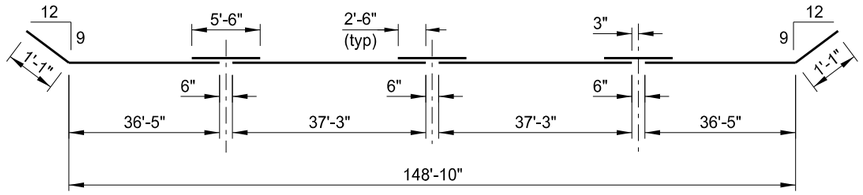
	STATE	PROJECT NUMBER	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)019	170	7



C1 - C2



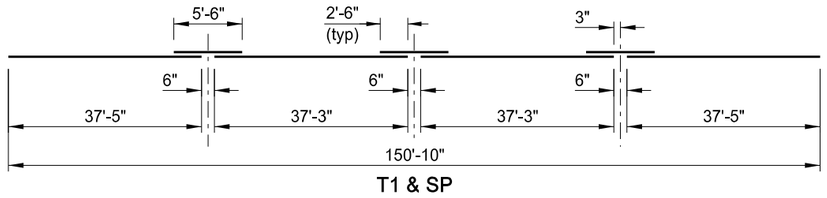
2 SETS SHOWN



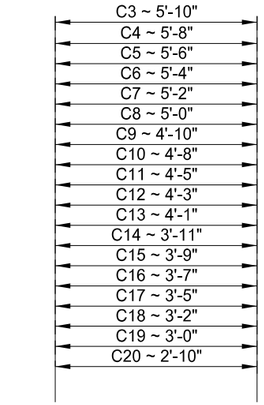
TE & SP

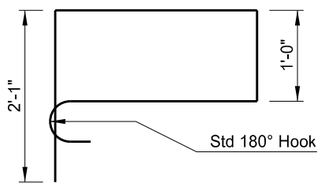
MARK	LENGTH 1 SET	BL1	BL2	SPACES
O1-O18	167'-3"	4'-9"	13'-10"	17
T4-T16	91'-0"	4'-0"	10'-0"	12

BAR CUTTING DETAILS

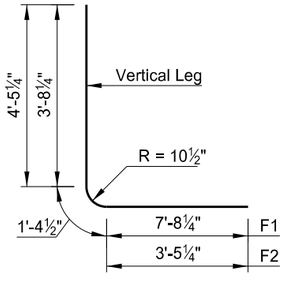


T1 & SP

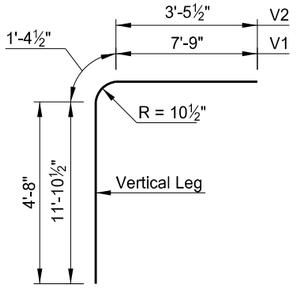




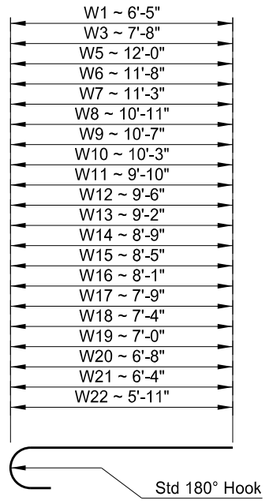
C3 - C20



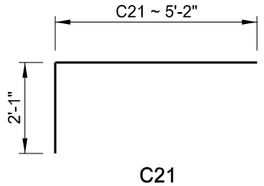
F1 & F2



V1 & V2



W1 - W22



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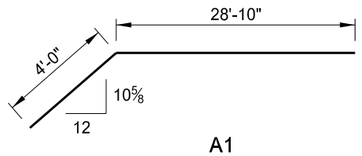
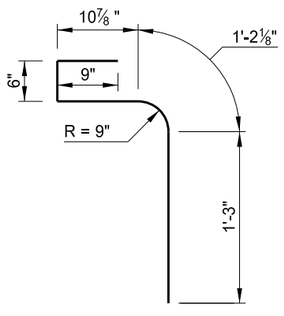


A1



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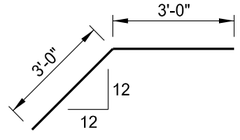

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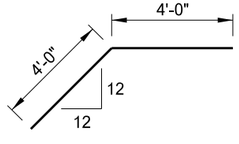

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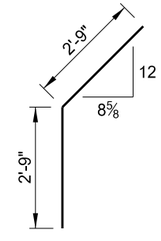

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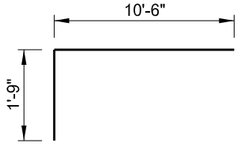

F12

This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

Cherry Creek
Cherry Creek Box Culvert

REBAR DETAILS

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-023(050)019	170	11

NOTES

100 SCOPE OF WORK: Work at this site consists of removing an existing structure and building a new triple barrel 14' x 12' x 151'-0" precast concrete box culvert.

105 WORK DRAWINGS: Submit work drawings for the precast concrete box culvert to the Engineer for review. Use the following minimum text sizes on all work drawing sheets.

Dimensions and Notes =	0.08”
Detail Subtitles =	0.09”
Detail Titles =	0.10”

202 REMOVAL OF STRUCTURE: The existing structure is 27’x19’ elliptical structural plate pipe, 62'-0" long with a clear roadway width of 28'-0" with cable guardrail. Include all work required to remove the bridge in the contract unit price for “Removal of Structure.”

Submit SFN 17987 “Asbestos Notification of Demolition and Renovation” to the North Dakota Department of Health 10 days before beginning removal of concrete.

210 ORDINARY BACKFILL: Compact material as specified in Section 203.04 E.2.a, “ND T 180.”

606 PRECAST SECTION: Tie the barrel sections together with prestressing strands or 1"ϕ tie bolts as shown on Standard Drawing D-714-22. Use a minimum of 6 - 0.5" diameter 270K strands for double box sections and 4 - 0.5" diameter 270K strands for single box sections, with one strand in each corner. Stress prestressing strands from opposite ends to a force of 20 kips. Use corrosion protected prestressing cables with their ends grouted. If tie bolts are used, place two ties per exterior wall at each joint located at third points of the wall clear height.

Payment for “Dbl 14Ft X 12Ft Precast RCB End Section” or “14Ft X 12Ft Precast RCB End Section” includes the apron, cutoff wall, parapet and wingwalls. Attach the apron to the last barrel section, the wingwalls and the cutoff wall. Attach the wingwalls to the last barrel section. Provide a welded tie type system for the connections of the apron to the box and wingwalls. Connect the wingwalls to the last barrel section by the use of tie bolts, steel-bolted plates or other approved method so the inside corner surface is smooth.

Use ASTM A36 steel for bolts, plates, angles, and studs. Use heavy hex nuts meeting the requirements of ASTM A563 and washers meeting ASTM F436, Type 1. Provide welded pipe sleeves meeting the requirements of ASTM A53, Grade B. Galvanize hardware and structural steel according to Section 854.

Welders are to meet the requirements of Section 105.06 D. Galvanize field welds according to Section 854.02.

Cast holes at 3'-0" centers through the apron and into the cutoff wall to receive ¾" diameter reinforcing bars. Cast holes in the last barrel section at 1'-0" centers for ½" diameter reinforcing bars to attach the parapet. Cast parapet against the section. Install the bars according to the manufacturer’s recommendations, with a high strength adhesive specifically intended for concrete anchorage, in accordance with Section 806.02.

Separate single or double cell precast units may be used as alternates to a multi cell culvert. Provide a minimum distance of 3" between separate precast units and a maximum distance of 1'-0". Fill this gap with a controlled density backfill. Use a controlled density backfill consisting of cement, water, pozzolanic materials, and fillers. Use a material that is fluid on placement to flow around and fill voids in the backfill area. Use a material that is able to support normal loads after 6 hours and have a compressive strength in the range of 75 psi to 125 psi at 28 days. If the mix design shown is used, no further testing will be required. The mix design yields approximately one cubic yard of flowable mortar.

MIX DESIGN

Cement	100 lbs
Fly Ash	300 lbs
Fine Aggregate	2600 lbs
Water	70 gals

For the 12" cap, use a weatherproof and freeze/thaw resistant, non-shrink cement grout material such as SikaGrout® 212, BASF Masterflow® 928, Euclid NS Grout, or an approved equal which complies with ASTM C1107.

Include the controlled density backfill and materials used for the 12” cap in the price bid for “Dbl 14Ft X 12Ft Precast RCB Culvert.”

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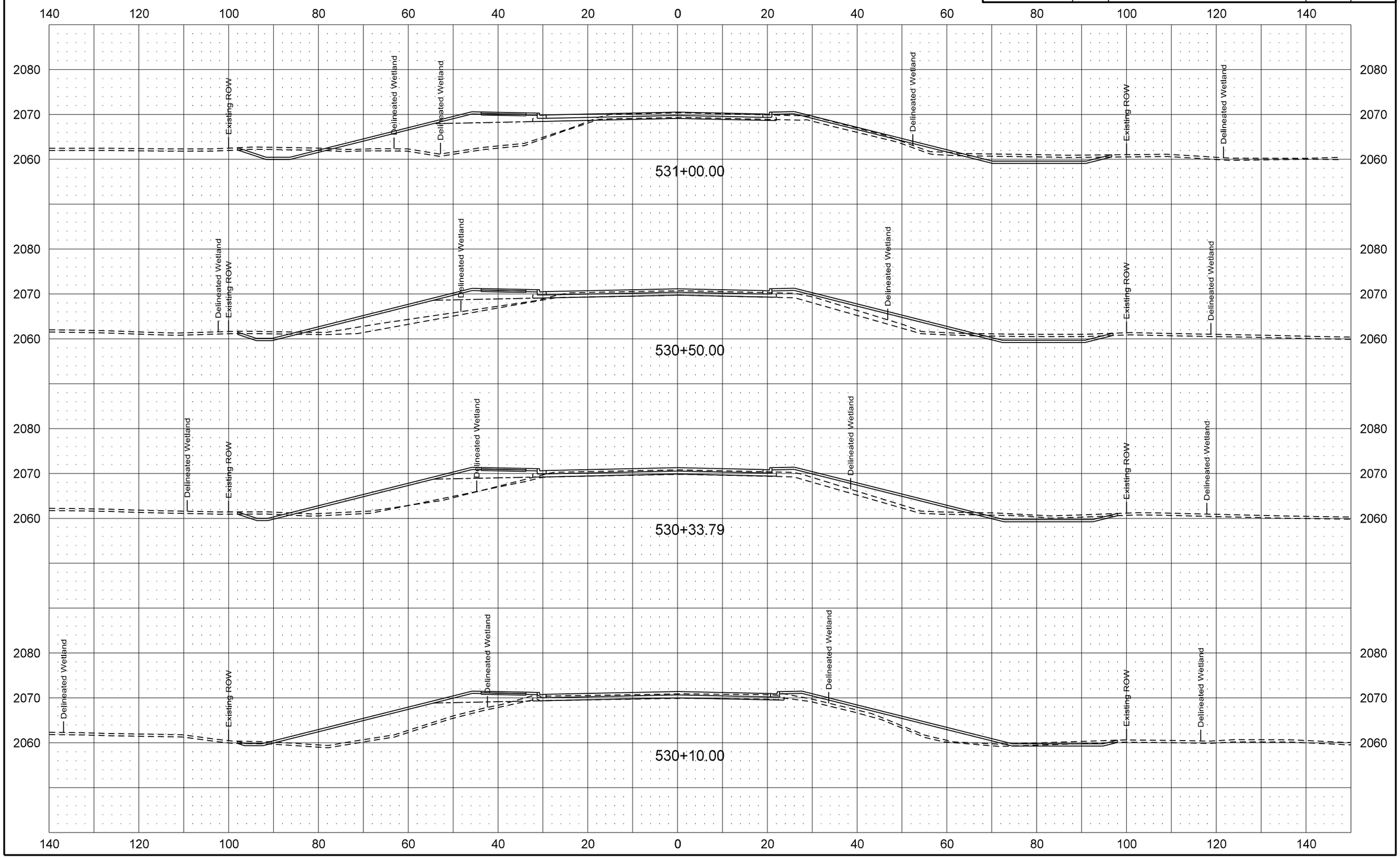

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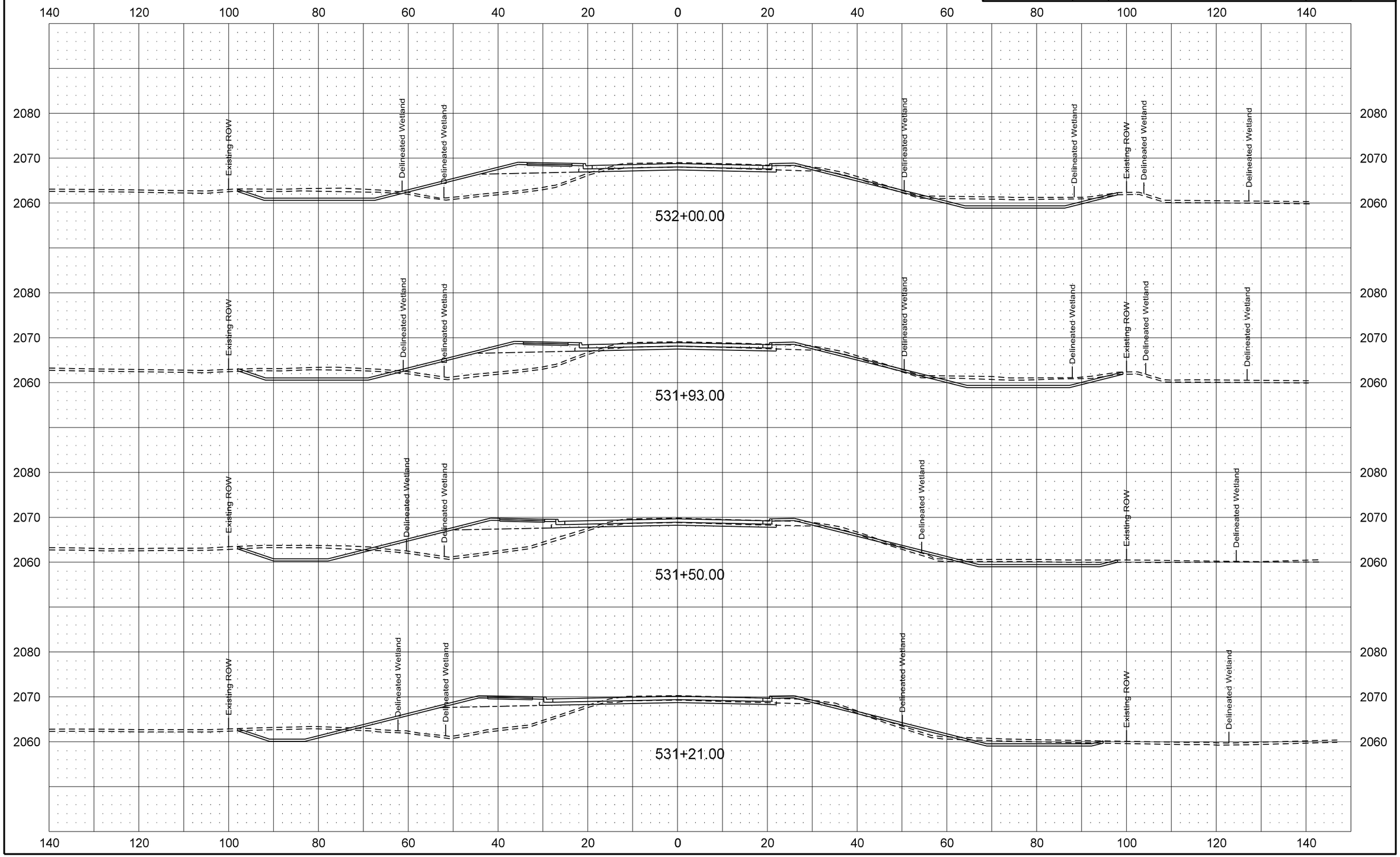

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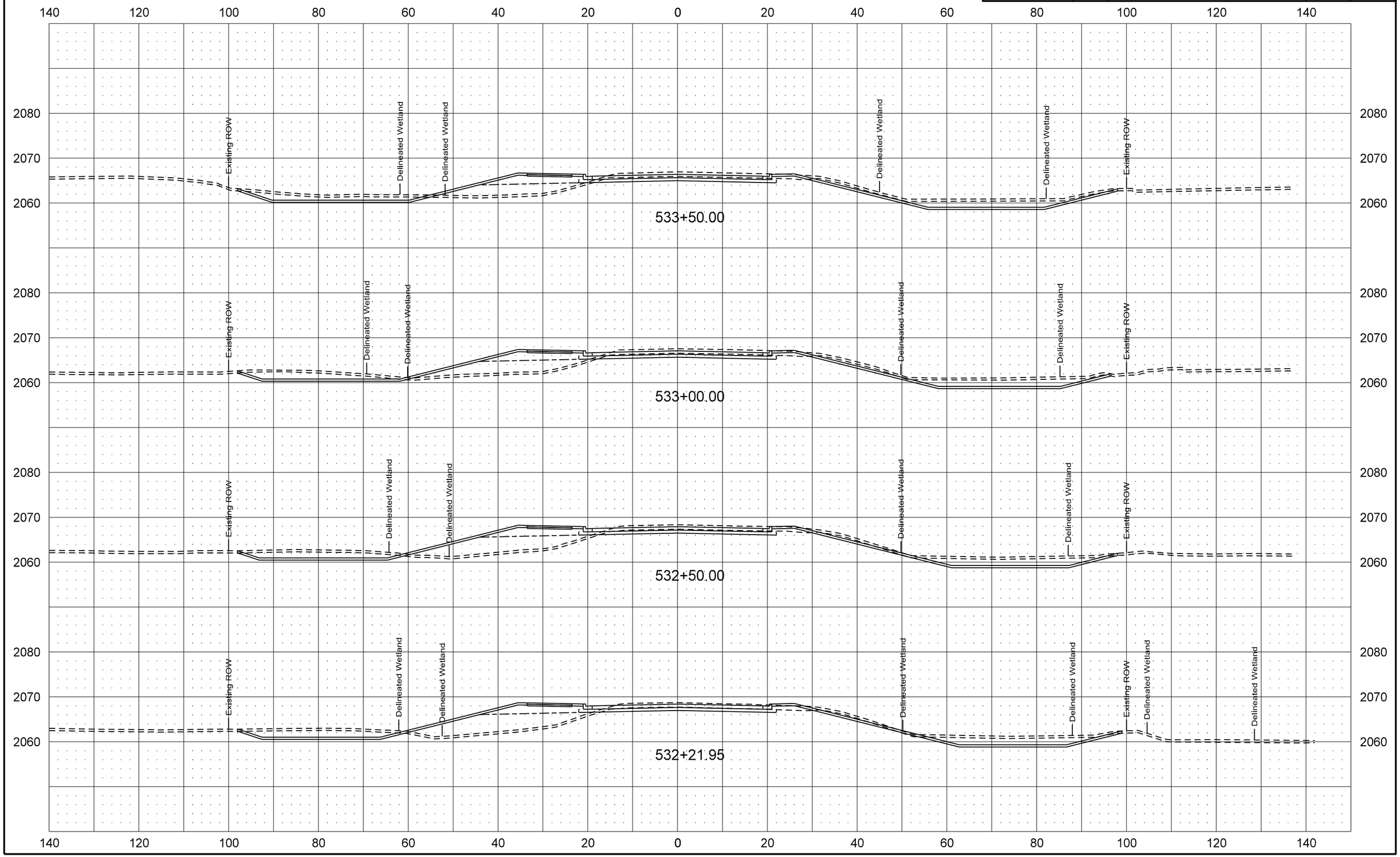

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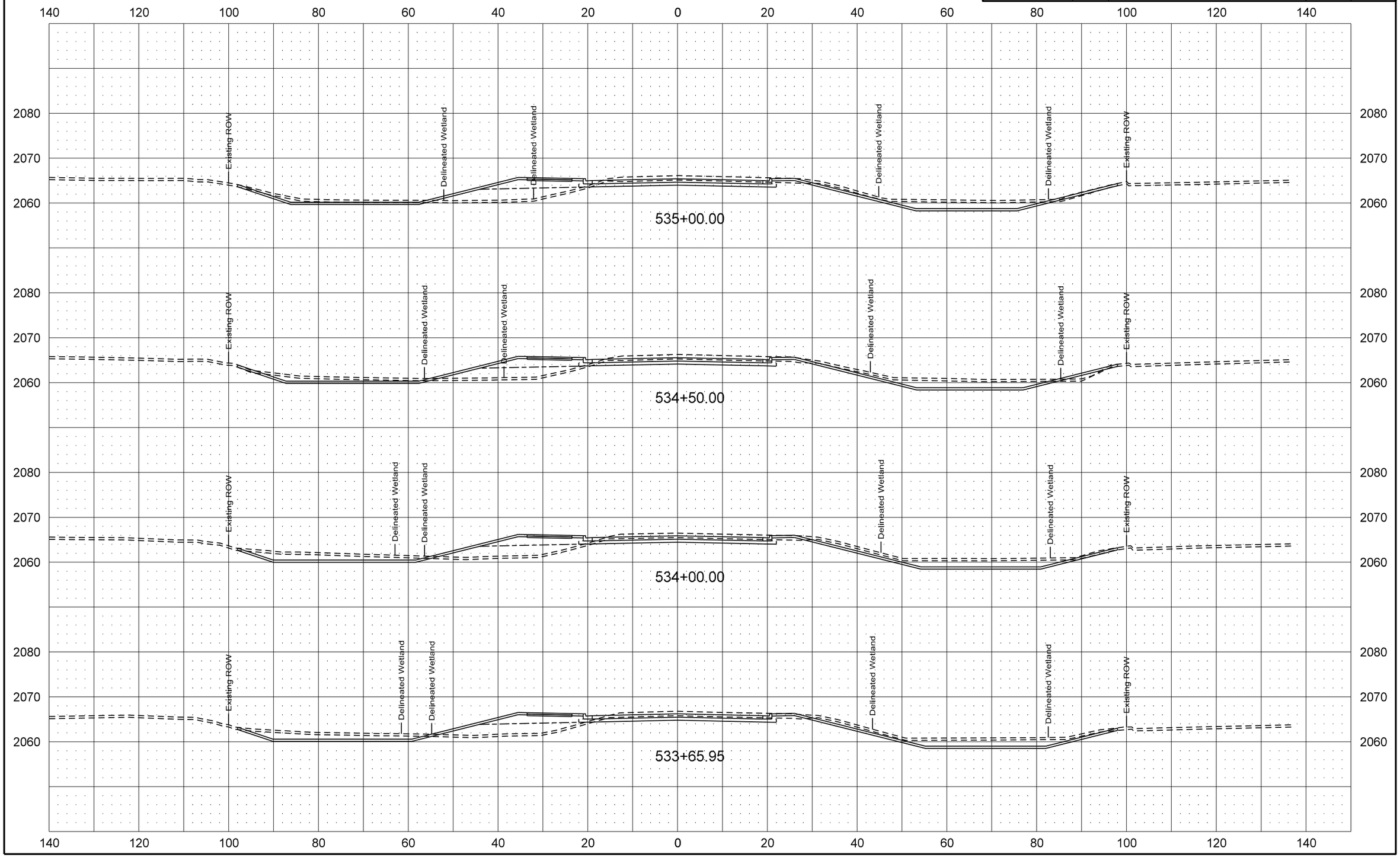

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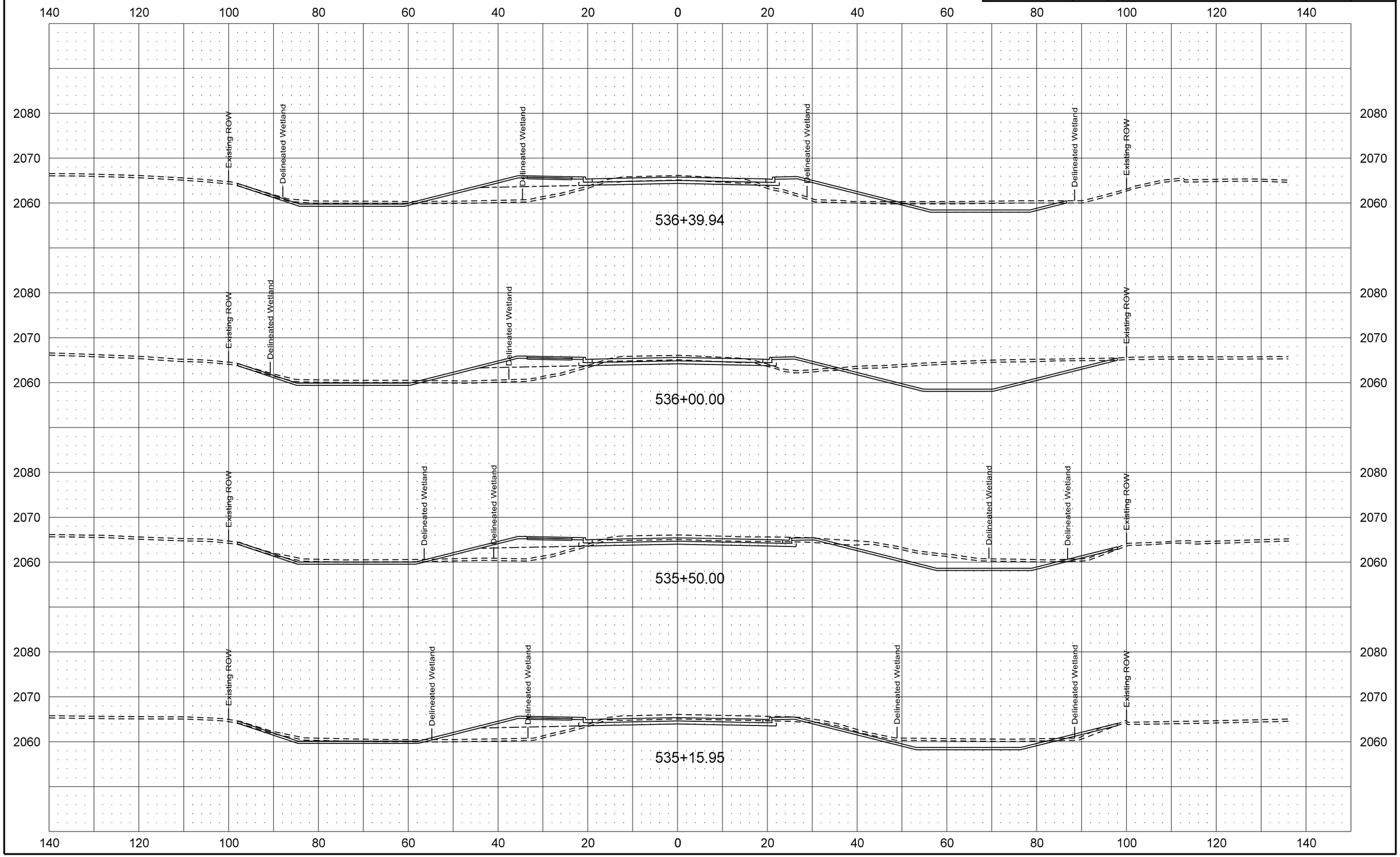

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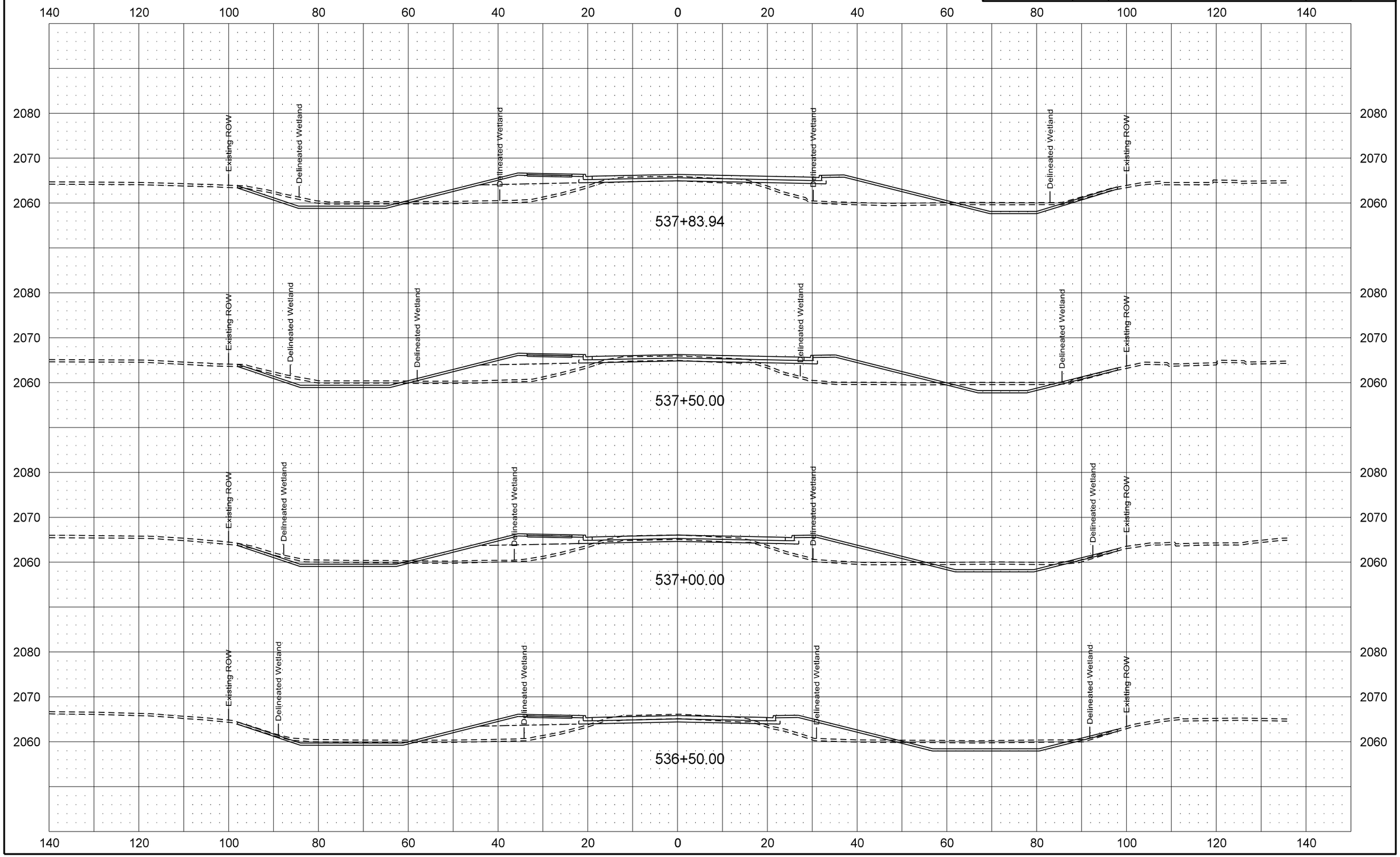

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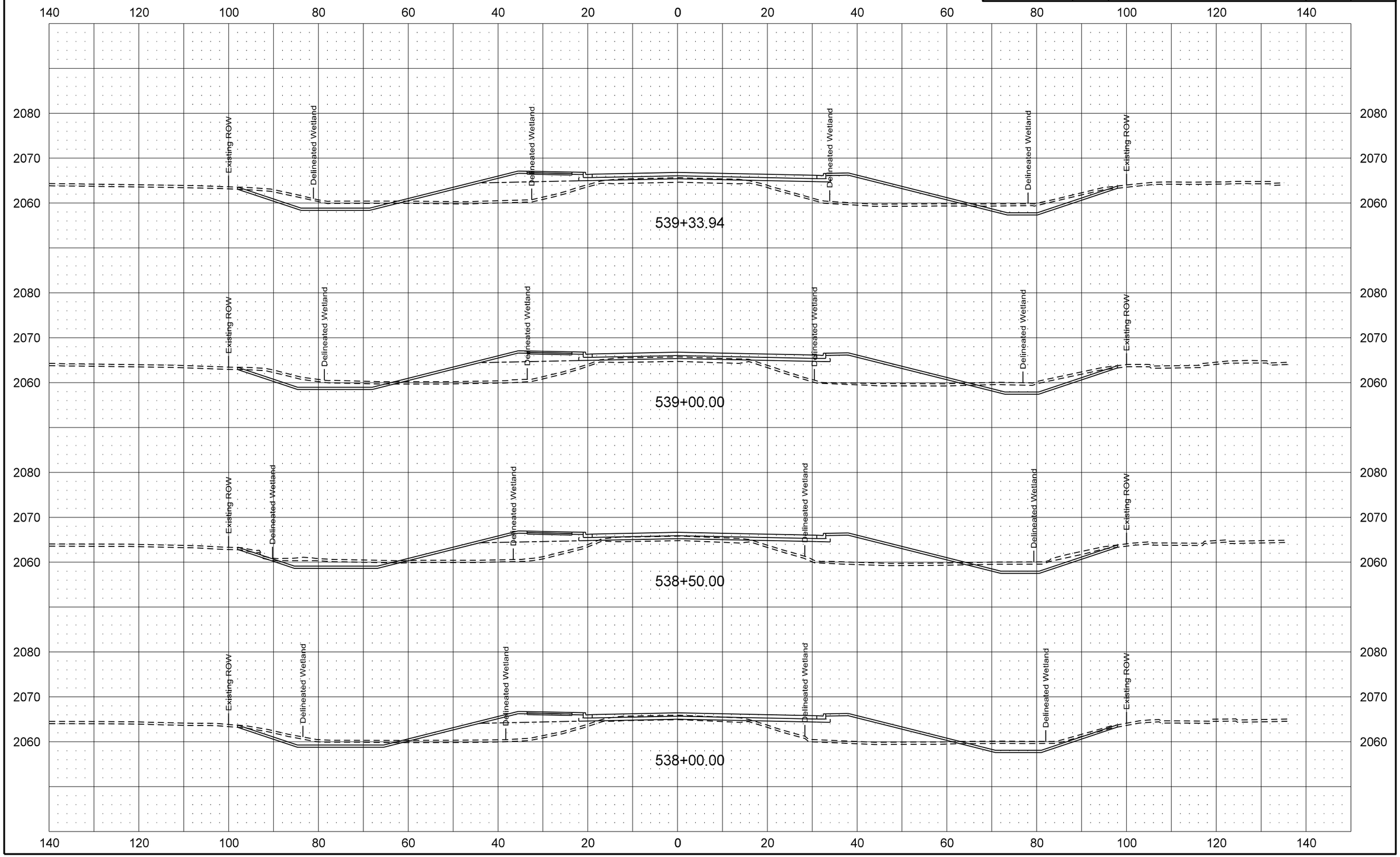

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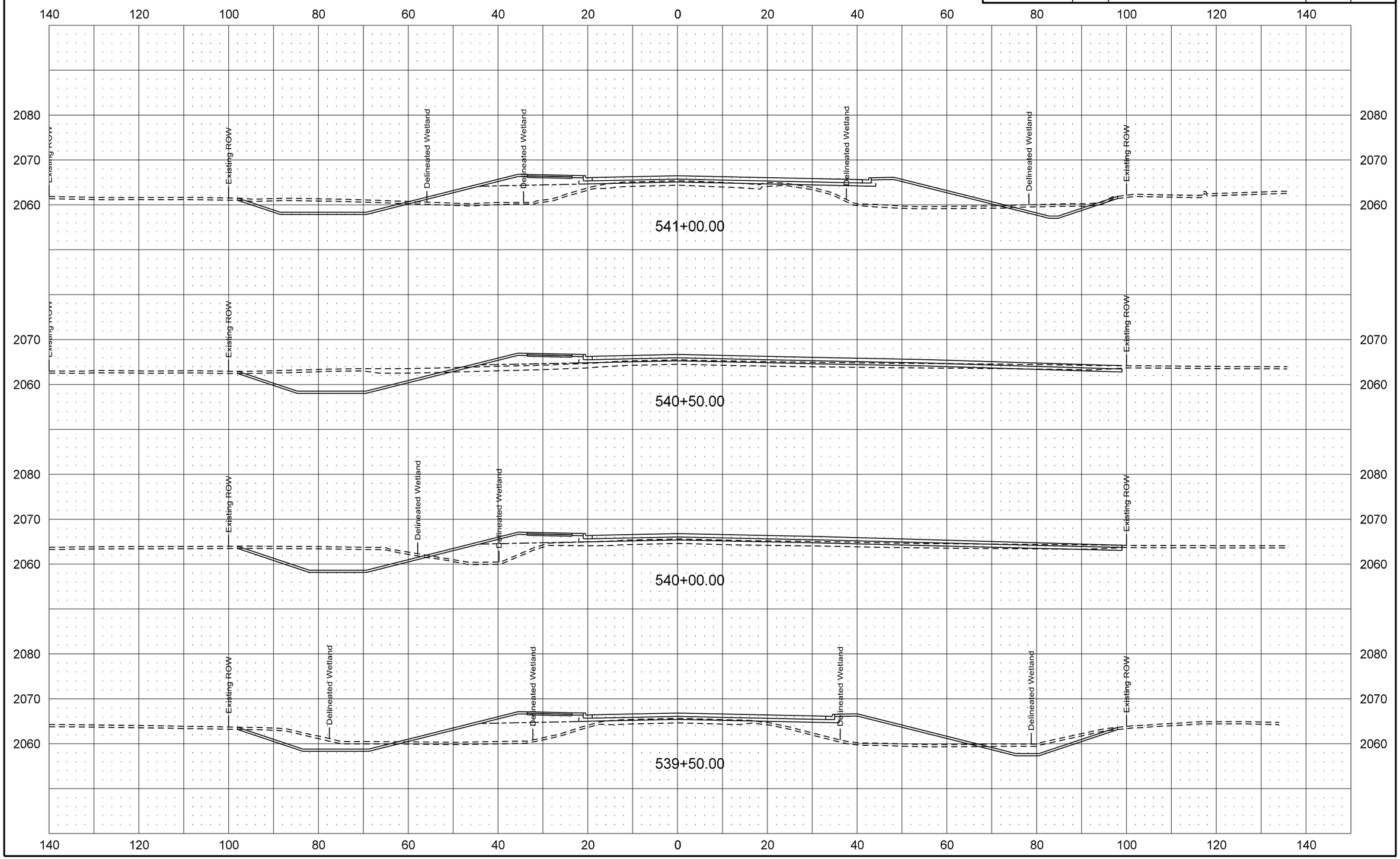

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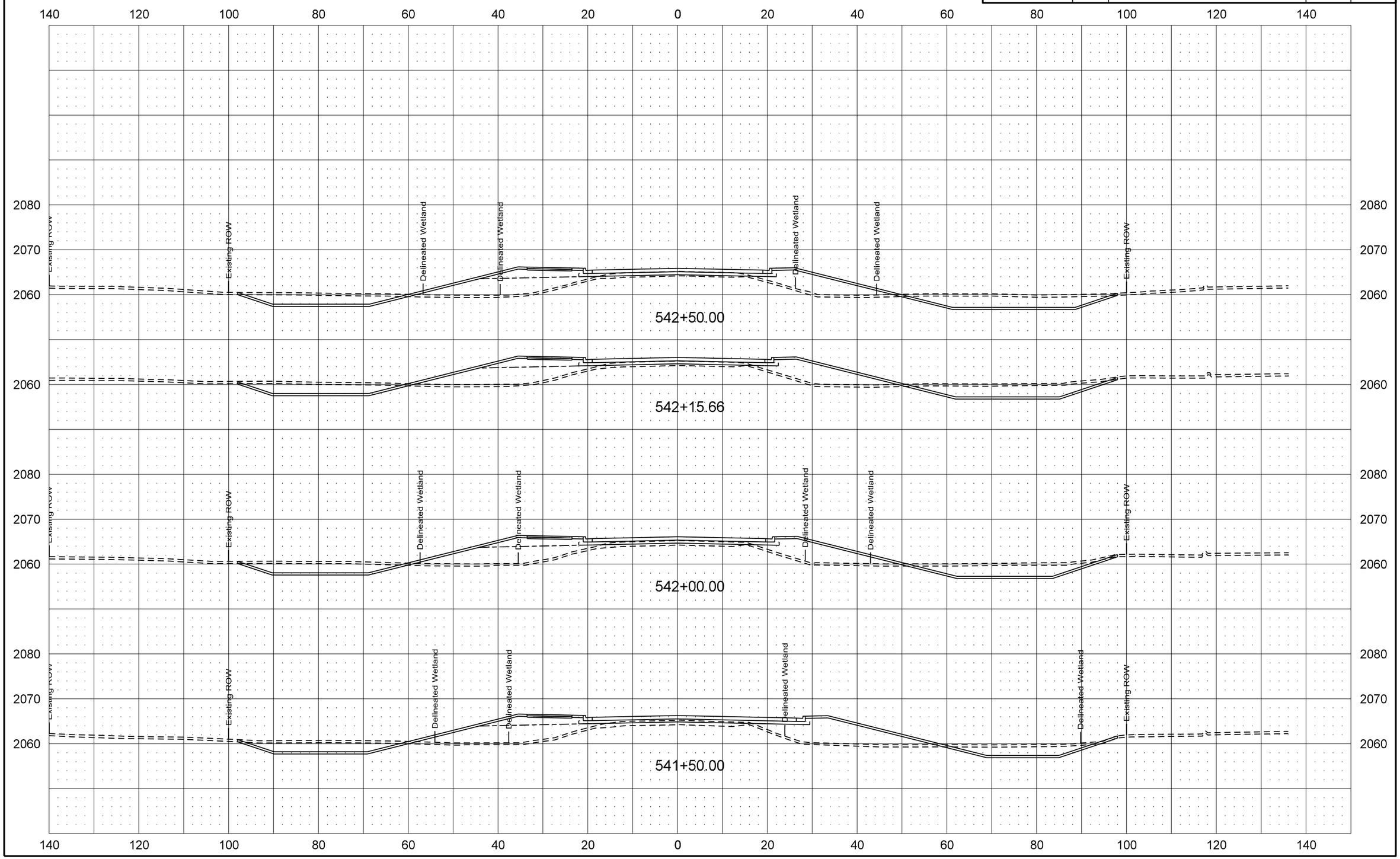

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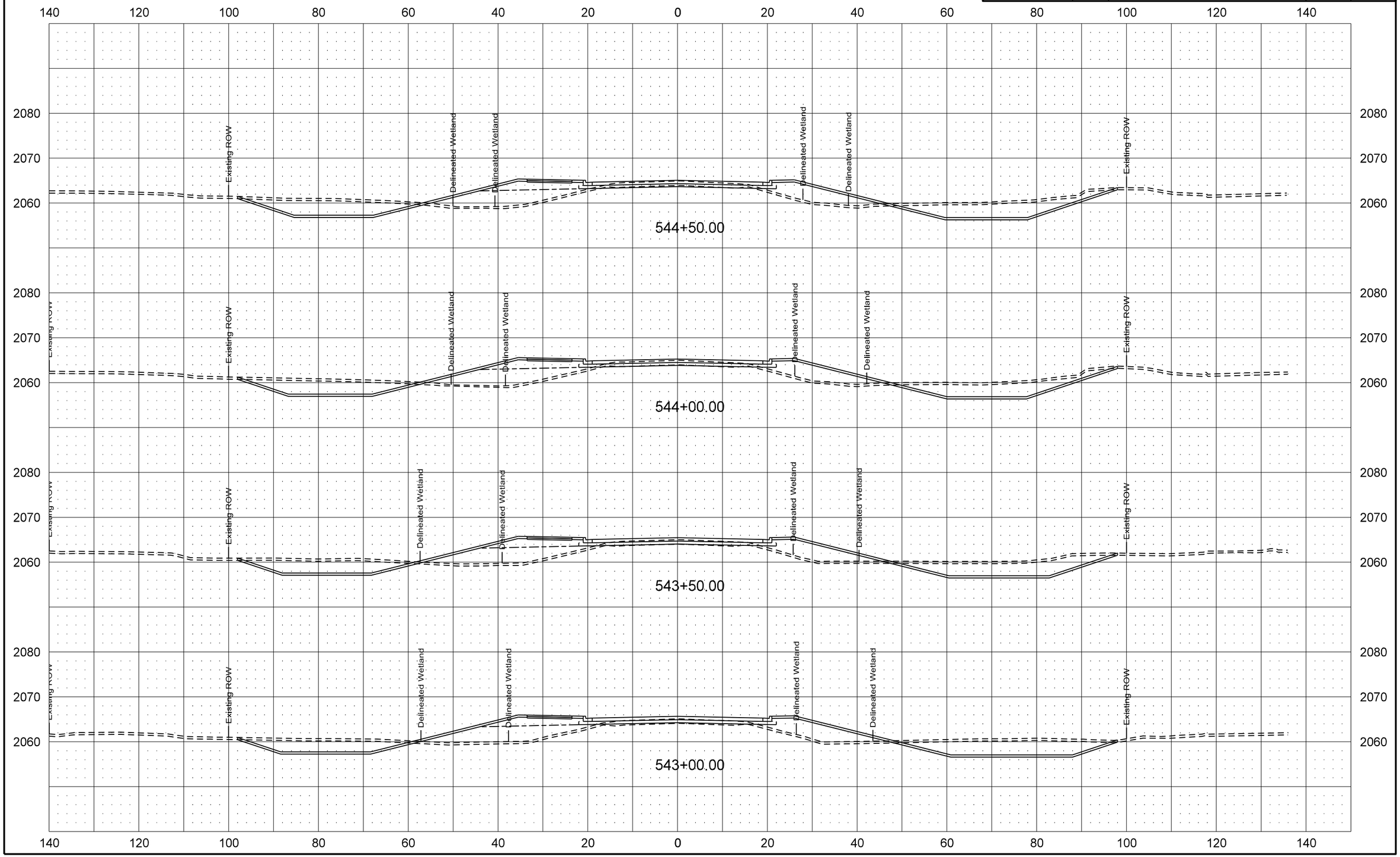

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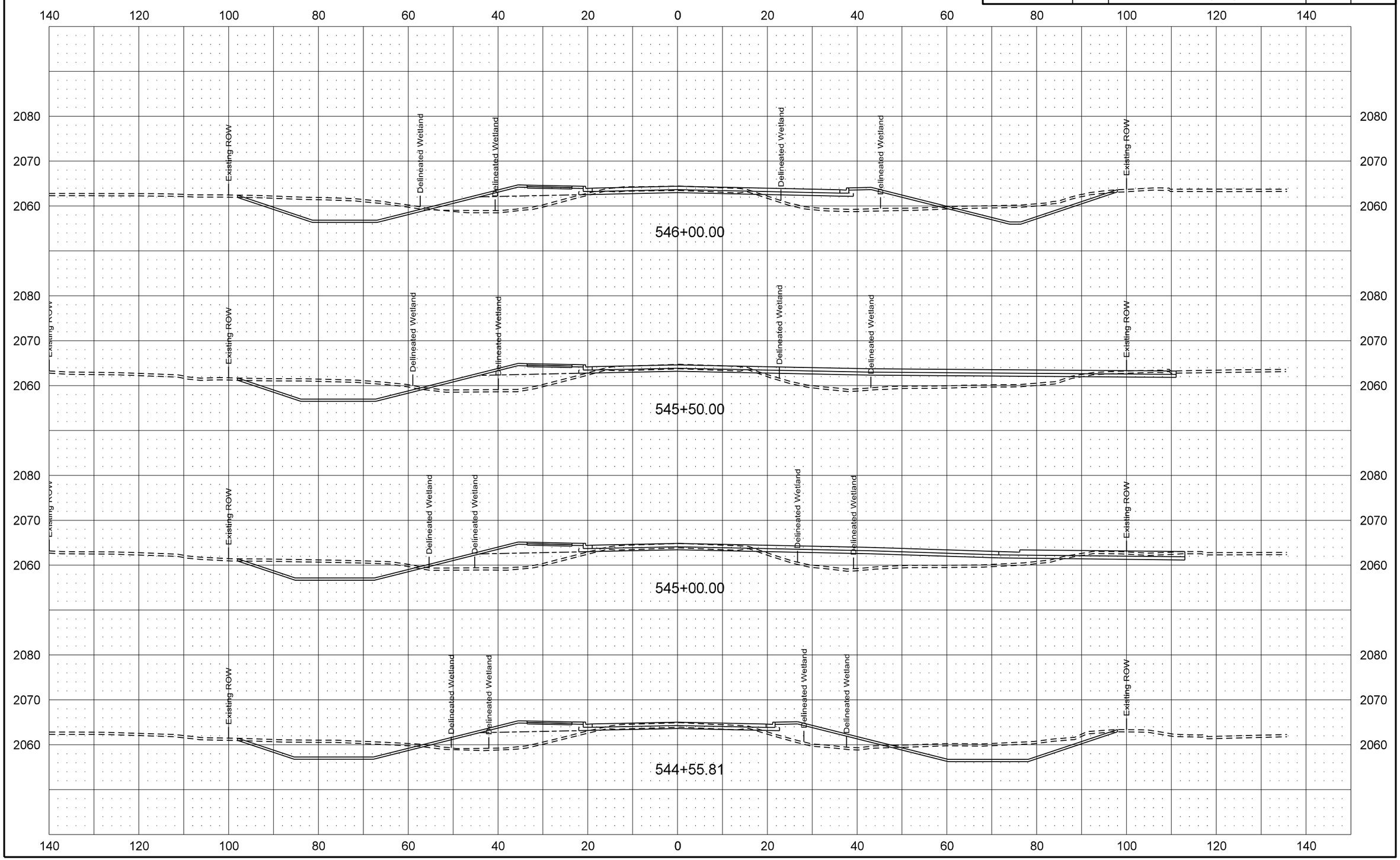

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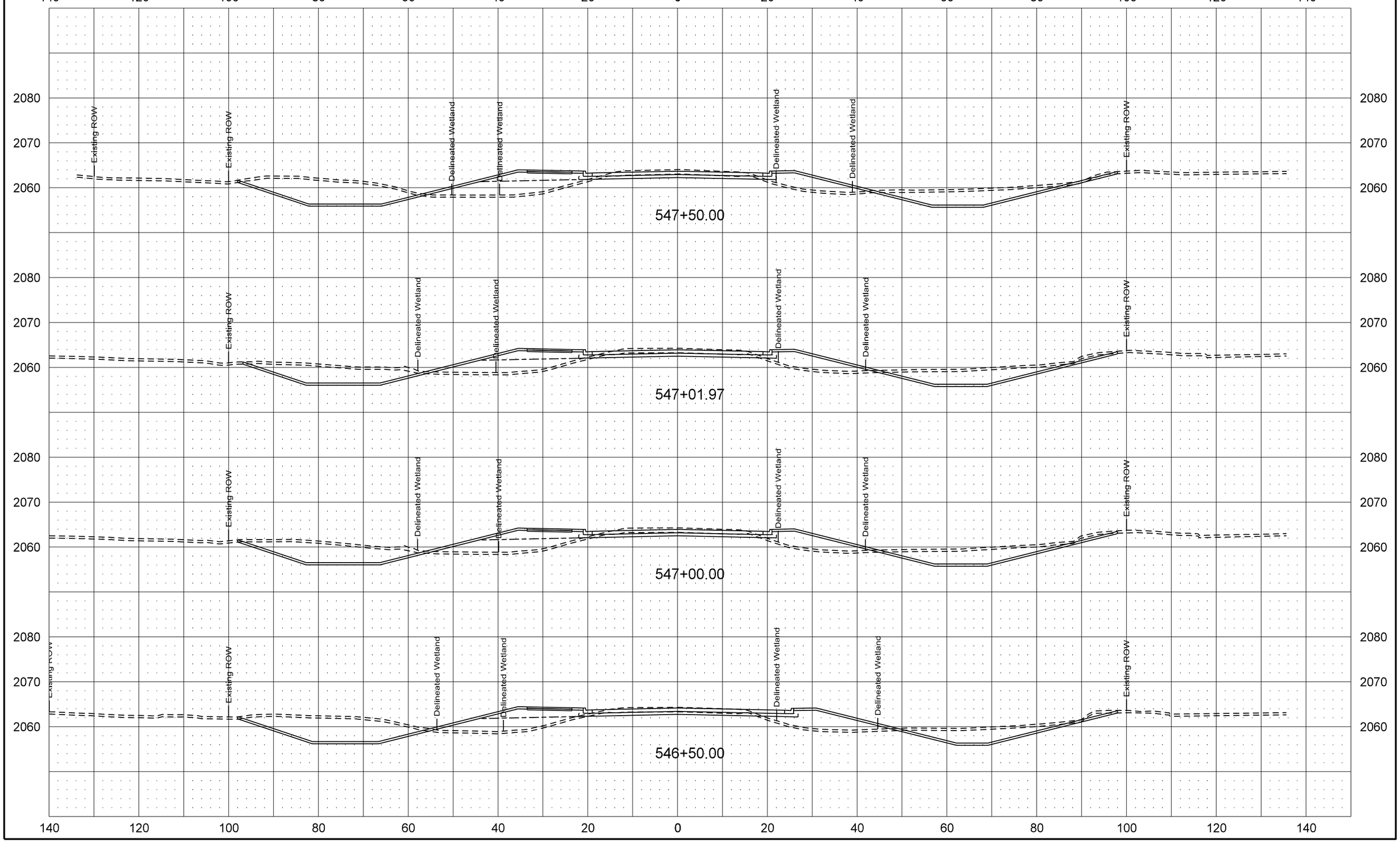

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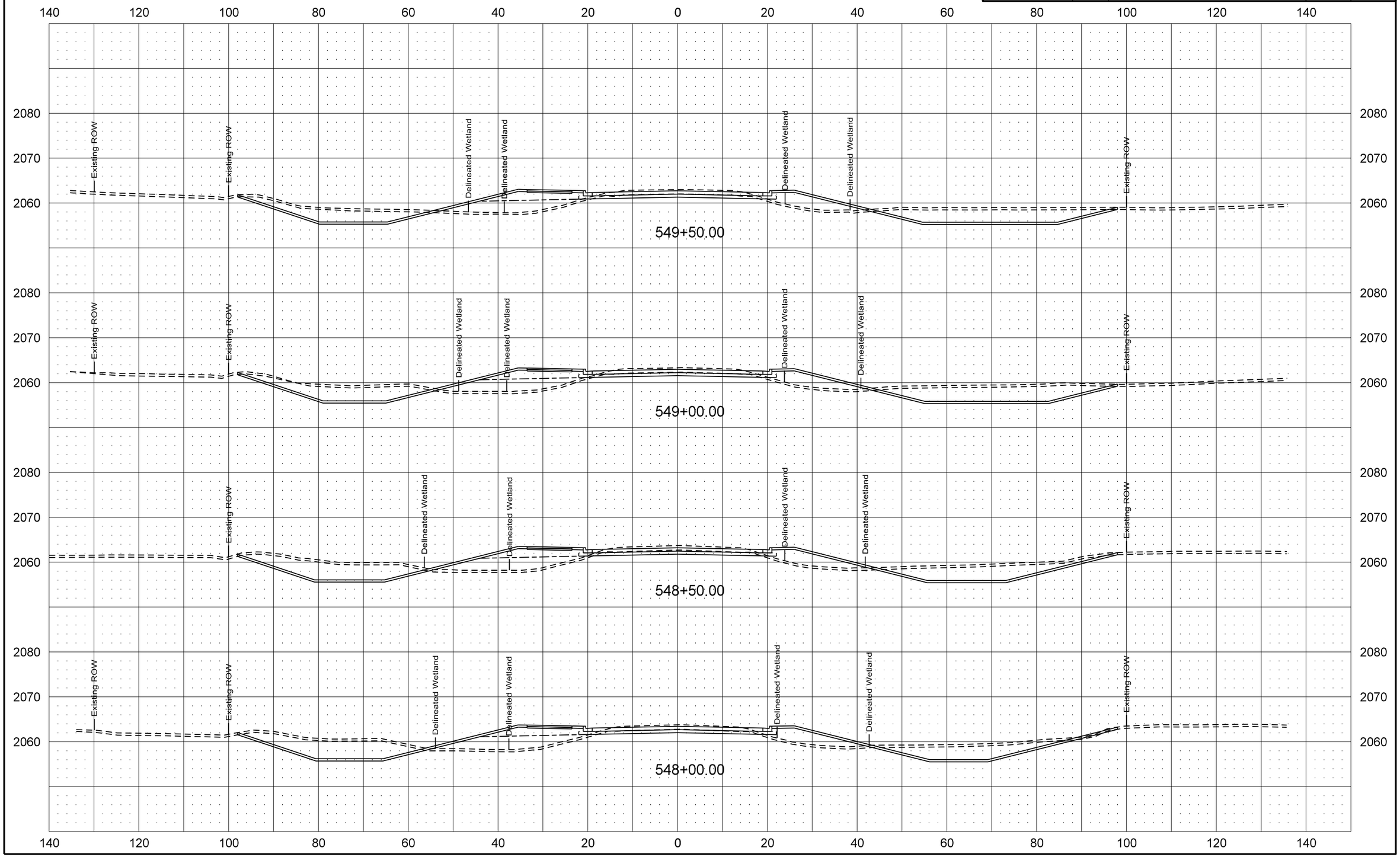

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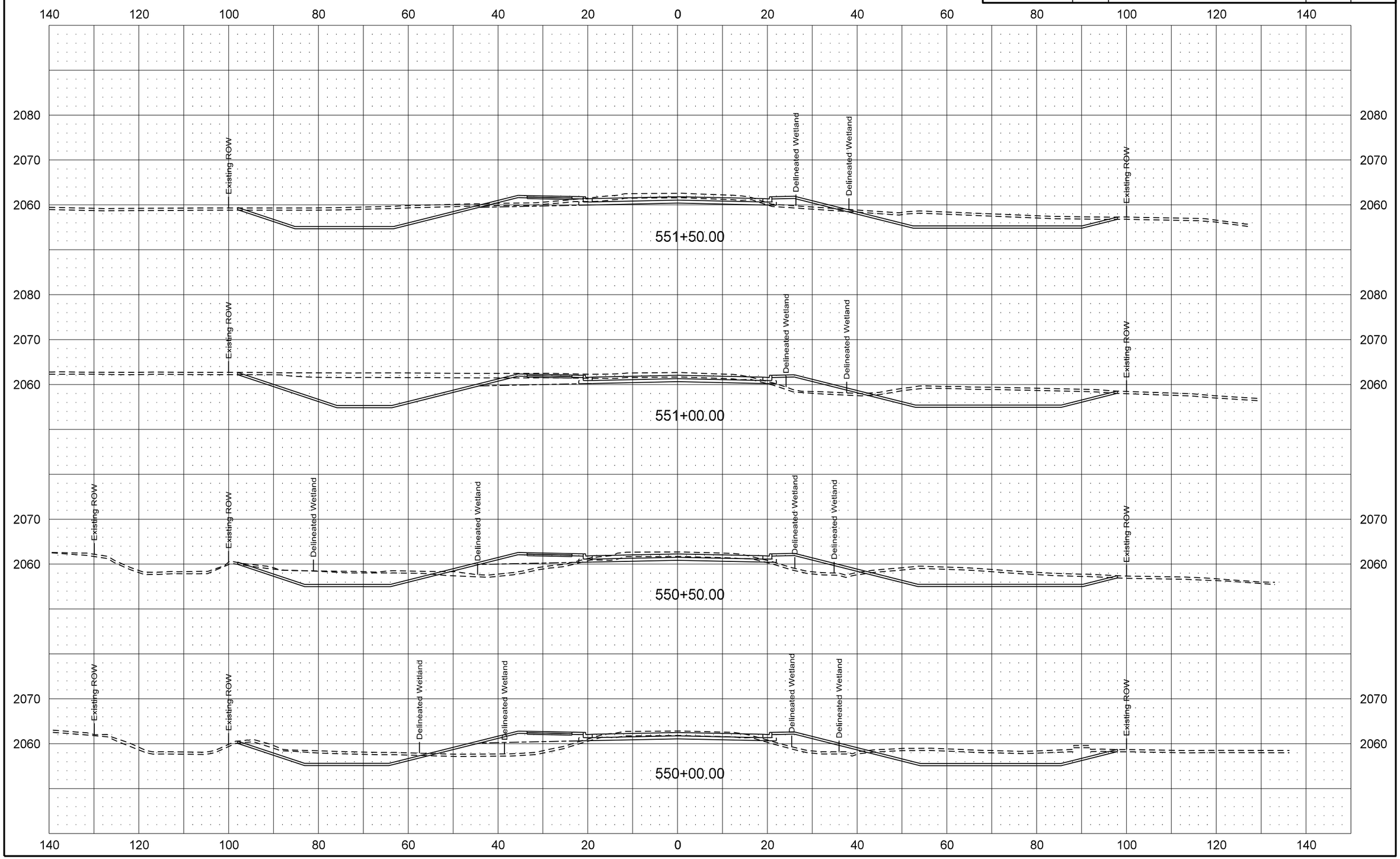

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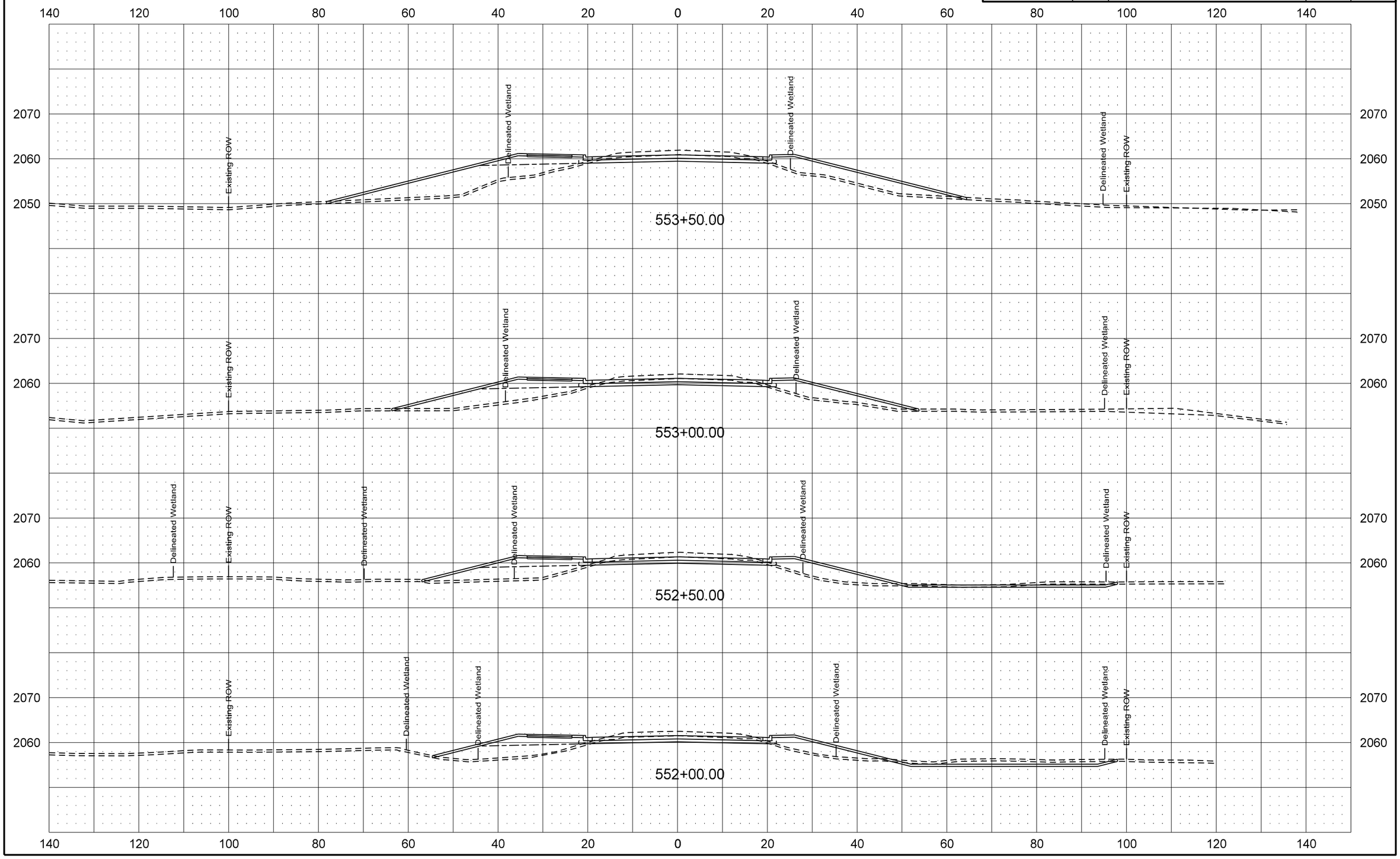

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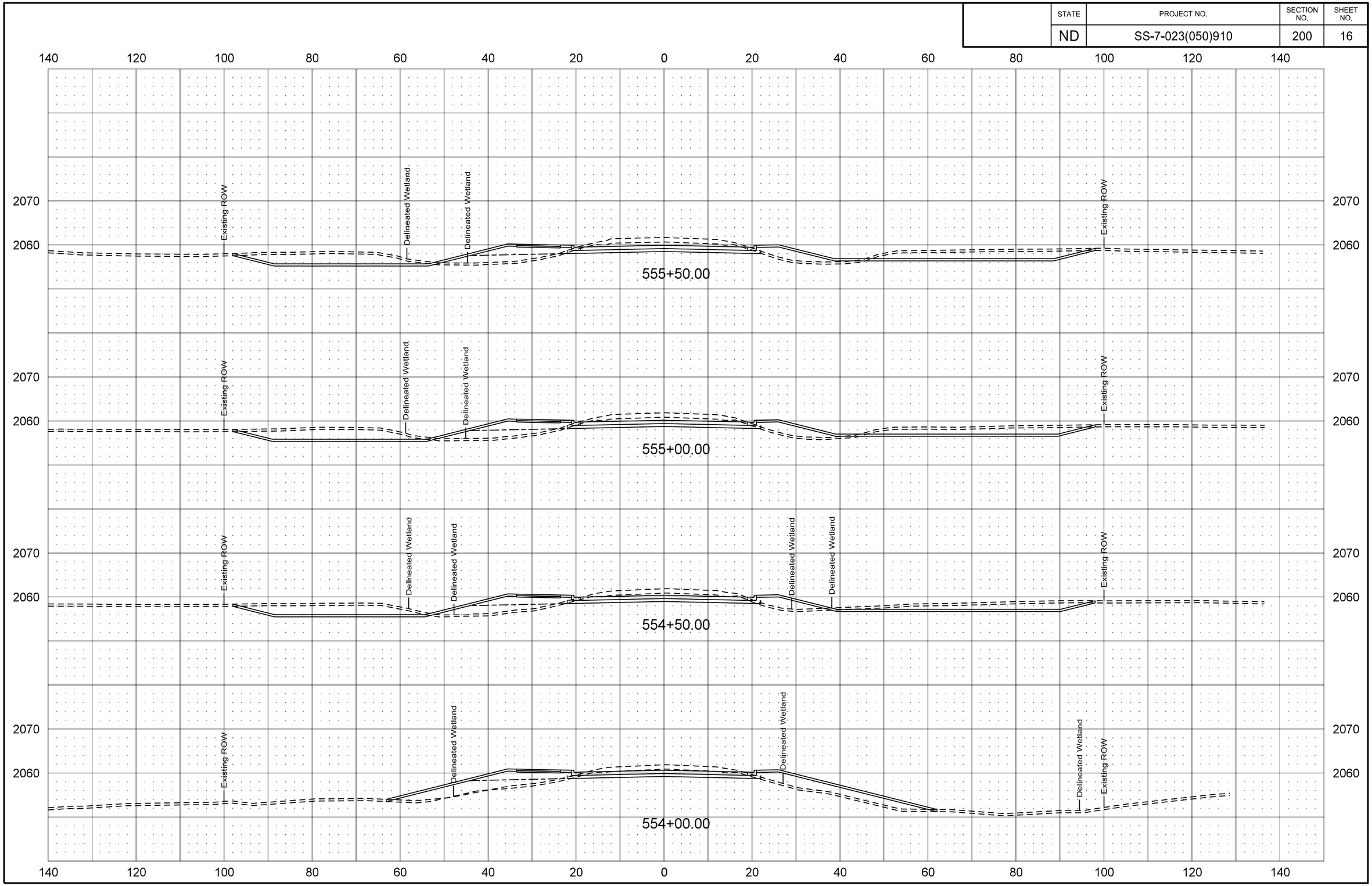

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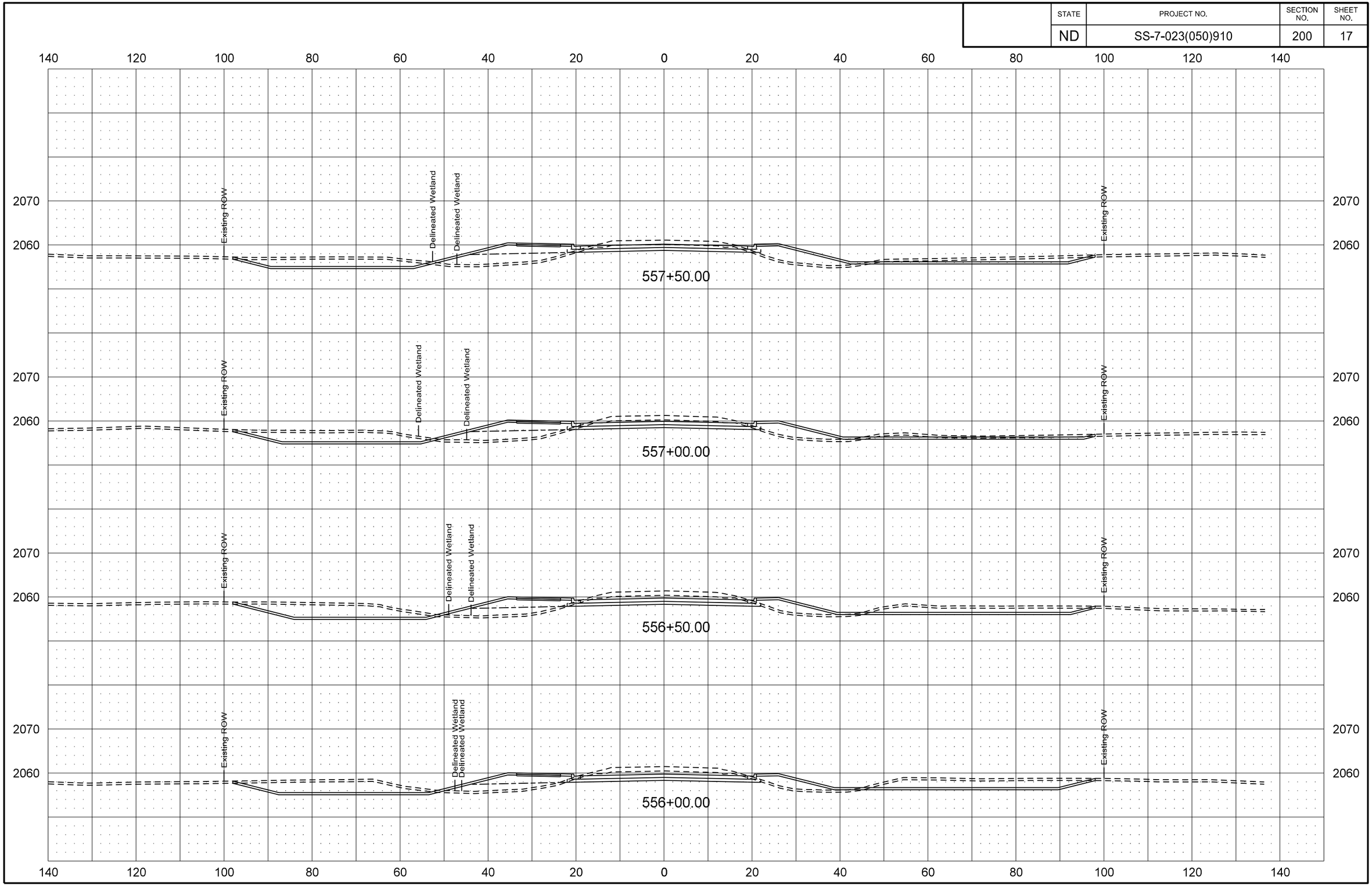

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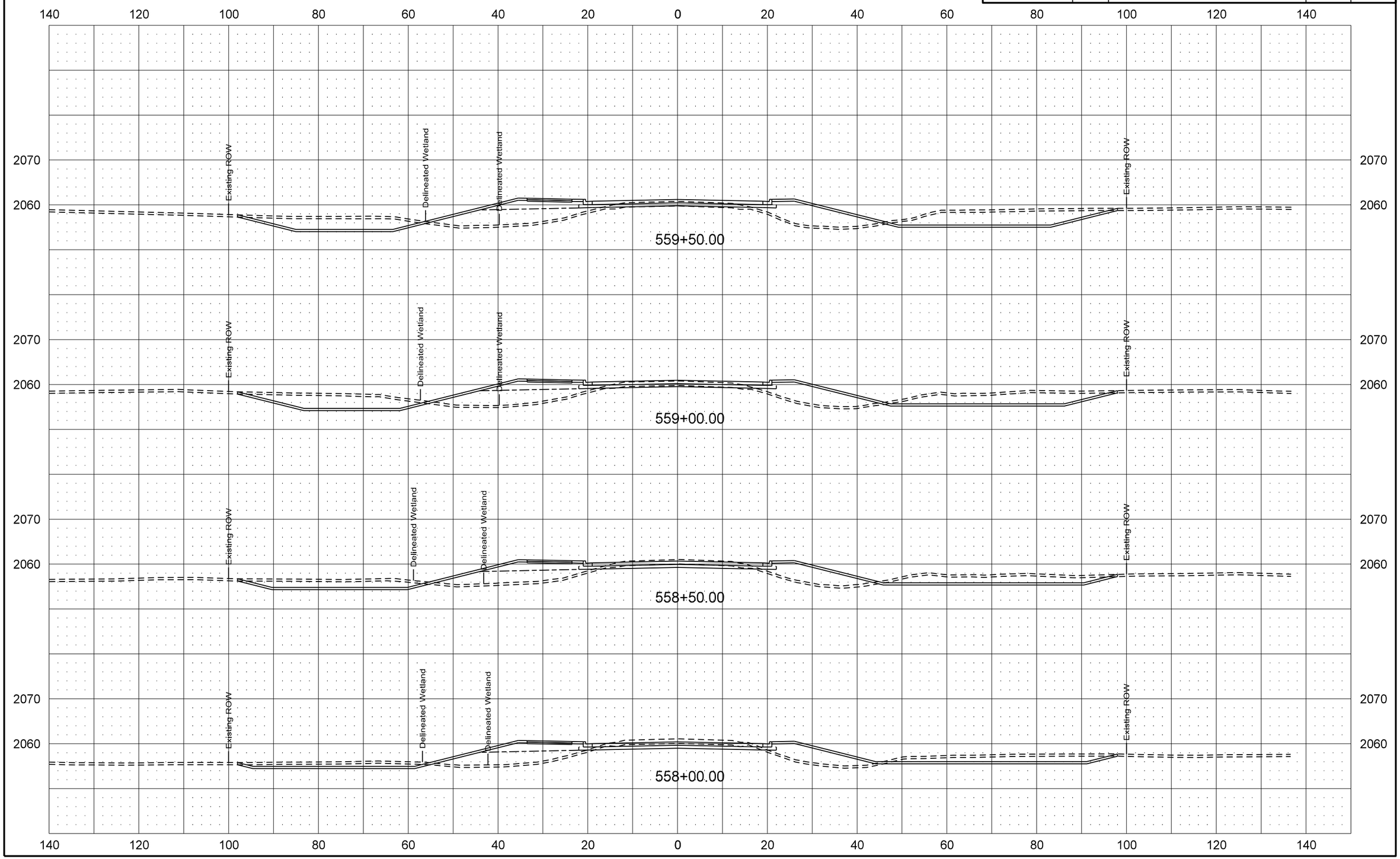

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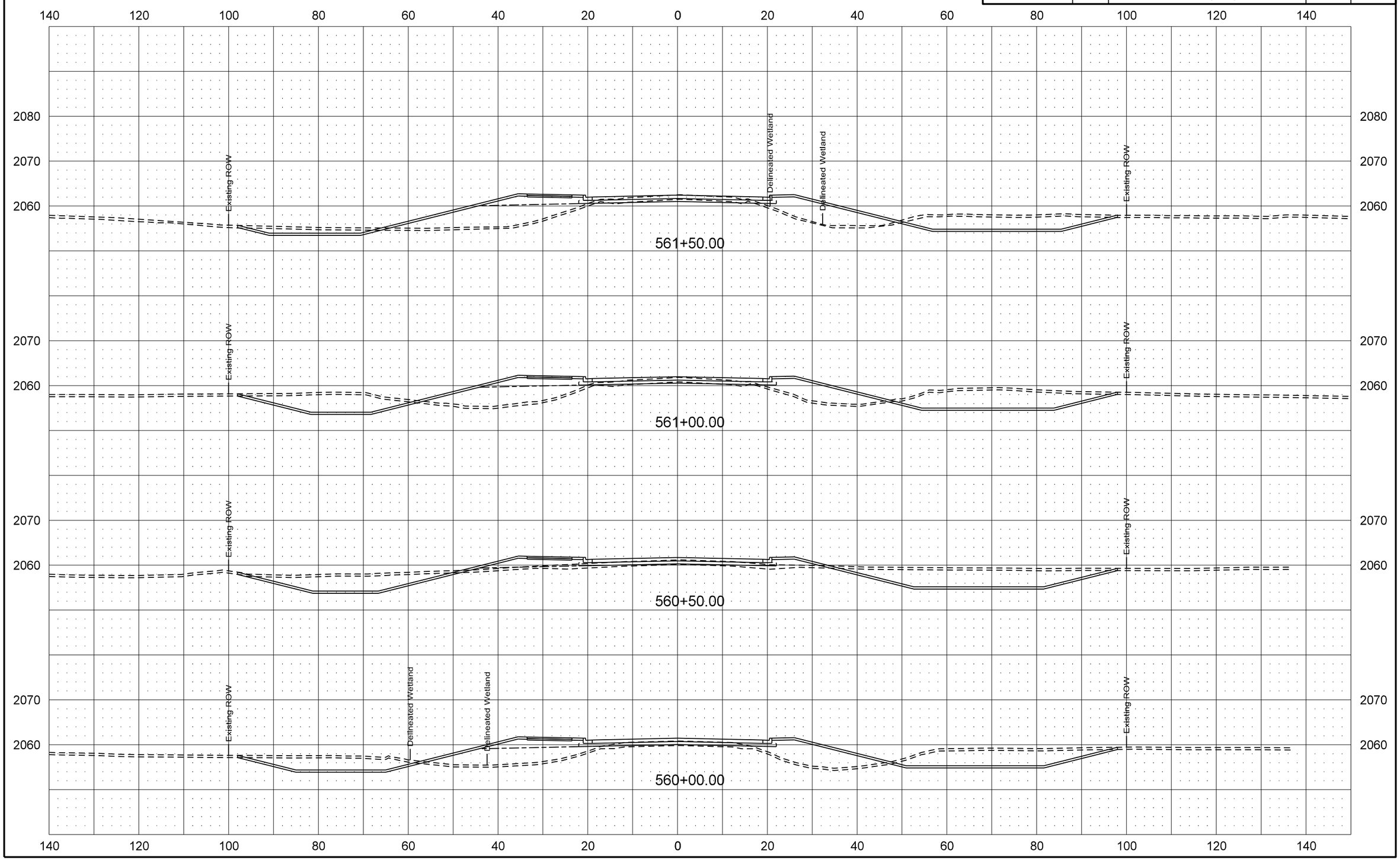

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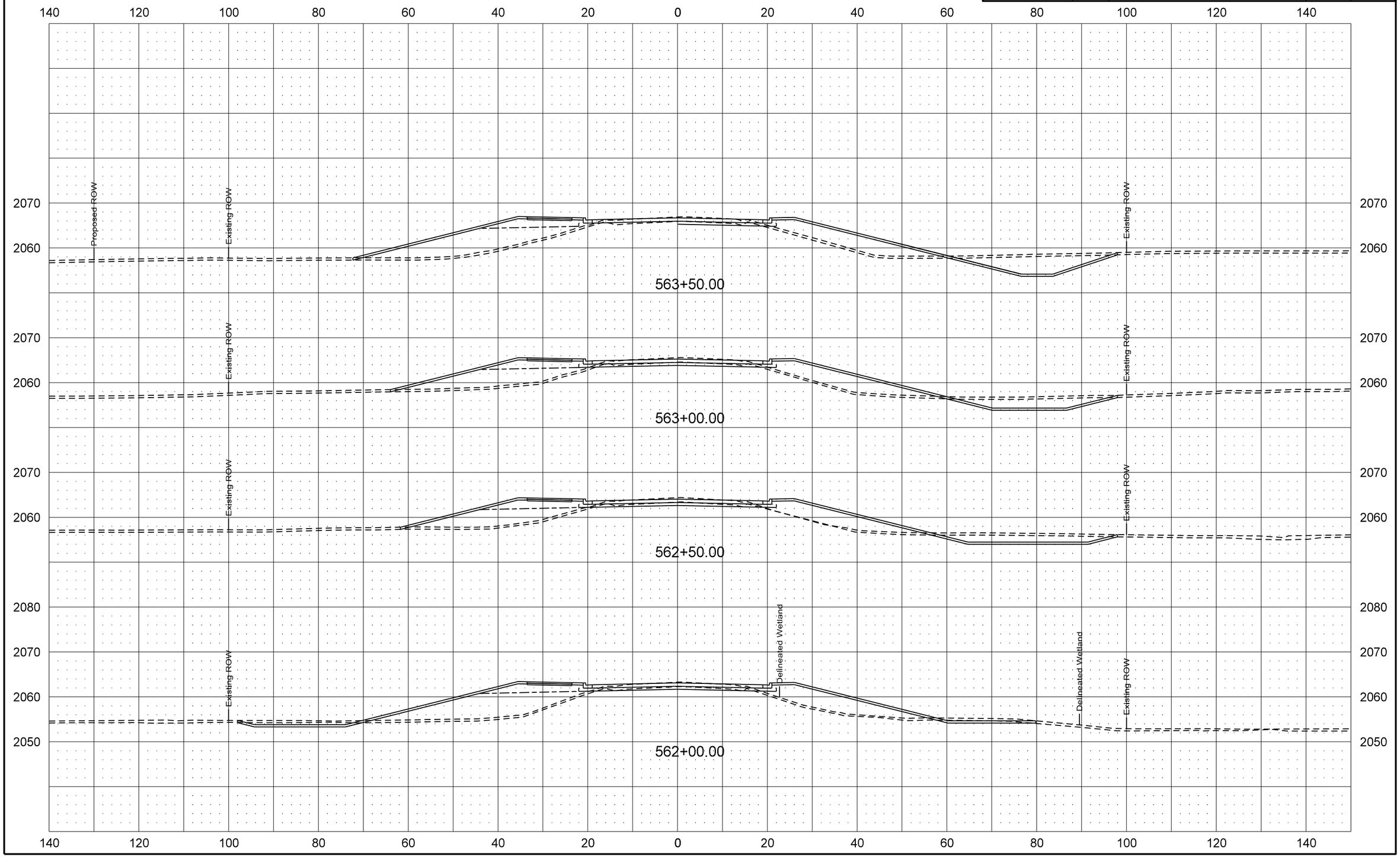

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2070
2060
2090
2080
2070
2060
2050

Proposed ROW
Existing ROW
Existing ROW

565+00.00

Delineated Wetland
Proposed ROW
Existing ROW
Delineated Wetland
Delineated Wetland

564+50.00

2070
2060
2050

Proposed ROW
Existing ROW
Existing ROW

564+00.00

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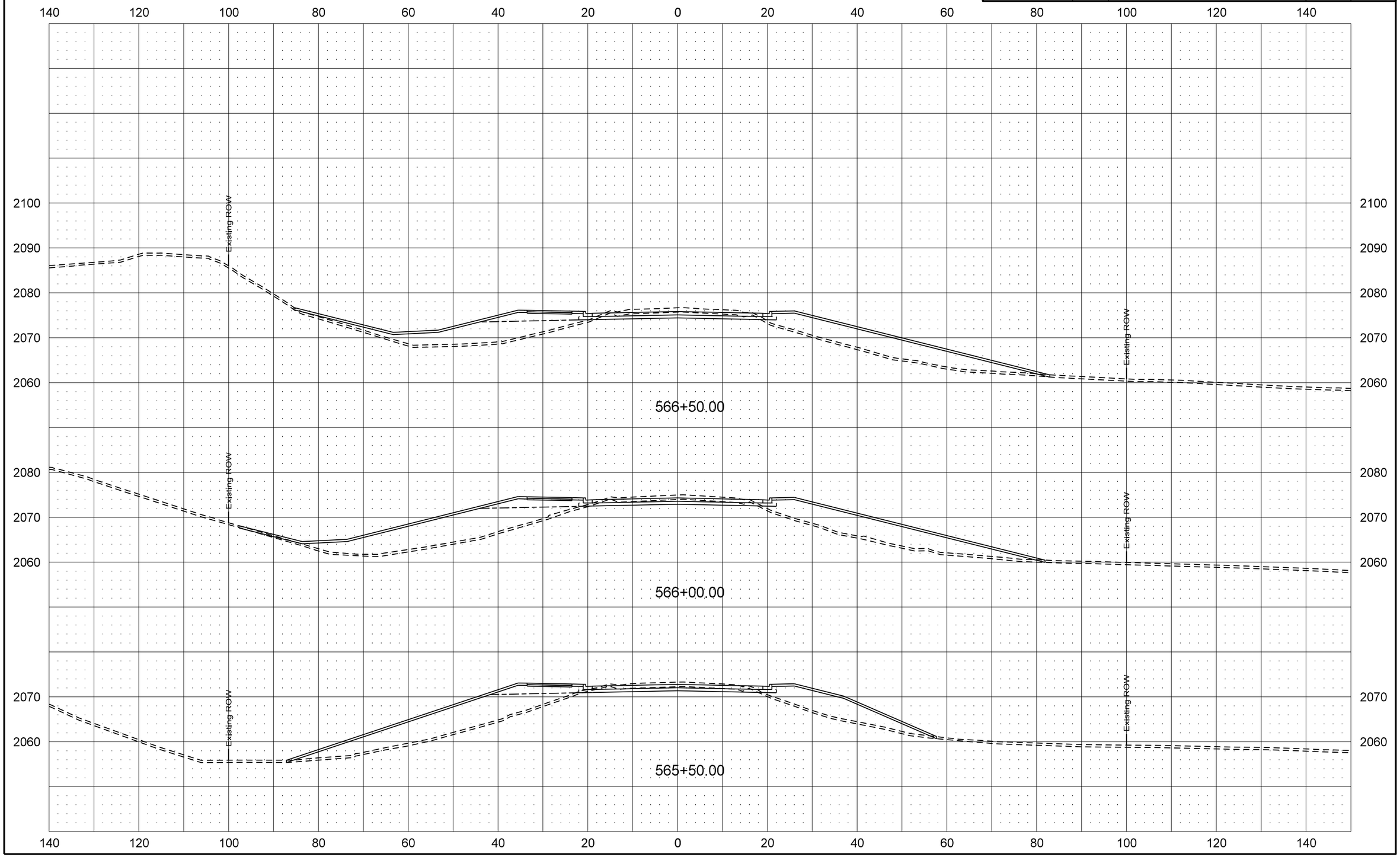

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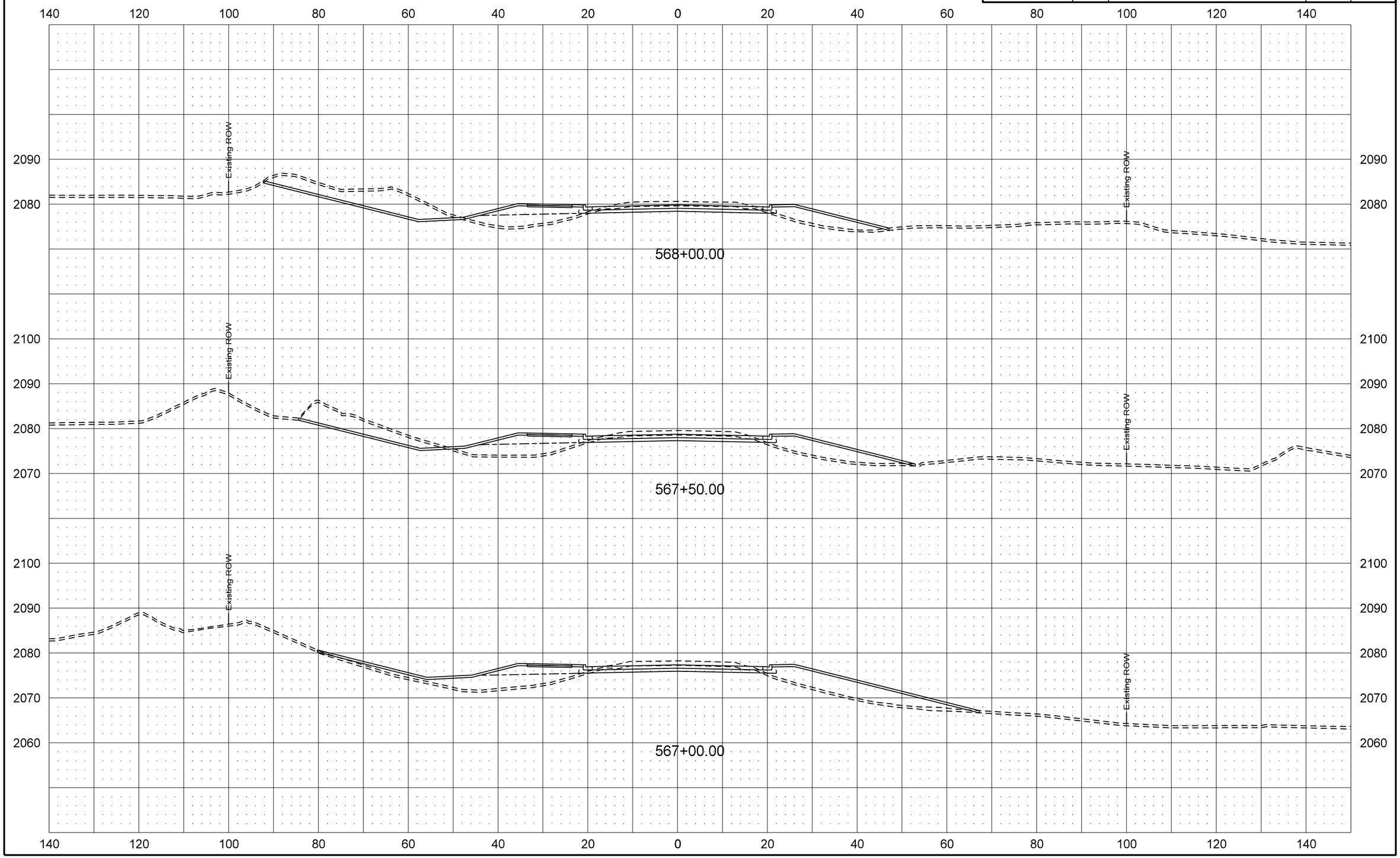

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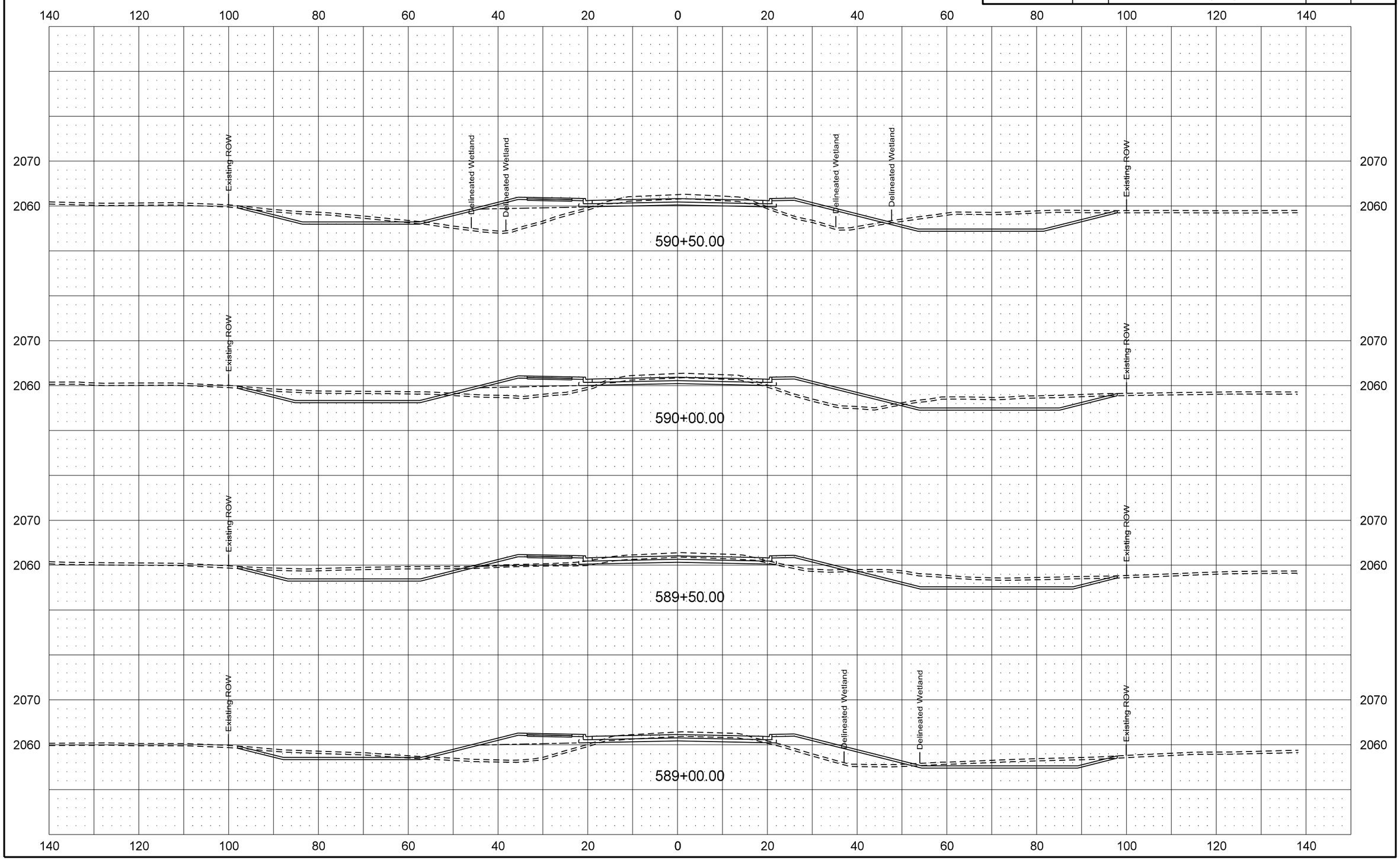

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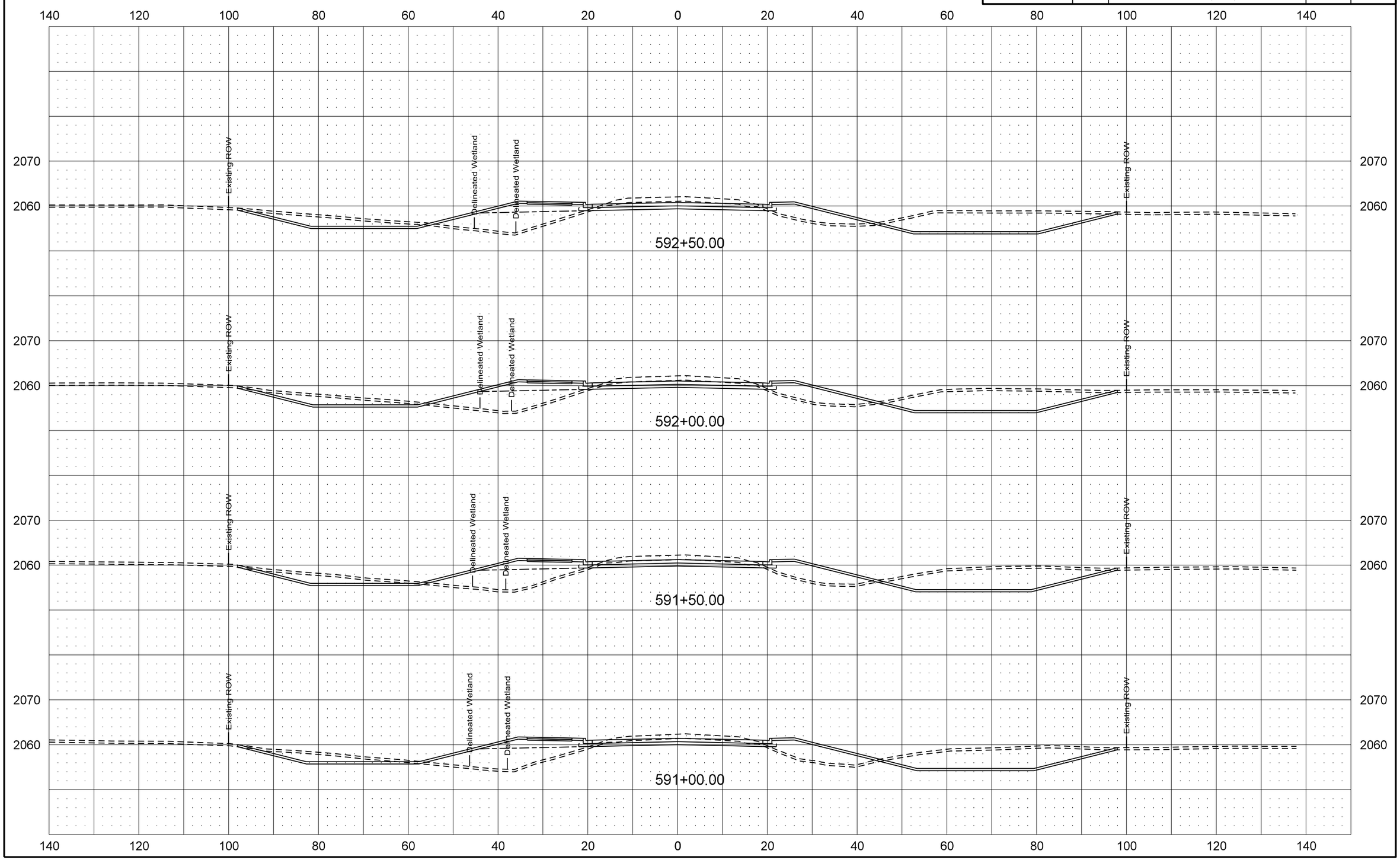

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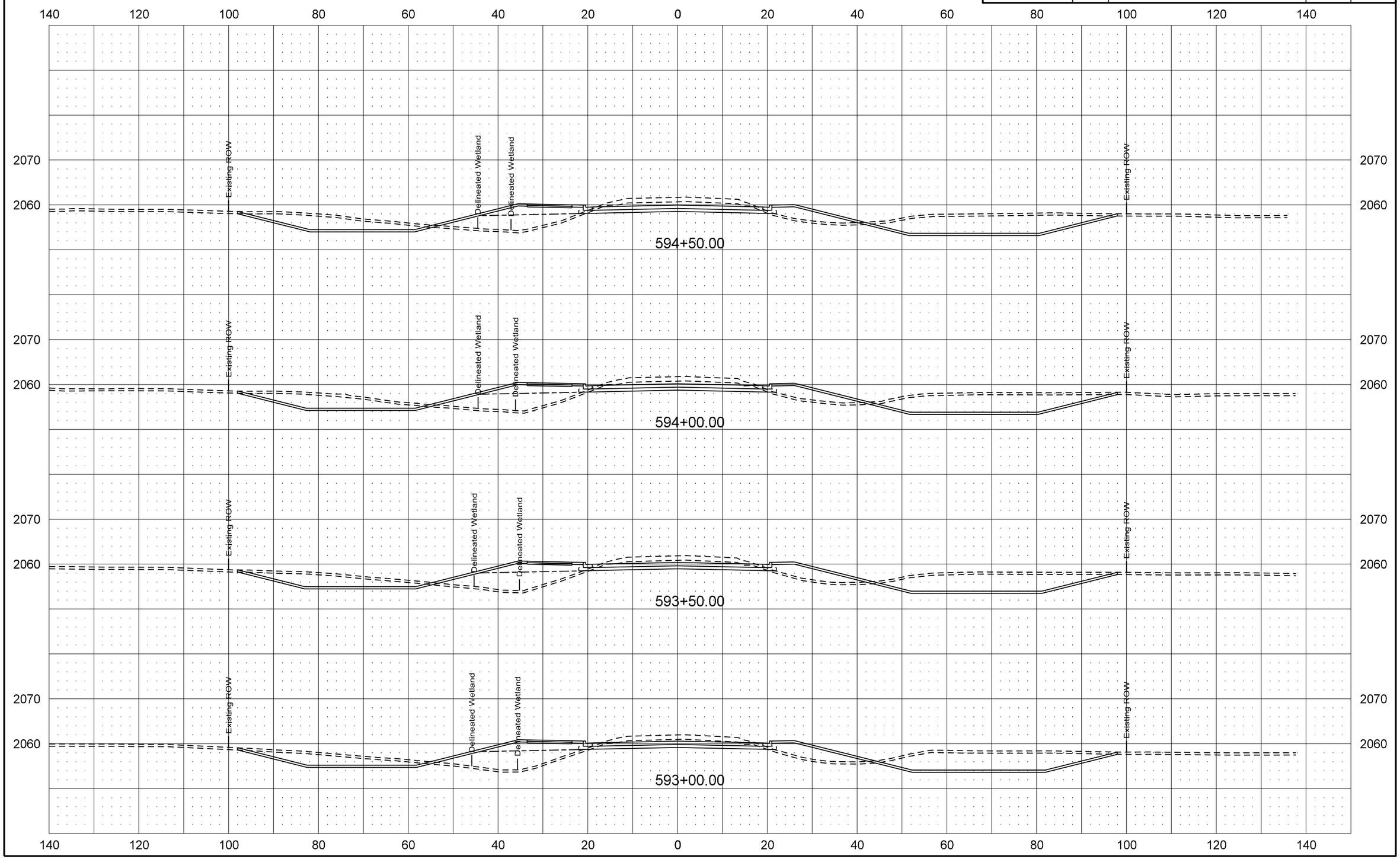

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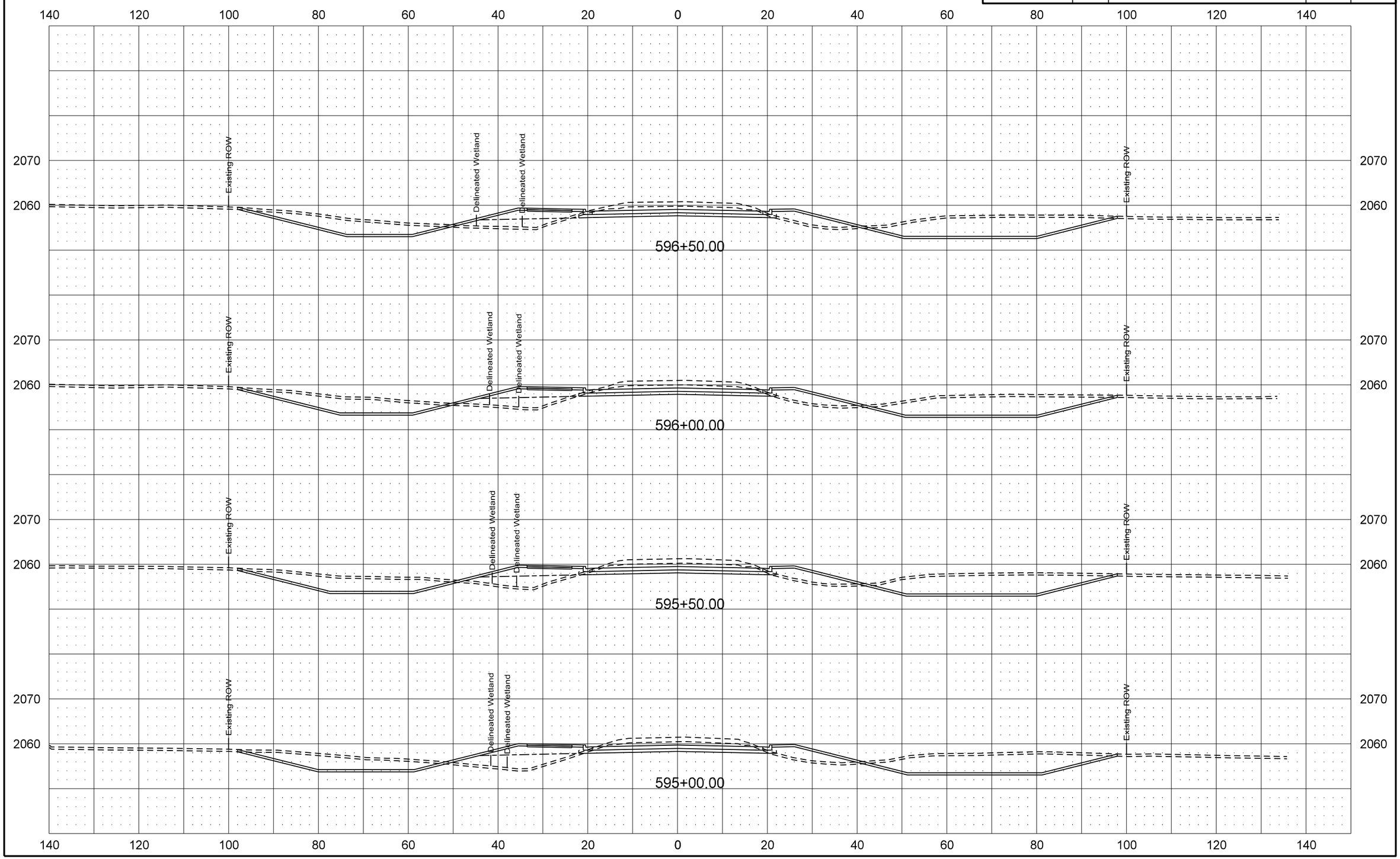

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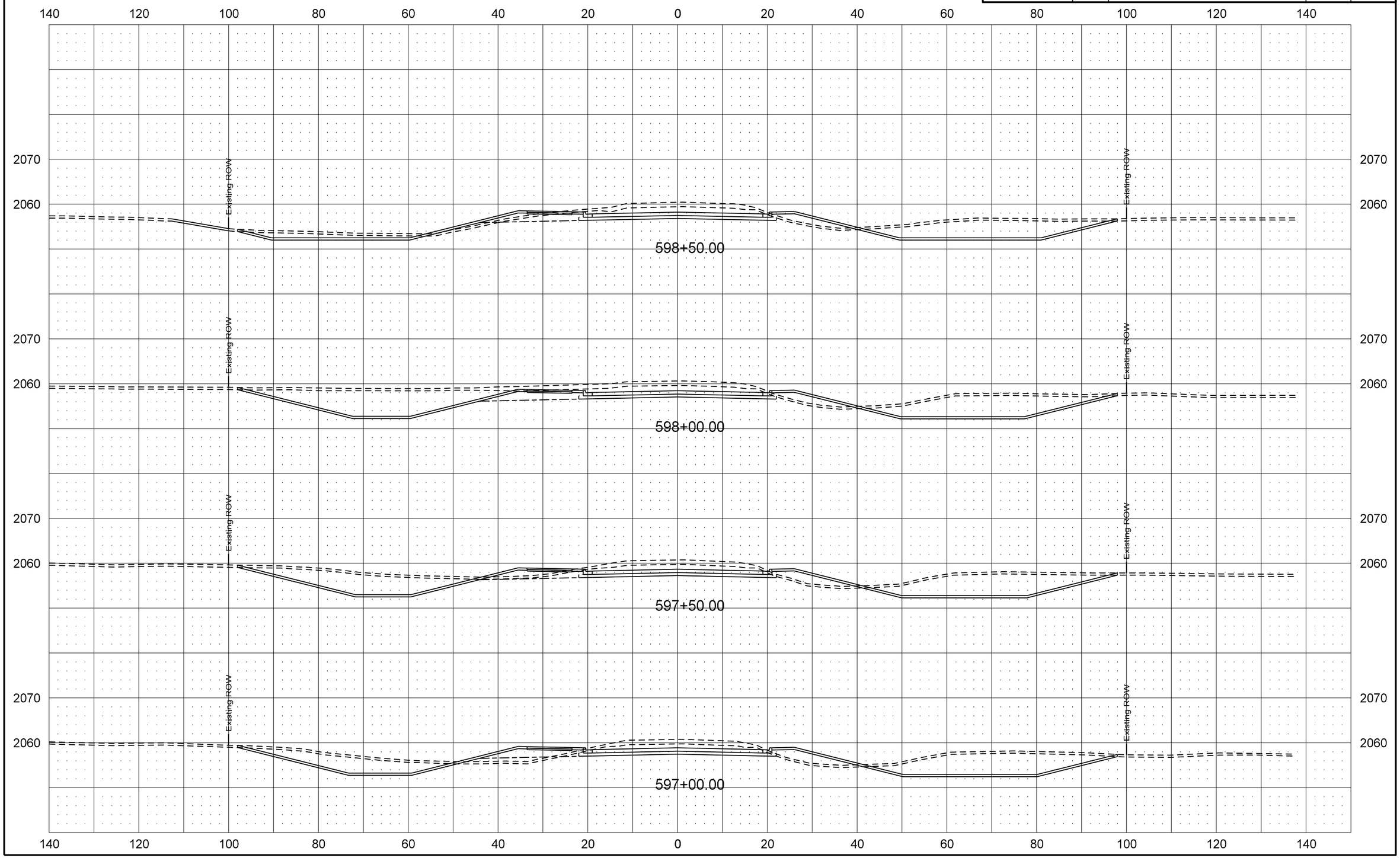

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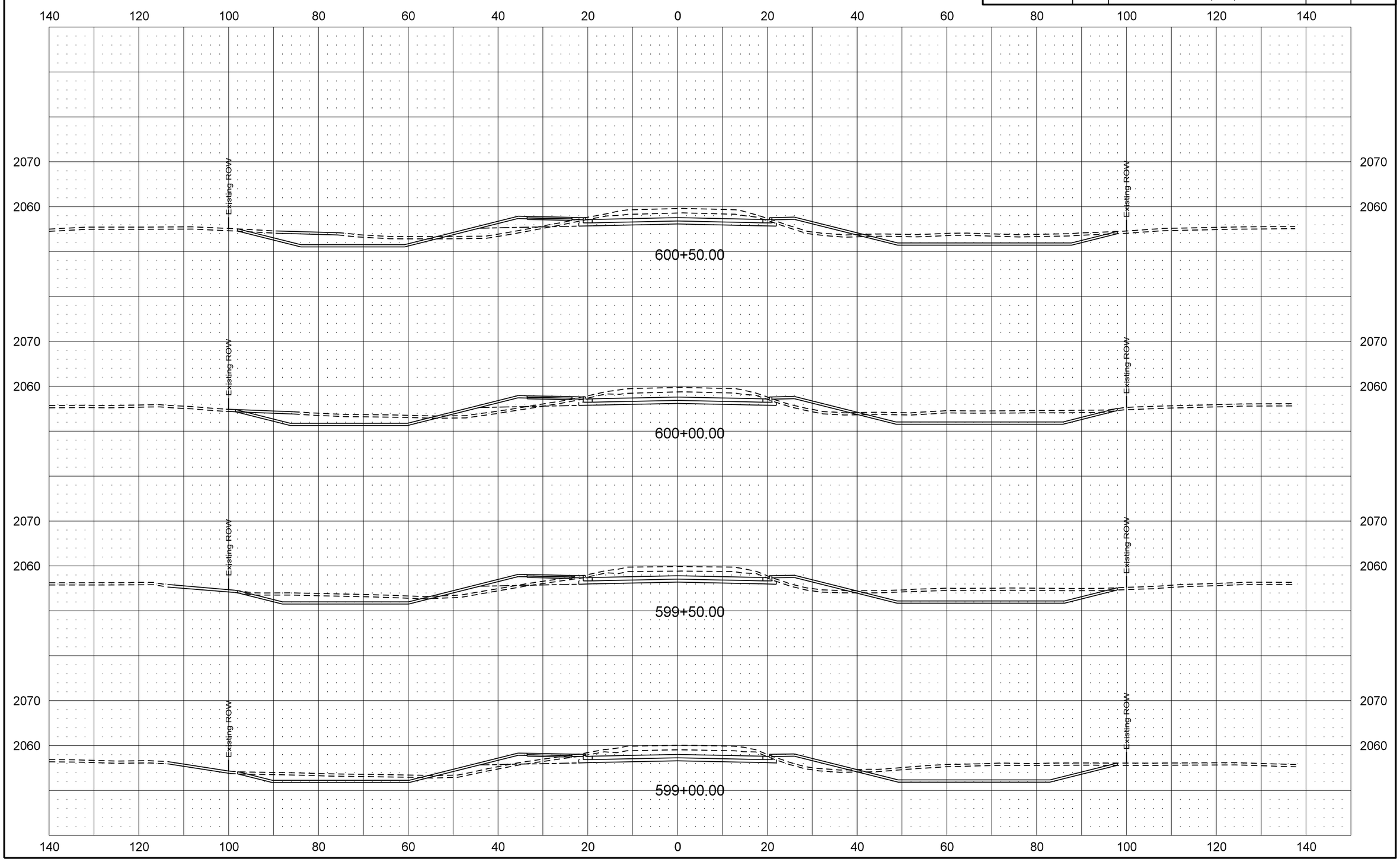

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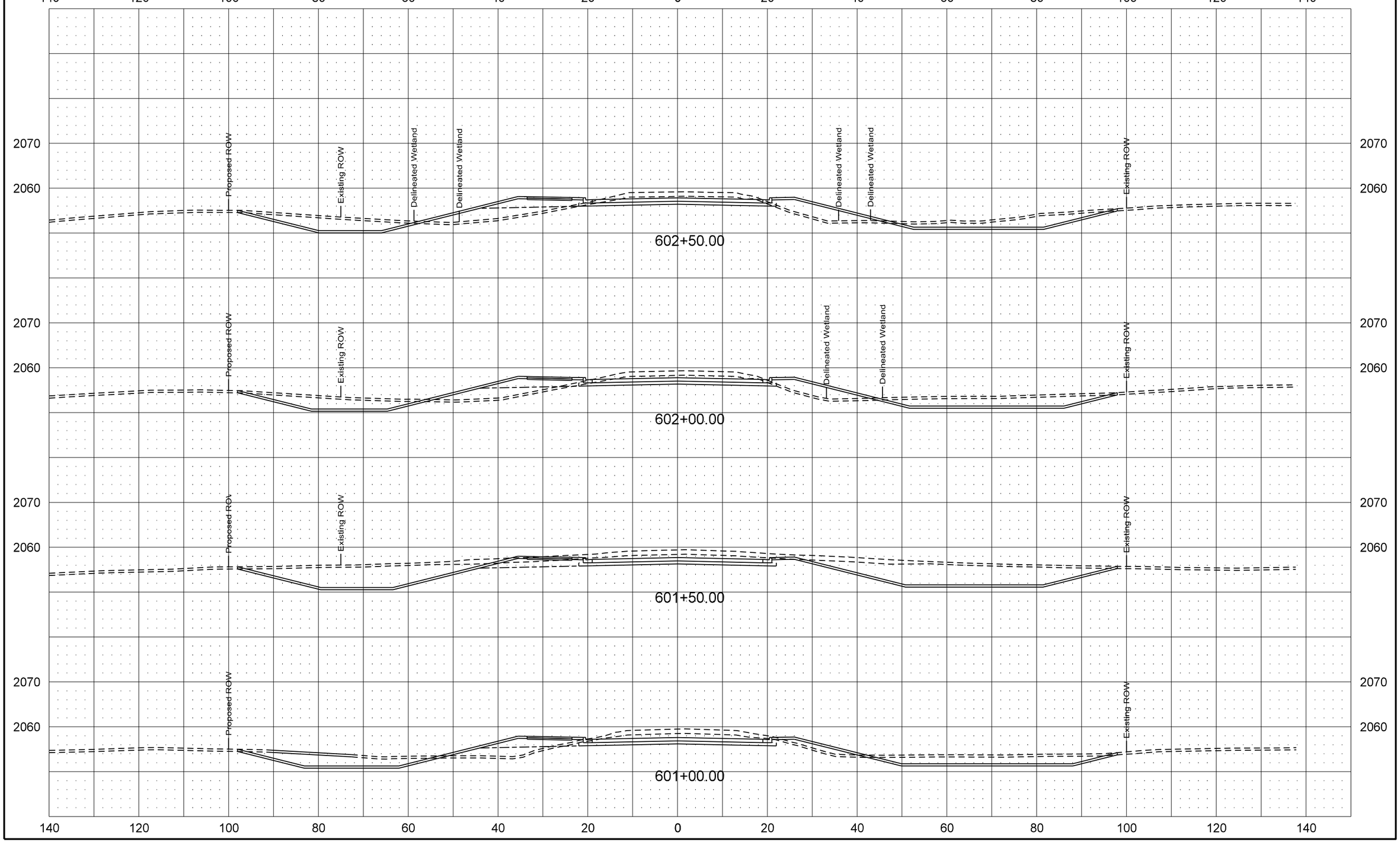

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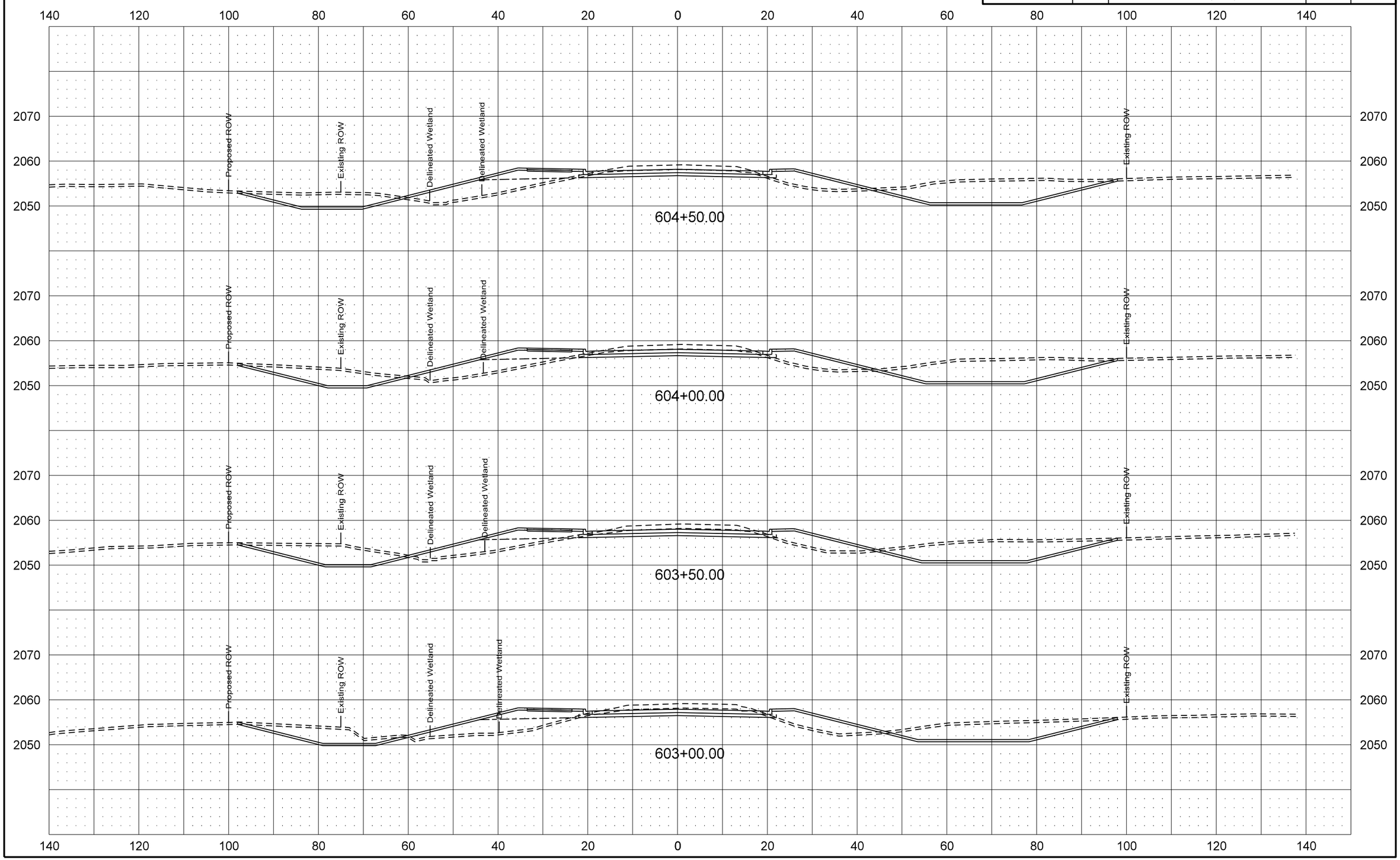

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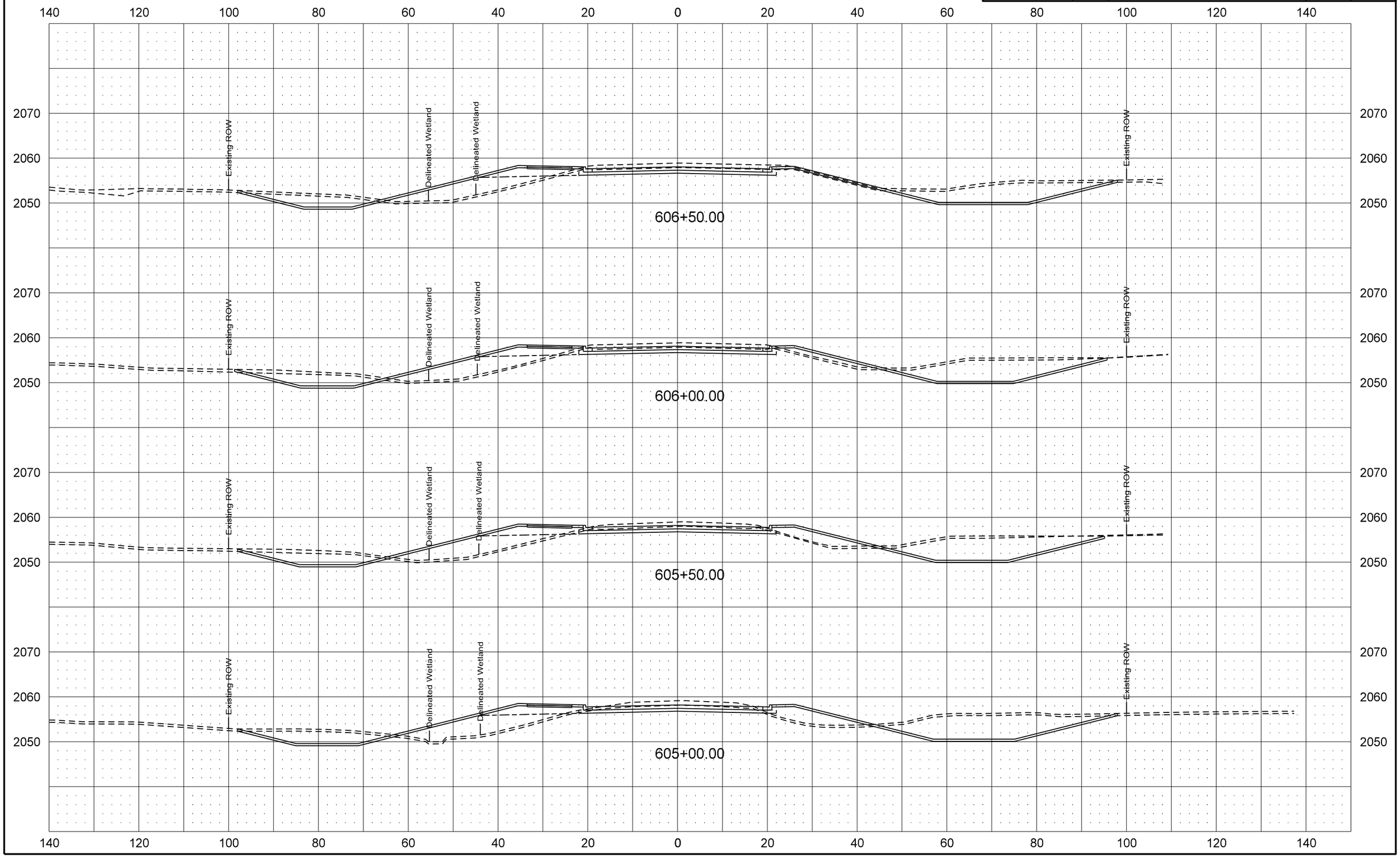

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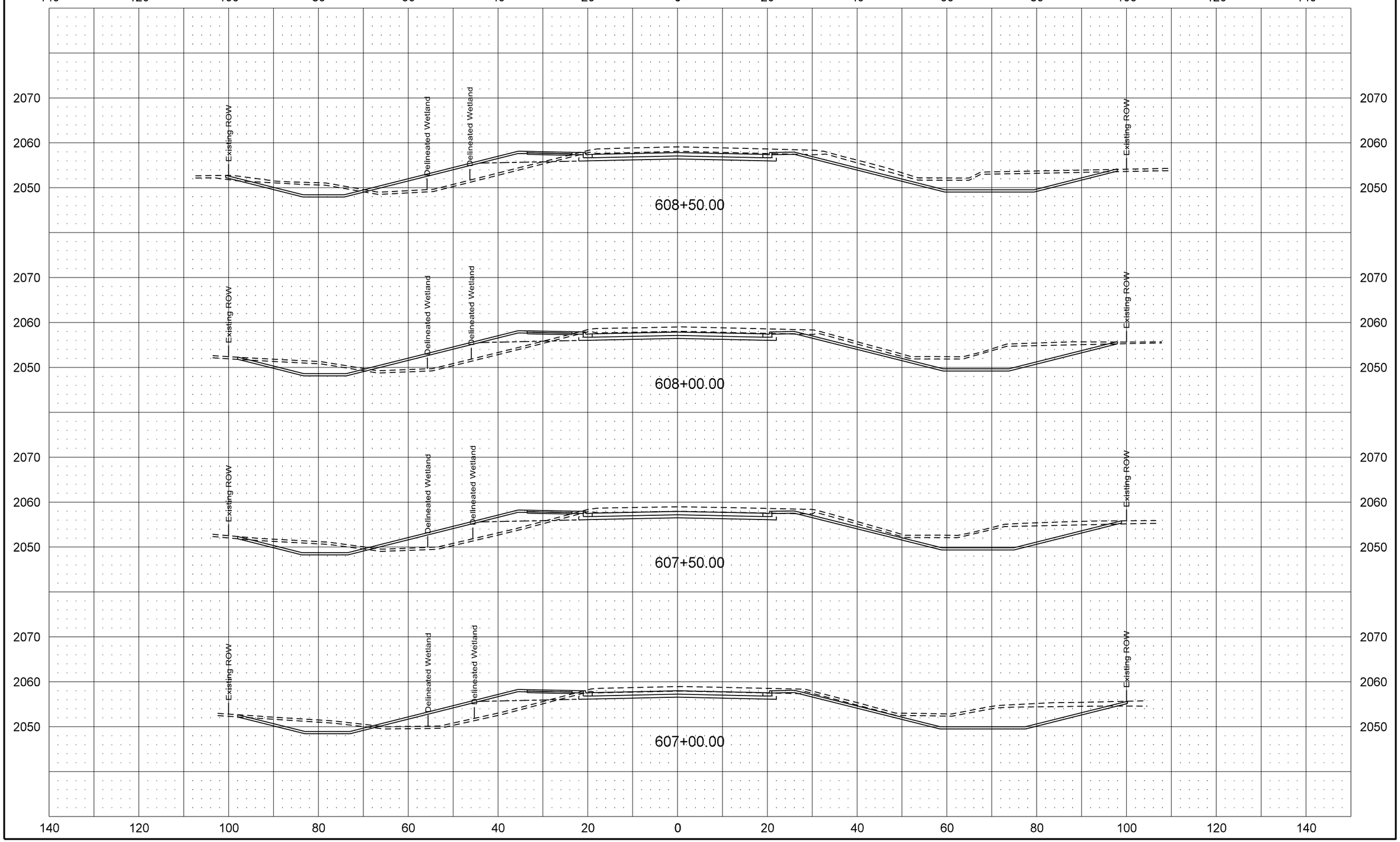

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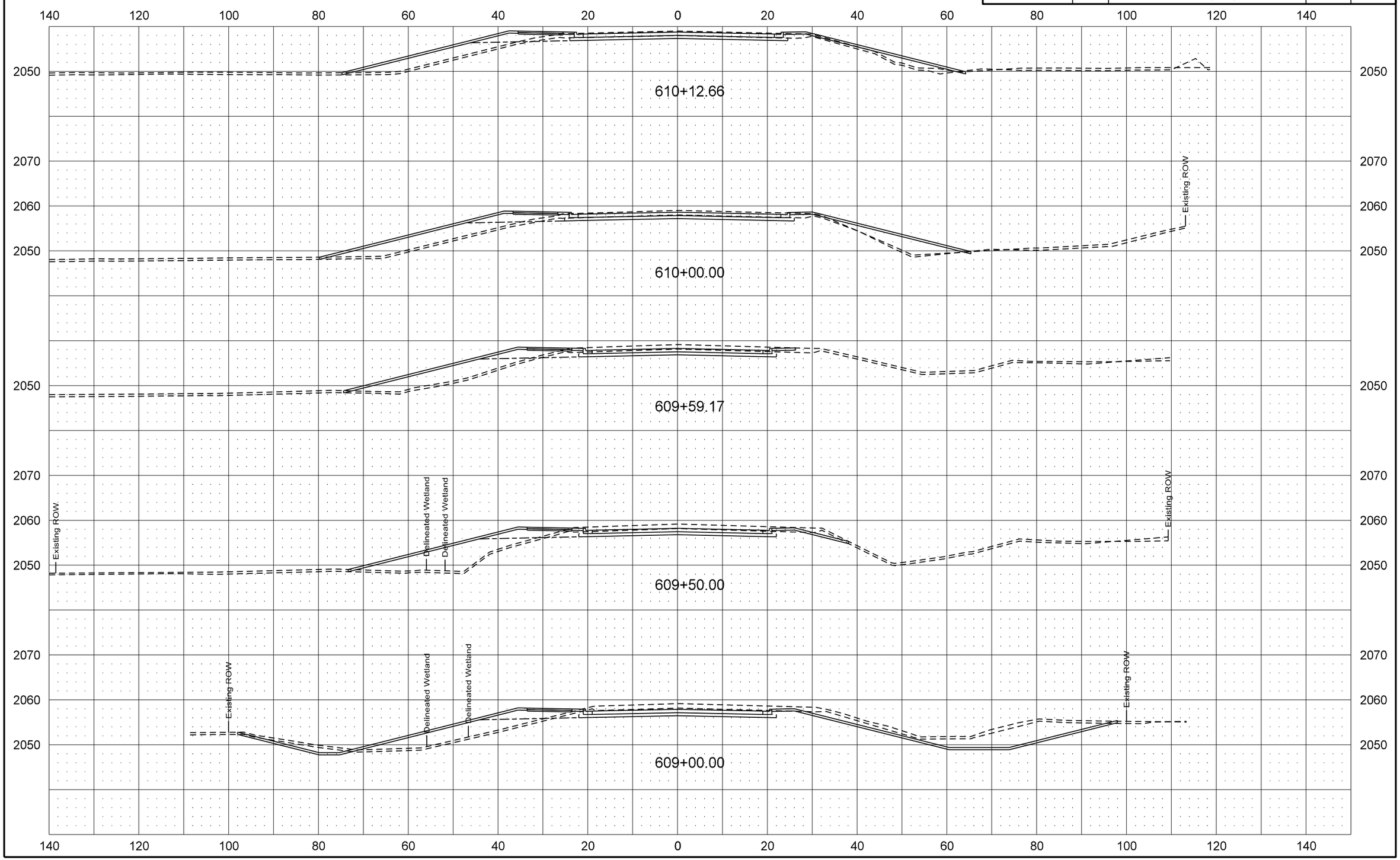

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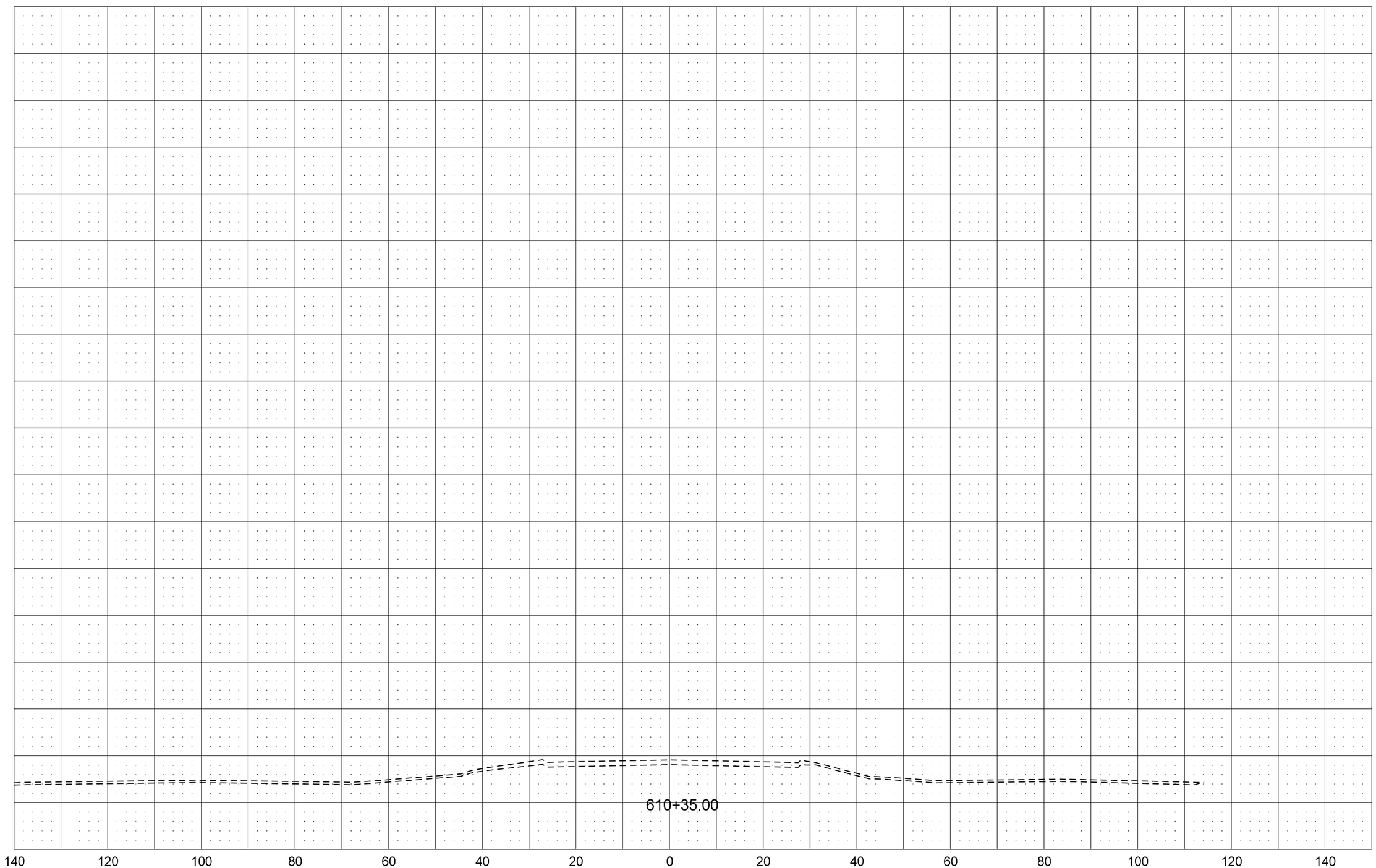
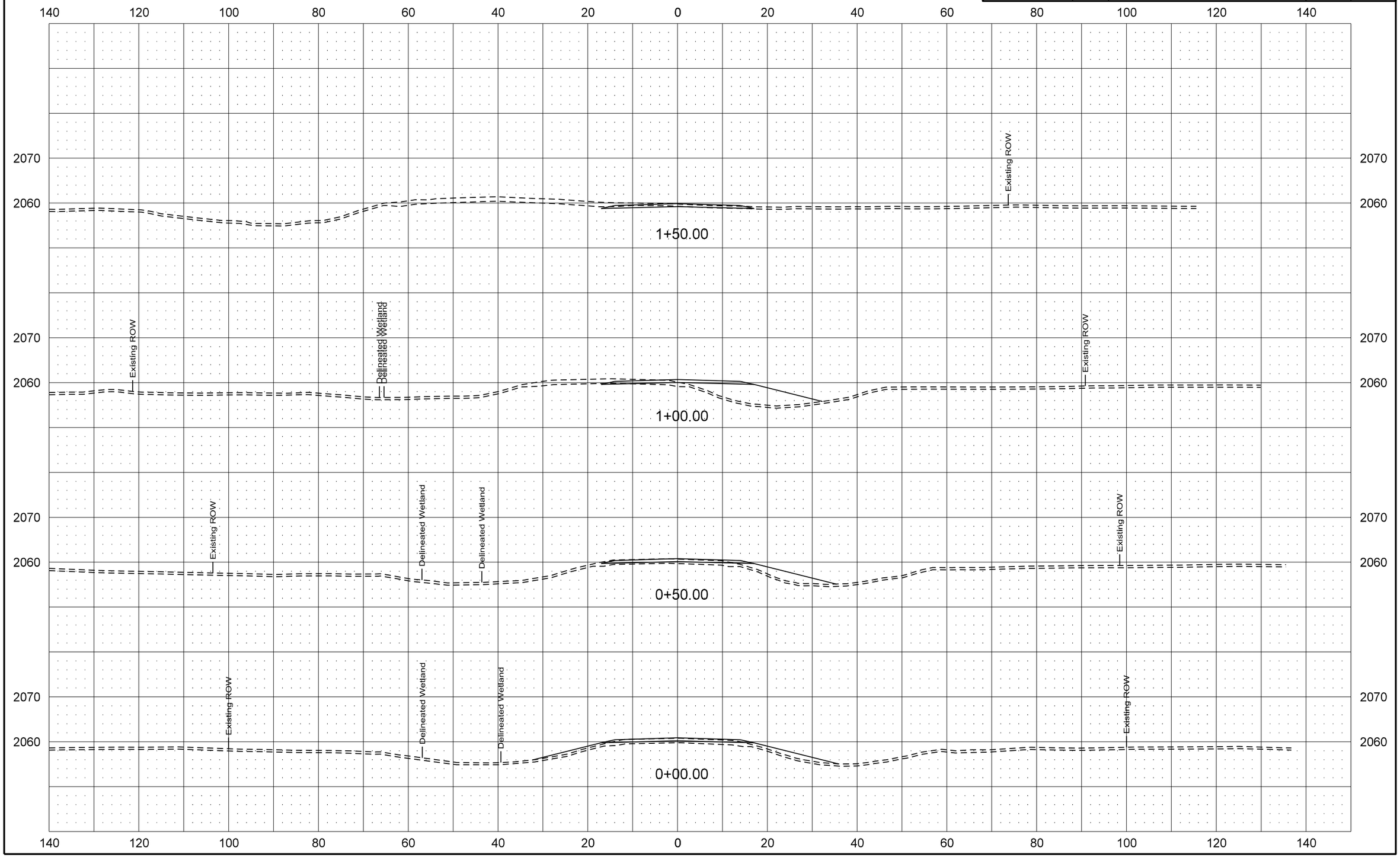


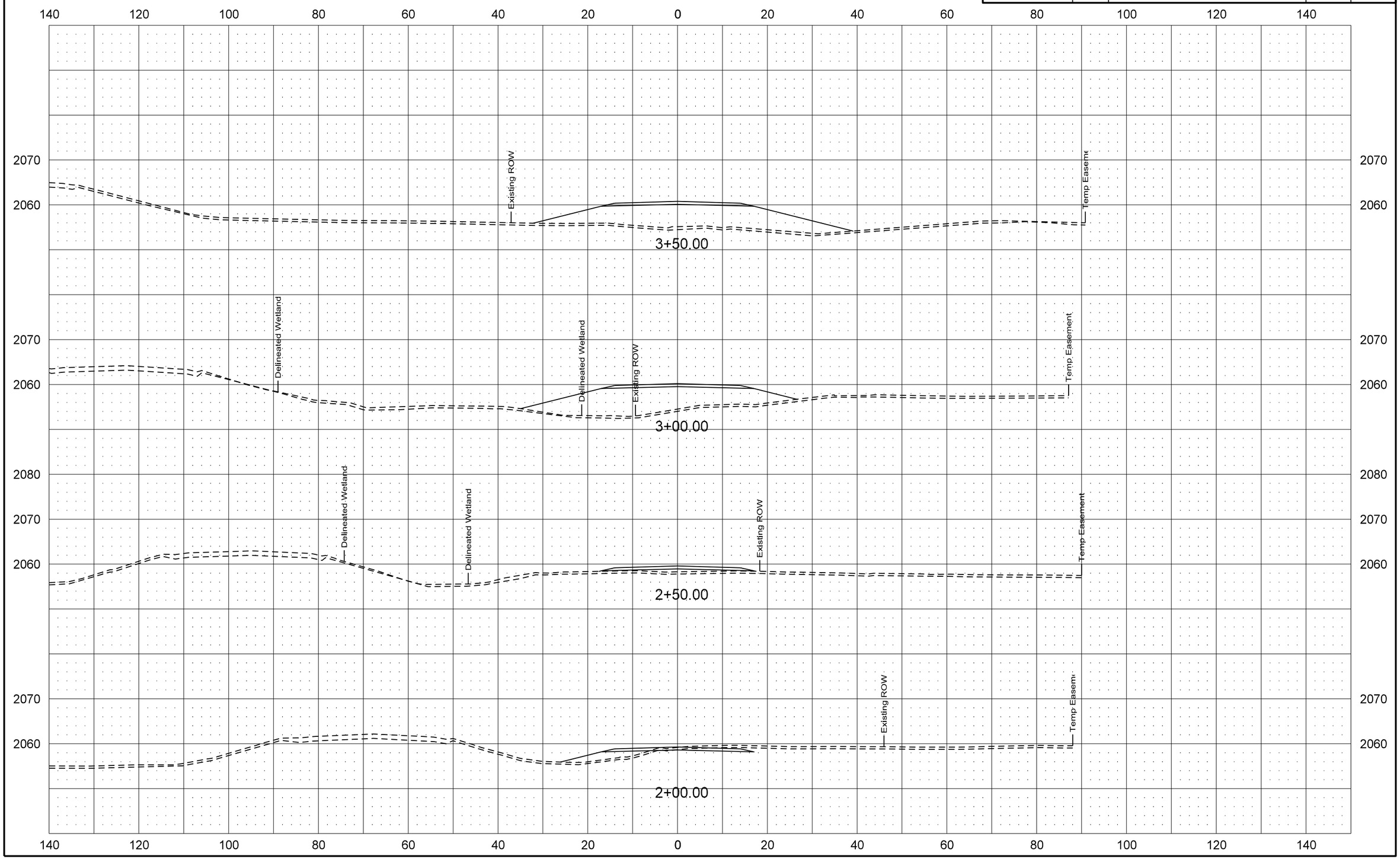
	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	200	36

TEMPORARY BYPASS



	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	200	37

TEMPORARY BYPASS



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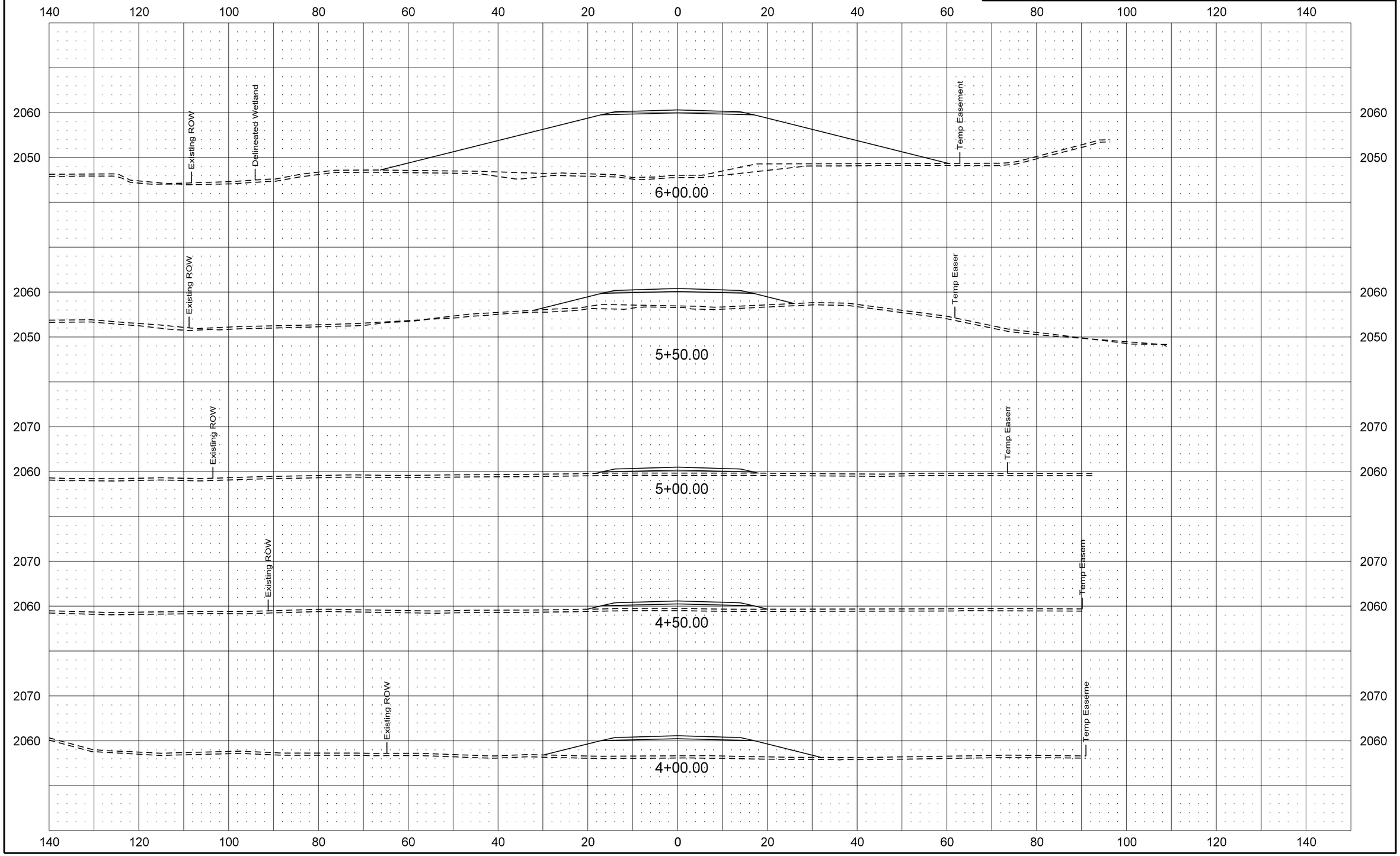
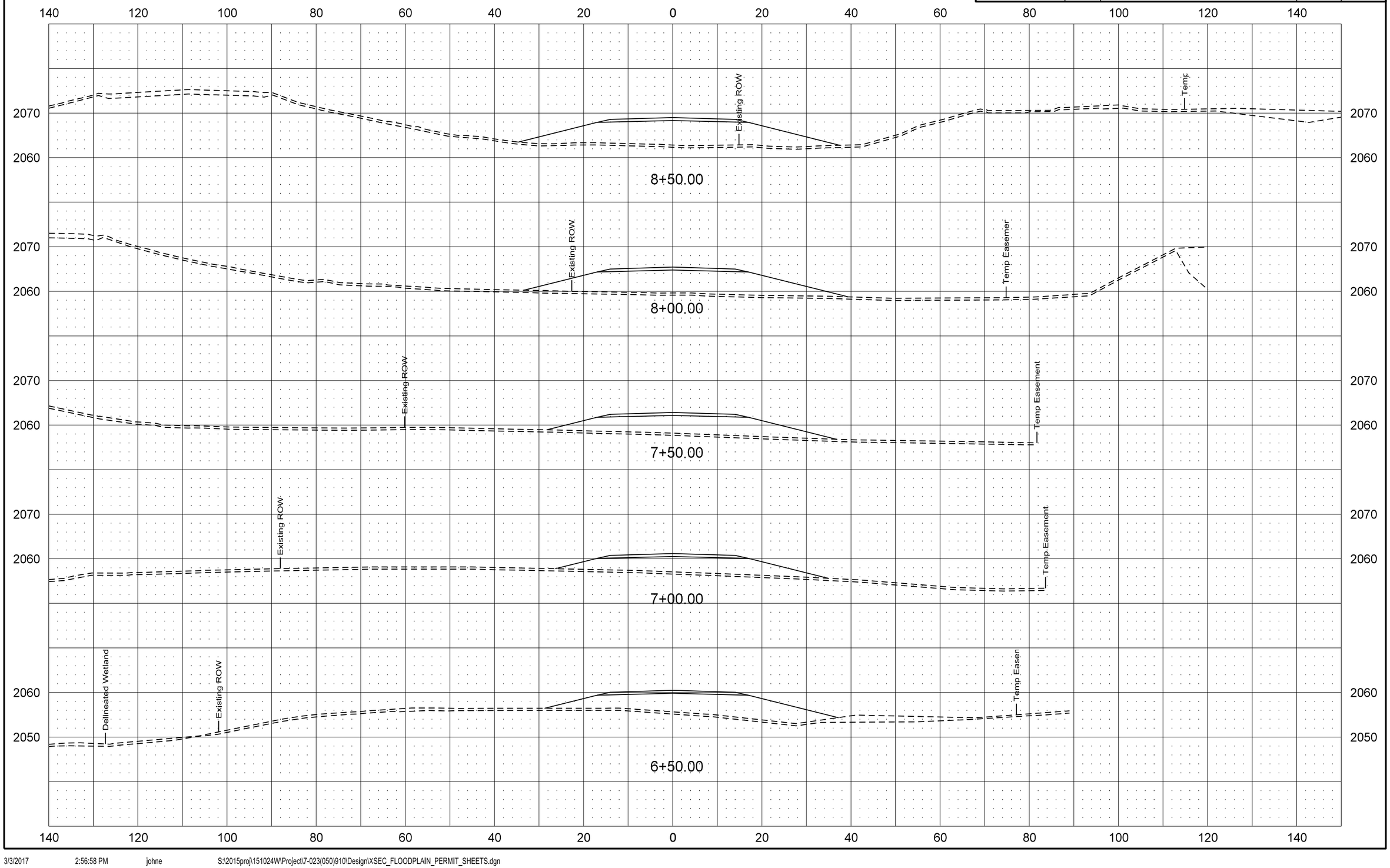
	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	200	38

TEMPORARY BYPASS



	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	200	39

TEMPORARY BYPASS



	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND	SS-7-023(050)910	200	40

TEMPORARY BYPASS