CONSULTANTS, INC.

MEMORANDUM

Project 23138

TO: **Seth Turner, PRRIP**

FROM: **Tom MacDougall, P.E. - RJH Consultants, Inc.**

CC: **Jonathan Mohr - LRE Water**

DATE: **July 29, 2025**

RE: **Elwood Expanded Recapture Reconnaissance Study, Phase 1 – Outlet Design**

1.0 Introduction

The Platte River Recovery Implementation Program (Program) retained LRE Water (LRE) to evaluate the feasibility and effectiveness of delivering environmental water to the Platte River from Elwood Reservoir via Plum Creek (Project). As part of this Project, LRE retained RJH Consultants, Inc. (RJH) to develop a 30-percent design of the facilities needed to control releases and convey flows from Elwood Reservoir to Plum Creek. The concepts presented herein were developed based on discussions with both the Program and the owner of Elwood Reservoir and the E-65 Canal, Central Nebraska Public Power and Irrigation District (CNPPID). Other entities collaborating on this Project include the State of Nebraska, Nebraska Department of Natural Resources (NeDNR), and the Tri-Basin Natural Resources District (TBNRD). The purpose of this memorandum is to present the 30-percent design of the control and conveyance facilities.

Background

Elwood reservoir is in Gosper County, Nebraska, about 3 miles north of the town of Elwood, Nebraska, and has an existing outlet located approximately 1 mile south of Plum Creek, a perennial stream that is tributary to the Platte River. The Program can store water for environmental releases in Elwood Reservoir. RJH understands that the typical base flows in Plum Creek are estimated to be between 5 and 15 cubic feet per second (cfs). The Program is evaluating if sufficient environmental flows could feasibly be released from Elwood Reservoir, conveyed via Plum Creek, and discharged into the Platte River with the goal of timing releases to reduce flow shortages in the Platte River near Grand Island. There are times when releasing supplemental flows to the Platte River can provide significant environmental benefits to threatened and endangered species.

Objectives

The objectives of RJH's 30-percent design were as follows:

- Select a preferred alternative for conveying up 100 cfs from Elwood Reservoir to Plum Creek.
- Refine concepts and develop an alignment and layouts for the preferred alternative (i.e., a buried pipeline) specifically considering land ownership and effects to parcels.

- Collect information for the existing bridges and culverts to understand if the use of existing infrastructure would be permitted by the owners.
- Compile available geological and geotechnical information for the preferred alternative to consider in the design and construction of the conveyance infrastructure.
- Develop a class 3 (budgeting level) cost opinion for the preferred alternative.
- Prepare a memorandum and figures to document the 30-percent design of the preferred alternative and associated cost opinion.

Herein, RJH presents a summary of the data collected and used to develop the 30-percent design, a description of the 30-percent design and rationale supporting initial design decisions, RJH's cost opinion, and considerations for advancing the design of the Project.

2.0 Data Collection

RJH collected data to identify site conditions and support evaluation of conveyance infrastructure alternatives.

Topography

RJH developed a topographic base map based on one-meter resolution Digital Elevation Model (DEM) data produced by Light Detection and Ranging (LiDAR) techniques and published by the United States Geological Survey (USGS) in 2017. The vertical coordinate system is the North American Vertical Datum of 1988 (NAVD88).

Geotechnical and Geological

RJH collected geologic and geotechnical data for the site vicinity from readily available published sources. Information obtained from these sources is summarized below.

Published Geologic Maps

Based on USGS maps of the south-central Platte River (Condon, 2005), the surficial geology of the area consists of floodplain deposits along the Platte River, terrace deposits along the margins of the floodplain deposits, and loess soils that create plateau-like hills outside of the terrace deposits. The loess hills consist predominantly of fine sand and silt layers. Loess is the predominate deposit within several formations mapped in the area, notably the 110-foot-thick Loveland Formation. Crete Formation sands and Sappa Formation silts underly the Loess deposits. At depth, the Grand Island formation and Ogallala Formation bedrock underly the sand and silt soils typically present within the upper 80 to 100 feet of the subsurface stratigraphy (RJH, 2021).

Borings in the West Elm Creek and Newark quadrangles, 25 and 40 miles east of Elwood, respectively, report the presence of floodplain terrace deposits consisting of sandy, silty, and sandy gravel loam overlying the Ogallala group bedrock. Occasional clay layers are present within the terrace deposits. The predominantly loam terrace deposits found in borings ranged from 34 feet deep to 157 feet deep. Depth to bedrock averaged 83 feet deep. In the Newark quadrangle to the east of Elm Creek, Pierre shale bedrock was encountered in three borings at an average of 234 feet deep.

Based on the USDA Soil Survey (NRCS, 2019), various silty loams are mapped near Elwood Reservoir. The soil descriptions reported in the NRCS' are similar to the clays and silts encountered by RJH (RJH 2021). Rock outcrops are not present near the vicinity of the preferred alternative.

Geotechnical Data Report – Elwood Dam Seepage Mitigation Project

RJH conducted a geotechnical investigation at Elwood dam in 2020. RJH advanced nine borings between 25.5 and 93.5 feet deep, using hollow stem augers. Seven borings were completed as piezometers, two backfilled with cement-bentonite grout.

RJH conducted additional geotechnical investigation at Elwood Dam in 2021 consisting of 5 boreholes between 25 and 95 feet deep. The lowest elevation of these borings extended to approximately elevation 2540 ft. The minimum elevation of the proposed pipeline project is approximately 2,485 ft, however the near-surface materials appear to be similar. The 2021 RJH borings advanced through various loess deposits of homogeneous clay and some silts. One boring encountered silty sands in the bottom of the boring. Bedrock was not encountered in any of RJH's borings. The geotechnical conditions encountered by RJH near Elwood Dam are documented in RJH's Geotechnical Data Report (RJH, 2021).

Groundwater Conditions

Based on aerial images, green vegetation and ponded water are present along the pipeline alignment for much of the year. Therefore, RJH anticipates that groundwater will be encountered at relatively shallow depths. Groundwater depths encountered closer to Elwood Reservoir (as reported in RJH 2021) are likely not representative of the groundwater conditions present along the proposed pipeline alignment.

Property Ownership

RJH downloaded parcel boundaries and property ownership data from Gosper County Assessor, published on the Gosper County website. The data obtained from Gosper County is approximate and sufficient to support 30-percent design, but more precise and controlled survey data will be required to develop legal descriptions of easements and to support development of final construction contract documents (i.e., plans and specifications).

NDOT Culvert and Bridge

RJH obtained as-built data for the US-283 culvert about 950 feet south of the Plum Creek – US-283 bridge from the Nebraska Department of Transportation (NDOT). The as-built data was used to perform hydraulic analyses to evaluate means of routing flow across the highway. The existing 8-ft by 8-ft box culvert that extends below Highway 283 has significant excess capacity to convey flows from a 100-year storm event and the additional 100 cfs proposed to be conveyed by this Project. NDOT has not confirmed if they would allow this Project to use the existing Right-of-Way and culvert to convey flows to Plum Creek.

3.0 Primary Project Components

Selection of a Preferred Pipeline Alignment

The preferred alternative was selected primarily based on the depths of excavation needed to install a conveyance pipeline. Open channel conveyance was considered unfavorable because of the disruption to private property and anticipated need for maintenance. Nine initial alternative pipeline alignments were considered. Alignments would cross the property of multiple landowners or require the use of the existing E-65 Siphon (which is considered to be unreliable for future use). Some alignments included excavations greater than 20 feet deep along reaches extending more than 300 to 500 feet.

Based on an initial evaluation of alignments, the Program, CNPPID, LRE, and RJH concluded that a pipeline generally parallel to Highway 283 was preferred.

RJH developed three alternative alignments for the buried pipeline that were generally parallel to Highway 283: an alignment within NDOT Right-of-Way (ROW), an alignment on private property east of the highway, and an alignment on private property west of the highway. RJH developed comparative cost estimates, rough design concepts, and key design considerations and constraints for each alignment, and presented the information in a May 2025 meeting with CNPPID, the Program, and LRE.

The Program selected the alignment on private property west of the highway (on Jane Jack Property) as the preferred alternative primarily because of constructability constraints with both the NDOT ROW alignment and the alignment east of the highway. The topography in the NDOT ROW and east of the highway is not conducive to the installation of a buried pipeline, requiring either significant excavation to depths exceeding 40 feet or trenchless installation methods. Therefore, the costs for the other alternatives were considered too high.

The preferred alternative includes a pipeline that would convey project flows about 4,760 feet. The buried pipeline alignment would be on Jane Jack's Property, generally trend northward, following the thalweg of a natural ephemeral drainage, and terminate at a plunge pool immediately upstream of an existing reinforced concrete box culvert under US-283. Flow discharged from the pipeline would next be routed eastward under US-283 through the culvert and drain to Plum Creek within a natural channel. The natural drainage channel extends approximately 100 feet downstream of the culvert discharge across property owned by Knoerzer Farms, Inc.

The system was designed to convey a maximum project flow rate of 100 cfs. The preferred alternative is shown on the attached Figures 1 through 8. Based on information provided to RJH by CNPPID, both Jane Jack and Knoerzer Farms, Inc are willing to sell easements for flow conveyance facilities.

The primary components of the preferred alternative to control and convey environmental releases from Elwood Reservoir to Plum Creek include:

- A reinforced concrete canal check structure with a radial gate.
- A reinforced concrete canal turnout (i.e., intake) structure.
- A 36-inch diameter High-density polyethylene (HDPE) buried pipeline.
- A reinforced concrete flowmeter vault.
- Two reinforced concrete air valve vaults with access manways spaced approximately every 1500 feet along the pipeline alignment. These would provide access for inspection and maintenance equipment.
- A reinforced concrete valve vault with two energy dissipation valves that provide downstream flow control.
- A riprap-lined outfall plunge pool upstream of the existing Highway 283 culvert and rip-rap lining erosion protection downstream of the culvert to convey flows to Plum Creek.

Below we provide additional information about each primary component.

Turnout and Check Structure

The turnout (i.e., intake) of the pipeline is located near a wye-shaped feature in the existing E-65 canal downstream of Elwood Reservoir, and a few hundred feet west of Highway 283. This location was selected to be in the vicinity of existing CNPPID gates, but also to provide sufficient distance between the two structures to avoid causing disruption to the hydraulics of either system.

The canal turnout structure turns flow from the canal to the pipeline and controls flow into the pipeline. It likely would be a cast-in-place reinforced concrete structure in the canal bank, similar to a culvert headwall structure with 90-degree wingwalls. The interior height of the structure would be about 12 feet (the total depth of the canal) and the interior length about 20 feet (horizontal length of the canal bank).

The structure would divert canal flow directly into a deeper concrete vault to allow enough water head to convey up to 100 cfs in the buried pipeline. Flow is then conveyed in a 36-inch-diameter HDPE pipe penetrating the headwall. RJH selected the concrete vault depth to decrease the headwater needed in the canal to operate the system at the maximum capacity of 100 cfs. The pipe would convey 100 cfs with about 8.5 feet of head on the center of the pipe orifice, which is achievable with routine canal operations and the concrete vault. Electrically operated slide gates or bulkheads would be provided on the pipe connection to the intake to allow for dewatering the pipeline system for maintenance.

The purposes of the check structure would be to contain and regulate canal flow, provide adequate headwater (about 3.5 feet deep) for the pipeline intake, and prevent flows from submerging the adjacent siphon in the E-65 canal operated by CNPPID. The check structure would be a cast-in-place reinforced concrete structure within the canal that spans the canal and generally conforms to the existing E-65 canal geometry. A 30-foot wide by 11-foot tall radial gate would be mounted on the check structure to regulate flows in the canal. The structure would include a concrete apron on the canal bottom and side slopes to prevent erosion of the canal in and around the check structure. A bridge or walkway over the canal and check structure (from bank to bank) would be included to provide access for inspection and maintenance.

The check structure included in the 30-percent design would allow continued use of CNPPID’s existing siphon. If continued use of the existing siphon is not needed, a less expensive alternative (with fewer operational and maintenance requirements) could be considered.

Pipe Material

RJH selected to use High-density polyethylene (HDPE) pipe for this pipeline. We considered various other pipe materials that are commonly used for municipal water and stormwater conveyance, including the following:

- Polyvinyl Chloride (PVC)
- HDPE
- Ductile iron pipe (DIP)
- Reinforced concrete pipe (RCP)
- Welded steel

RJH performed a cursory review of the key advantages and disadvantages of the above pipe materials and eliminated the following:

- DIP and RCP were eliminated from further consideration because material and installation costs are higher than HDPE and do not offer any performance benefits over HDPE for the selected alternative.
- PVC is typically used for potable water mains and is installed in sticks of pipe with gasketed bell-and-spigot-type joints. The pipe is likely less expensive per linear foot than HDPE, but not by a significant amount. HDPE is widely known to be more durable, has a longer design life and would require less maintenance.

RJH advanced HDPE and steel beyond the cursory evaluation because both materials had distinct advantages and disadvantages for this design application.

Pipe Material – Criteria Matrix

RJH developed a design criteria matrix to compare the key design considerations for HDPE and steel pipes. The matrix is shown in Table 1.

TABLE 1
DESIGN CRITERIA MATRIX, HDPE VS. STEEL

Design Criteria	Pipe Material	
	HDPE	**Steel**
Design Life	• <50 years	• >100 years
Material Properties	• Flexible, can accommodate bends • High thermal expansion • Susceptible to abrasion erosion from sediment load	• Can deform and accommodate differential settlement • Relatively low thermal expansion • High strength
Construction/ Installation	• Prone to damage during construction • Easy to install • Joints are heat-welded and pipe is flexible • Requires specialty fusion equipment • Requires long staging area to weld/feed pipe into trench	• Durable to stage and construct • Requires field coating of holdbacks • Requires conventional welding equipment • Requires typical staging area
Testing	• Requires hydrostatic testing and field welding	• Requires hydrostatic testing and field welding
Joints/Bends	• Joints are welded and watertight	• Joints are welded and watertight • Special bends and fittings can be fabricated
Replacement	• Cannot be lined in the future – requires removal and replacement	• Can be slip-lined with a smaller diameter pipe
History of Use	• Less case history	• Extensive case history
Corrosion	• Corrosion resistant	• Requires a cathodic protection system and coating
Cost	• Low initial cost	• Relatively high initial cost

Steel pipe has several key advantages, including durability and design life, an extensive case history, and more replacement options in the future. However, the advantages are associated with an overall higher initial cost and the need to provide and maintain a cathodic protection system. HDPE has a lower initial cost and is easier to maintain, although it has a shorter expected life.

Pipe Material – Cost

RJH estimates that steel pipe would cost about 50 percent more than HDPE for the selected alternative. The relative cost was estimated to provide a basis for comparison and selection of preferred pipe material.

Pipe Material – Selection

RJH selected HDPE in coordination with the Program and LRE for the pipeline material. HDPE provides a low-maintenance, cost-effective design solution in this application and meets the purpose and objectives of the project. The disadvantages of HDPE can be mitigated by working with an experienced pipeline contractor to properly stage the site and install the pipe.

Capacity and Pipe Size

RJH performed hydraulic calculations to size an HDPE pipe for the maximum project design flow of 100 cfs. Calculations were performed in general accordance with industry standard hydraulic methods and considered inlet- and outlet-controlled flow conditions and pressurized pipe flow. A nominal pipe diameter of 36 inches was selected. Pipe velocities will be less than about 15 feet per second (fps) at maximum system operating capacity, which is acceptable for HDPE pipe based on the Plastic Pipe Institute (PPI) Handbook of Polyethylene Pipe (PPI, 2008), which allows up to about 25 fps.

Flow Meter Vault

A flow meter vault would be installed about 300 feet downstream of the transition vault on CNPPID property, near the Jane Jack property line. The flow meter vault would house and provide access to a 36-inch inline electromagnetic flow meter. The vault would require an electric power supply to record and transmit measurements from the flow meter. The flow meter would provide flow readings in a partially full or full pipe within 1 percent of the actual flow rate. The location of this vault would likely require construction of an access road. RJH selected to locate the vault as shown on Figure 1 and 2 primarily to reduce the depth of the vault, and to provide sufficient distance away from the transition vault to provide more accurate flow measurement.

Electrical and Control Instrumentation

An electric power supply would be required at the canal check structure, canal turnout structure and flow meter vault. Electrical and control equipment would include an electromagnetic flowmeter with remote readout and electric actuators for the slide gates with remote operation and position indicators. Power for the electrical components would be routed from the existing overhead powerlines located on the west side of US-283.

In this 30-percent design, RJH did not include components or costs for remote monitoring and operations. If remote monitoring and operation is wanted, these facilities can be included in later stages of design.

Air Valve Vaults

The design includes reinforced concrete vaults spaced at intervals of about 1,500 feet to allow installation of combination air valves and provide access to the pipeline for inspection and maintenance. Combination air valves are required on the pipeline to allow air in and out of the system during filling and draining of the pipe to prevent collapse of piping, and to release accumulated air while the system is operational and under pressure. There would be a total of two manholes installed along the pipeline. The manholes would likely be precast concrete structures.

Valve Vault

A reinforced concrete vault will be located at the discharge end of the pipe to house downstream control valves. The main pipeline will include a tee fitting to a smaller pipe which was sized to convey flows from about 1 cfs to 20 cfs. The main pipe will include a reducer and a 30-inch diameter valve to convey flows from about 13 cfs to over 100 cfs. Fixed cone valves were selected for the control valves to provide energy dissipation and flow control. This dual-valve outlet system provides flow control to approximately 1 cfs accuracy throughout most of the design discharge range (i.e., 1 to 100 cfs).

Plunge Pool (Outfall)

RJH selected a riprap plunge pool for the pipeline outfall design. A plunge pool is a typical pipe outfall design and consists of a flared riprap basin with a dissipator pool at the pipe outfall and an apron to stabilize flow prior to discharging to the main drainage channel. The dissipator pool would be approximately 15.5-feet-long, and the apron would be about 7.5-feet-long. Riprap would be placed beyond the plunge pool in a continuous layer throughout the drainage channel and near the entrance to the US-283 culvert to minimize erosion around the culvert intake structure. The pipeline discharge would include a culvert headwall structure to stabilize and protect the end of the HDPE pipeline.

US-283 Culvert

RJH identified the size and geometry of the existing US-283 culvert based on the as-built drawings from 2018 provided by NDOT. The culvert is an 8-foot-span by 8-foot-rise reinforced concrete box culvert that is 82 feet long, extending from a concrete intake structure on the west side of US-283 to a concrete discharge structure on the east side of US-283. Hydraulic information was requested from NDOT and was not available. RJH developed a model of the culvert using the Federal Highway Administration (FHWA) HY-8 Culvert Hydraulic Analysis Program to identify the hydraulic capacity of the culvert. Based on the model, the culvert can convey approximately 1,060 cfs before the highway overtops (about 15.4 feet of water depth at the inlet) and can convey the project maximum flowrate of 100 cfs with about 2.6 feet of water depth at the inlet.

Discharge to Plum Creek

The US-283 culvert is approximately 150 feet from the main Plum Creek channel, and culvert flows are routed to Plum Creek in a discharge channel that has naturally developed between the culvert and Plum Creek. The existing channel is heavily vegetated and has become incised from periodic culvert discharges during rain events. Based on the observed erosion, RJH selected riprap to stabilize the discharge channel and prevent further erosion during Project releases. The riprap channel would be trapezoidal with a bottom width of about 5 feet, 2 Horizontal to 1 Vertical (H:V) side slopes, and a depth of about 4 feet, and would terminate at the confluence with Plum Creek. The riprap used for the plunge pool is anticipated to be adequate to stabilize the channel and prevent erosion that could undermine the existing culvert outfall structure. Based on information from the landowner (Mr. Knoerzer) received through CNPPID on July 29, 2025, a concrete low-water crossing or a culvert will likely be needed to maintain vehicle access across the discharge channel.

Easements

It is anticipated that a 50-foot wide permanent easement will be required along the pipeline alignment for access to the Air-Valve Vaults and for general pipeline access and maintenance. A temporary easement of 100-feet wide would be required along the pipeline to facilitate construction of the selected alternative.

NDOT Coordination

RJH began coordination with NDOT to identify if the existing culvert can be used to discharge the Project flows, if there would be limitations or requirements, and if a permit would be required. Coordination with NDOT is ongoing. RJH was not able to receive definitive information from NDOT prior to the publication of this memorandum. If NDOT will not permit or allow the use of the existing culvert, the alternative route and discharge location at the US-283 bridge shown on Figure 1 will be considered.

Geotechnical Design and Construction Considerations

Based on experience with similar projects, and the published geologic and geotechnical data reviewed for this Project, RJH concludes that the key geotechnical considerations for 30-percent design are:

- The pipeline and appurtenant facilities (intake, vaults, check structure, etc.) will likely be founded on loess soils consisting predominately of sandy or clayey silts, and interlayered and intermittent deposits of other alluvial soils (i.e., sands, silts clays, and possibly minor gravels).
- The soils are likely excavatable with conventional excavation equipment. Blasting or specialized excavation methods will likely not be required.
- Groundwater is likely shallow, needs to be better defined, and must be considered in design.
- Control of both surface and groundwater will be needed to construct the Project.
- To construct the turnout (i.e., intake) structure and check structure, the E-65 canal will require either a drawdown, diversion, or a cofferdam to construct. Dewatering for excavations that extend below these structures should be anticipated.
- Construction of the turnout structure vault and adjacent piping will likely require deep excavations. Deep excavations will likely require the use of shoring and trench support systems.
- Structures can be founded on shallow foundations. The bearing capacity and strength of the soils to support vaults and pipelines is likely within typical ranges, and unique or significant measures to appropriately support the foundations of the pipe and appurtenant structures are likely not required.
- Corrosion potential and sulfate content of the soil and water needs to be better understood. Based on data from RJH 2021, the soils may be corrosive to steel. Selection of metal components including the slide gates, trashracks, and fastening

hardware would be based on the corrosion potential of the soil. The concrete cement type would be selected based on the sulfate content in the soil and water.

4.0 Cost Estimate

RJH developed an "Opinion of Probable Construction Cost" (OPCC) for the 30-percent design of the preferred alternative. The OPCC presented is considered a Class 3 estimate as defined by ASTM E2516-11: Standard Classification for Cost Estimate Classification Systems. This class designation is used when the design is between 10- to 40-percent complete. Class 3 estimates are appropriate to use for project budgetary purposes.

Cost opinions were developed by estimating quantities of primary elements of the work based on the 30-percent design and unit costs developed from the following sources:

- Published and non-published bid price data for similar work.
- R.S. Means Heavy Construction Cost Data for 2025.
- Manufacturers' budgetary price quotes.
- RJH's previous experience and judgment.

The "Base Construction Cost" (BCC) for each Project component is the sum of construction costs for primary work elements. The OPCC is the sum of the BCC, construction contingencies, and engineering and administration costs. The OPCC includes the following allowances:

- 30-percent of the BCC for contingencies. Construction contingency is commonly 10-percent when the design is 100-percent complete. However, we recommend a 30-percent contingency for this OPCC because of:
  - The current status of design (30-percent).
  - The Project's remote location.
  - Limited contractor availability in the current construction market.
- 15-percent of the BCC for construction engineering and administration.
- 10-percent for unlisted items.
- 10-percent for design engineering to advance the design to 100-percent complete.

The OPCC is presented in Table 2. Additional information regarding the cost opinion is presented in Attachment 1.

TABLE 2
OPCC SUMMARY

	Cost
BCC	$5,485,400
OPCC	$9,050,910

The OPCC is based on professional opinions and will change as design details are further developed. Actual costs could be affected by a number of factors beyond current control such as supply and demand for the types of construction required at the time of bidding, changes in material supplier costs, changes in labor rates, competitiveness of contractors and suppliers, availability of qualified bidding contractors, changes in applicable regulatory requirements, and changes in design standards. Conditions and factors arising as the Project proceeds from design through bidding and construction may result in construction costs that differ from the estimate provided in this memorandum. In addition, other project costs beyond the construction of the conveyance system may be required that are not accounted for herein (i.e., environmental permitting, easement acquisition, etc.).

5.0 Advancing the Project

Advancement of the Project will require additional data collection, design, and coordination with stakeholders. RJH anticipates stakeholders would include local landowners, NDOT, CNPPID, and permitting agencies. RJH anticipates that some of the actions needed to advance the Project include:

1. Obtain a topographic and property boundary survey of the Project site to facilitate civil design and layout. The concepts presented in this report are based on publicly available topographic data.
2. Continue discussions with NDOT to verify if the existing culvert can be used to convey flow to plum creek or if an alternative route is required.
3. Continue coordination with land owner's to obtain the required easements for the selected alternative.
4. Perform a geotechnical exploration to obtain site-specific soil and groundwater data. RJH recommends advancing boreholes and performing sampling and testing including:
    - Structures and Vaults:
        - Drill to at least 15 feet below the planned bottom of excavation at each structure. Due to a shallow water table, these boreholes may need to be advanced using mud rotary or rotary wash drilling techniques.
        - Perform in-situ Standard Penetration Tests (SPT) at no greater than 5-foot intervals. Collect undisturbed samples from the materials on which the structure will bear.
        - Perform the following laboratory tests: Index (gradation tests, moisture content, Atterberg limits, unit weight), soil corrosion, soil strength, consolidation, and standard Proctor density tests.
    - Pipeline:
        - Minimum seven (7) Test Pits along alignment, including one at the location of the discharge area.
        - Lab Testing:
            - Soil index, soil corrosion, Standard Proctor density tests, and permeability.
5. Evaluate and comply as needed with environmental permitting requirements. The Project may require obtaining environmental permits to construct and operate the Project.
6. Evaluate if additional public safety features should be included in the Project at the selected discharge location such as guardrail along US-283.

7. Perform final engineering and analyses needed to support designs for a cost-effective and reliable conveyance system. The concepts presented herein are considered 30-percent complete.

6.0 References

Banyopadhyay, S S. (1983). *Geotechnical Evaluation of Loessial Soils in Kansas, Transportation Research Record 945.* Washington D.C.: Journal of The Transportation Research Board.

Condon, S. (2005). *Geologic Studies of the Platte River, South-Central Nebraska and Adjacent Areas—Geologic Maps, Subsurface Study, and Geologic History.* United States Geological Survey (USGS).

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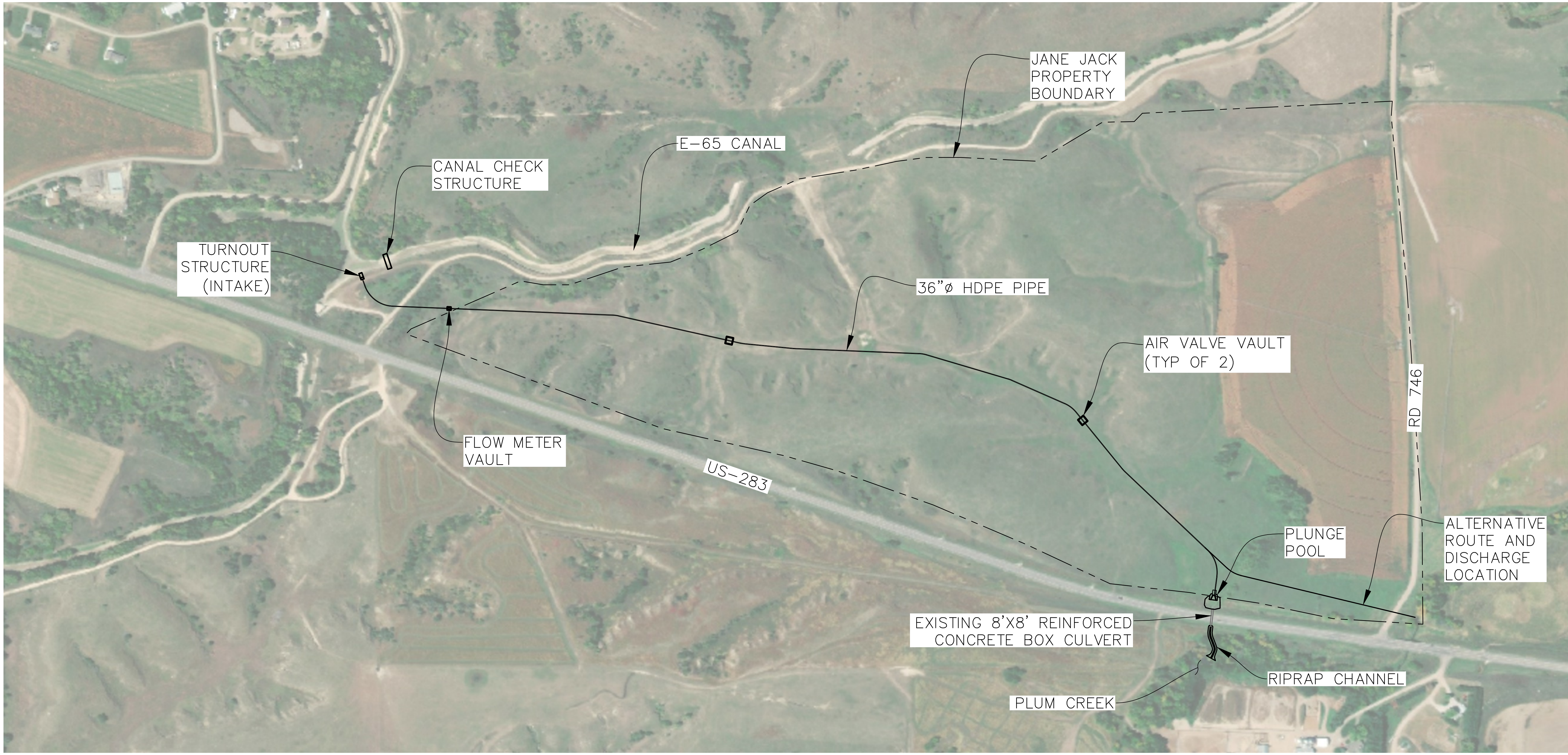
RJH Consultants, Inc. (2021). *Geotechnical Data Report, Elwood Dam Seepage Mitigation Project, Gosper County, Nebraska.* Denver, CO: Central Nebraska Public Power and Irrigation District.

Figures:

Attachments:

BES/ATM/atm/ecp



PRELIMINARY
NOT FOR CONSTRUCTION

0 250 500 1000
SCALE IN FEET

RJH CONSULTANTS, INC.

ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN

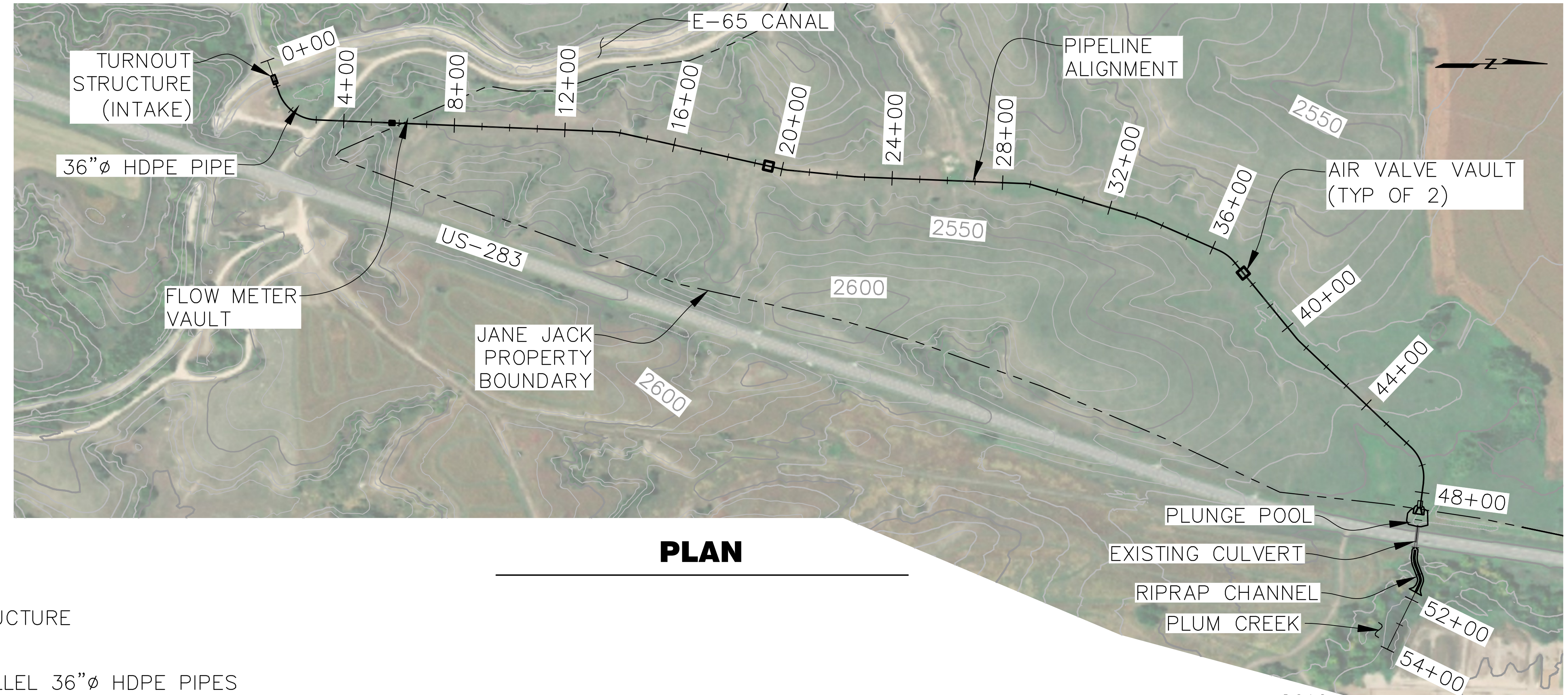
GENERAL PLAN OF MODIFICATIONS

PROJECT NO. 23138

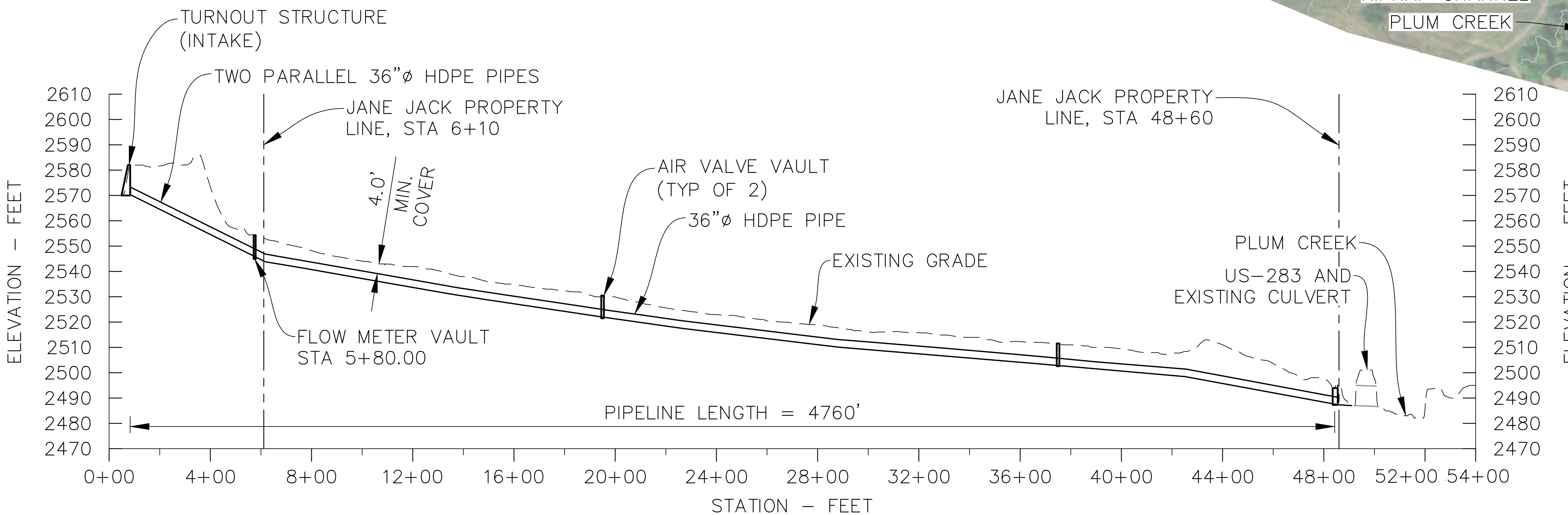
July 2025

Figure 1

P:\23138 – ELWOOD RECAPTURE RECONNAISSANCE STUDY\CAD\30PDESIGN\23138_20250725_30PDESIGN_PLANANDPROFILE.DWG 7/29/2025 9:50 AM



PLAN



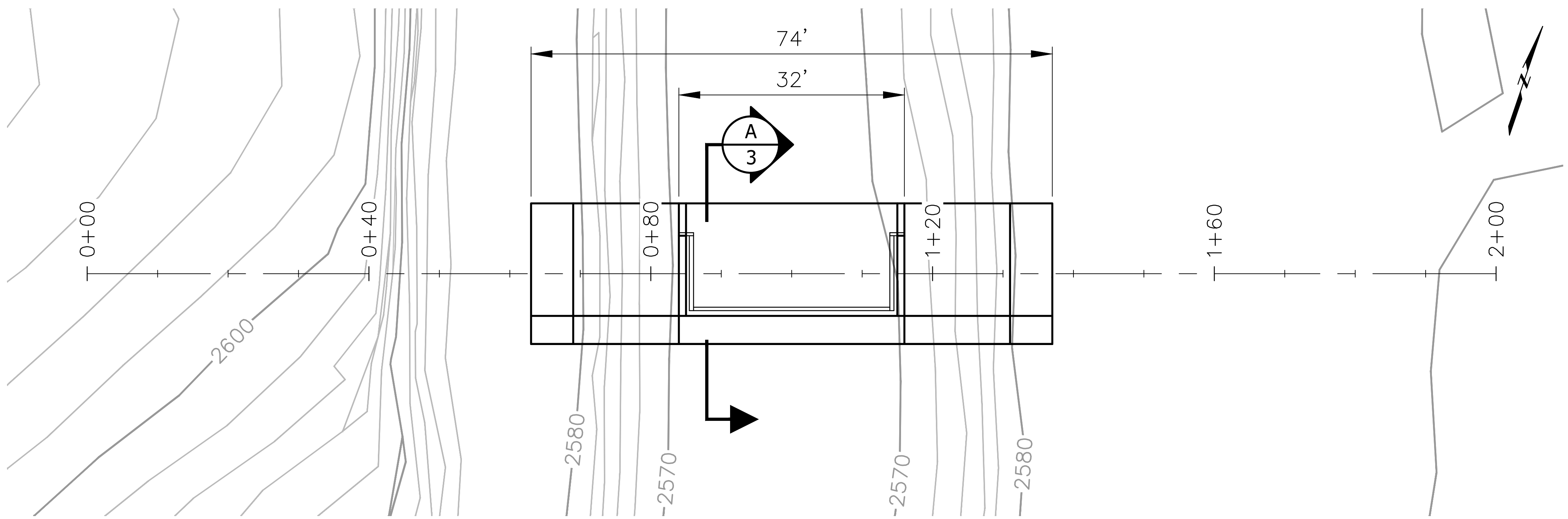
PROFILE

PRELIMINARY
NOT FOR CONSTRUCTION

0 250 500 1000
HORIZ. SCALE: 1" = 500'
VERT. SCALE: 1" = 50'

RJH CONSULTANTS, INC.	ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN	PIPELINE PLAN AND PROFILE	
	PROJECT NO. 23138	July 2025	Figure 2

P:\23138 – ELWOOD RECAPTURE RECONNAISSANCE STUDY\CAD\30PDESIGN\23138_20250725_30PDESIGN_PLANANDPROFILE.DWG 7/29/2025 9:50 AM



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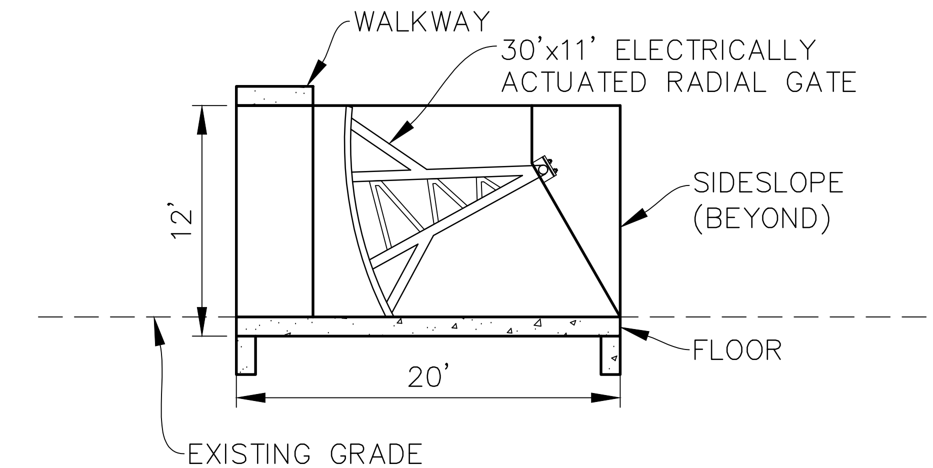
SCALE IN FEET



SECTION A 3

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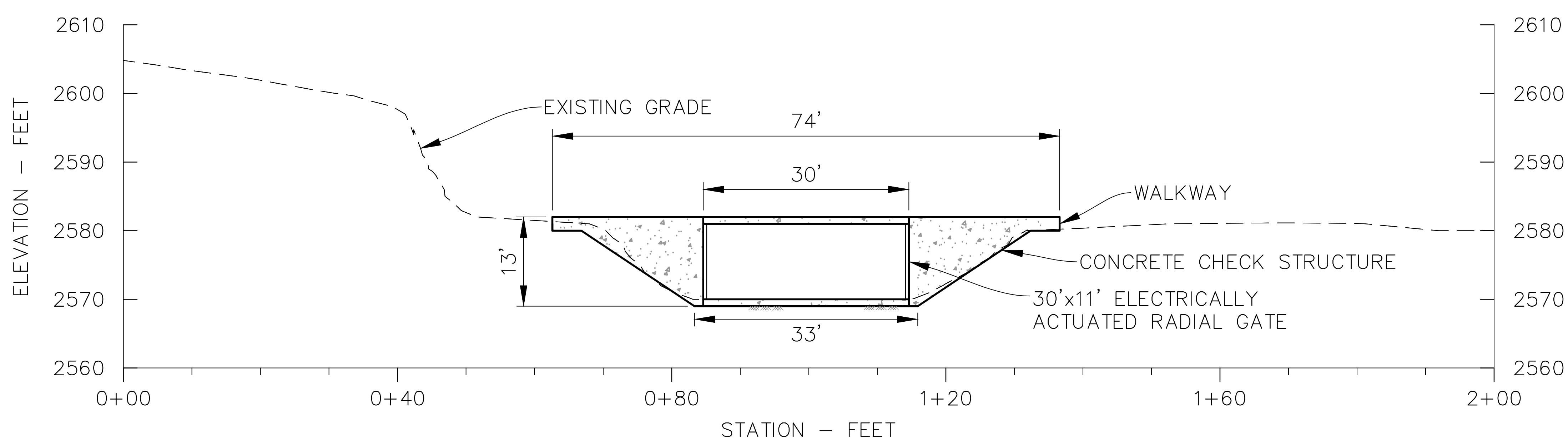
SCALE IN FEET



PROFILE

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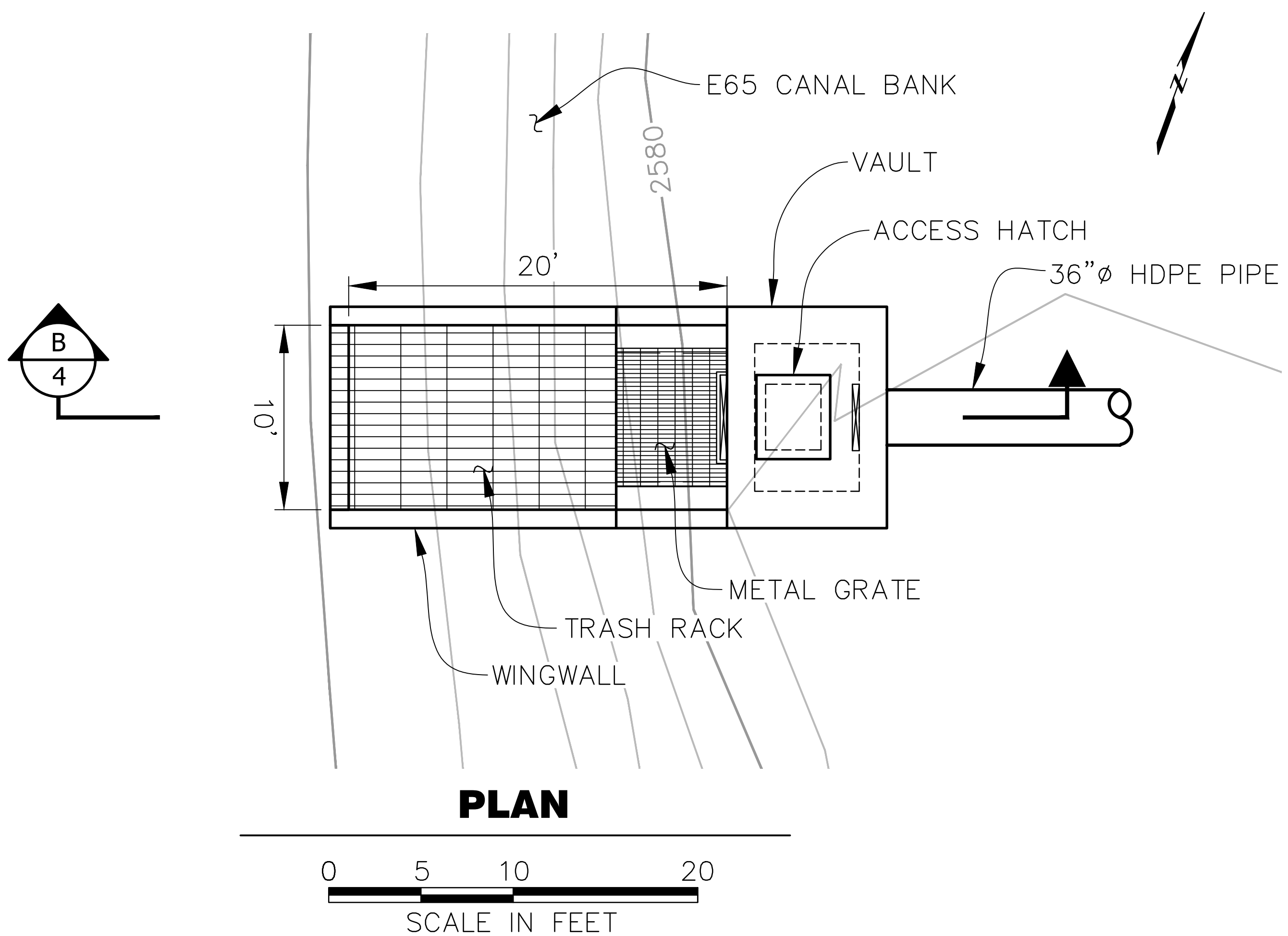
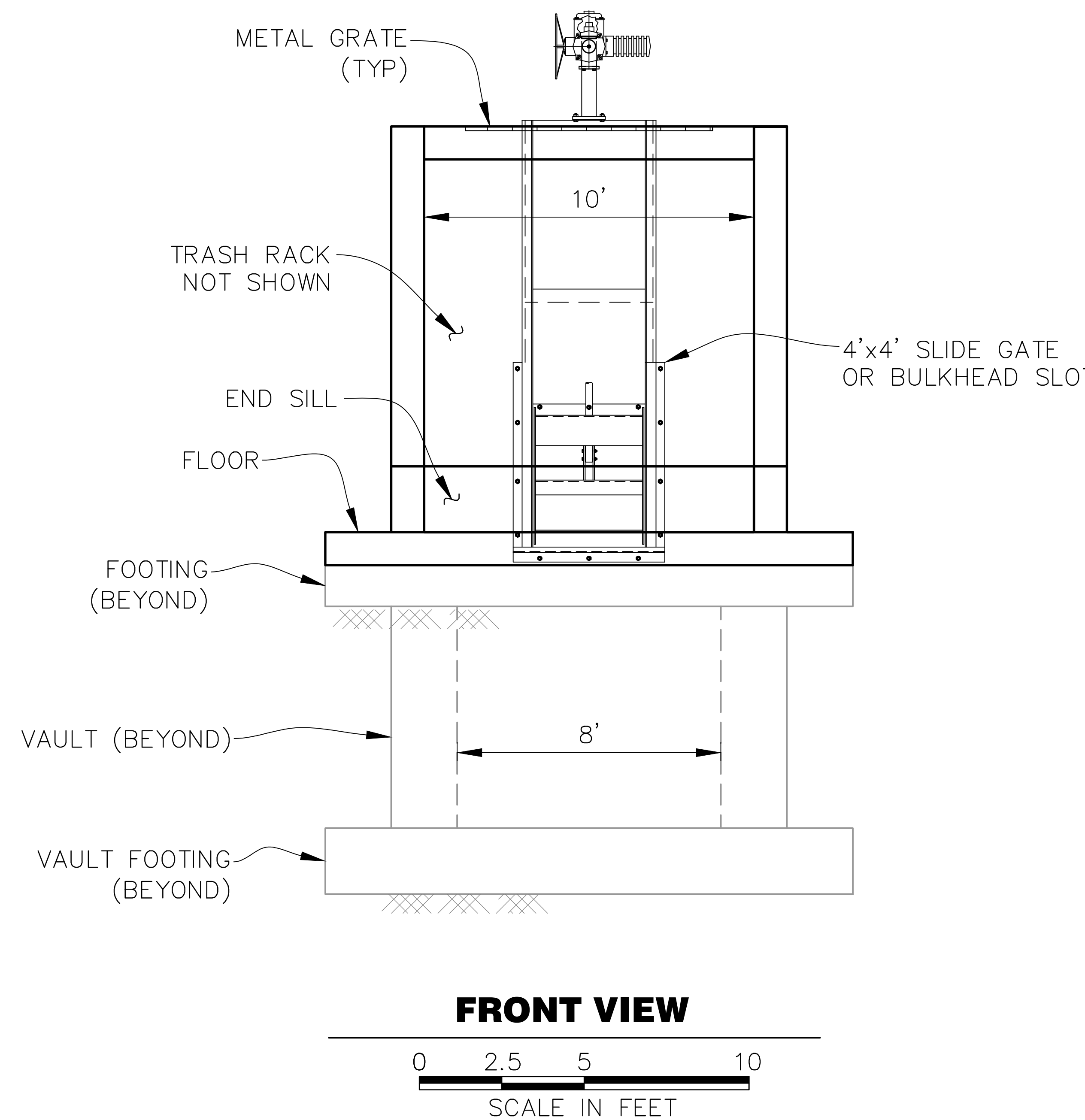
SCALE IN FEET

PRELIMINARY
NOT FOR CONSTRUCTION

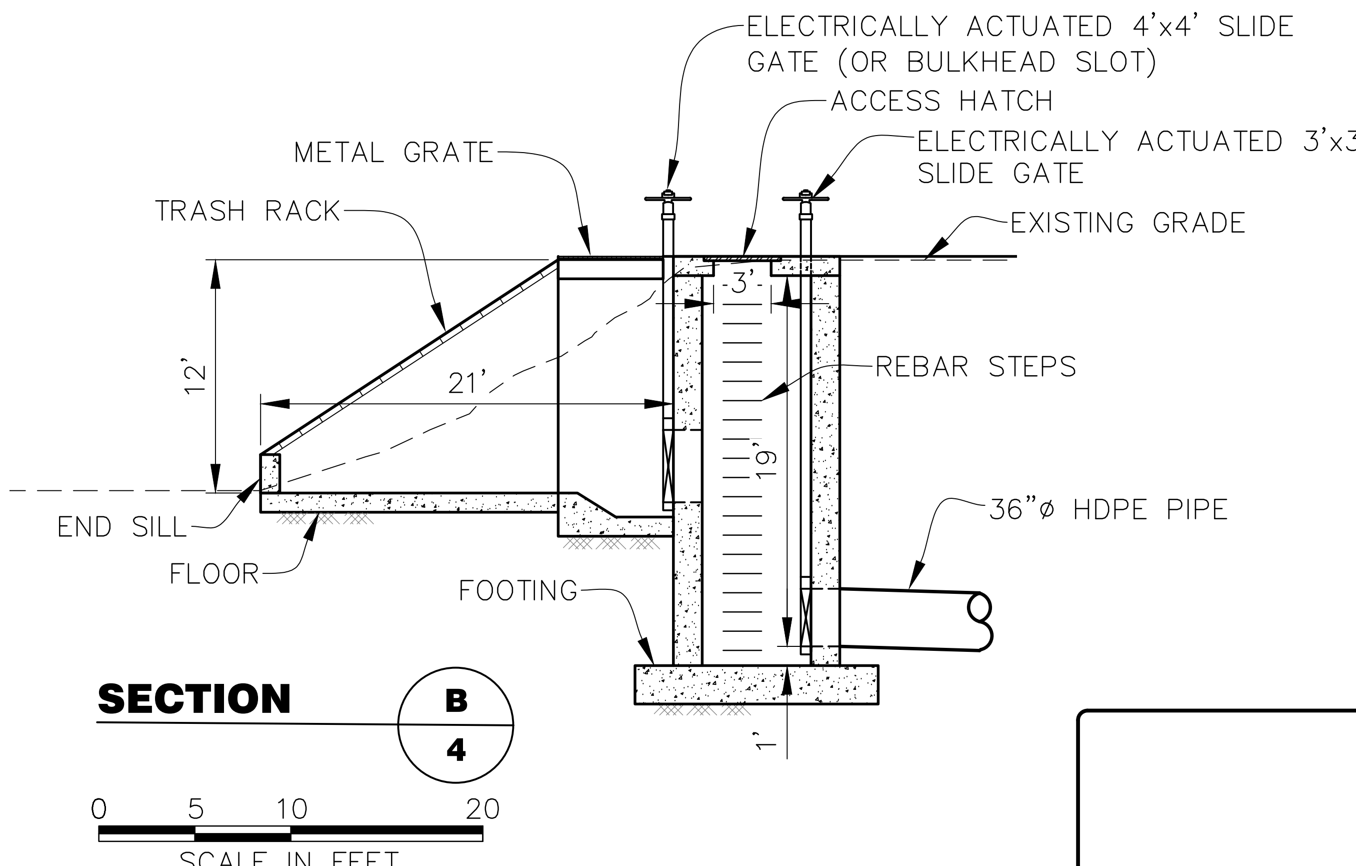
RJH CONSULTANTS, INC.	ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN	CANAL CHECK STRUCTURE
	PROJECT NO. 23138	July 2025 — Figure 3



PLAN



FRONT VIEW



SECTION B-4

PRELIMINARY
NOT FOR CONSTRUCTION

RJH CONSULTANTS, INC.

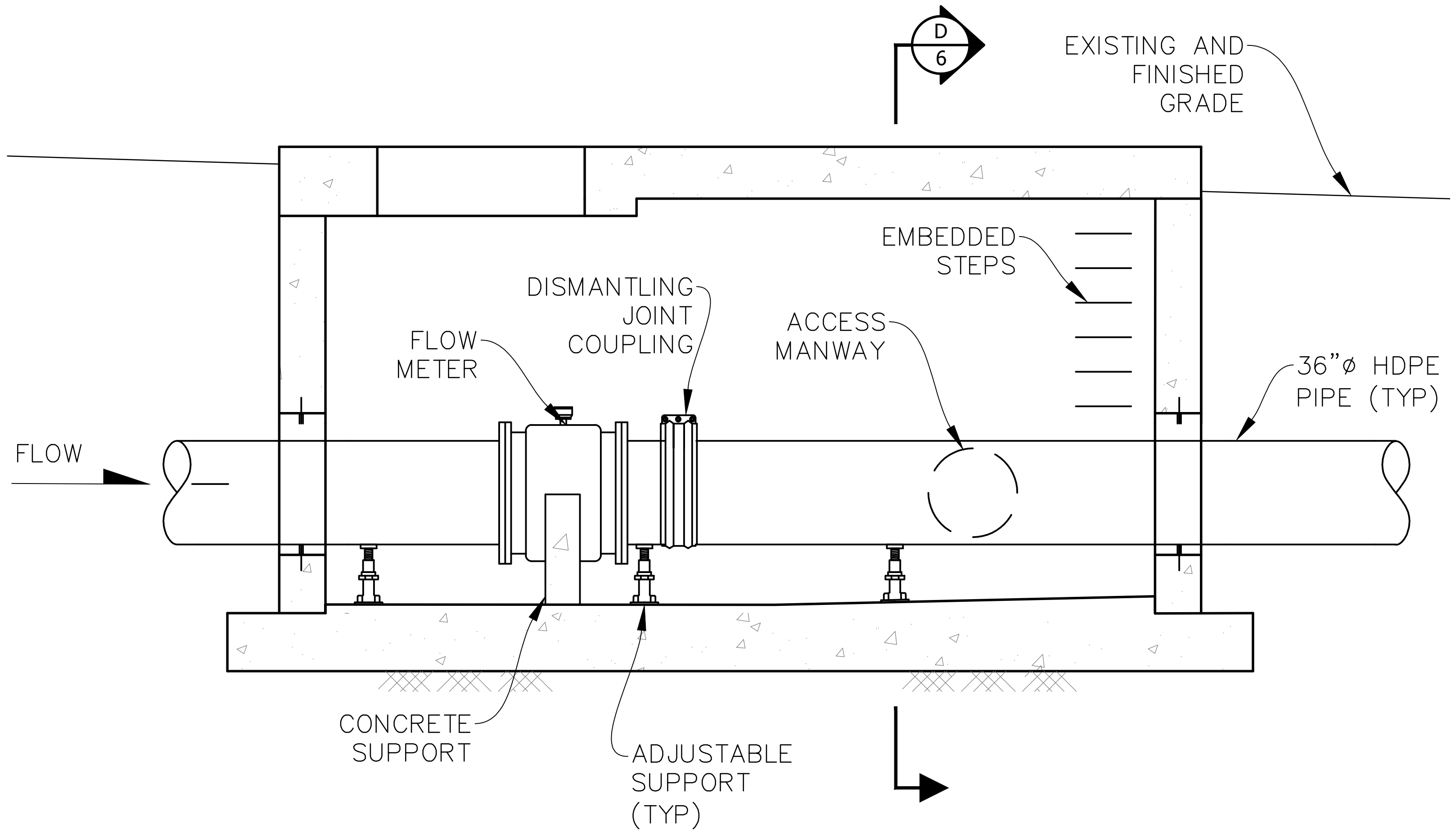
ELWOOD OUTLET
FEASIBILITY STUDY -
PHASE I OUTLET DESIGN

PROJECT NO. 23138

TURNOUT STRUCTURE
(INTAKE)

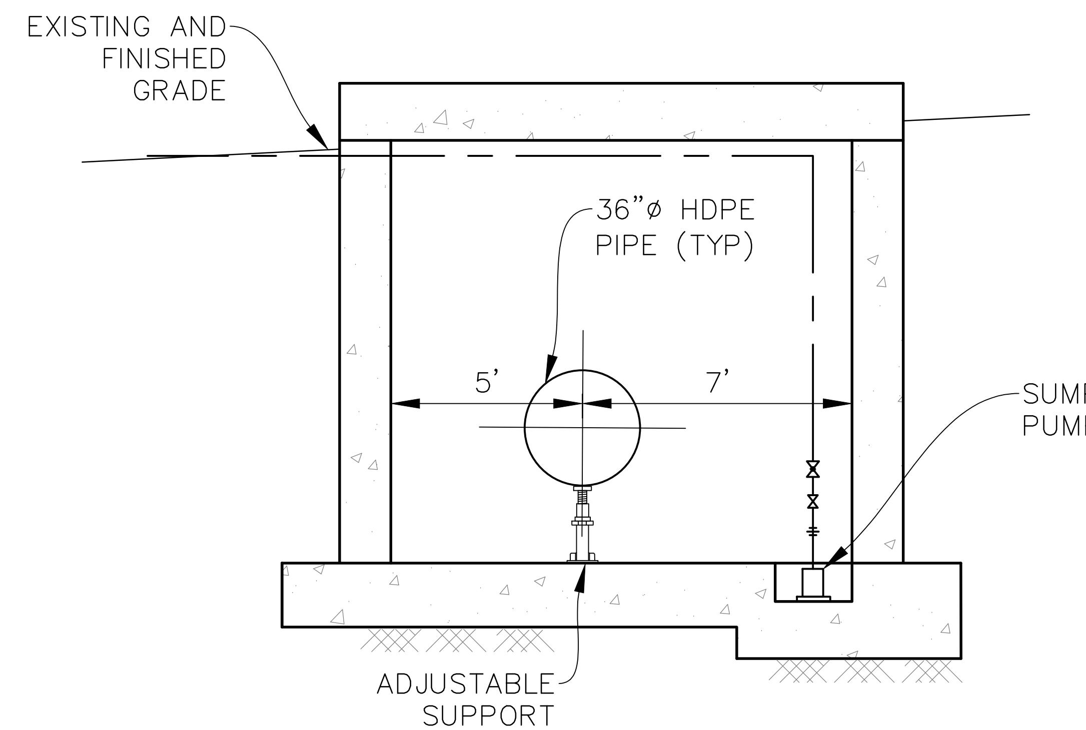
July 2025

Figure 4



PROFILE

0 2.5 5 10
SCALE IN FEET



SECTION D/6

0 2.5 5 10
SCALE IN FEET

PRELIMINARY
NOT FOR CONSTRUCTION

RJH CONSULTANTS, INC.

ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN

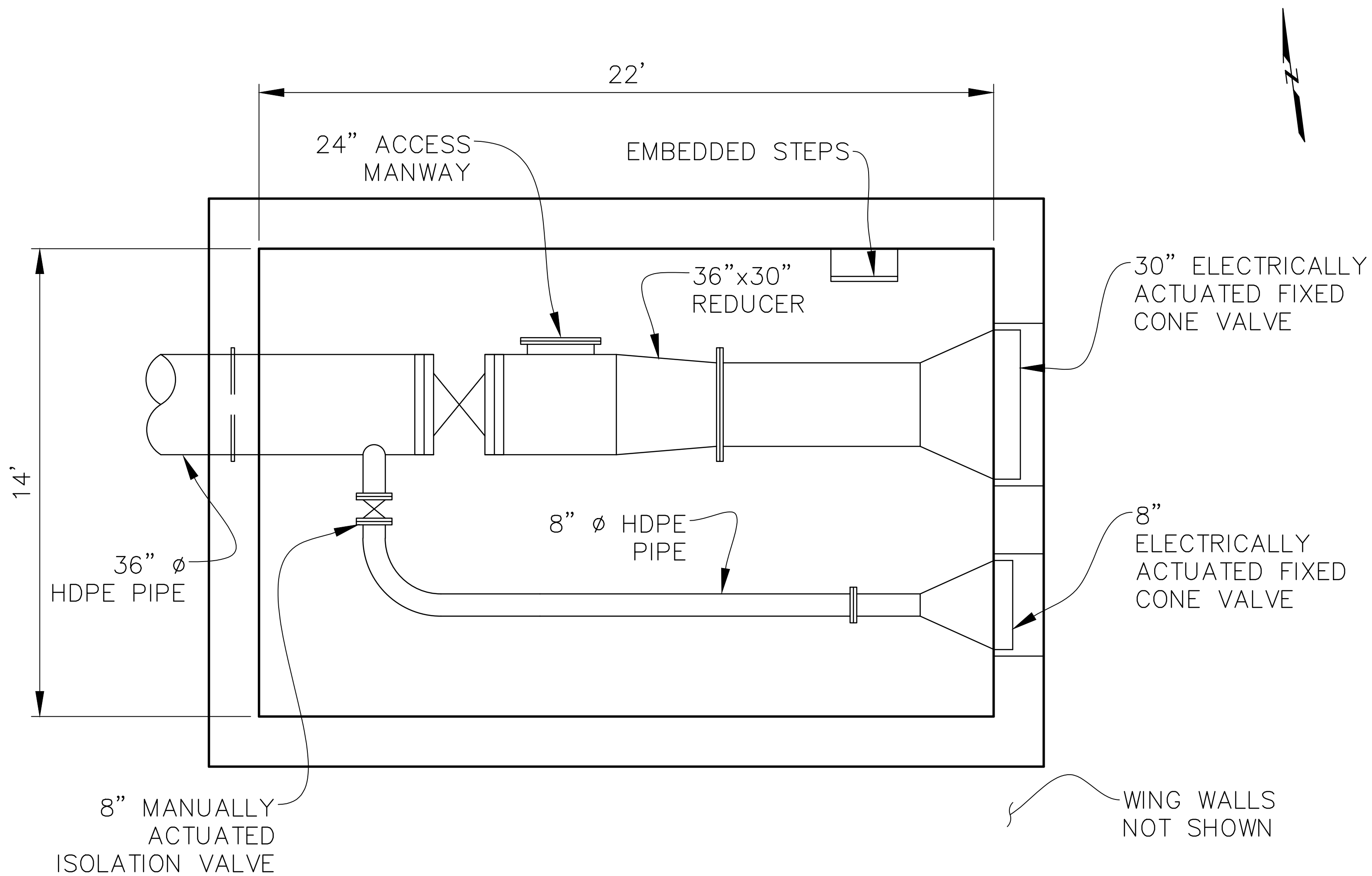
PROJECT NO. 23138

FLOW METER VAULT

July 2025

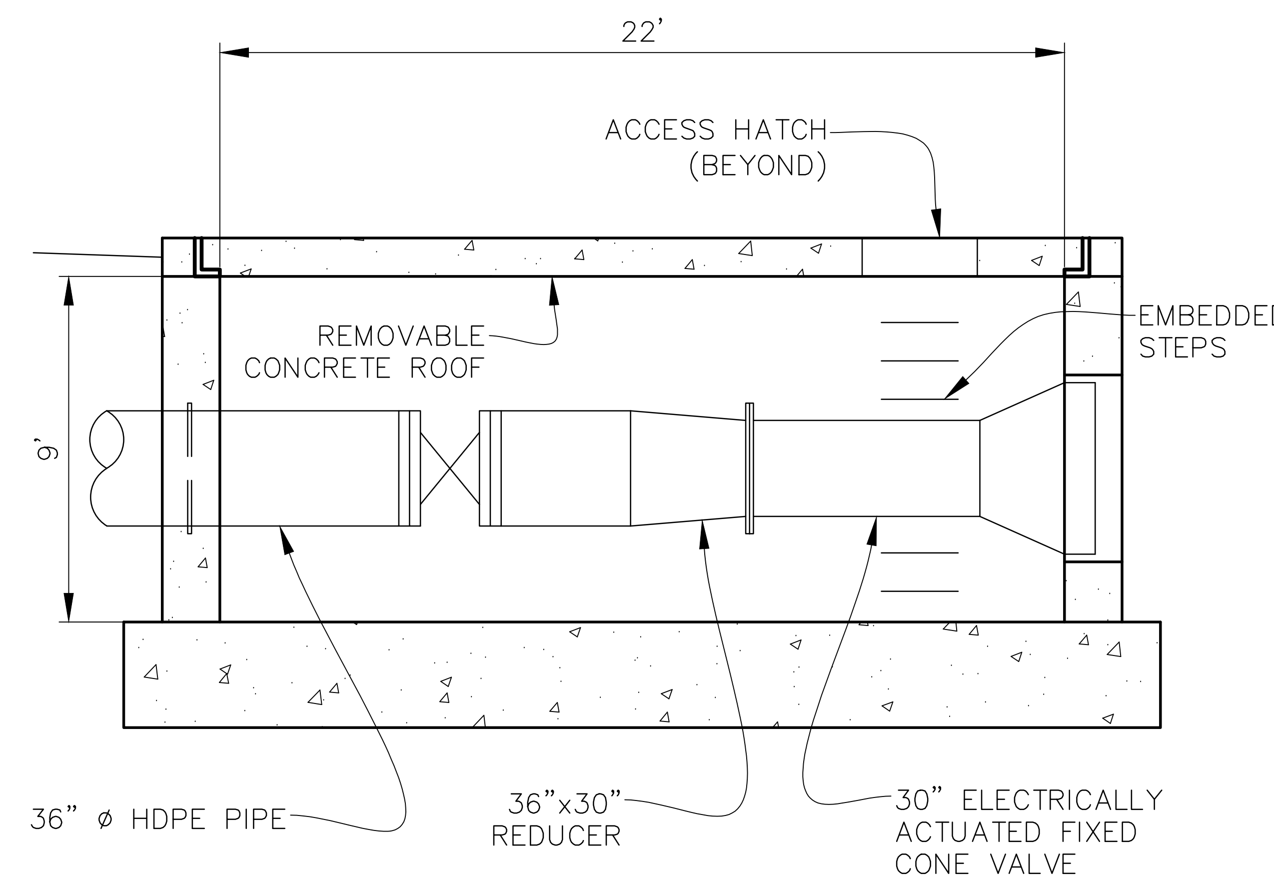
Figure 5

P:\23138 - ELWOOD RECAPTURE RECONNAISSANCE STUDY\CAD\30PDESIGN\23138_20250725_30PDESIGN.DWG 7/29/2025 9:51 AM



PLAN

0 2.5 5 10
SCALE IN FEET

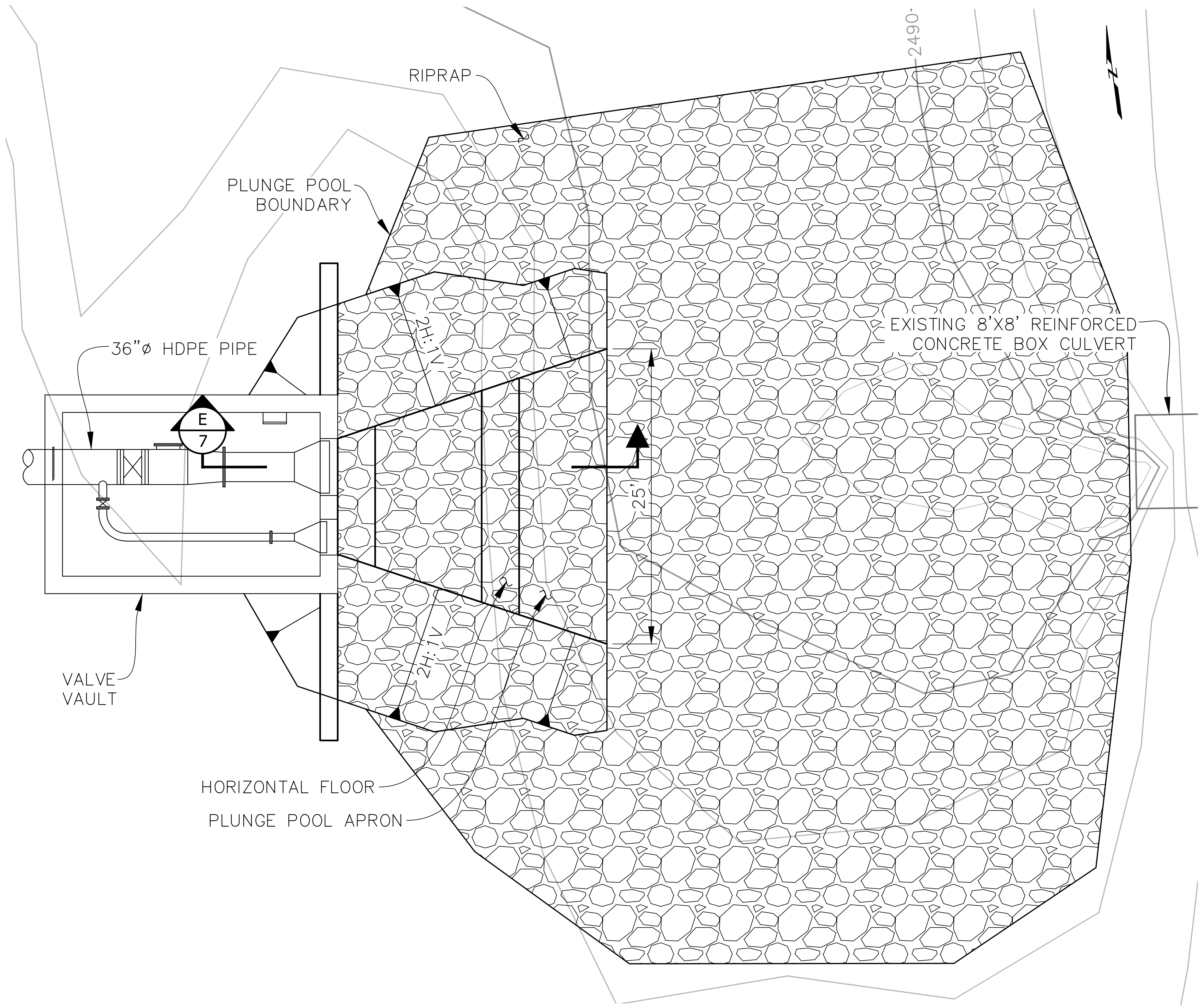


PROFILE

0 2.5 5 10
SCALE IN FEET

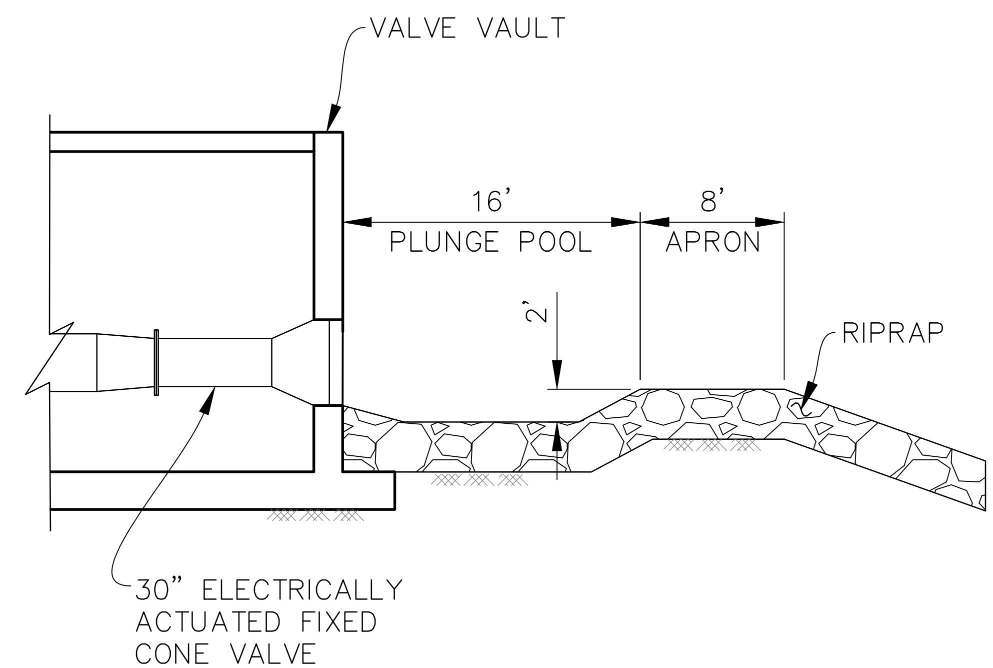
PRELIMINARY
NOT FOR CONSTRUCTION

RJH CONSULTANTS, INC.	ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN	VALVE VAULT	
	PROJECT NO. 23138	July 2025	Figure 6



PLAN

0 5 10 20
SCALE IN FEET



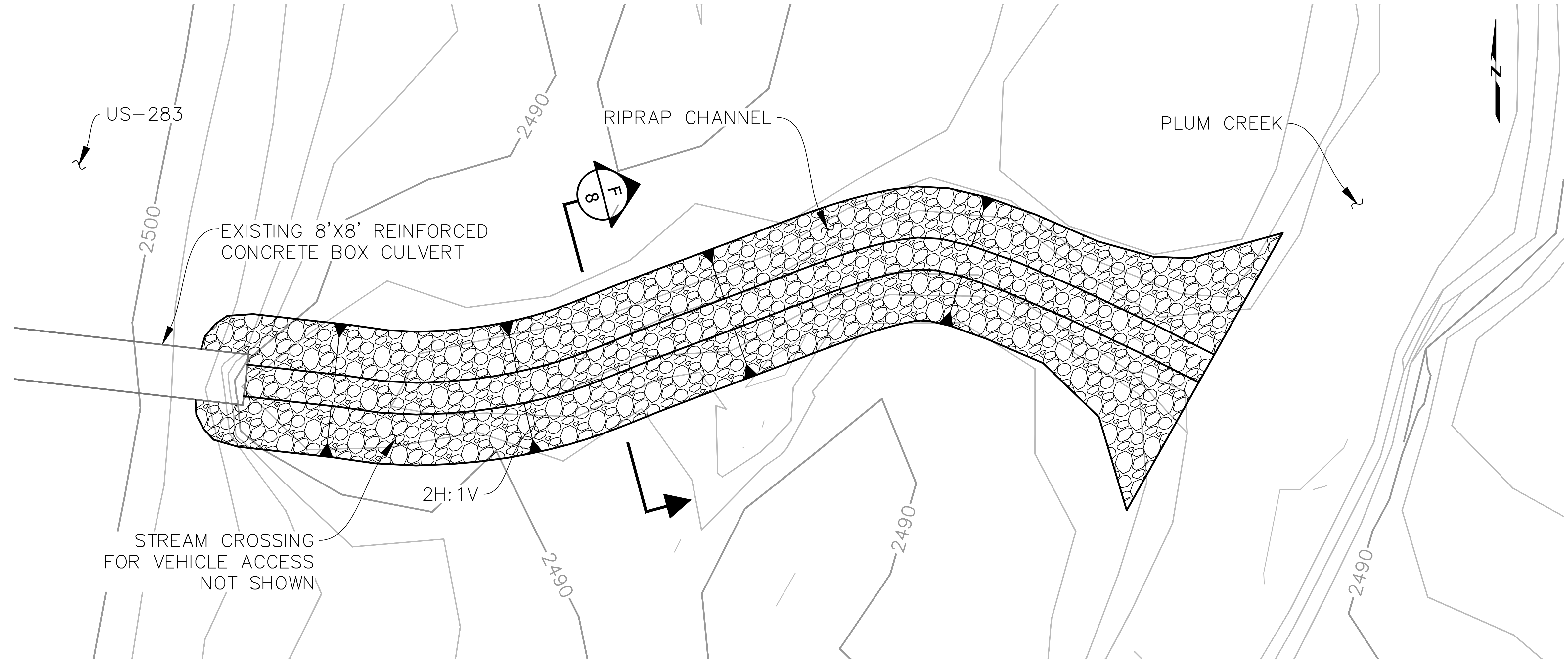
SECTION E/7

0 5 10 20
SCALE IN FEET

PRELIMINARY
NOT FOR CONSTRUCTION

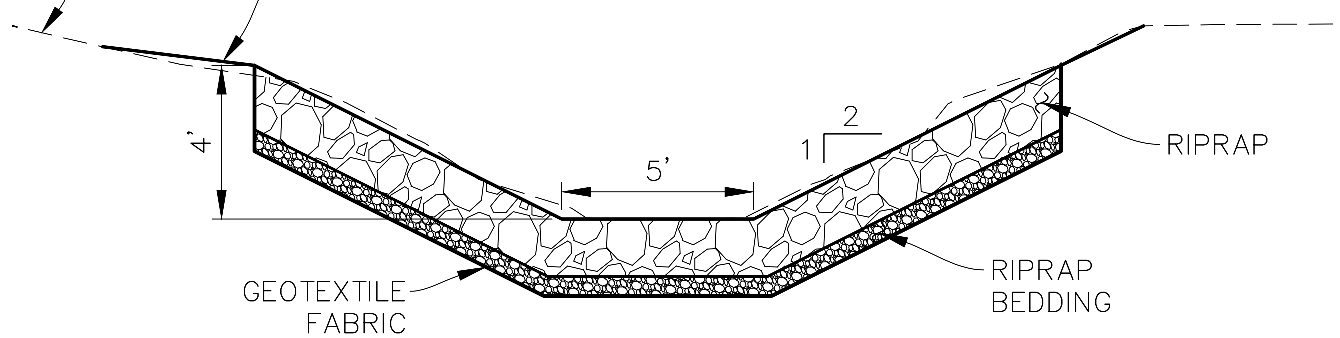
RJH CONSULTANTS, INC.

ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN	PLUNGE POOL
PROJECT NO. 23138	July 2025 — **Figure 7**



PLAN

0 10 20 40
SCALE IN FEET



SECTION F / 8

0 2.5 5 10
SCALE IN FEET

PRELIMINARY
NOT FOR CONSTRUCTION

RJH CONSULTANTS, INC.

ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN

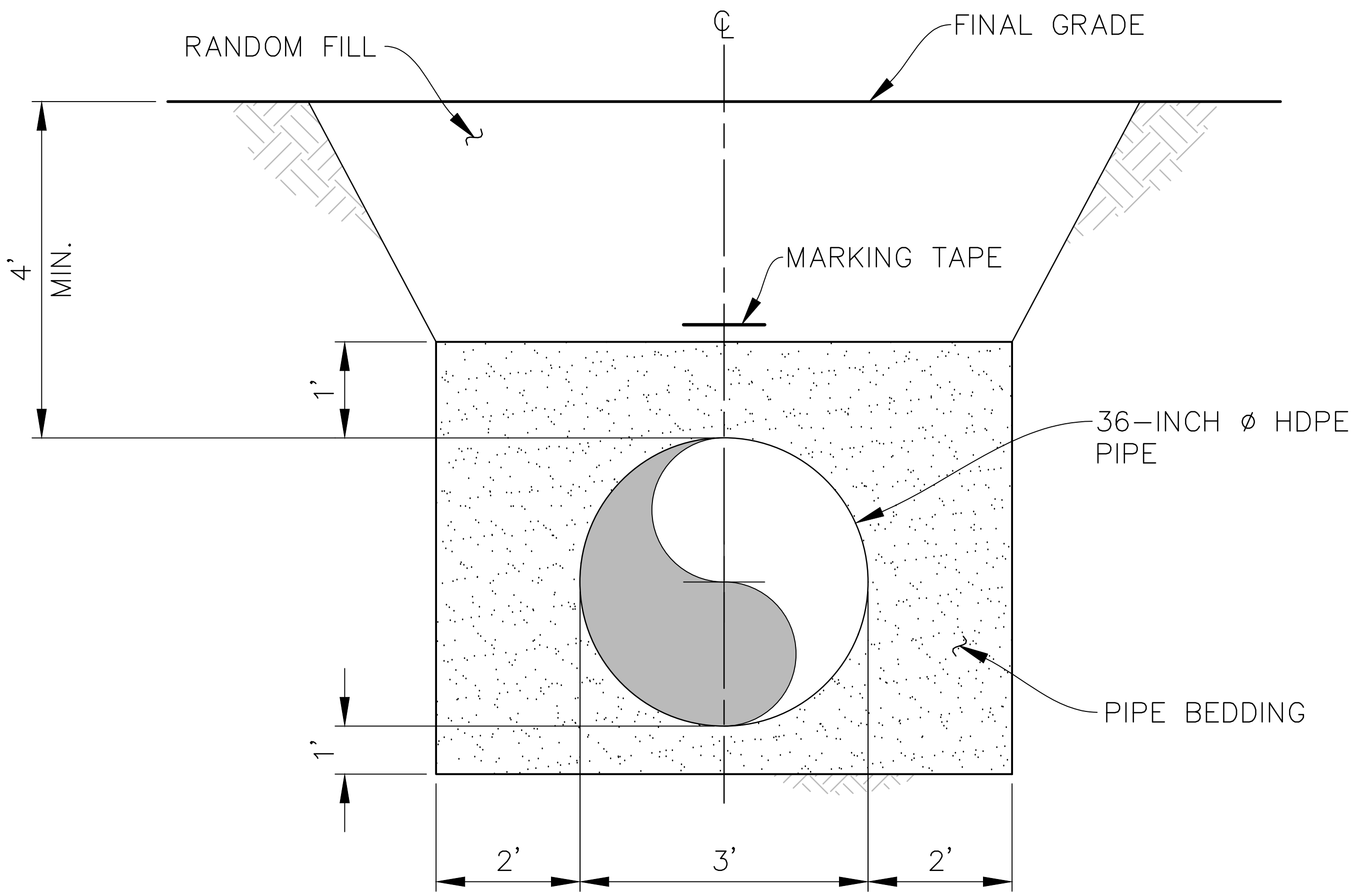
RIPRAP CHANNEL

PROJECT NO. 23138

July 2025

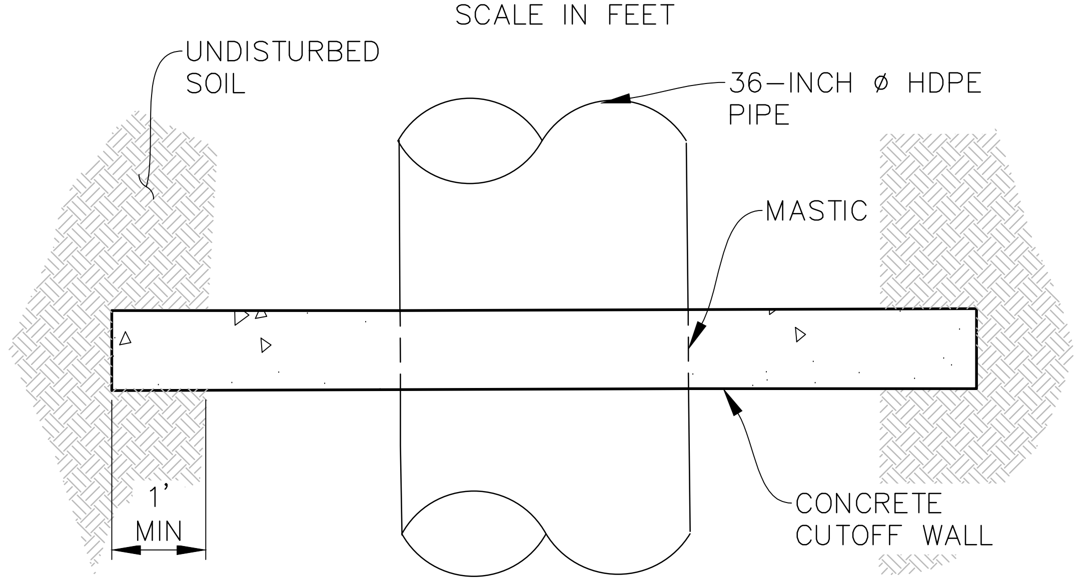
Figure 8

P:\23138 – ELWOOD RECAPTURE RECONNAISSANCE STUDY\CAD\30PDESIGN\23138_20250725_30PDESIGN.DWG 7/29/2025 9:50 AM



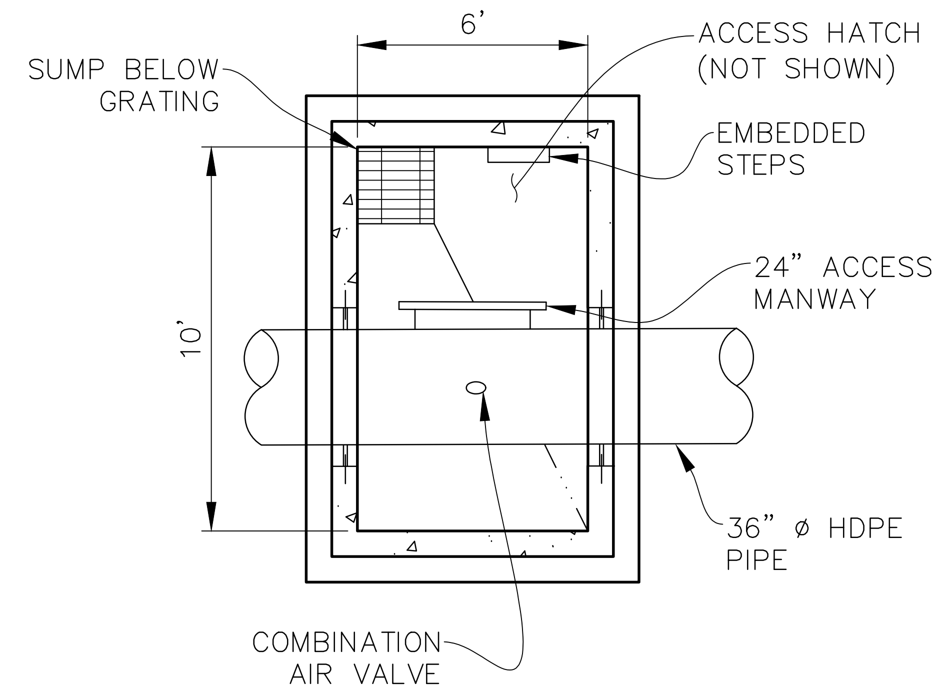
TYPICAL PIPE TRENCH DETAIL

0 1 2 4
SCALE IN FEET



TYPICAL CUTOFF WALL PLAN

0 1 2 4
SCALE IN FEET



AIR VALVE VAULT PLAN

0 2.5 5 10
SCALE IN FEET

PRELIMINARY
NOT FOR CONSTRUCTION

RJH CONSULTANTS, INC.

ELWOOD OUTLET FEASIBILITY STUDY - PHASE I OUTLET DESIGN

TYPICAL DETAILS

PROJECT NO. 23138

July 2025

Figure 9

ATTACHMENT 1

OPCC

July 29, 2025

RJH Consultants, Inc.

Elwood Expanded Recapture Reconnaissance Study, Phase 1 – Outlet Design

Attachment 1 - Opinion of Probable Construction Cost (OPCC)

Item No.	Item	Unit	Estimated Quantity	Unit Price ($)	Total Price ($)
General					
1	Mobilization and Demobilization	LS	1	50,000	50,000
2	Clearing and Grubbing	LS	1	30,000	30,000
3	Dewatering	LS	1	250,000	250,000
4	SCADA and Instrumentation	LS	1	250,000	250,000
5	Access Roads	LS	1	30,000	30,000
HDPE Pipeline					
6	36" HDPE Pipe	LF	4,760	165	785,400
7	Excavation, Pipe Bedding, Backfill	LF	4,760	250	1,190,000
8	Trench Boxes	LS	1	100,000	100,000
9	Air Valve Vault	LS	2	70,000	140,000
10	Flow Meter Vault	LS	1	250,000	250,000
11	Turnout Structure and Vault, Slide Gates	LS	1	400,000	400,000
12	Fixed Cone Valve Vault w/ Bifurcation	LS	1	400,000	400,000
Other Structures					
13	Canal Check Structure w/ Radial Gate	LS	1	1,500,000	1,500,000
14	Riprap Plunge Pool	LS	1	50,000	50,000
15	Riprap Channel (d/s of US-283 Culvert)	LS	1	60,000	60,000
Base Construction Cost (BCC)					**5,485,400**
Unlisted Items (10% of BCC)					548,540
Design and Construction Contingency (30% of BCC)					1,645,620
Design Engineering (10% of BCC)					548,540
Construction Engineering and Management (15% of BCC)					822,810
Opinion of Probable Construction Cost (OPCC)					**9,050,910**