HELIUM SIPHON
FINAL CONCEPTUAL DESIGN REPORT

Prepared for

Navajo Nation Department of Water Resources
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TABLE OF CONTENTS

INTRODUCTION

The Helium Siphon begins at Hogback Canal, crossing the San Juan River and discharges into the Helium Lateral. This project will replace the Helium Siphon with new pipe, rehabilitate the concrete intake structure adding a new trash rack and safety rope, construct a new outlet structure, and install turnouts according to the conceptual design. The last third of the siphon will be re-routed to better serve the farmland. The project also abandons the current Helium Siphon in the residential areas south of the San Juan River.

Project Background

While in operation, the Helium Siphon served 951 acres via a 40-inch steel coal tar pipeline approximately 9,750 feet long. This siphon is fed by the Hogback Canal and is located in the Shiprock Chapter (Figure 1). The existing inlet structure is functional and will be rehabilitated and used for the new siphon.

Helium Siphon Deficiencies

Deficiencies for the Helium Siphon include:

- The siphon failed in 2009 and no longer conveys water. It has not been determined why the siphon doesn't convey water. Work crews have continuously repaired a section of the pipe 500 ft north of the San Juan River until they determined that the steel pipe is no longer usable.
- The intake channel feeding the siphon intake structure needs to be cleaned coupled with minor rehabilitation, the 40-inch slide gate turnout replaced, trash rack replaced, and the security fence replaced.
- A portion of the existing Helium Siphon south of the San Juan River has had significant development both near and on top of the existing pipeline.
- No log boom or safety rope at the intake structure.

Alternatives and Selection

Because Helium Lateral Siphon is no longer in operation, the alternatives to be considered include:

1. Replace the siphon using the existing route.
2. Replace the existing 40-inch steel pipe with 36-inch plastic pipe. The existing inlet structure is functional and will be rehabilitated and used for the new siphon. The proposed siphon alignment will be installed west of the existing siphon (Figure 1). The proposed 36-inch siphon alignment is 11,300 feet long and follows the existing alignment for approximately 5,180 feet, crossing the Bluff Road and the San Juan River (Figure 1). Upon crossing the floodplain, the proposed alignment diverts from the existing siphon to avoid new municipal and housing development. The proposed alignment continues along the edge of the development until it ties into the existing Helium Lateral. A new outlet structure is required at the new tie-in location.
    a. The 36-inch siphon option is the best option if gravity pressure to the school pumping plant is desired. Another option being reviewed for siphon replacement is a 30-inch pipeline. However, it would also require a booster pump to get water to the school pumping plant.
    b. HDPE and PVC were both examined as pipe material. PVC pipe appears more economical. A more detailed analysis of these options and their costs is in

Appendix E. HDPE will still be used in saturated areas and for highway crossings.

On April 13, 2016, the United States Bureau of Indian Affairs met with the Navajo Nation Department of Water Resources Technical, Construction, and Operations Branch where alternative two was selected (Appendix E). The reason why alternative two was selected was the new route is adjacent to the current farm land and doesn't impact the developed land to the south. We also recommend that PVC pipe be selected over HDPE due to cost savings and familiarity by local entities. The only places where HDPE would be utilized are for road and river crossings.

Three reviews of this conceptual design were completed between the Bureau of Indian Affairs and the Navajo Nation Department of Water Resources from February 25, 2016 until October 11, 2016. Minutes for each review may be found in Appendix F.

In addition, the new route was developed after consulting with local farmers, Dine College, Central Consolidated Schools, and to Shiprock Chapter. The route was finalized in a review meeting held on April 14, 2016. Shiprock Chapter passed a resolution on May 11, 2016 supporting the proposed new route (See Appendix E). The Navajo Nation Department of Water Resources needs to pursue a legal survey of the route and work with the Navajo Nation Land Department to obtain a right-of-way.

Figure 1. Helium Siphon Layout Map

CONCEPTUAL DESIGN

In 2003, NNDWR and Keller-Bliesner Engineering (KB) derived a conceptual design to correct the identified deficiencies. The Helium Siphon's existing steel pipe has exceeded its economic life and is no longer operational, requiring replacement. The conceptual design recommends that the existing 40-inch siphon should be replaced with a 36-inch DR 41 C905 PVC pipeline. PVC was chosen as the piping material because it is economical, non-corrosive, and durable. The 36-inch PVC pipeline is sufficient in size to convey the design flow to meet downstream demand. The pressure rating (DR41 or 100 psi) exceeds 125% of the maximum static pressure which meets recommended practices for addressing surge.

Road crossings and the river crossing will use 36-inch DR26 HDPE pipe sleeved in either the existing 40-inch steel pipe or new steel pipe to complete these crossings. HDPE is used in these locations to eliminate the risk of pipe joints. Repair couplings will be used to transition between the HDPE pipe and PVC pipe.

The existing siphon under the San Juan River should be investigated further to see if it may be utilized as a sleeve prior to designing a new crossing. If the existing siphon is suitable, it will save money, reduce impacts to the river, and reduce uncertainty involved with diverting the river.

The conceptual design uses the existing inlet structure but recommends a new outlet since it discharged to a different location. Drawing D100 in Appendix A shows a conceptual design for the outlet. The outlet includes a valve and orifice plate that maintains upstream pressure while dissipating energy that is discharged into Helium Lateral. The orifice plate is required to ensure water deliver to Central Consolidated existing pump located near the outlet of the current siphon. The existing Helium Siphon turnout from Hogback Canal requires replacement (Figure 2). The siphon intake channel requires rehabilitation with a new security fence around the intake channel and the intake structure (Figure 3 and Figure 4).

Field turnouts will follow a design typical of other irrigation pipelines in the Shiprock area (D105 in Appendix A). The field turnout will consist of a take-off tee, an isolation valve, and air vent, and a riser valve with turner. Air vents on the main line are enclosed in concrete manholes to reduce vandalism as shown on D102 in Appendix A. Flush out valves are to be located in low areas of the pipeline as shown on D103 in Appendix A.

The existing siphon will be abandoned in place (Appendix G). The new siphon follows on the west side of the existing alignment for approximately 5,180 feet to the south edge of the San Juan River floodplain (Figure 1). Dewatering will be required in the San Juan River crossing and throughout portions of the floodplain. Pea gravel will be used to bed the PVC pipe in saturated areas. New laterals are required to serve existing demands originally served by the existing siphon. Most notable is a lateral that will supply the Central Consolidated irrigation pump (See L100 in Appendix A).

Figure 2. Helium Siphon Turnout to be Replaced

Figure 3. Helium Siphon Intake Channel to be Rehabilitated

Figure 4. Helium Siphon Intake Structure

INVESTIGATIONS

The following investigations were completed:

1. Original siphon investigation by KB (2003) (Figure 5).
2. Siphon alignment investigation by KB in April 2015, and Shiprock Chapter and shareholder preliminary design discussions.
3. Topographic surveys by the Navajo Nation Department of Water Resources and Johnson Mapping and Surveying, LLC with support from KB. The original survey was conducted in June 2015. Follow-up surveys were conducted in September 2015 and April 2016. (Appendix C).
4. Soil test pits excavated to assess sub-surface soil and identify water table in June 2015 (Appendix D).

In addition, interviews conducted with geotechnical engineers familiar with the area of the Helium Siphon river crossing indicate that the sub-terrain strata is a deep layer of loose alluvium aggregate. This deterred the conceptual design from pursuing a bore underneath the river to cross the San Juan River.

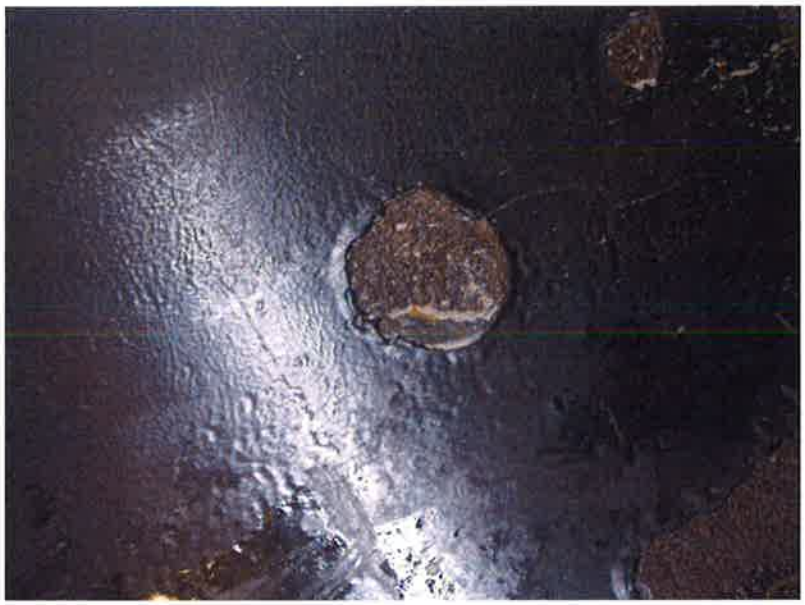

Figure 5. Helium Siphon 40-inch Steel Coal Tar Pipeline Corrosion in 2002

DESIGN CRITERIA

The conceptual design was completed by KB with input from NNDWR. KB was responsible for overall direction, Designs and Specifications, permitting, and reporting.

Designs yet to be completed include:

- Layout drawing
- Security fencing around the inlet and outlet structures

Crop Mix Data

Crop mix data for irrigated lands within the project area (Table 1) are based on surveys given to area farmers

Table 1. Crop Mix Summary for Fruitland-Cambridge Irrigation Project

Crop	Crop Mix (%)
Alfalfa[1]	54%
Alfalfa establishment	6%
Corn 1st Planting[2]	13%
Corn 2nd Planting[2]	12%
Melons	3%
Pasture (extensive grazing)	10%
Vegetables (warm)	2%
Total	**100.0%**

Table adapted from surveys provided to Gadii'ahi farmers.
[1]Alfalfa is typically planted on a 9-year rotation; thus, 1/9 of the alfalfa acreage is assumed to be in fall establishment.
[2]Corn plantings are staged so there is a continuous harvest in the fall. Plantings are typically 20 days apart.

Weather Data

Daily climate data for CIR calculations (1980 – 2009) were obtained from a CD-ROM produced annually by Hydrosphere Data Products. This CD contains National Climatic Data Center (NCDC) COOP weather station data (Hydrosphere 2009). Weather data from the National Weather Service Shiprock (USC00298284) weather station were used for the Hogback, Fruitland, Cambridge, and Gadaii'ahi CIR calculations.

On-Farm Efficiency

On-farm efficiency (Table 2) varies based on the irrigation system type employed at the farm level. The most common irrigation types within the project area are graded furrow, border irrigation systems. The associated average design application efficiency (Ea) was used (65%) in the design flow analysis.

Table 2. Probable Application Efficiencies (Ea) for On-farm Irrigation Systems.

On-farm Irrigation System Type	Ea (%)	Average Design Ea (%)
Periodic move lateral (hand or side roll)	60-75	68
Periodic move gun type or boom sprinklers	50-60	55
Fixed laterals (solid set)	60-75	68
Traveling sprinklers (gun type or boom)	55-67	61
Center pivot – standard	75-85	80
Linear (lateral) move	80-87	84
LEPA – center pivot and linear move	90-95	93
Drip/Trickle[1]	85-95	90
Level furrow, border or basin.	50-95	73
Graded furrow, border (75% of runoff reuse)	55-90	73
Graded furrow, border (0% runoff reuse)	50-80	65

Table adapted from the Chapter 2 of the 1993 National Engineering Handbook Tables 2-48, 2-49, 2-50, and 2-51.
1. Drip/Trickle application efficiency adapted from Morris et. al 2006.

Conveyance Efficiency

The Hogback Canal provides water to the Helium Siphon turnout. The canal conveyance efficiency is estimated to be 75%. The siphon conveyance losses will be minimal with the new HDPE pipeline. The siphon conveyance design efficiency is 95%.

Crop Curves

The crop curves (Table 3) used to calculate crop evapotranspiration are primarily developed using data taken from the FAO-56 publication (Allen et al. 1998), and data gathered during irrigation scheduling by Keller-Bliesner Engineering (2000–2004). Other sources are noted in the crop table notes. Typical planting and harvest dates are taken from the local farmers and NIIP historical data.

FAO-56 on pages 95 and 96 describes the crop growth stages (Figure 6) used in the crop curves as follows:

- **Initial stage (ini).** The initial stage runs from planting date to approximately 10% ground cover.

- **Crop development stage (dev)**. This stage runs from 10% ground cover to effective full cover.
- **Mid-season stage (mid)**. The stage runs from effective full cover to the start of maturity.
- **Late season stage (late).** The late season stage runs from the start of maturity to harvest or full senescence.

In Table 3, the column headings L_ini, L_dev, L_mid and L_late correspond to the four crop development stages described in FAO-56. These crop stages each have a crop coefficient value (Kc) which is multiplied by the reference crop evapotranspiration (ETo) to obtain crop evapotranspiration (ETc). Kc_ini, Kc_mid and Kc_end are crop coefficient (Kc) values corresponding with each crop stage (Figure 6).

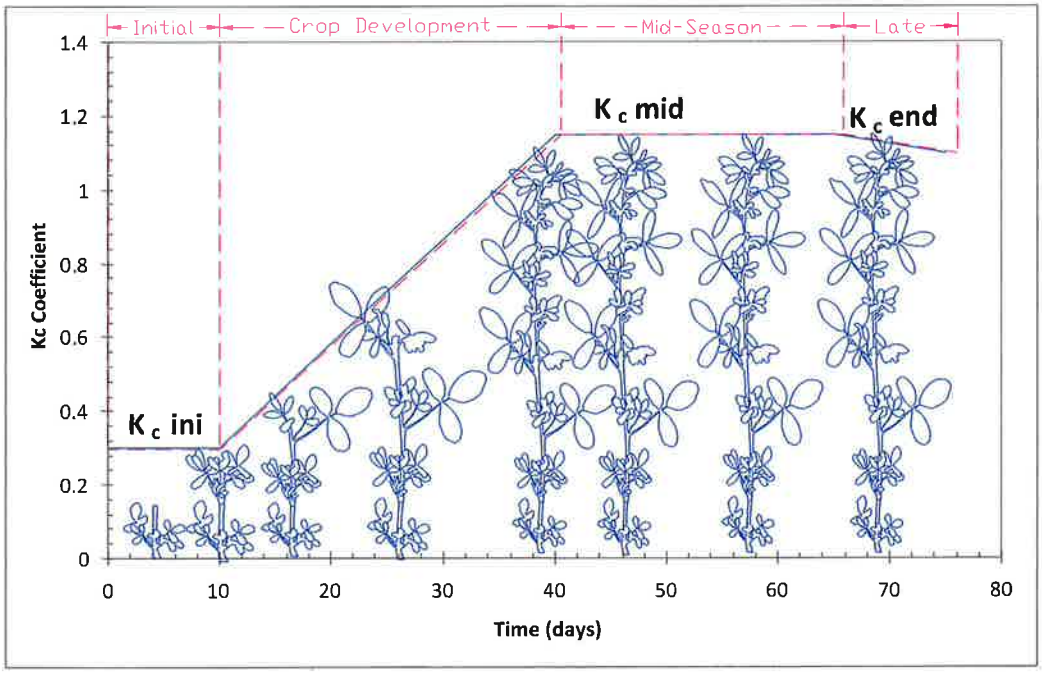

Figure 6. FAO Style Crop Coefficient Curve (Allen et al. 1998)

Consumptive Irrigation Requirement

One of the first steps performed in an irrigation system design analysis is the calculation of peak crop evapotranspiration.[1] Once this is determined, irrigation systems can be adequately sized to meet this peak demand. When peak crop evapotranspiration is calculated, typically a consumptive irrigation requirement (CIR) is also calculated for use in determining a field delivery requirement and a diversion requirement.

To understand consumptive irrigation requirement calculations, the separate components must also be defined. Consumptive irrigation requirement is equal to the crop evapotranspiration[2]

[1] Evapotranspiration (ET) is the sum of evaporation and plant transpiration.

[2] Crop Evapotranspiration (ETc) is evapotranspiration from a specific crop, water not limiting.

minus effective precipitation.[3] Crop evapotranspiration is calculated by translating the reference evapotranspiration[4] to the crop. This translation uses a set of coefficients specific to the crop type (Crop Coefficient, Kc). Effective precipitation is calculated based on actual precipitation, the mean monthly consumptive use, and the useable soil water storage. The effective precipitation was computed using the Soil Conservation Service (SCS) TR21 method (SCS, 1970). The useable soil water storage depth of 3 inches was used in this calculation. Using all these components, the daily crop CIR and ET were calculated using proprietary software developed by KB called KB-ET.

The reference evapotranspiration used in this analysis was chosen based on the weather data available at the Shiprock weather station. Since only temperature and precipitation data were available, the 1985 Hargreaves reference evapotranspiration equation was selected for use in KB-ET (Hargreaves et al. 1985). Missing data from the Shiprock weather station (1980 – 2009) were filled using a software tool called CLIME, also developed by KB.

CLIME reads National Climatic Data Center (NCDC) weather data compiled by Hydrosphere Data Products and uses a ratio proportion method to interpolate and fill missing daily temperature and precipitation data with data from the selected neighboring stations (Paulhus and Kohler 1952). For this analysis, daily ratios are calculated for the 30-year period (1/1/1980 – 12/31/2009). These 366 ratio values are then used to relate the temperature and precipitation from one station to another and fill any missing data between the same periods. The weather stations used in the filling process include Shiprock, Fruitland, Farmington, and Bloomfield.

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[3] Effective Precipitation is the amount of precipitation that is stored in the soil and used by the crop to meet crop ET.

[4] Reference Crop Evapotranspiration (ETo) is evapotranspiration from a hypothetical grass reference crop, water not limiting.

Table 3. Crop Curve Parameters used for Hogback, Fruitland, Cambridge, and Gadaii'ahi CIR Calculations

Crop	Cutting	Start Date	End Date	Start Temp	End Temp	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_mid	Kc_end
Alfalfa	1	-	-	**25**	**25**	10	30	25	10	0.4	1.2	1.15
Alfalfa	2-3	Previous harvest	45 days after start	-	-	5	20	10	10	0.4	1.2	1.15
Alfalfa	4	Previous harvest	-	-	**25**	4	30	20	15	0.3	0.75	0.75
Alfalfa establishment		**8/15**	-	-	**25**	30	40	60	5	0.4	0.85	0.85
Corn – 1st planting		**4/27**	**8/14**	-	-	20	30	50	10	0.7	1.15	1.05
Corn – 2nd planting		**5/17**	**9/3**	-	-	20	30	50	10	0.7	1.15	1.05
Melons		**5/19**	**8/25**	-	-	20	25	60	30	0.5	1.0	0. 5
Pasture		-	-	**25**	**25**	10	20	170	79	0.3	0.75	0.75
Vegetables		-	-	**32**	**32**	25	35	40	20	0.5	1.0	0.75

Table Notes:

1. **Alfalfa, 1st cutting.** FAO-56 Table 11. 1st cutting cycle and 75 day development period. Subsequent cuttings use a 45 day cutting cycle. Alfalfa is usually in flower at harvest, and 3 – 4 crops per year are achieved. FAO-56 Table 12 Kc Coefficients. The start dates are temperature based and vary from year to year. The initial season start dates are based on the last occurrence of a 25°F (-4°C) temperature in the spring. The season end dates are based on first occurrence of 25°F (-4°C) temperature in the fall.
2. **Alfalfa, 2nd and 3rd cutting.** 45-day Development Periods. Alfalfa is usually in flower at harvest, and 3 – 4 crops per year are achieved. FAO-56 Table 12 Kc Coefficients. The start dates are based on the day of the previous cut date, and the end dates are 45 days later.
3. **Alfalfa, 4th cutting.** NIIP Development Periods. Fields are typically pastured with sheep after the 3rd alfalfa cutting. FAO-56 Table 12 Kc Coefficients are for pasture (extensive grazing). The season end dates are based on first occurrence of a 25°F (-4°C) temperature in the fall.
4. **Alfalfa establishment**. Navajo Indian Irrigation Project (NIIP) Development Periods. NIIP Kc Values (none in FAO manual). Average start dates are based on typical NIIP planting dates. Season end based dates are bases on the first occurrence of a 25°F (-4°C) temperature in the fall.
5. **Corn 1st and 2nd plantings.** FAO-56 Table 11 Development Periods. Maize, sweet, and arid climate. FAO-56 Table 12 Kc Coefficients. Corn plantings are staged for a continuous harvest starting on 4/27. The harvest date is based on 110-day growth period for corn.
6. **Melons.** NIIP Development Periods. Kc Values FAO-56FAO-56 Table 12. Pumpkin, Winter Squash. Average season start is based on typical NIIP planting dates. Season end is based on average harvest date NIIP.
7. **Pasture.** FAO-56 Table 11 Development Periods. Pasture (extensive grazing). Kc Values FAO-56 (Table 12). Harvest season start/end based on last occurrence of 25°F (-4°C) temperature in the spring and the first occurrence of 25°F (-4°C) temperature in the fall. (FAO-56 Table 11 footnote #4).
8. **Vegetables.** FAO-56 Table 11 Development Periods for 120-day sweet melons. FAO-56 Table 12 Kc Coefficients. Pumpkin/squash. Harvest season start based on last occurrence of 32°F frost in the spring. Season end is based on first occurrence of 32°F in the fall or end of curve, whichever comes first.

Design Flow Requirements

For sizing irrigation delivery systems, two different peak irrigation requirements are important. The first is the aggregate peak crop mix irrigation requirement (7 day cumulative mix ET) and the second is the peak water requirement (ET) of any crop on a segment of the delivery system (NEH 1993).

The peak crop mix requirement (including fallow) is used to size canals and structures in the upper end of the supply system, because there is little likelihood that the entire area will be planted to the crop with the maximum peak capacity requirement. However, as you design segments toward the end of the system the maximum peak individual crop ET should be used. This is because the high demand crop could comprise the majority of the service area. The average application efficiency during the peak use period should be used to compute the water requirement.

The design flow requirements were calculated by dividing the peak ET value in inches/day by the product of the on-farm efficiency and the conveyance efficiency values, and then converting these values to gpm per acre (Table 4). The design flow for the Helium Siphon is 8.8 gpm per acre. Through GIS analysis, it was determined that the area to be served by the Helium Siphon is 941 acres. This equates to a siphon design flow of 8,267 gpm or 18.4 cfs.

Pipeline Hydraulics

The 36-inch PVC pipeline size was verified using a hydraulic model in EPANET. A Hazen Williams coefficient of 150 was used for the PVC pipe. The elevation difference between the inlet and the new outlet is 48.5 ft. However, the maximum elevation for water deliveries occurs at the Shiprock School District pumping plant near the existing siphon outlet. The elevation difference between the siphon inlet and the pumping plant intake is 11.9 ft. The siphon head loss at the design flow (18.4 cfs) was calculated to be 9.4 ft. Providing 2.5 ft of head (1.1 psi) at the pumping plant. The maximum velocity of the siphon at design flow is 3.1 fps which will not cause surge or water hammer issues for the pipe and also provide sufficient sweeping velocities.

Table 4. Design Flow Requirements.

Item	System Level	Field Level Design			
	Helium Siphon	Gated Pipe with furrows	Center Pivot	Periodic Move Sprinklers	Drip
Peak 7-day Crop Mix ET (in/day)[1]	0.34	n/a	n/a	n/a	n/a
Peak 7-day Average Crop ET (in/day)[1]	n/a	0.34	0.34	0.34	0.34
Flowrate: No losses and 100% efficiency (gpm/ac)	6.4	6.4	6.4	6.4	6.4
On-Farm Application Efficiency %	65%	65%	80%	68%	85%
Conveyance Efficiency %	95%	99%[2]	99%[2]	99%[2]	99%[2]
Design Flow Rate (gpm/ac)	8.8	8.4	6.9	8.1	6.5

Note: [1]This is taken at a 90% exceedance probability and assume 15% of the land is fallow.
[2]Field lateral pipeline efficiency.

Pipeline Material

The 36-inch DR 41 PVC pipe was evaluated structurally using a hoop stress calculation recommended *Design of PE Piping Systems* (Figure 7). Surge pressure was determined to be 62 psi which is less than the 100 psi pressure rating. The Figure 7 calculations show that the DR 41 PVC meets all hoop stress and surge pressure design requirements.

Navajo Nation Department of Water Resources
Helium Siphon Design
PVC pipe design

14-Jun-16

By: Michael Isaacson, Keller-Bliesner Engineering, LLC

REF: Handbook of PVC Pipe, page 124

US Water Surface elev	4982	ft
Lowest Elevaton on Pipe	4865	ft
Internal Pressure	50.64935	psi
OD	38.3	inches
Wall thickness	0.934	inches
Hydrostatic Design Basis	4000	psi
Safety Factor	2.5	<----- Safety factor for C905
Hoop Stress	1600	psi
Pressure Rating	79.98715	<---- Less than 100 psi specified for DR41 C905

Figure 7. Hoop Stress and Surge Pressure Calculations

Backfill Design

The maximum backfill for the siphon is 5.5 ft. The Timoshenko equation was used to determine the deflection of the PVC pipe with a live load. A deflection of less than 1 percent was calculated indicating that the material selection is more than adequate (Figure 8).

Navajo Nation Department of Water Resources
Helium Siphon Design
Backfill Design

11-Nov-16

By: Michael Isaacson, Keller-Bliesner Engineering, LLC

Ref: Handook of PVC pipe

Dead Load

h	4	ft	h/Bd	0.770465
w	125	lb/cu ft		
Bd	5.191667	ft		
Bc	3.191667	ft		
Cd	0.7	<---- From Figure 6.5		
Wc	1449.881	lb/ft		

Deflection

Soil Support Factor	1		
Dl	1		
K	0.108		
Dm	19.15	in	
EI	400000	in. lb	
E'	1000	psi	
r	19.15	in	
x	1.327484	in	
	3.47%		Less than 7.5 %. Good

Figure 8. Backfill Design Calculations

Buoyancy Check

Part of the siphon is installed in saturated conditions. The backfill was verified to ensure that the pipe would not float once empty. The minimum backfill of 3.5 ft was used to determine if the weight of the fill would prevent the pipe from floating. The weight of the soil profile above the pipe and the pipe itself is 878 lbs while the buoyant force is 441 lbs (Figure 9). Once backfilled, the pipe will not float when empty.

Helium Siphon

11-Nov-16

Buoyancy check on backfilled pipe

By: Michael Isaacson

Pipe Outside Diameter	38.3	inches	<< 36" DR 41 C905 PVC
Pipe Inside Diameter	36.3	inches	
Backfill	3.5	ft	
Water level below ground	1	ft	
Backfill weight	125	lb/cu ft	
Weight of empty Pipe	79	lb/ft	
Weight of saturated soil above pipe	622.3538	lb/ft	
Weight of dry soil above pipe	268.223		
Total	969.5768	lb/ft	
Buoyant force	499.2402		

Fill is sufficient

Figure 9. Pipeline Buoyancy Calculations

Structure Designs

Manhole and drains were designed to ensure that the access pipe and manholes would reach ground level. The outlet was designed according to Reclamation's *Design of Small Canal Structure, 1978.* The downstream water surface was estimated using Manning's Equation.

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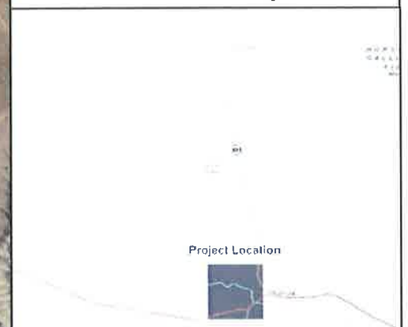
APPENDIX A – DRAWINGS

Helium Siphon Project Location

Location map



Drawing index

Sheet No	Title	Drawing	Rev
0	Plan & Profile Drawing	L100	1
1	Plan & Profile Drawing	P101	1
2	Plan & Profile Drawing	P102	1
3	Plan & Profile Drawing	P103	1
4	Plan & Profile Drawing	P104	1
5	Plan & Profile Drawing	P105	1
6	Plan & Profile Drawing	P106	1
7	Plan & Profile Drawing	P107	1
8	Plan & Profile Drawing	P108	1
9	Plan & Profile Drawing	P109	1
10	Plan & Profile Drawing	P110	1
11	Plan & Profile Drawing	P111	1
12	Plan & Profile Drawing	P112	1
13	Plan & Profile Drawing	P113	1
14	Plan & Profile Drawing	P114	1
15	Plan & Profile Drawing	P115	1
16	Plan & Profile Drawing	P116	1
17	Plan & Profile Drawing	P117	1
18	Plan & Profile Drawing	P118	1
19	Plan & Profile Drawing	P119	1
20	Plan & Profile Drawing	P120	1
21	Plan & Profile Drawing	P121	1
22	Helium Siphon Discharge Structure	D100	0
23	Helium Siphon Air-Vent Manhole	D102	0
24	Helium Siphon Pipe Blow-Off Fixtures	D103	0
25	Helium Siphon Pipe Weight Blocks	D104	0
26	Helium Siphon Pipe Weight Blocks	L105	0

#	Verson/Revisions	Date (MM/DD/YY)	Design	Draw	Check	Approved
		8/18/16	SS	MM	MI	
1	Added Lateral	11/14/16	MI	MM	MI	

Coordinate System: NM Plane West
Datum:

Technical Construction and Operations Branch
Ft. Defiance, AZ

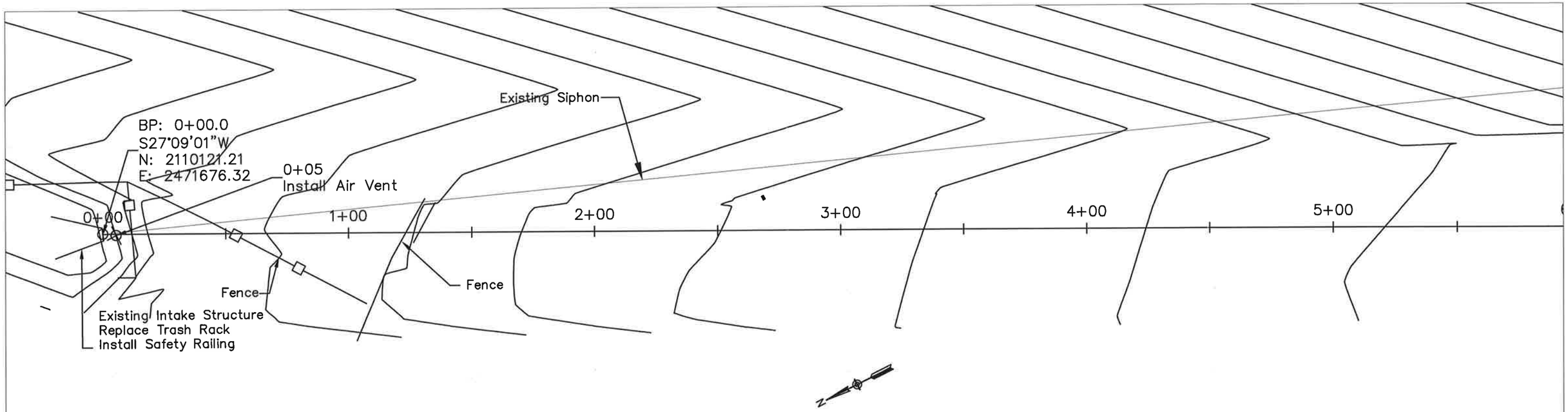
KELLER-BLIESNER ENGINEERING, LLC.

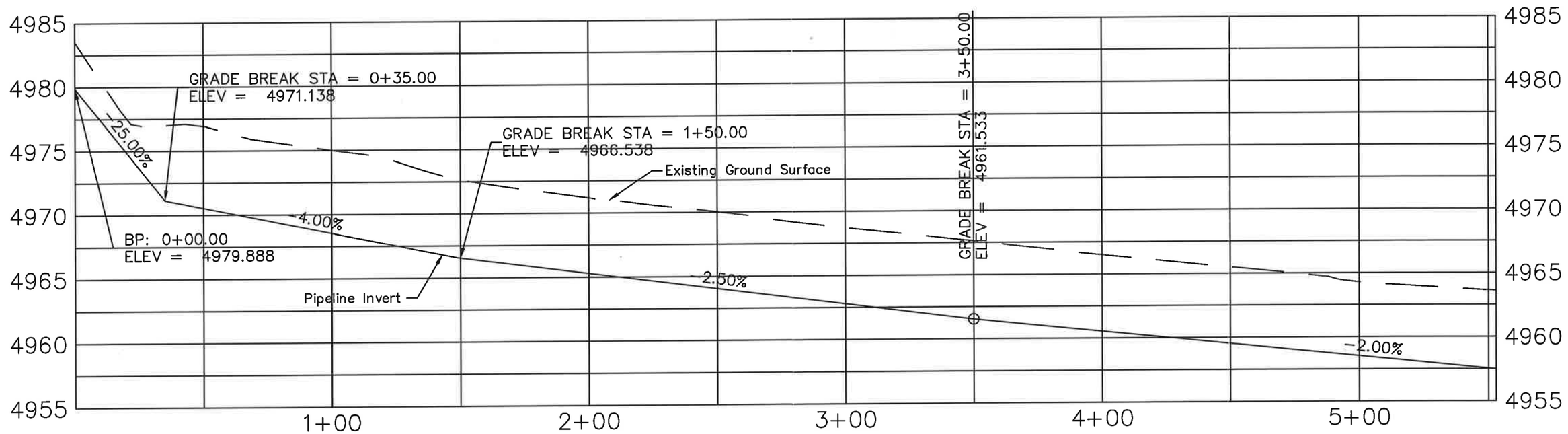
Navajo Nation Department of Water Resources

Hogback-Cudei Irrigation Project

Helium Siphon

Job No. NNDWR
Date: 08/18/16
Sheet 0 of 23
DRAWING NO. | REV





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#	Verson/Revisions	Date (MM/DD/YY)	Design	Draw	Check	Approved
1	60% Conceptual Designs	05/27/16	SS	SS		
0	Draft Conceptual Designs	05/07/16	SS	SS		

0 25 50 Feet

Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon 20160527ss.dwg

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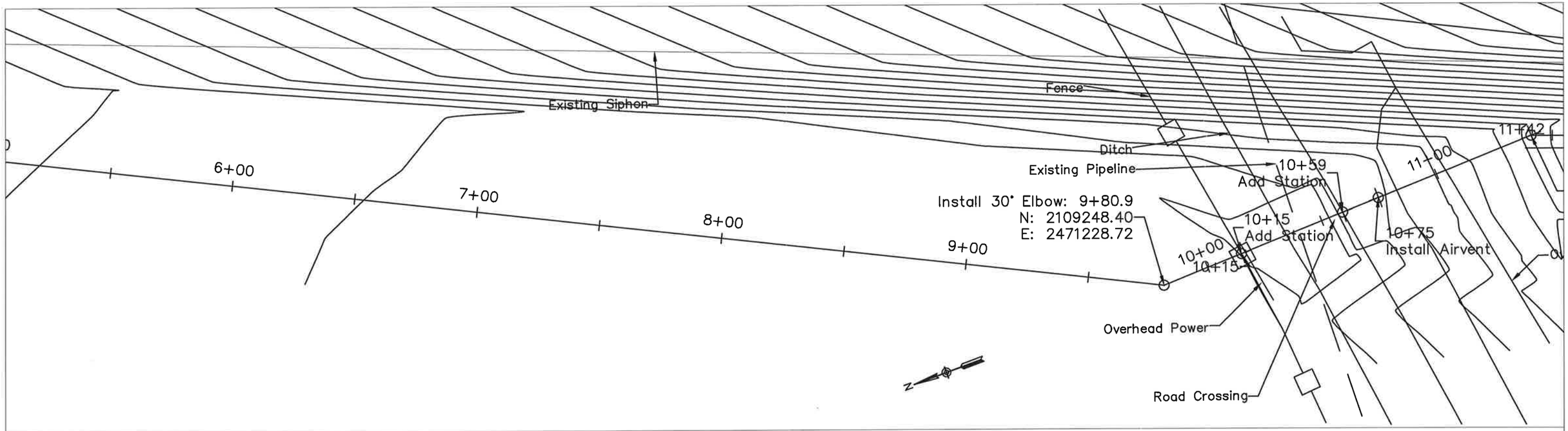
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR	
Date: 05/27/16	
Sheet 1 of 22	
DRAWING NO. P101	REV 1



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Coordinate System: NM West Zone NAD83
Datum: NAVD88
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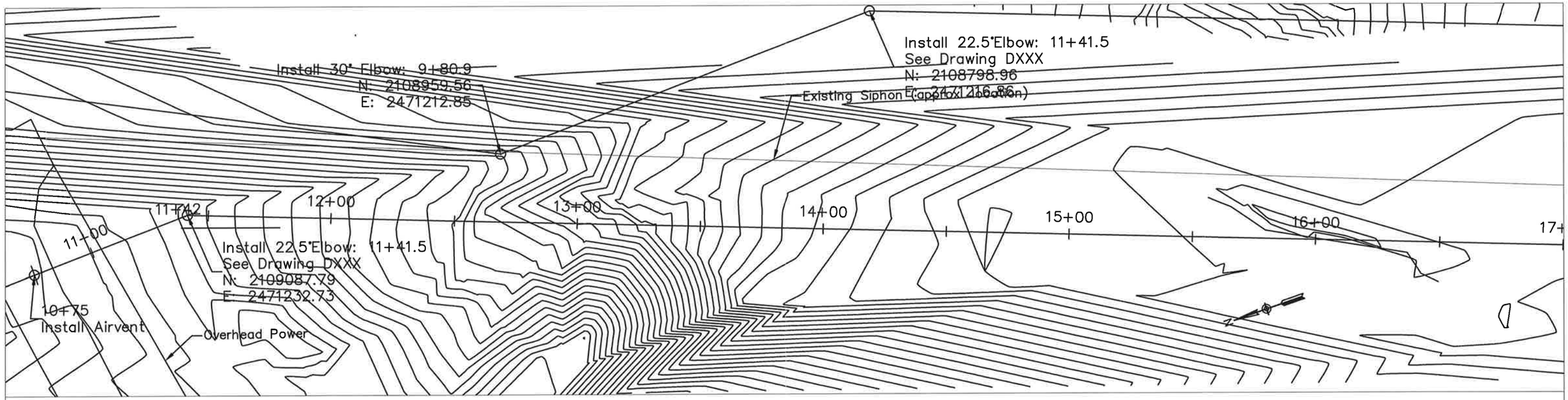
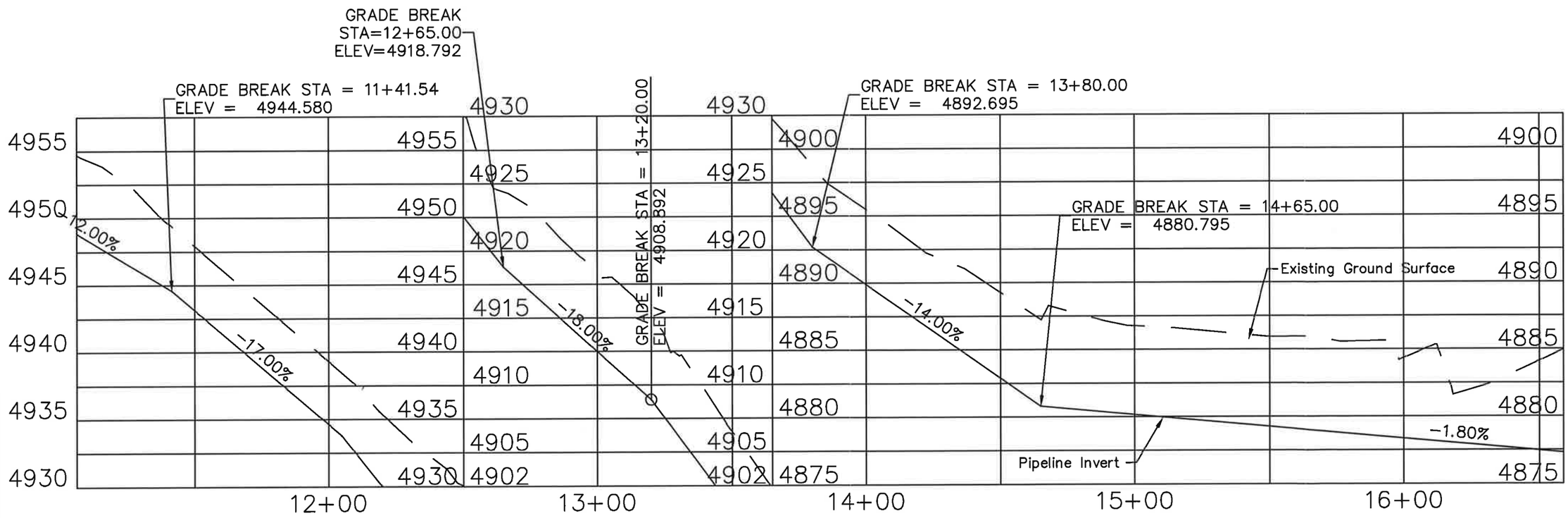
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 2 of 22
DRAWING NO. P102
REV 1





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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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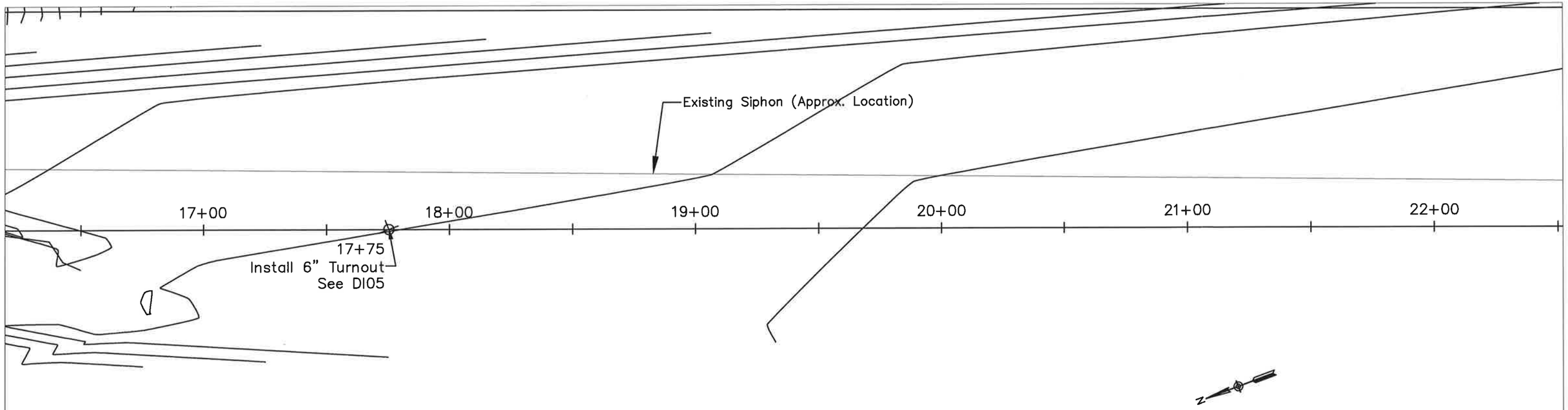
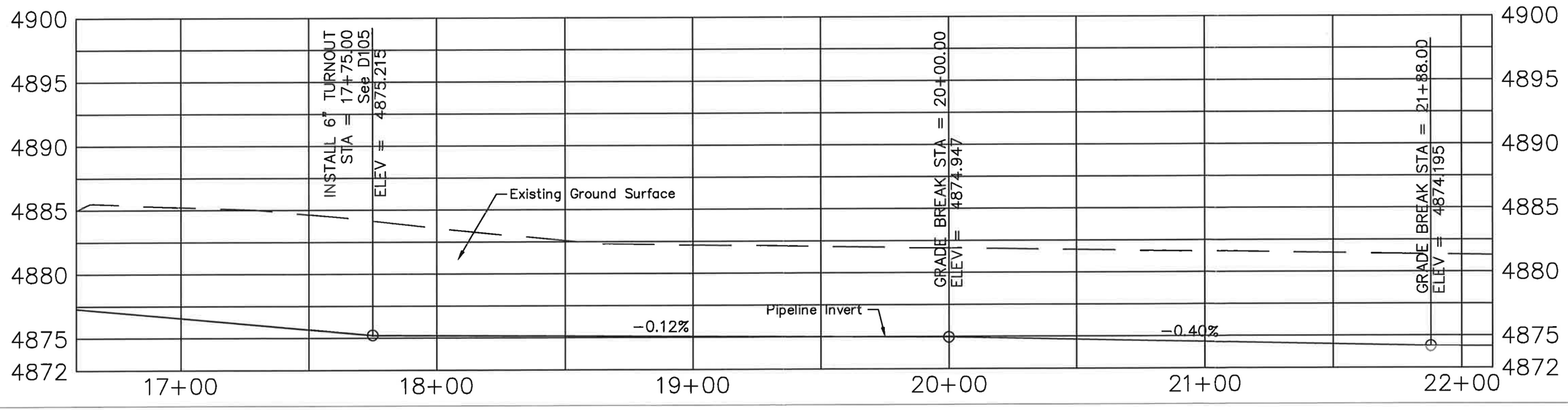
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 3 of 22
DRAWING NO. P103
REV 1





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Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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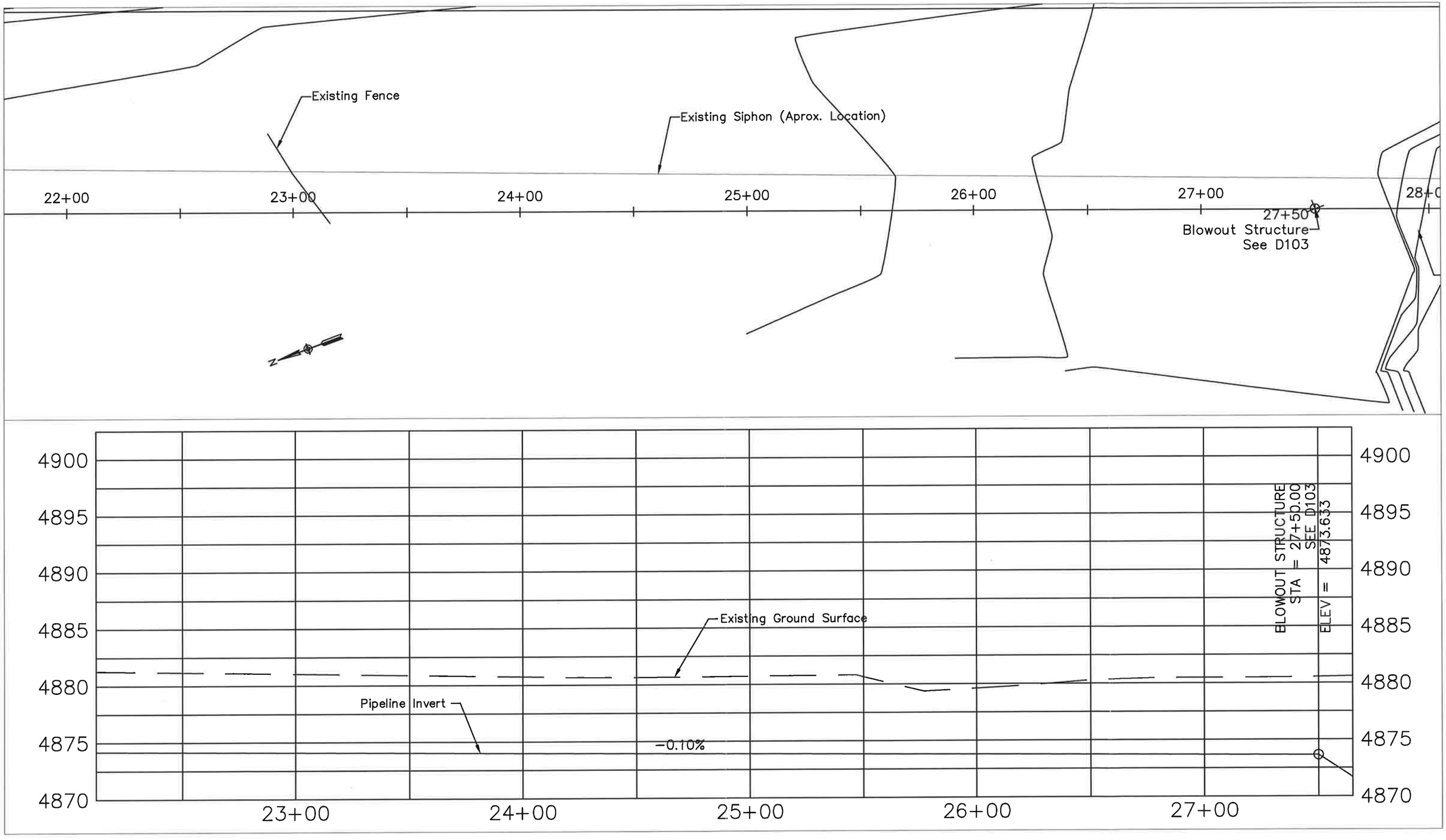
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 4 of 22
DRAWING NO. P104
REV 1



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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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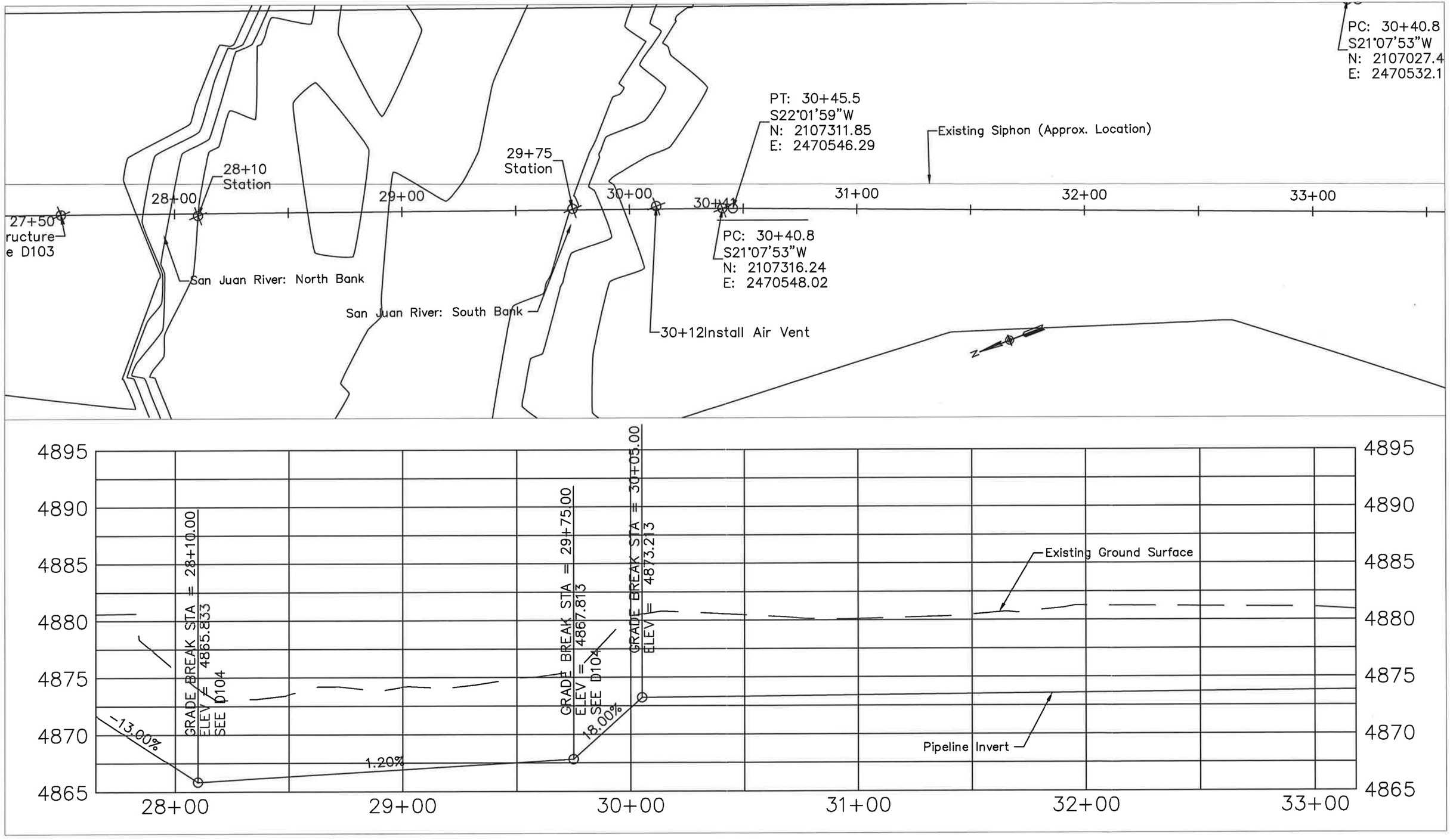
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 5 of 22
DRAWING NO. P105
REV 1



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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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Navajo Nation Department of Water Resources

Helium Siphon

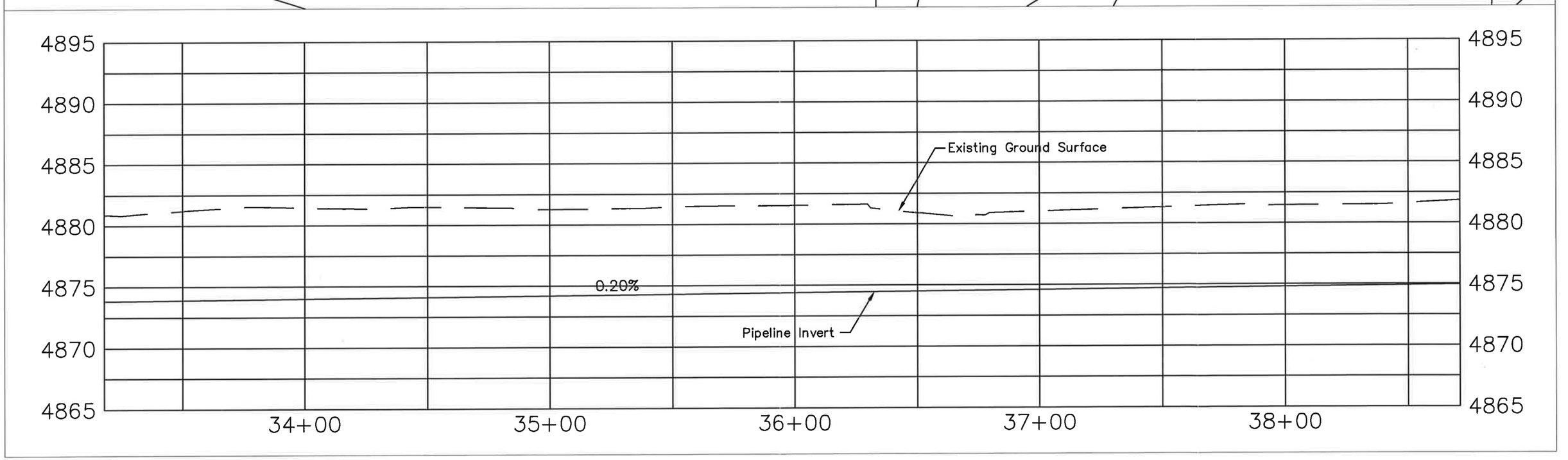
Plan & Profile Drawing

Job No. NNDWR	
Date: 05/27/16	
Sheet 6 of 22	
DRAWING NO. P106	REV 1

PC: 30+40.8
S21°07'53"W
N: 2107027.40
E: 2470532.16

Existing Siphon (Approx. Location)

33+00 34+00 35+00 36+00 37+00 38+00 39+00



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0 25 50 Feet

Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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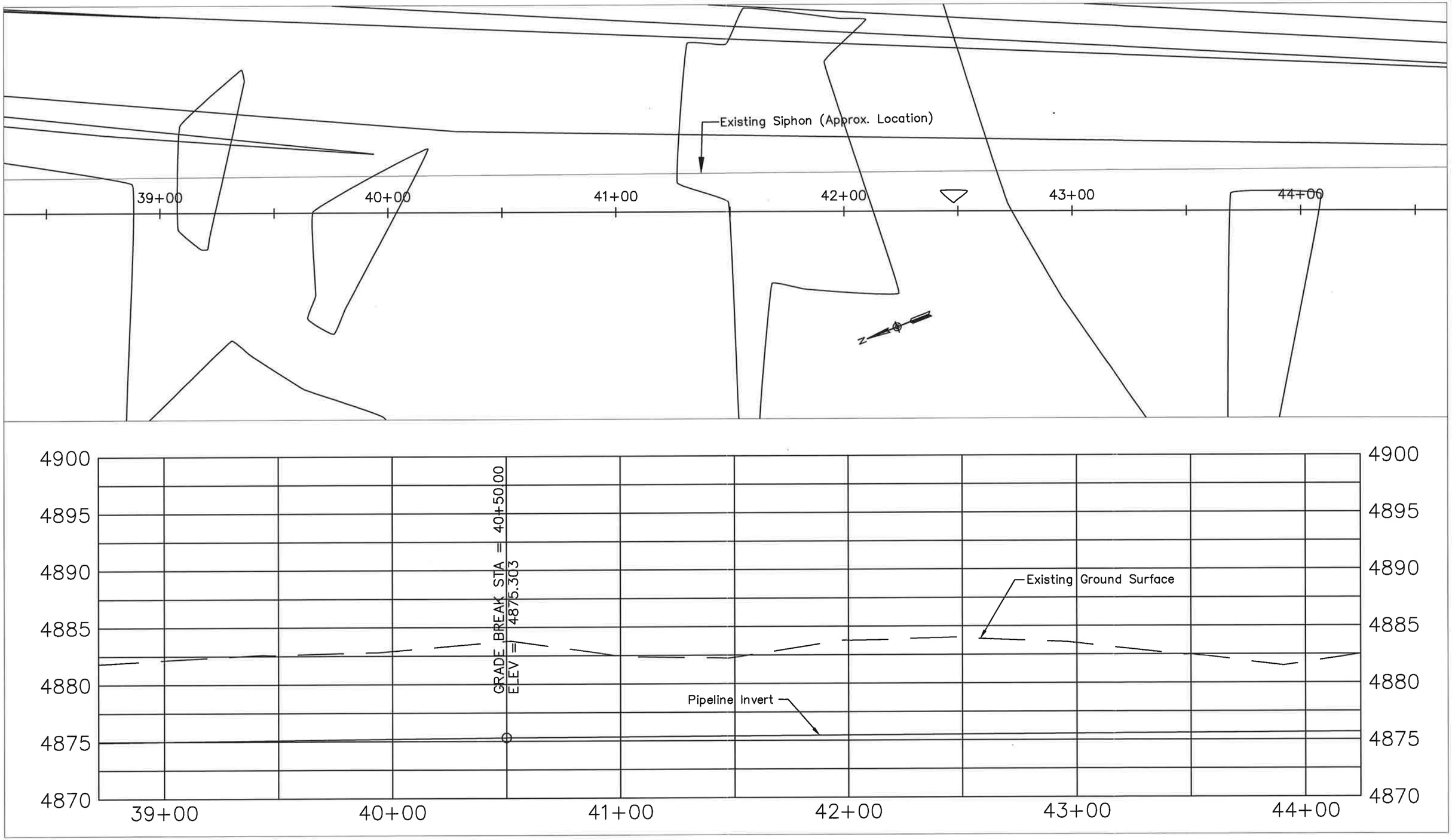
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 7 of 22
DRAWING NO. P107
REV 1



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0	Draft Conceptual Designs	05/07/16	SS	SS		

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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
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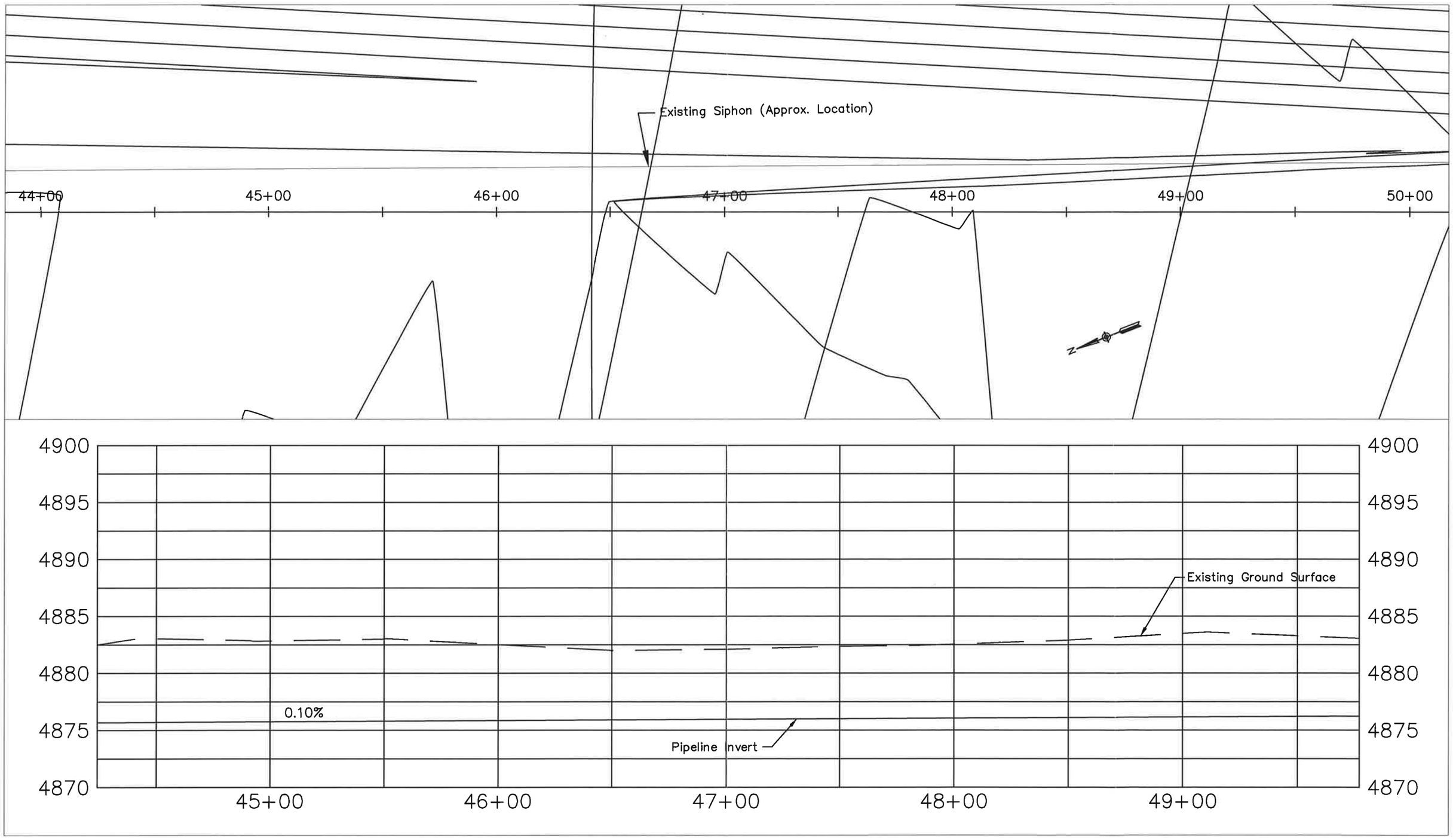
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 8 of 22
DRAWING NO. P108
REV 1



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0 25 50 Feet

Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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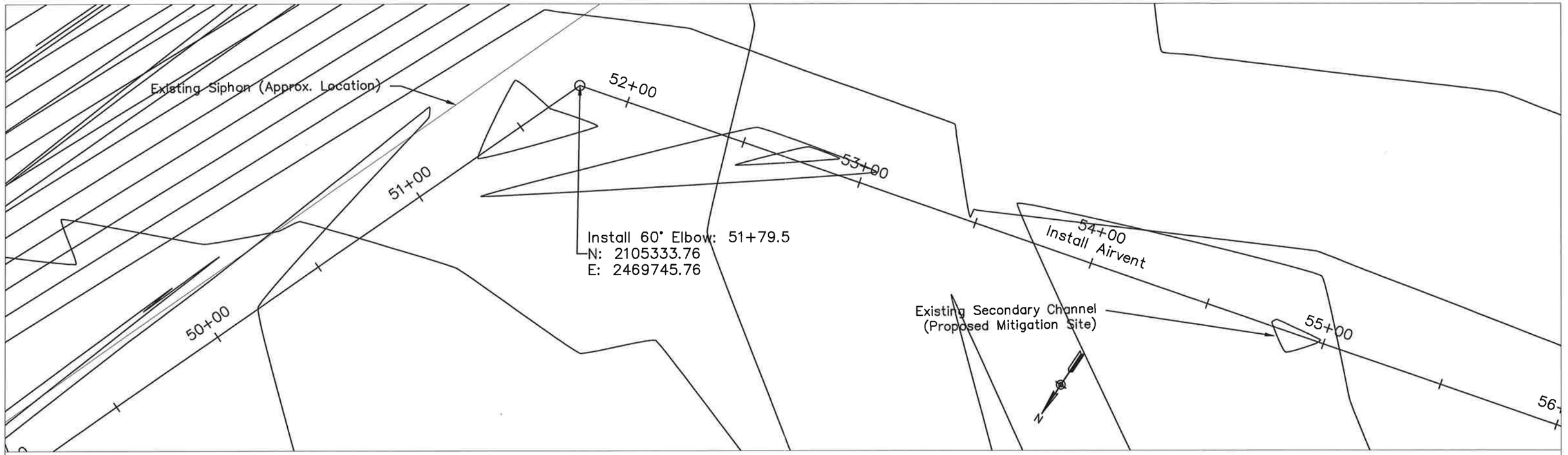
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 9 of 22
DRAWING NO. P109
REV 1



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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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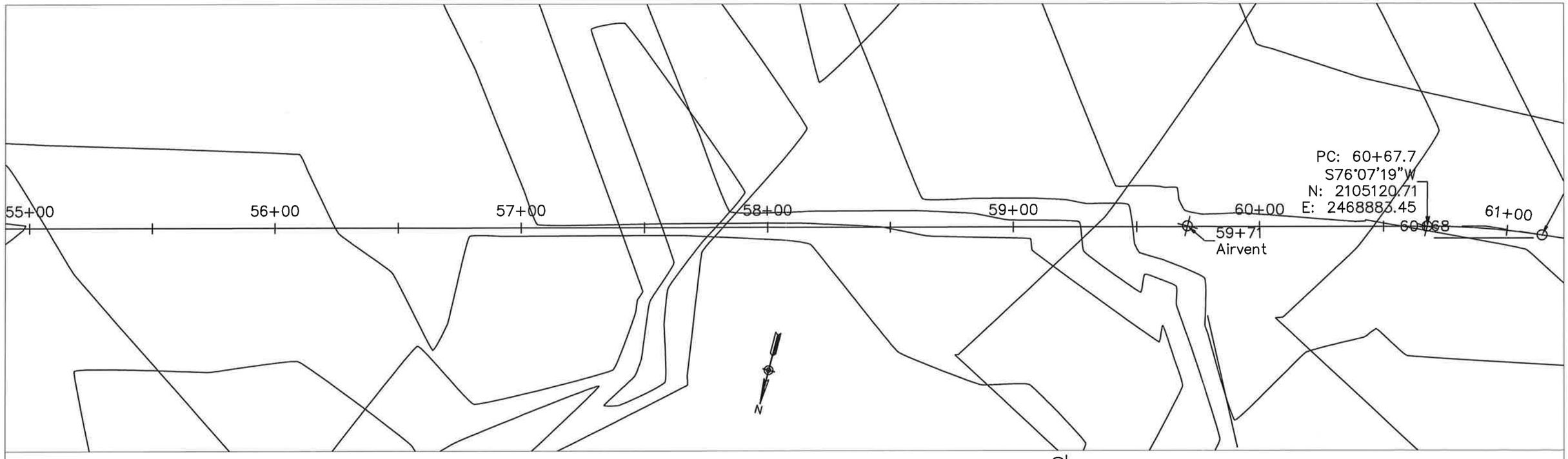
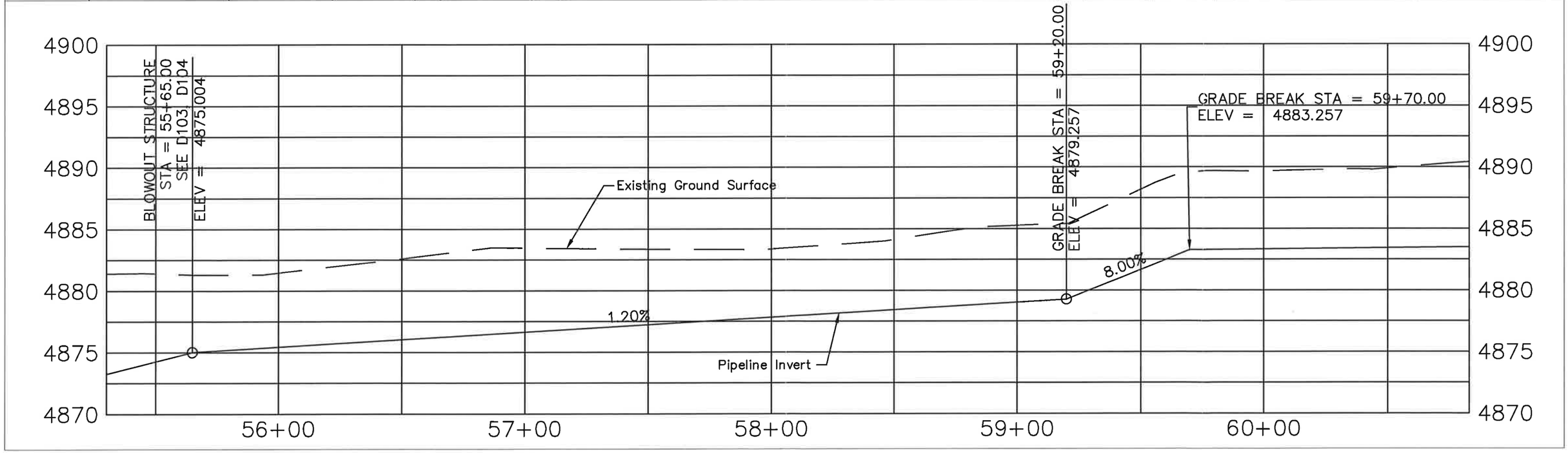
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 10 of 22
DRAWING NO. P110
REV 1





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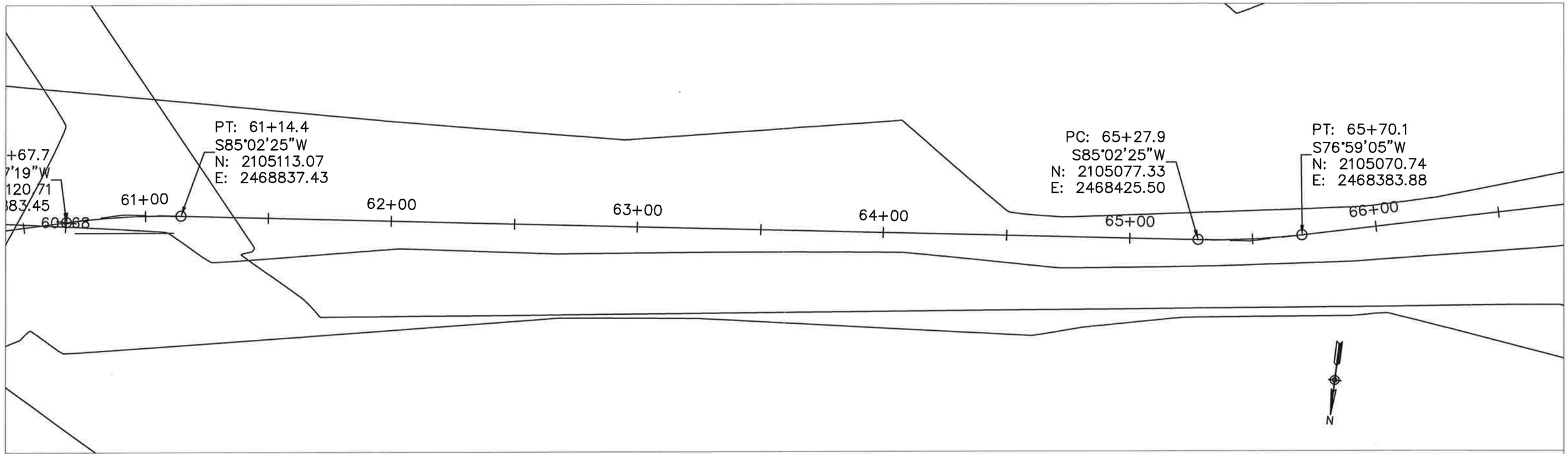
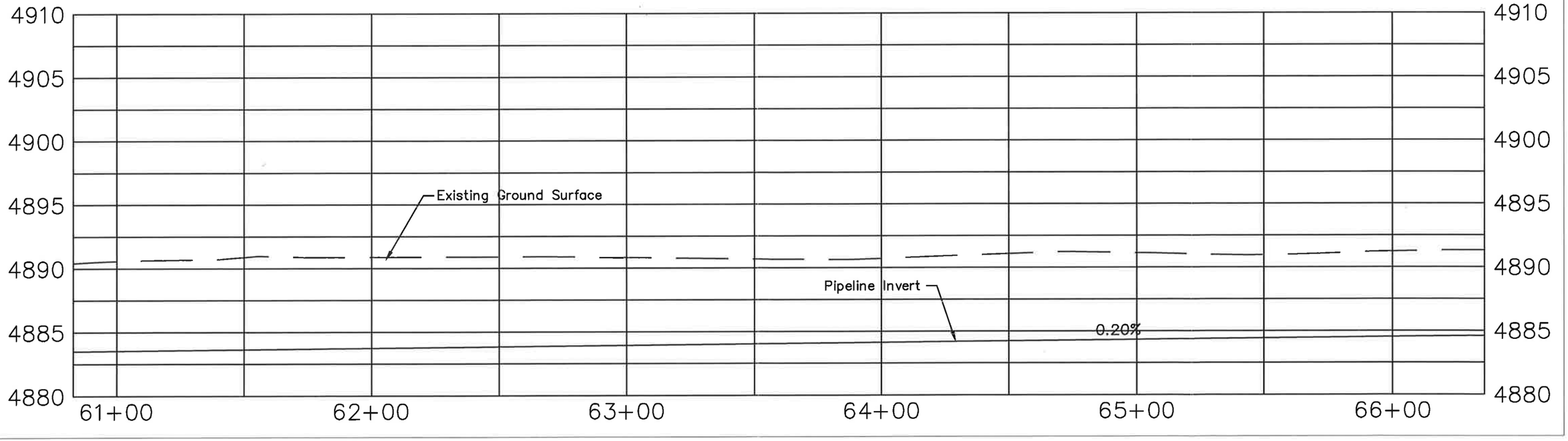
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 11 of 22
DRAWING NO. P111
REV 1





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0 25 50 Feet

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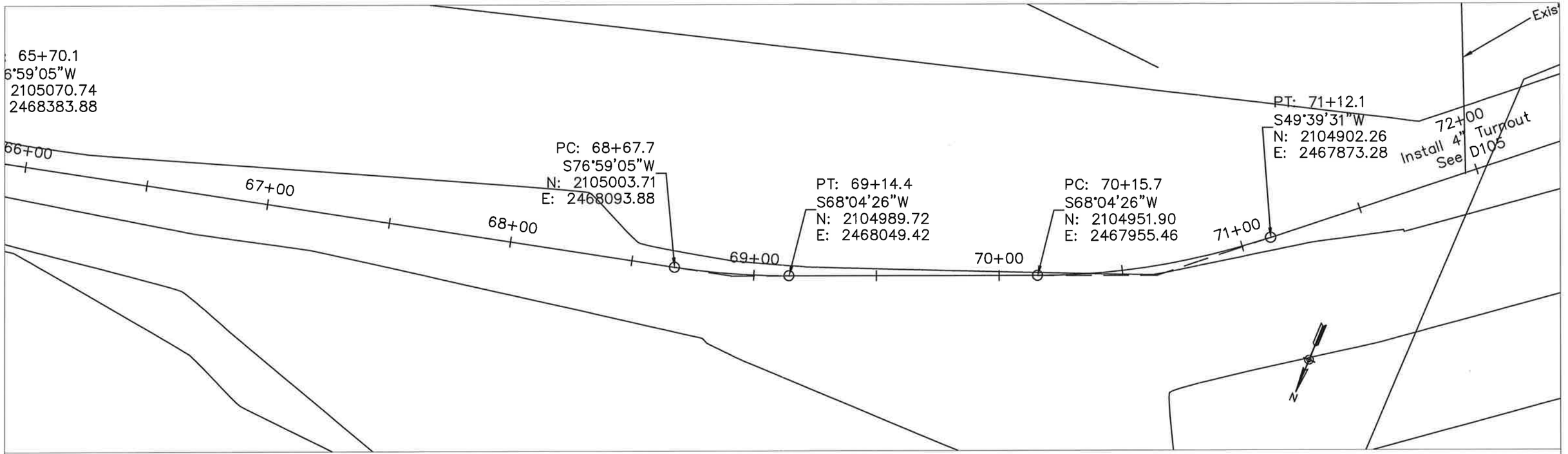
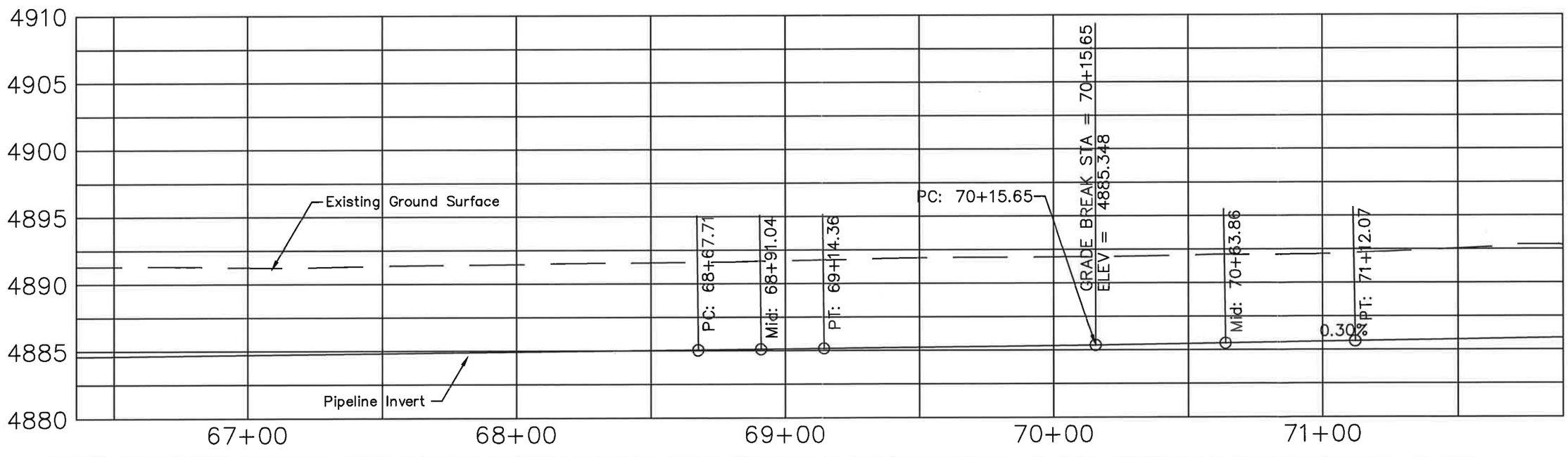
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 12 of 22
DRAWING NO. P112
REV 1





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Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
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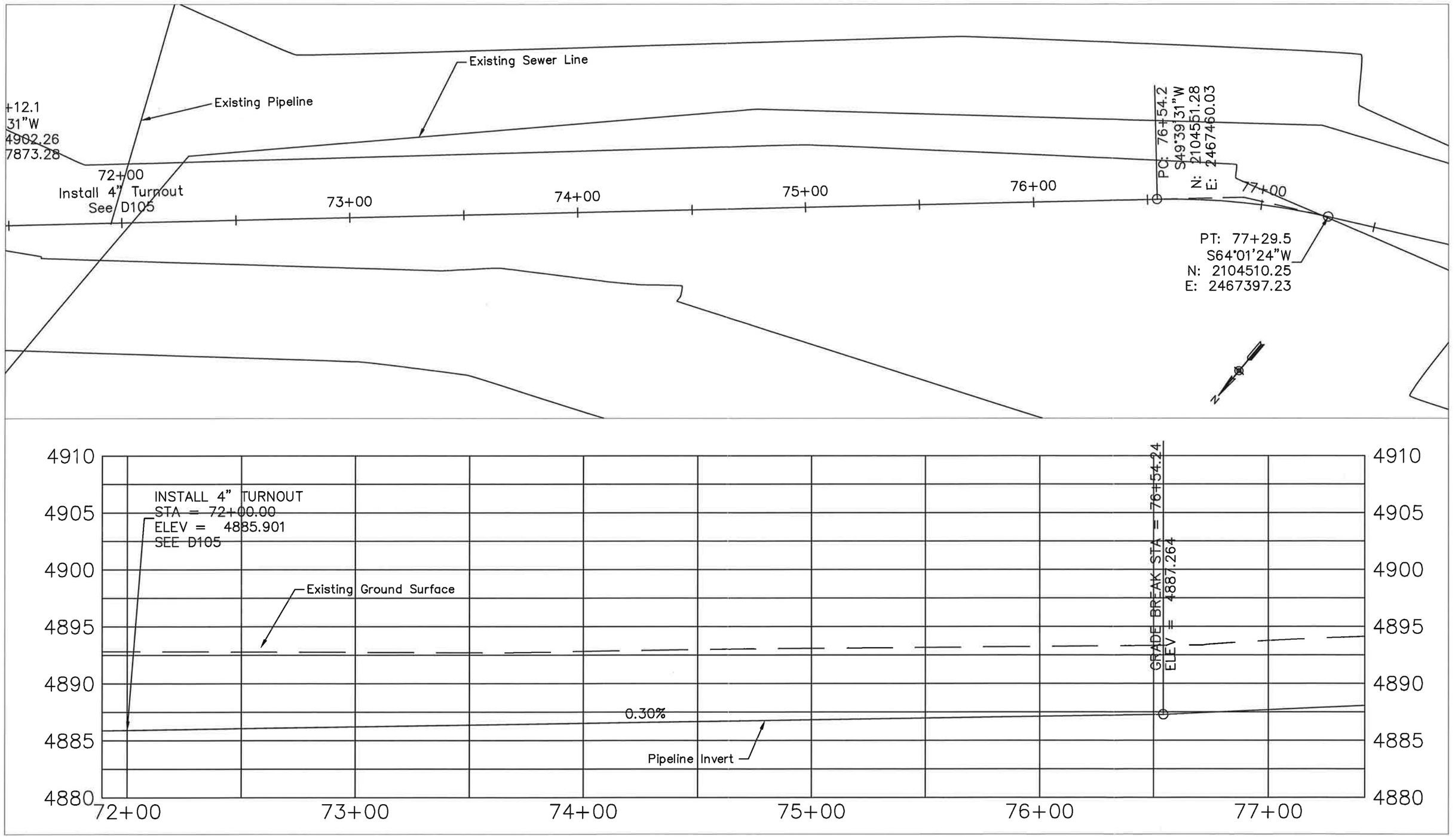
Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 13 of 22
DRAWING NO. P113
REV 1



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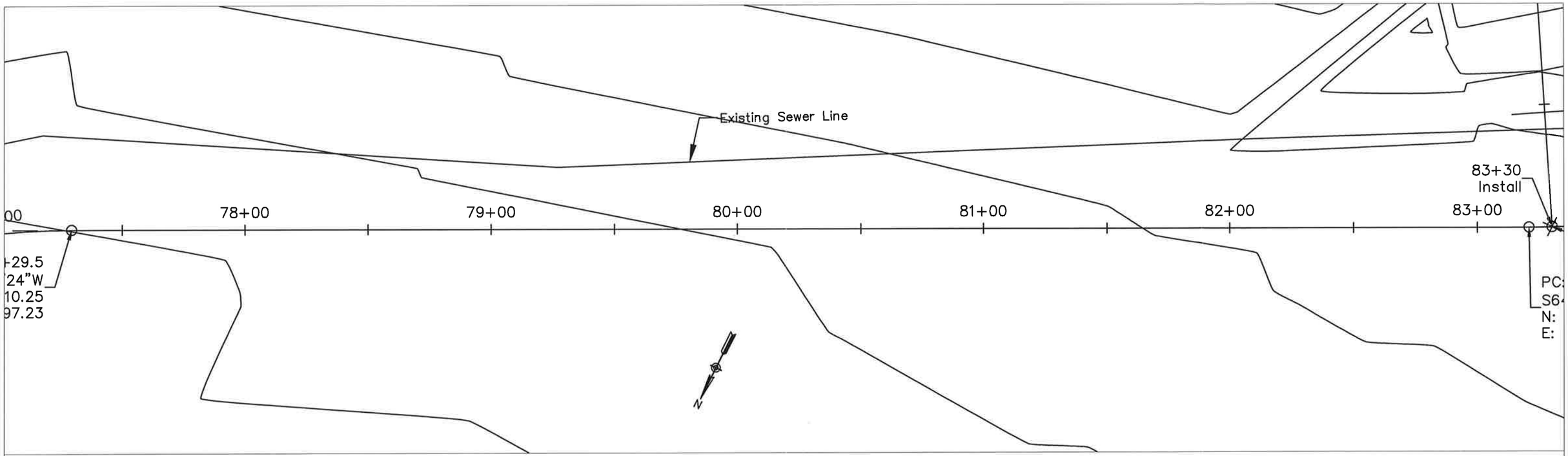
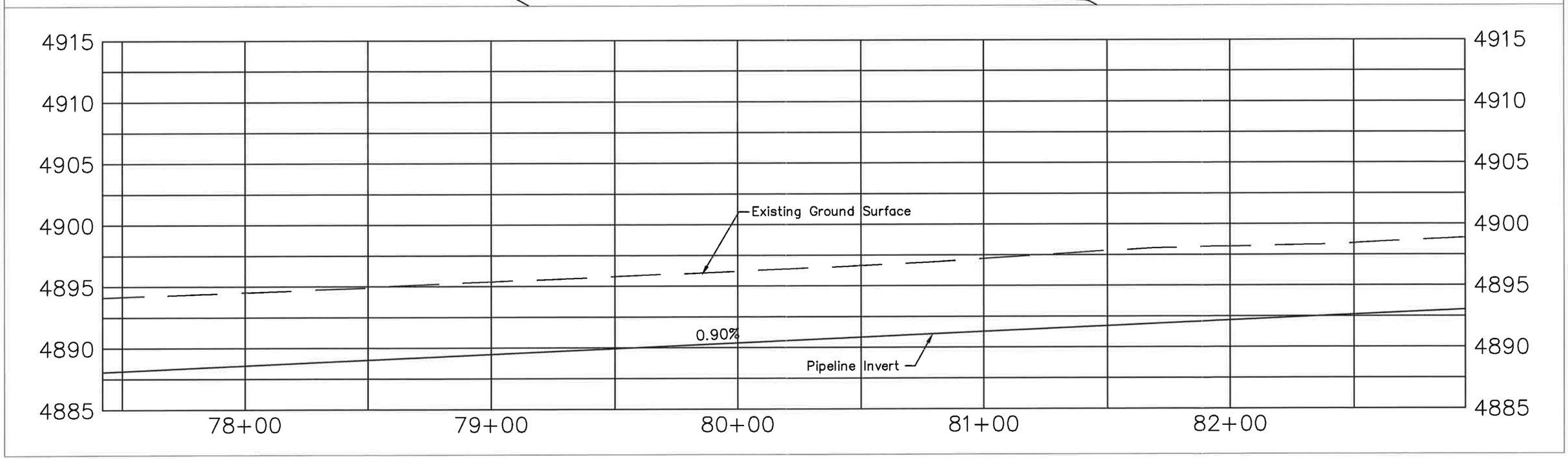
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 14 of 22
DRAWING NO. P114
REV 1





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Coordinate System: NM West Zone NAD83
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File Name: HeliumSiphon_20160527ss.dwg

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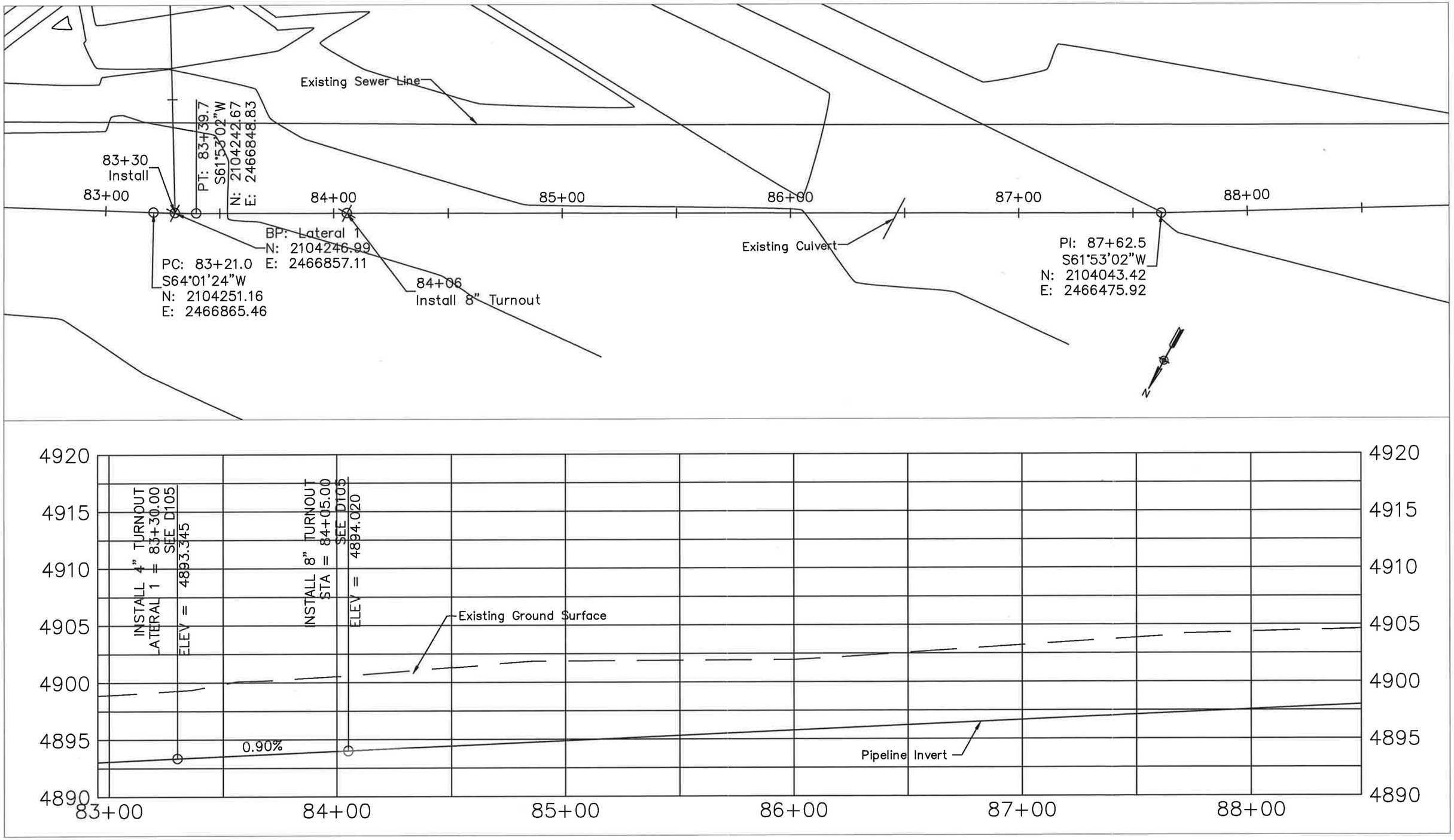
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 15 of 22
DRAWING NO. P115
REV 1



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	0	Draft Conceptual Designs	05/07/16	SS	SS		

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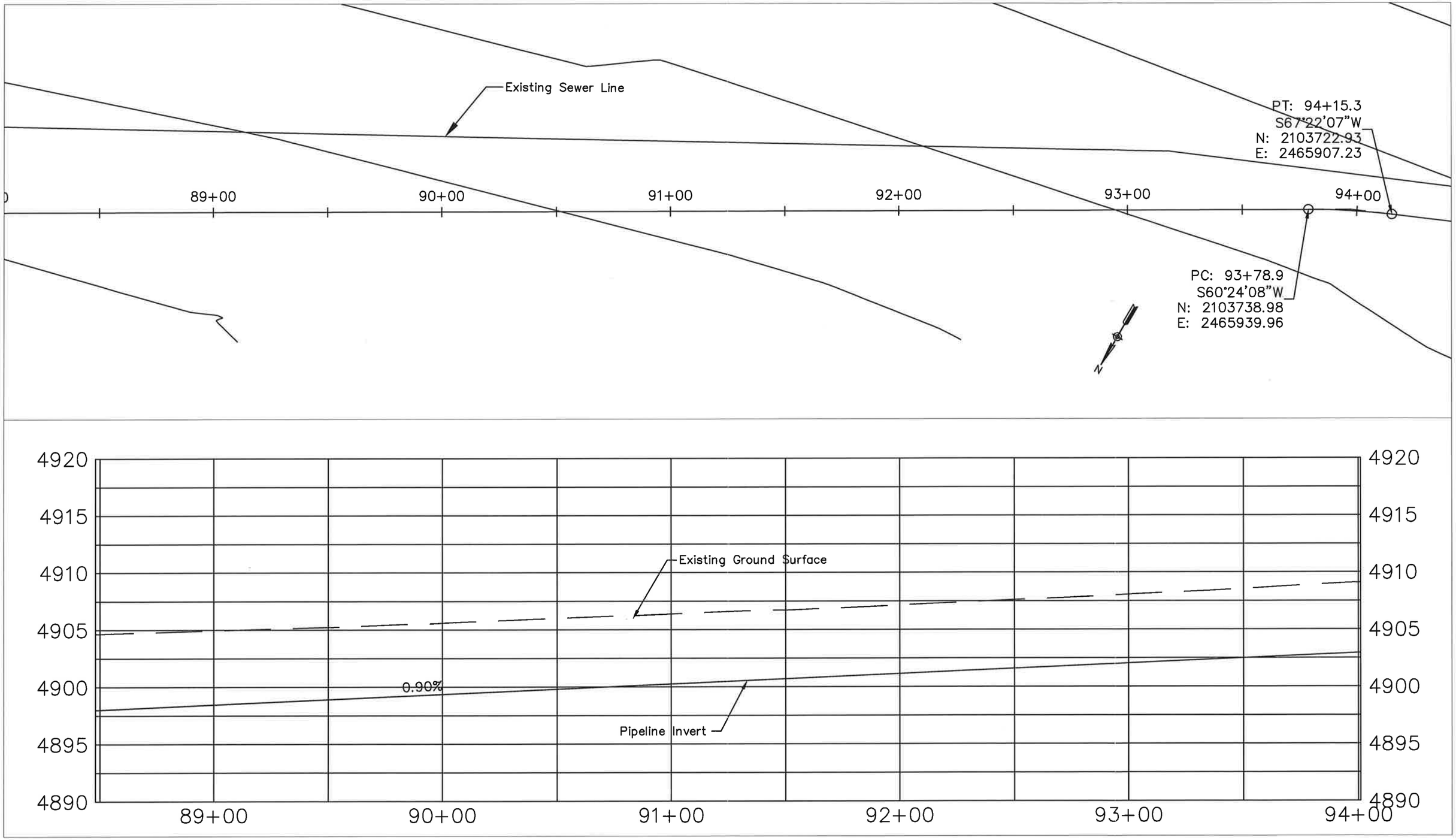
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 16 of 22
DRAWING NO. P116
REV 1



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Coordinate System: NM West Zone NAD83
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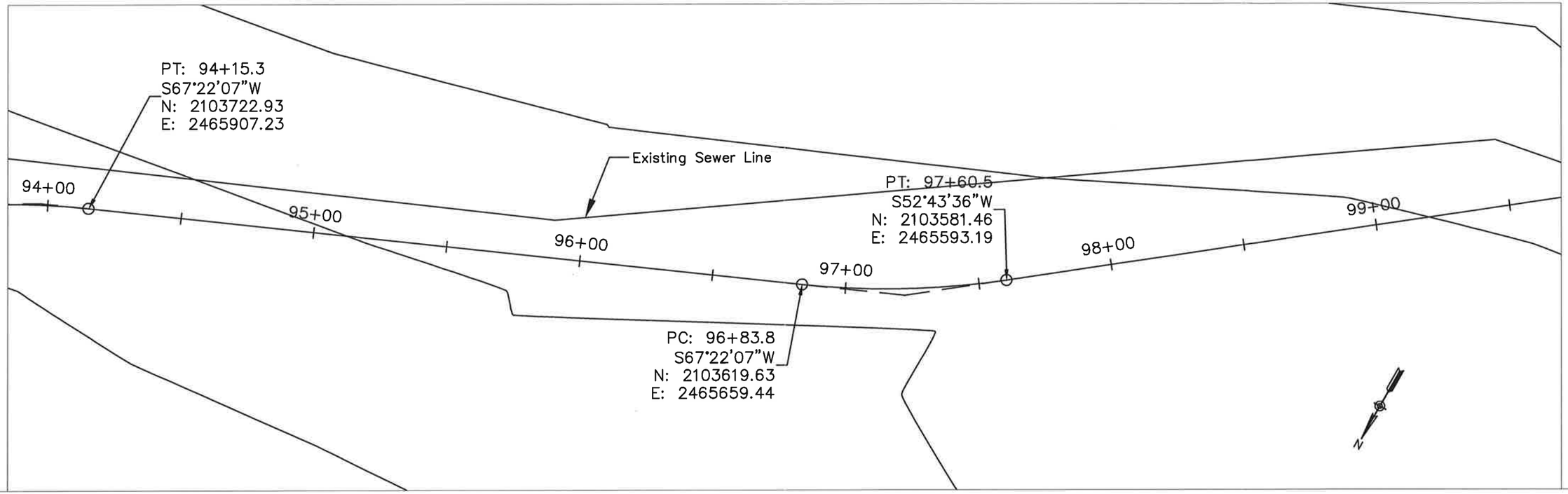
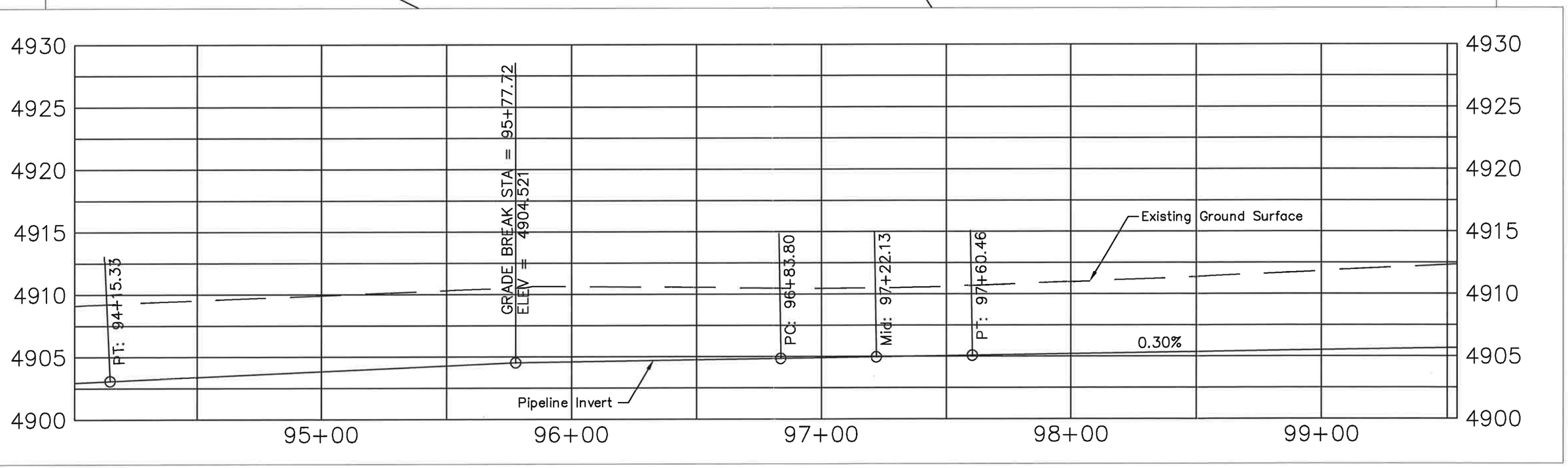
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet 17 of 22
DRAWING NO. P117
REV 1





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Coordinate System: NM West Zone NAD83
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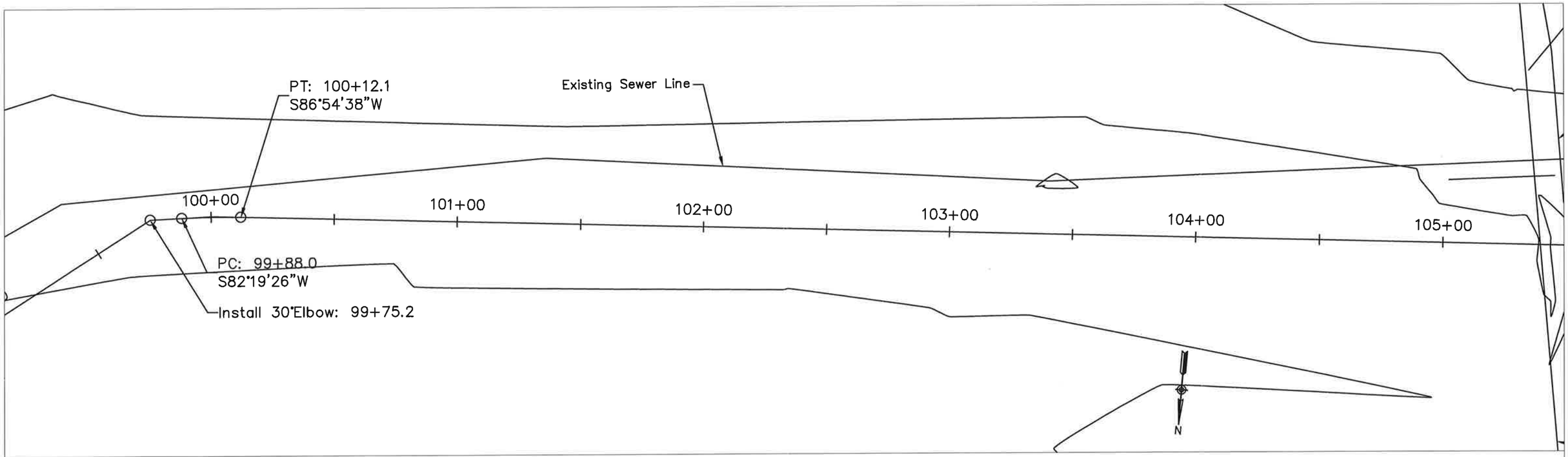
78 E. Center Logan, Utah 84321

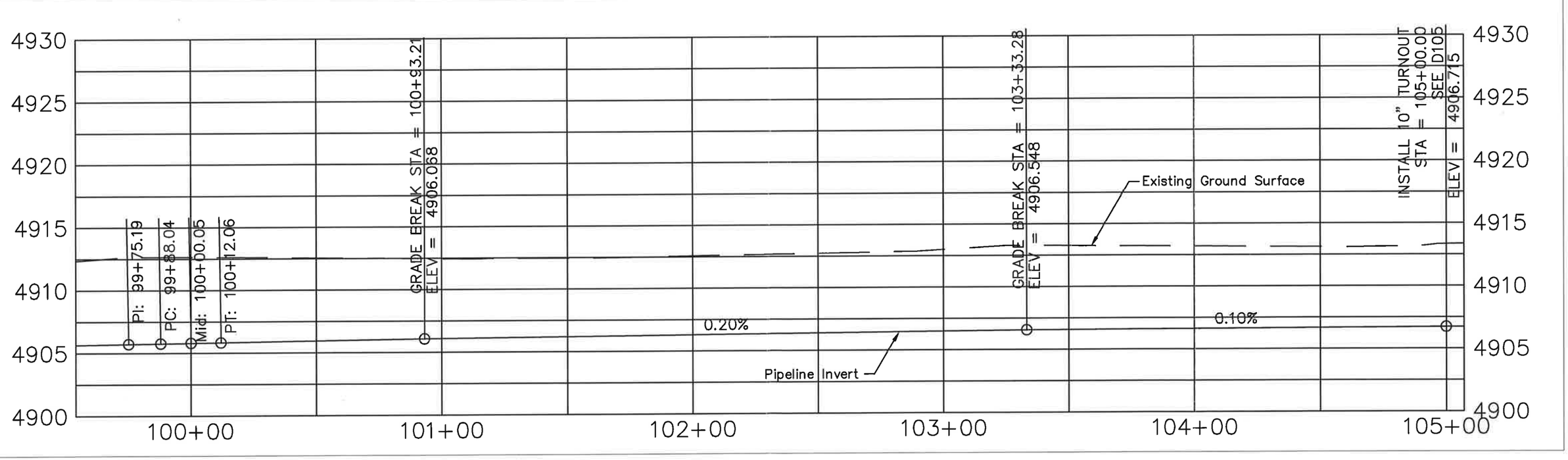
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR	
Date: 05/27/16	
Sheet 18 of 22	
DRAWING NO. P118	REV 1





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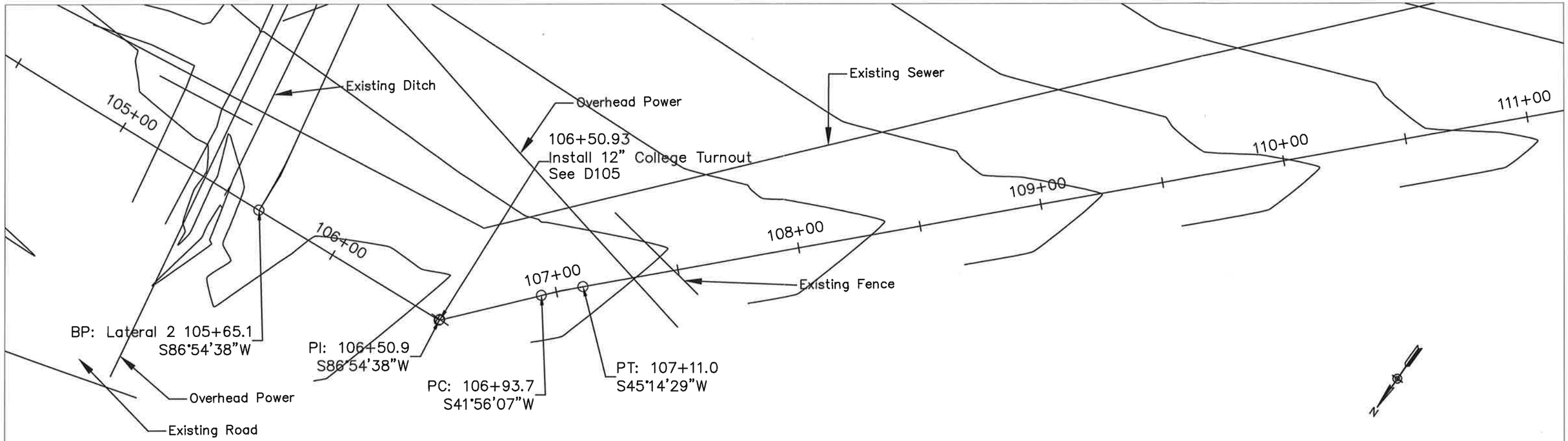
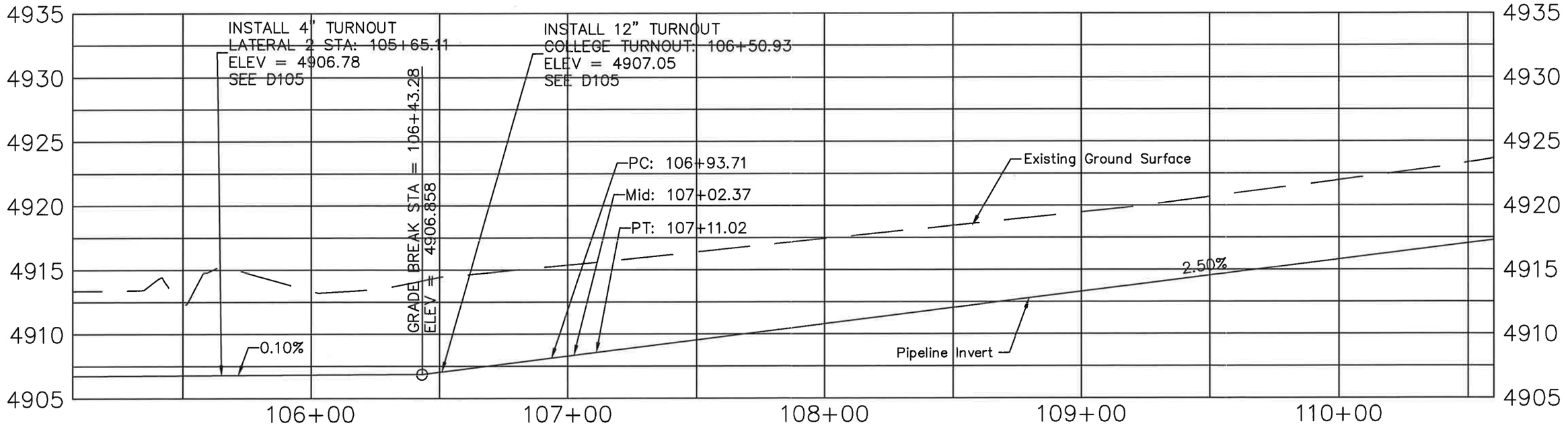
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet of
DRAWING NO. P119
REV 1





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0	Draft Conceptual Designs	05/07/16	SS	SS		

0 25 50 Feet

Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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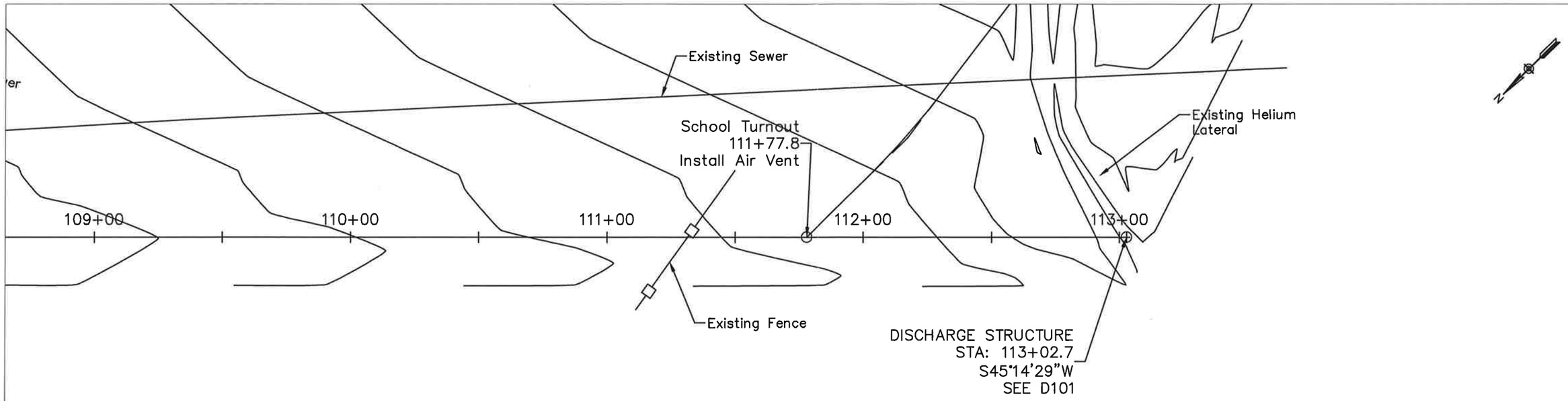
78 E. Center Logan, Utah 84321

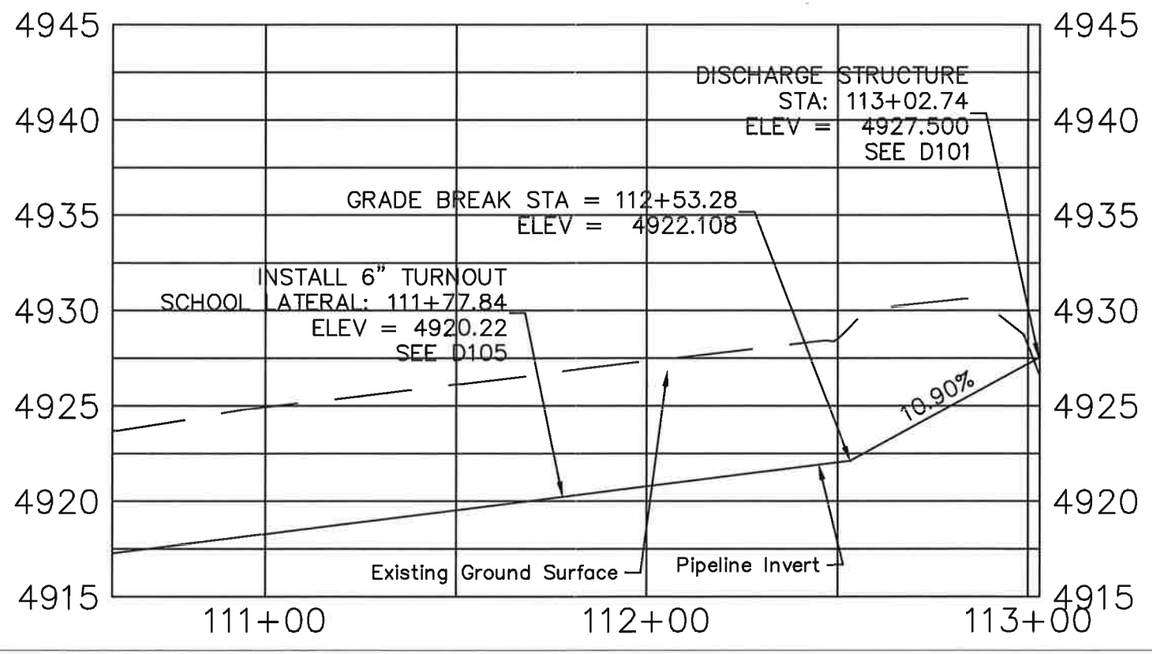
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR
Date: 05/27/16
Sheet of
DRAWING NO. P120
REV 1





(#)	Verson/Revisions	Date (MM/DD/YY)	Design	Draw	Check	Approved
1	60% Conceptual Designs	05/27/16	SS	SS		
0	Draft Conceptual Designs	05/07/16	SS	SS		

0 25 50 Feet

Coordinate System: NM West Zone NAD83
Datum: NAVD88
Survey Data Source: Johnson Mapping & Surveying, BIA
File Name: HeliumSiphon_20160527ss.dwg

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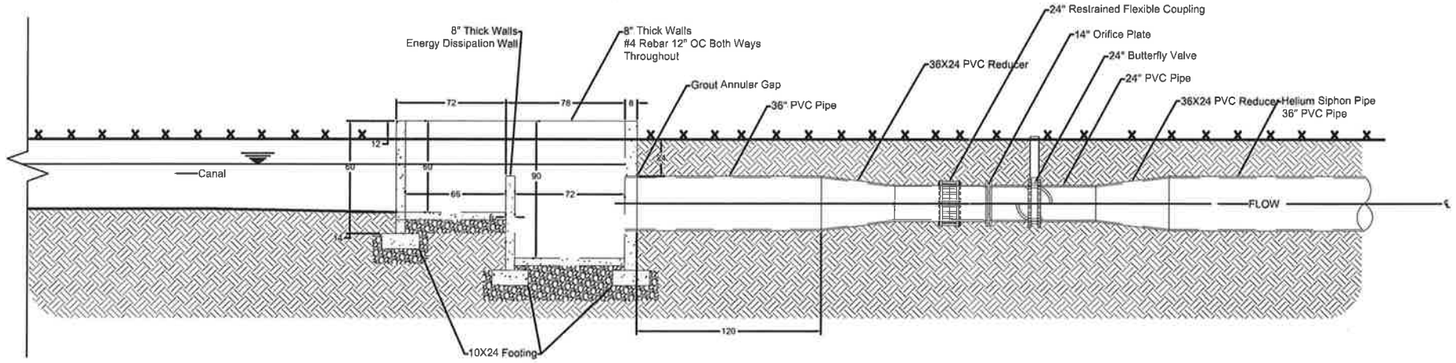
78 E. Center Logan, Utah 84321

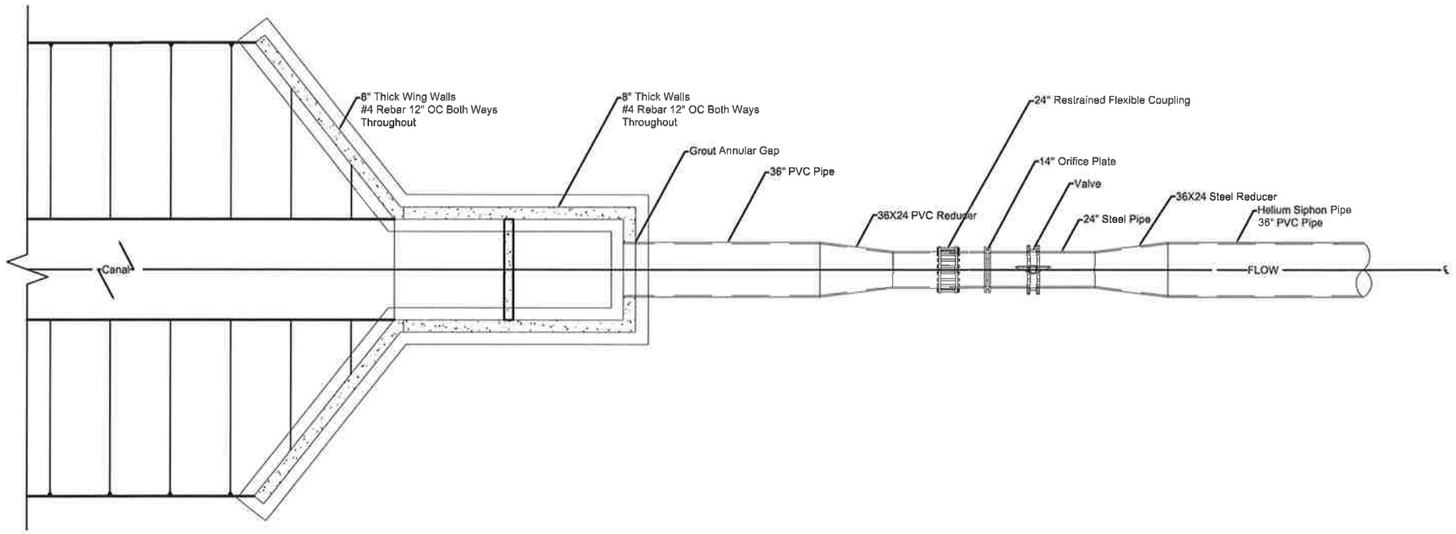
Navajo Nation Department of Water Resources

Helium Siphon

Plan & Profile Drawing

Job No. NNDWR	
Date: 05/27/16	
Sheet of	
DRAWING NO. P121	REV 1





Siphon Discharge Structure

#	Verson/Revisions	Date	Design	Draw	Check	Approved
			SS	ASB	MI	MI

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SCALE OF : NTS

Coordinate System:
Datum:
Survey Data Source:
File Name:

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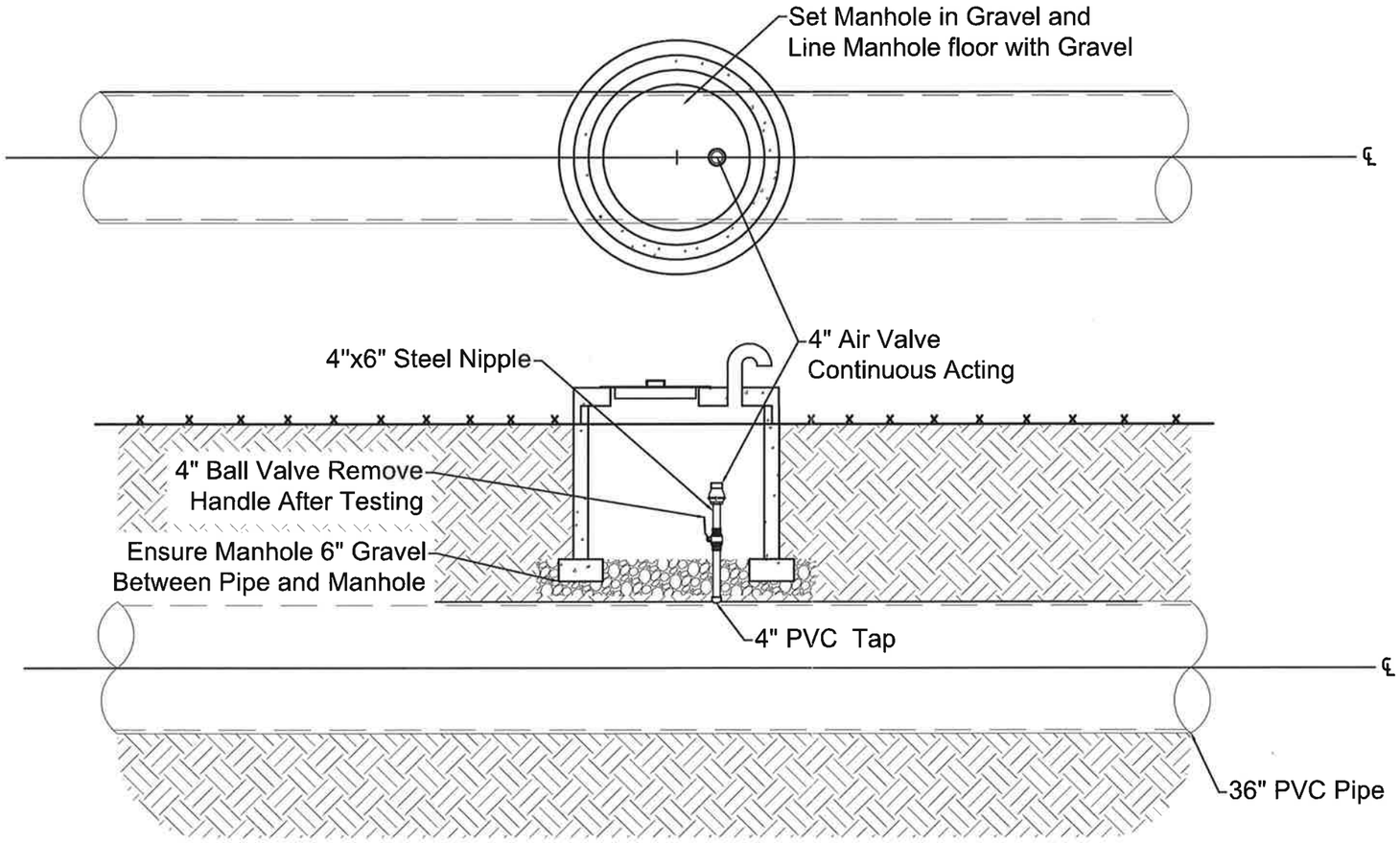
Navajo Nation Department of Water Resources

Hogback Pumping Plant

Helium Siphon
Discharge Structure

Job No. NNDWR
Date: 04/30/16
Sheet 18 of 22
DRAWING NO. D100
REV 0



Air Vent in 48" Manhole

#	Verson/Revisions	Date	Design	Draw	Check	Approved
			SS	ASB	MI	MI

0,5 0 0,5 1,0
SCALE OF : NTS

Coordinate System:
Datum:
Survey Data Source:
File Name:

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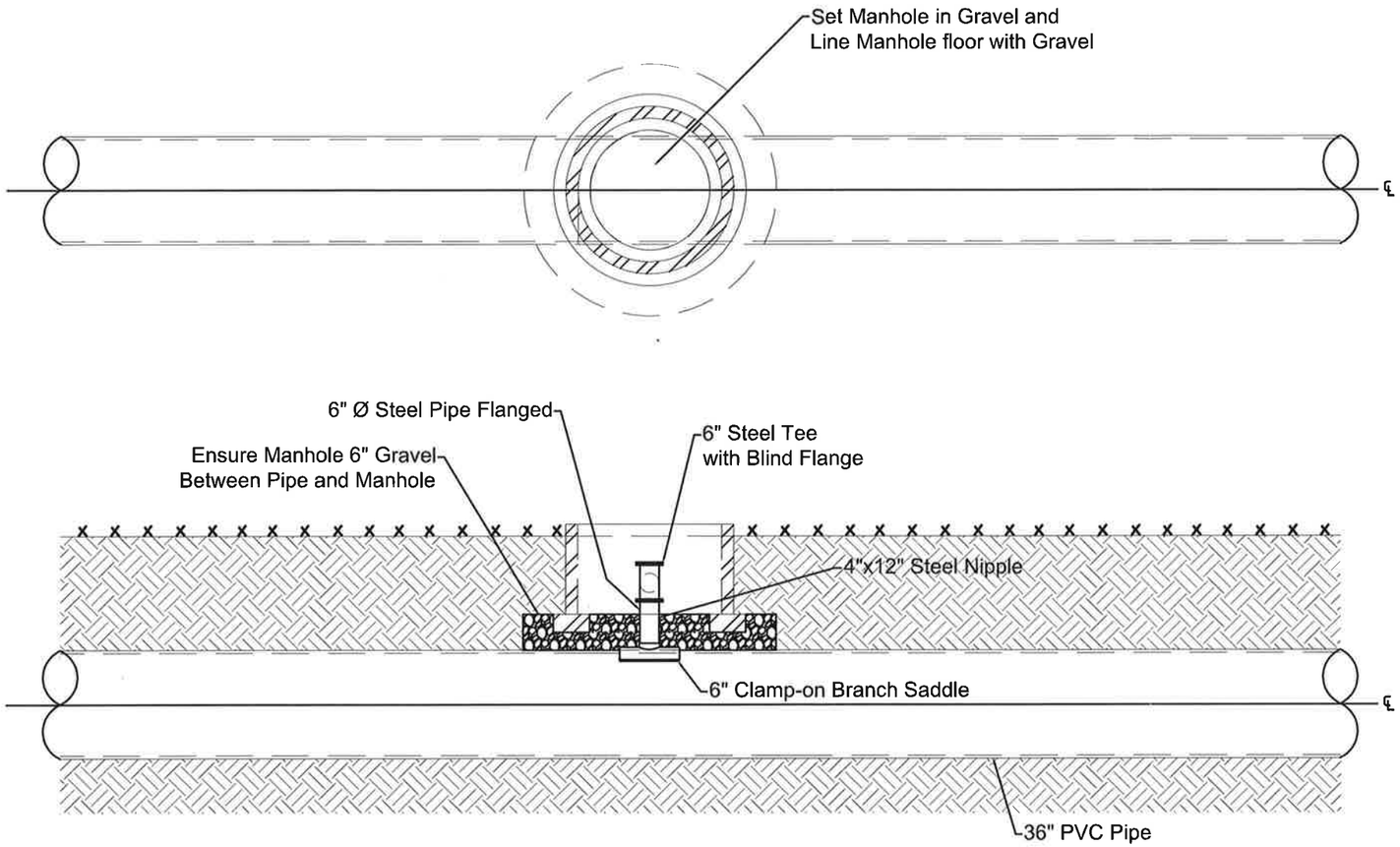
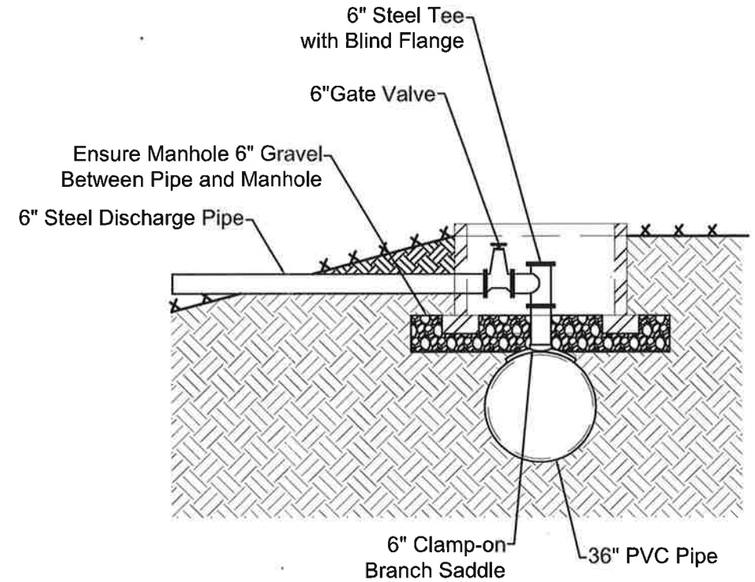
78 E. Center Logan, Utah 84321

Navajo Nation Department of Water Resources
Hogback Pumping Plant
Helium Siphon
Air-Vent Manhole

Job No. NNDWR
Date: 04/30/16
Sheet 19 of 22
DRAWING NO. D102
REV 0





Blow-Off Valve in 48" Manhole

#	Version/Revisions	Date	Design	Draw	Check	Approved
			SS	ASB	MI	MI

0,5 0 0,5 1,0
SCALE OF : NTS

Coordinate System:
Datum:
Survey Data Source:
File Name:

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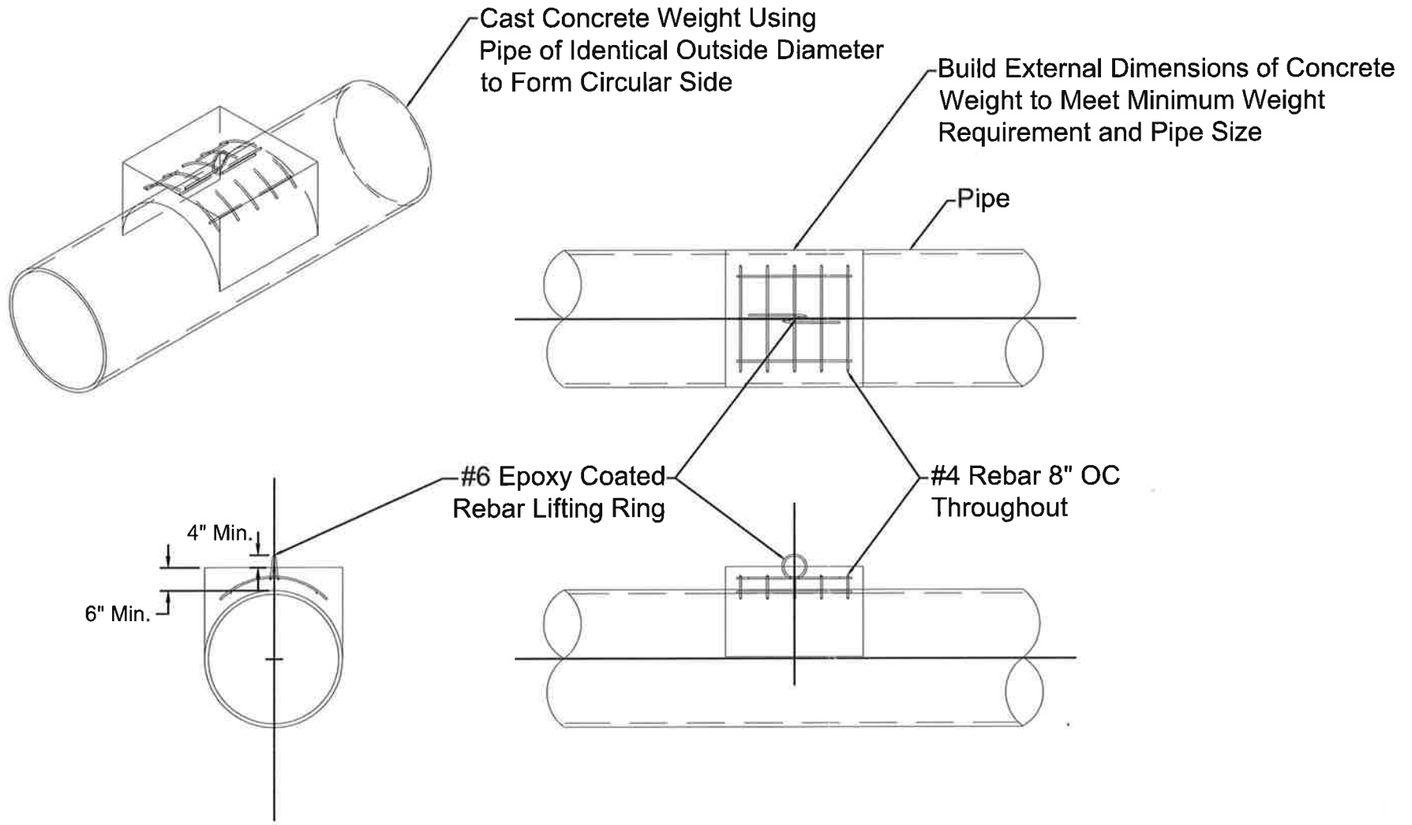
78 E. Center Logan, Utah 84321

Navajo Nation Department of Water Resources
Hogback Pumping Plant
Helium Siphon
Pipe Blow-Off Fixtures

Job No. NNDWR
Date: 04/30/16
Sheet 20 of 22
DRAWING NO. D103
REV 0



Notes:

1. Install Weights Every 10' OC On All Portions of the Pipe that lays with the San Juan River.
2. Each Concrete Weight Shall Weigh No Less than 300 lbs.
3. Maintain a Minimum of 2" of Concrete Depth to Rebar Accept on the Lifting Rings.

Concrete Weight Detail

#	Verson/Revisions	Date	Design	Draw	Check	Approved
			SS	ASB	MI	MI

0.5 0 0.5 1.0
SCALE OF : NTS

Coordinate System:
Datum:
Survey Data Source:
File Name:

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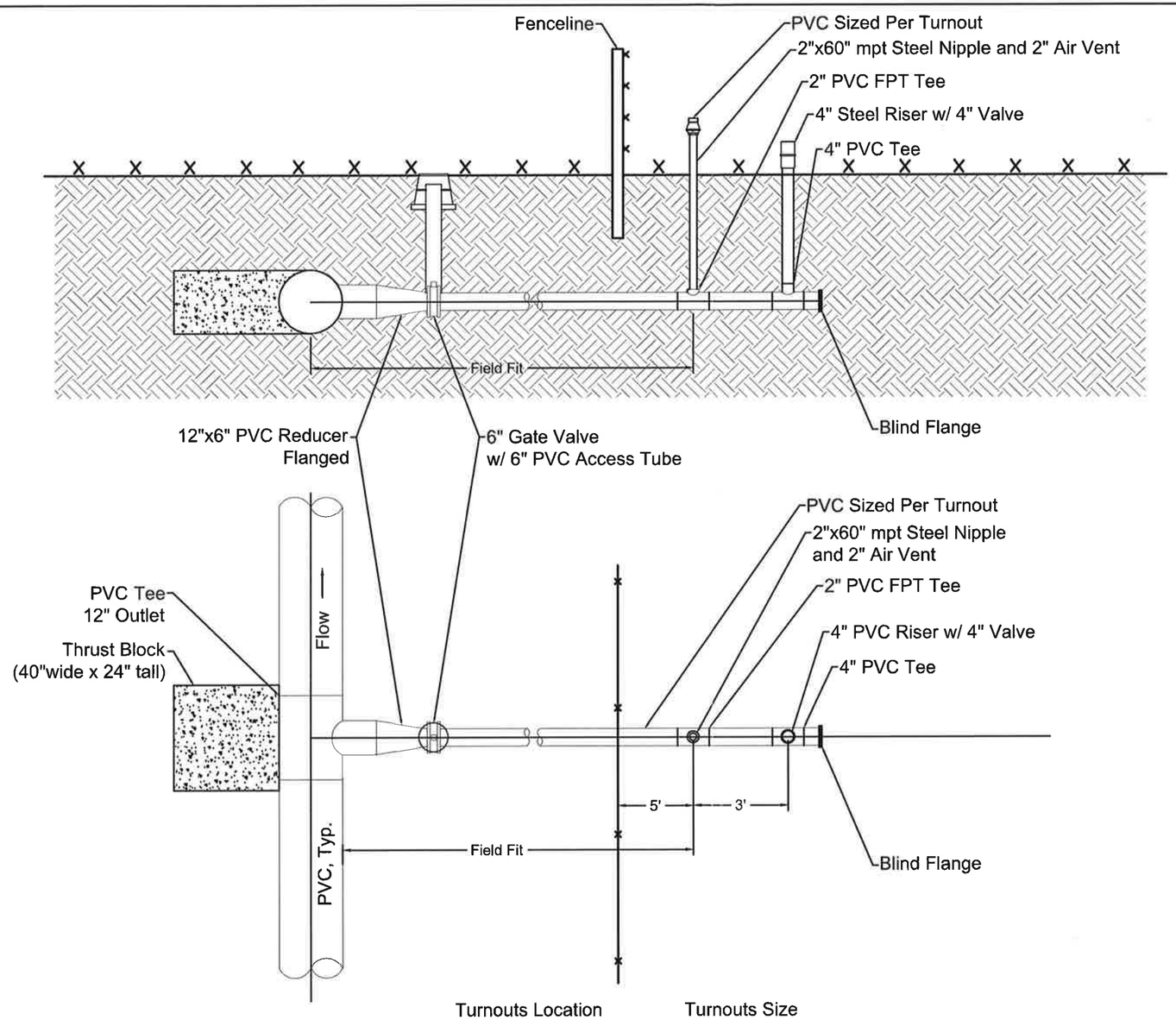
Irrigation & Water Resources
78 E. Center Logan, Utah 84321

Navajo Nation Department of Water Resources
Hogback Pumping Plant
Helium Siphon
Pipe Weight Blocks

Job No. NNDWR
Date: 04/30/16
Sheet 21 of 22
DRAWING NO. D104
REV 0



Turnouts Location	Turnouts Size
17+75	6"
72+00	4"
83+30	4"
84+06	8"
105+00	10"
106+50.93	12"
111+77.8	6"

Turnout Typical

NTS

#	Verson/Revisions	Date	Design	Draw	Check	Approved
			SS	ASB	MI	MI

0.5 0 0.5 1.0
SCALE OF : NTS

Coordinate System:
Datum:
Survey Data Source:
File Name:

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Irrigation & Water Resources
78 E. Center Logan, Utah 84321

Navajo Nation Department of Water Resources
Hogback Pumping Plant
Helium Siphon
Pipe Weight Blocks

Job No. NNDWR
Date: 04/30/16
Sheet 22 of 22
DRAWING NO. D105
REV 0

APPENDIX B – DESIGN-BUILD SPECIFICATIONS

San Juan River Navajo Irrigation Projects
Hogback Irrigation Project
Helium Siphon Replacement

DESIGN-BUILD SPECIFICATIONS

Prepared for

Navajo Nation Department of Water Resources
Technical Construction and Operations Branch
P.O. 678
Ft. Defiance, AZ 86504

Prepared by

Keller-Bliesner Engineering, LLC
78 East Center
Logan, Utah 84321
(435) 753-5651

November 14, 2016

PART 1 – GENERAL

1.01 WORK INCLUDED

A. This scope of work covers all design, material, and workmanship required to replace the Helium Siphon and appurtenances, install trash screen, turnouts, laterals, and construct the blowout and outlet structures per the Drawings and Specifications. This scope of work also covers abandonment of the existing siphon in certain locations in the event construction funding becomes available.

B. General. The existing Helium Siphon is a 40-inch steel coal tar pipeline that diverts water from the Hogback Canal to the Helium Lateral. The existing siphon is approximately 9,750 feet long, providing water to almost 1,000 acres on the south side of Shiprock, New Mexico.

C. This project replaces the current pipeline with a new 36-inch PVC pipe and installs new PVC laterals to serve historic demands. The new PVC siphon is 11,303 feet long and follows the existing alignment for approximately 5,200 feet. The siphon crosses the San Juan River and on the south edge of the floodplain, the new alignment diverts from the existing siphon to avoid new municipal and housing development. The new alignment continues along the edge of the developed area, and adjacent to agricultural land served by the siphon, until tying into the existing Helium Lateral about 380 feet north of Highway 64. The new siphon alignment generally follows the existing alignment until reaching the south side of the San Juan River floodplain. The project also installs a 6-inch PVC lateral pipeline from the outlet of Helium Siphon to the Central Consolidated School District irrigation pump located at the end of the existing siphon.

D. Scope. Work covered includes all design, design approval, demolition, disposal, earthwork, excavation, dewatering, handling, installation, mechanical work, electrical work, concrete work, structural work, backfill, and final grading to complete the work as shown in the conceptual design report and described in these specifications. All material, unless specified, are furnished by the Contractor.

1.02 GENERAL

A. All design work shall be completed under the direction of a Professional Engineer currently licensed to provide engineering services in the state of New Mexico and qualified to complete the scope of work.

B. All materials, unless otherwise noted, shall be of new, first-quality manufacture, free from defects and suitable for the intended use. Where manufacture's names are used in the Specifications it is for the purpose of establishing the standard for quality and general configuration. Products of other manufacturers will be considered, provided they meet the same standards and the manufacture's name and product specifications are submitted to the Engineer for approval.

C. The Owner has secured National Environmental Policy Act (NEPA) compliance for this project with the exception of the Clean Water Act Section 401 and 404 permits. The Contractor shall comply with all the contract specifications to ensure compliance with the NEPA. The Contractor shall assist NNDWR with applying for the 401 and 404 permits during the design phase of the project.

D. The Contractor shall be responsible for submitting a Notice of Intent (NOI) with the United States Environmental Protection Agency and be responsible for preparing and implementing a Storm Water Pollution Prevention Plan.

E. The Contractor shall be responsible for complying with New Mexico one-call requirements prior to completing any excavation work.

F. The Contractor shall provide all other permits, fees, materials, labor, and equipment necessary to complete the work.

G. All workmanship shall be of the highest quality.

H. All work shall be performed in strict accordance with these Specifications, and the applicable national, state and tribal law, codes and regulations. In addition, manufacturer's instructions for all materials shall be strictly followed. In the event of disagreement between national and tribal codes and these Specifications, the codes shall prevail. Such situations shall be discussed with the Engineer prior to proceeding with the work in question.

I. In the event of conflicts between Specifications, Drawings and field conditions, the Engineer shall be consulted. No changes in the design or construction method shall occur without the review and approval of the Engineer. If changes in the Drawings or Specifications are deemed necessary by the Contractor, details of such changes shall be submitted to the Engineer for review as soon as practical to allow time for review before installation.

J. Materials damaged in the course of installation shall be repaired or replaced at the discretion of the Engineer. The Contractor shall be liable for damage during handling or installation of all materials, whether provided as a part of this Contract or provided by others, and shall repair or replace the material at the option of the Engineer at the Contractor's expense.

K. Proper handling and storage of all materials and equipment prior to installation shall be the responsibility of the Contractor.

L. Cost. The cost of all materials furnished by the Contractor and the cost of all work performed by the Contractor necessary to complete the project as described by the drawings and these specifications and the material specifications shall be included in the prices listed in the Bid Schedule.

1.03 WARRANTY

A. Contractor warranty. Contractor shall warrant the work to be free from defects for a period of one year after completion of the project. Warranty shall cover all work performed by the Contractor and all materials provided by the Contractor.

B. Manufacturer warranties. All manufacturer warranties for materials furnished by this scope of work shall be transferred to:

Navajo Nation Department of Water Resources
Technical Construction and Operations Branch
P.O. 678
Ft. Defiance, AZ 86504

C. Costs. All costs associated with warranting the scope of work as described in the drawings and specifications shall be included in the bid schedule for each item applicable to the warranty.

PART 2 – DESIGN

2.01 GENERAL

A. Objective. The Contractor shall complete final design of the conceptual design approved by the Owner for replacing Helium Siphon. The conceptual design is described in the Conceptual Design Report.

B. Materials. The Contractor shall furnish all necessary materials, equipment, and labor necessary to install the 36-inch PVC pipe per Drawings and Specifications.

C. Qualifications. All work shall be completed under the direction of a Professional Engineer currently licensed in the state of New Mexico and qualified to complete the scope of work. All design documents completed for this scope of work shall be stamped by the Professional Engineer.

D. Geotechnical Investigation. The Owner has completed some geotechnical investigation of the site. This investigation is located in Appendix D of the conceptual design report. All additional geotechnical work shall be the responsibility of the Contractor.

E. River Crossing Investigation. The Contractor shall investigate the possibility of using the existing Siphon as a sleeve to cross the San Juan River. The Contractor shall be responsible for all investigative work necessary to complete this investigation. If the existing siphon is found viable for completing the crossing, then the Contractor shall incorporate the river crossing into the design. If the existing siphon is not usable, then the Contractor shall design and assist the Owner with obtaining permits for making a new crossing across the San Juan River.

F. Survey Data. The Owner has completed a topographical survey of the project area. This may be found in Appendix C of the conceptual design report. All additional survey data shall be the responsibility of the Contractor.

G. Design Review. The Contractor shall submit to the Owner a design review schedule that includes reviews at:
   - 30% completion
   - 60% completion
   - 90% completion

   Each review shall consist of a meeting between the Contractor, the Owner, and the Bureau of Indian Affairs.

H. Approval. The Contractor shall obtain approval of the design by the Owner prior to any construction.

I. Design Standards. The Contractor shall comply with the following design standards or approved equivalent:

J. Minimum Documents. The Contractor shall furnish six (6) copies of the drawings, specifications, and the standard operation manual.

K. As Built Drawings. The Contractor shall furnish as-built drawings for the replacement within 30 days after construction completion.

L. Payment. The Contractor shall submit all costs associated with the design for the project and the river crossing investigation in Bid Item 1. This cost assumes that the existing siphon may be used to sleeve the new pipe across the San Juan River and pays for all investigations necessary to determine whether or not the existing siphon is suitable. If the investigations conclude that the siphon cannot be used, then the Contractor shall submit the costs for designing and permitting a new river crossing in Bid Item ADD 5 which will only be executed in the event the existing siphon is not suitable.

PART 3 – SITE CONDITIONS, PREPARATION & RESTORATION

3.01 GENERAL

A. During construction, disturbance of the area shall be minimized. Construction activity shall be kept to the right-of-way at all times. Activity outside the construction boundary shall be by permission from the owner only. Keep project area neat and orderly at all times, free of rubbish and excess construction materials.

B. Prevent contamination of the project area. Do not dump waste oil, fuel, rubbish or other similar contaminants on the ground or in any streambed. The Contractor shall avoid contamination of the aquifer, soil or streams with any contaminant and shall be liable for containment and cleanup of any such contamination at his own expense.

3.02 ENVIRONMENTAL QUALITY PROTECTION

A. Landscape Preservation. The Contractor shall be responsible for restoring any land disturbed by construction activities. This includes preserving the natural landscape by keeping construction impacts to a minimum, limiting all activity within the designated construction boundaries, cleaning the construction area during construction and after completion of the project, re-grading disturbed lands so natural contours are restored, and providing proper drainage to prevent erosion during and after construction. The remediation plan shall be submitted and approved by the Engineer.

B. Vegetation Preservation. The Contractor shall preserve and protect existing vegetation which is not required to be removed by construction activity

C. Water Quality Management. The Contractor shall be responsible for any sediment and erosion control, wastewater control, and storm water management for all land within the construction boundary and any drainage to and from the construction boundary during the duration of the project. All Federal, State, and Tribal requirements for maintaining water quality during construction activity shall be met. The Contractor shall prepare and submit a storm water pollution prevention plan and a Notice of Intent as required by the Clean Water Act section 402 permit 14 days prior to construction. The contractor shall submit a weekly inspection sheet of any measures implemented by the storm water pollution prevention plan.

D. Air Quality Management. The Contractor shall comply with any applicable Federal, State, or Tribal regulations governing air quality for construction activity for the duration

of the project. This includes all equipment emissions and dust abatement.

E. Cultural Preservation. The Contractor shall protect any sites identified by the Navajo Nation as having any historical, religious, scientific, pre-historical, or archeological significance warranting preservation. No such areas are currently known to be within the construction boundaries. Should the Contractor discover any additional historical, religious, scientific, pre-historical, or archeological findings, all work involving that site shall cease until clearance is obtained. Expenses incurred by the delay shall be negotiated between the Owner and the Contractor. Any excess disturbances by the Contractor or any individual associated with the Contractor as judged by the Navajo Nation shall be subject to the full extent of the law.

F. Submittals. The Contractor shall submit to the Owner a copy of any required permit to complete the scope of work two days prior to any construction activity.

G. Payment. All material and labor costs associated with preserving environmental quality shall be included in the bid schedule for the applicable items. The costs for preparing, submitting, and complying with a storm water pollution prevention plan shall be included in Bid Item 2.

3.03 SAFETY

A. General. The Contractor shall fully comply with all Federal, State and Tribal safety regulations.

B. Safety Program. The Contractor shall establish and maintain a safety program during the duration of the project. The Contractor shall submit the safety program to the Owner for approval 14 days prior to any construction activity. Minutes of weekly safety meetings shall be submitted to the Owner for the duration of the project

C. Payment. The costs for establishing and maintaining a safety program shall be included in Bid Item 2.

3.04 STAGING AND EQUIPMENT SERVICE AREA

A. The Owner will designate a suitable equipment staging and service area for the Contractor within 1/4 mile of the project area. The staging and service area may be used for parking of equipment and storage of materials prior to installation. The Contractor shall be responsible for security at the staging area. Servicing of equipment and vehicles will be allowed only at the designated service area, except in cases where the repair must be performed on site before the equipment can be moved.

B. Care shall be taken to avoid fuel and oil spills. All waste material, packaging and unused material shall be removed from the site upon completion of the Contract.

C. The staging area shall be free of debris and re-graded to its original surface contour upon completion of the Contract.

D. Costs associated with establishing and maintaining a staging area for the duration of the project shall be Bid Item 2.

3.05 UTILITIES

A. General. Existing utilities may be located at the site. The Contractor shall identify all utilities, mark them during the duration of the project, and protect them from all construction activity. Any damage to existing utilities by the Contractor or their sub-contractors shall be repaired as directed by the utility owner at the Contractor's expense.

B. NM One Call. The Contractor or any sub-contractor shall submit a confirmation number to the Owner at least two days prior to any excavation at the site. The Contractor shall maintain the confirmation number for the duration of the excavation.

C. Electricity. The Contractor is responsible for all required electrical requirements necessary to complete construction of the project.

D. Water. The Contractor is responsible for all required water requirements necessary to complete the project.

E. Payment. The costs for working with utilities shall be included in Bid Item 2.

PART 4 – MATERIALS

4.01 GENERAL

A. General. All materials, unless otherwise noted, shall be of new, first-quality manufacture, free from defects and suited for the intended use. Where manufacturer's names are used in the Specifications it is for the purpose of establishing the standard for quality and general configuration. Products of other manufacturers will be considered, provided they meet the same standards and the manufacture's name and product specifications are submitted to the Engineer for approval.

B. Handling. Materials damaged in the course of transportation or installation shall be repaired or replaced at the option of the Engineer.

C. Warranties. All material manufacture warranties shall be transferred to the Owner at the completion of the project.

D. Storage and security. The Contractor is responsible for storing all material including the security of all material for the duration of the project. Any damage or loss shall be repaired or replaced by the Contractor at the Contractor's expense. This is to include any salvage material in the Contractor's care between the time of demolition and transport to the Owner.

E. Payment. All costs associated with furnishing, handling, storing, and the security of all material furnished by this contract are to be included in the applicable cost in the bid schedule.

4.02 PVC PIPE

A. Material Furnished by the Contractor. The Contractor shall furnish all PVC pipe required to complete the scope of work.

B. Material Specifications for 36-inch PVC Pipe. Pipe shall conform to AWWA C905 specification with gaskets meeting ASTM F477 and joints in compliance with ASTM D3139. Pipe shall conform with DR 41 cast-iron pipe outside diameter.

C. Material Specification for PVC less than 36-inch (for Turnouts). All 12-inch, 8-inch, and 6-inch PVC pipe shall be rigid polyvinyl chloride (PVC) extruded from Type 1, Grade 1 or 2 PVC resin with a hydrostatic design stress of 2,000 psi for water at 73.4 F, designated as PVC 1120 or PVC 1220 conforming to ASTM Standard D1784. Pipe included shall be either12-inch, 8-inch, and 6-inch diameter PIP PVC, class 100 with a Standard Dimension Ratio (diameter over thickness) of not more than 41. All pipe shall be furnished with integral bell gasket joints, conforming to ASTM Standard D3139, "Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals." The recommended lubricant for joining the pipe joints shall be furnished.

D. C905 PVC Fabricated Fittings. Fittings shall be fabricated from C905 PVC pipe conforming to AWWA C905. All C905 fittings shall have a dimension ratio of DR25. Fittings shall be manufactured with gasketed bell "push-on" ends.

E. PIP PVC Fabricated Fittings. All PIP PVC fittings shall comply with ASTM D1784, D2564, D2855, and F477. The pressure rating for the fittings is SDR 41 (100 psi). The pressure rating shall be maximum internal pressure ratings, non-shock at 73˚F. All PIP PVC fittings shall be manufactured with gasketed bell "push-on" ends.

F. Payment. Costs for handling, transporting, and storing material furnished by the Owner shall be included in Bid Item 3 for 36-inch PVC Helium Siphon and in Bid Item 10 for 6-inch PVC School Lateral Pipeline.

4.03 HDPE PIPE

A. Material Furnished by the Contractor. The Contractor shall furnish all HDPE pipe required to complete the scope of work. HDPE pipe shall be used for road crossings and the river crossing.

B. Material Specifications Smooth Walled Pressurized Pipe. Black PE materials used for the manufacture of polyethylene pipe, tube and fittings shall be PE 3408 high density polyethylene meeting ASTM D3350 cell classification 445574C (formerly PE 2406 meeting 345464C per ASTM D3350-02) and shall be listed in the name of the pipe and fitting Manufacturer in PPI (Plastics Pipe Institute) TR-4 with a standard grade HDB rating of 1600 psi at 73°F. The material shall be listed and approved for potable water in accordance with NSF/ANSI 61.

C. Fabricated Fittings. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings. Fabricated fittings shall be rated for internal pressure service at least equal to the full service pressure rating of the mating pipe. Fabricated fittings shall be tested in accordance with AWWA C906.

D. Payment. Costs for handling, transporting, and storing material furnished by the Owner shall be included in Bid Item 3. Costs for furnishing additional material shall also be included in Bid Item 3.

4.04 BLOW-OUT STRUCTURES

A. General. Two blow-out structures, with associated 6-inch PVC branch saddle, 6-inch PVC tee and blind flange, 6-inch gate valve and steel discharge pipe, and 48-inch manhole is required. The blow-out structures will be used to empty the siphon by gravity flow using the gate valve. The remaining water can be pumped out by accessing the siphon via the blind flange.

B. Drain Valve. The blow-out structure attached to the 36-inch PVC pipe with a 6-inch weld-on PVC branch saddle that is flanged to tie into a 6-inch PVC tee with blind flange. The 6-inch gate valve attaches to the tee at the tee at 90 degrees as shown in the Drawings. A 6-inch steel discharge pipe is attached to the discharge of the gate valve.

C. Payment. Costs for furnishing the manholes, drain and associated elements shall be included in Bid Item 4.

4.05 PIPELINE CONCRETE WEIGHT

A. General. These precast concrete weights shall be cast to the outside diameter of the 36-inch PVC pipe as shown in the Drawings.

B. Concrete Weight. The external dimensions of the concrete weight shall be conform to the width of the pipe. The length shall be adequate to maintain a weight of now less than 300 lbs. The weight shall be reinforced with #4 rebar at 8" OC throughout. Maintaining a minimum of 2 inches of concrete depth to rebar. Except for the #6 epoxy coated rebar lifting ring.

C. Payment. Costs for furnishing the pipeline concrete weights shall be included in Bid Item 5.

4.06 CONCRETE

A. Cement. The cement to be used shall conform to the "Standard Specification for Portland Cement" designation C.150 of the American Society for Testing Materials (ASTM). The recommended cement is Type II Normal Portland Cement. Any request to deviate from this will be subject to approval by the Engineer. No rapid hardening (Type III) cement types will be allowed.

B. Water. Water to be used for concrete mixing shall be potable water.

C. Aggregate. Aggregate proposed for concrete shall be subject to inspection and approval by the Engineer. The dust content, measured as the percentage of material passing a 75μm sieve shall not exceed 5% in the case of fine aggregate and 1.5% in the case of coarse aggregate. The fineness modulus shall fall in the range of 1.6 to 3.5 (inclusive). The chloride content of the aggregates shall not exceed 0.03% by mass and the aggregate shall be free of organic materials.

D. Admixtures. The use of accelerating admixtures will not be allowed. The use of water reducing admixtures is encouraged in order to lower the water/cement ratio.

E. Mixture Design. The mix shall be designed to conform to the following parameters:

1. 28-day minimum compressive strength f'c = 4000 psi
2. Maximum water/cement ration = 0.45 (by weight)
3. Total entrained air = 5% (-1% to +1%)
4. Maximum size of aggregate = 3/4-inch
5. Minimum slump = 2-inch and maximum slump = 4-inch

F. Mixing, Transporting and Placing. All work shall be conducted in accordance with ACI 212.2, "Guide for Use of Admixtures in Concrete," ACI 211.1. "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete," ACI 304. "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete."

G. Curing. Minimum times for stripping formwork shall be 48 hours. No concrete shall be backfilled until after a 48-hour curing period. Should cement other than Type I be used, formwork/backfilling times shall be subject to review by the Engineer.

H. Reinforcement. Reinforcement shall conform to ASTM 615 or ASTM 616 or A617. The minimum characteristic yield strength f_y=60 ksi unless noted otherwise. All reinforcement bars shall be #4 deformed placed on 12-inch centers each way unless noted otherwise. Footings shall have two rows of #4 rebar. Dowel pins 12-inch on center extending at least 12 inches into the vertical walls shall be placed in all footings or

slabs used as footings and tied to the reinforcement steel of the walls. Where required, transition bars between walls and the footings shall be bent to conform to the shape of the structure. All reinforcement plans shall be submitted to the Engineer for approval 15 days prior to forming any structures. Ties for reinforcement shall be black annealed wire not less than 1/16-inch in diameter.

I. Cover. The minimum cover to any reinforcing bar shall be two inches for 6-inch thick slabs and walls and three inches for 8-inch or greater slabs and walls.

J. Embedded Items. All items to be embedded in the concrete shall be securely fastened to the reinforcement in the correct positions. No concrete shall be placed before the Engineer has inspected the reinforcement, built-in items and formwork and certified them as ready for concrete placement. Such inspection and certification shall in no way relieve the Contractor of any liabilities due to errors and/or omissions of any part of the construction.

K. Tolerances

Compressive Strengths. No more than 5% of the random samples collected shall yield strengths less than the specified strength and no individual test shall yield a strength more than 10% below the specified strength.

Dimensional Tolerances. Variation in cross sectional sizes, positions of built-in items, plan dimensions, levels and any linear structural dimensions shall be -1/4 inches to +1/2 inches.

L. Quality Control. All concrete and reinforced concrete work will be subject to inspection and testing according to the provisions of the applicable ASTM standards as listed under Section 1, Volume 01.04, "Steel-Structural, Reinforcing, Pressure Vessel, Railway" and Section 4, Volumes 04.01 "Cement; Lime; Gypsum" and 04.02, "Concrete and Aggregates," without compromising the requirements of other standards and specifications as mentioned elsewhere within this document.

i. The frequency of casting test cylinders for concrete compressive strength tests will be determined by the Engineer. Generally, one set of three will be taken per pour over 5 cubic yards and a minimum of one set per 30 cubic yards placed.

ii. No backfill on top of reinforced concrete shall commence before the concrete has reach a minimum of 70% of its design compressive strength.

iii. Inspection by the Engineer will be required before re-commencing work after completion of each of the following concreting stages:

1. Placing rebar and built-in items
2. Erecting formwork
3. Placing concrete
4. Stripping formwork
5. Backfilling against the structure

M. Payment. All costs associated with furnishing concrete included in the applicable bid item.

4.07 SECURITY FENCE

A. General. A commercial grade chain link fence should be installed for security and safety purposes.

B. Round Steel Pipe. The pipe shall be Schedule 40 standard weight pipe, in accordance with ASTM F1083.

C. Fence Fabric. The material shall be manufactured from galvanized steel wire. The size of the steel wire core shall be 9 gauge.

D. Fittings. The fittings shall meet the requirements for ASTM F626.

E. Gates. The swing gates shall meet the requirement of ASTM F900.

F. Payment. All costs associated with furnishing the power supply included in Bid Item 5.

4.08 VALVES

A. General. All pipe valves shall be wafer style steel valves designed to be installed between two ½-inch steel flanges with 150 lb. bolt patterns. Each valve shall include the required bolts, nuts, and washers to install the valve. All bolts, nuts, and washers shall be a minimum of grade 5 and zinc coated steel.

B. Butterfly Valve. All butterfly valves shall be a wafer style valve. The valve shall have an epoxy coated cast iron body with locating lugs. The resilient seal shall consist of a stainless steel disc with Buna N liner. The shafts shall be fabricated from stainless steel. The bearings shall be bronze. The valve shall be gear operated with a hand wheel.

C. Continuous Acting Air Vent. Air/vacuum relief valves shall be sized as shown on the Drawings, designed to discharge air until the line is filled and then continuously discharge air once pressurized.

D. Turnout Air Vent. Air/vacuum relief valves shall be sized as shown on the Drawings, designed to discharge air until the line is filled and then opened once the

E. Gate Valve. The gate shall be a double disk line gate valve capable of a 60 ft. head. The body shall be epoxy coated cast iron with iron seats that slip onto a CL 80 PIP PVC valve. The operator nut shall be a 2-inch operating nut on a non-rising bronze stem suitable for underground service. The valve shall come with a 4-inch PVC access tube, cap, and operating key.

F. Riser Valve. All tee riser valves for the turnouts shall be a PIP by O.D steel tee riser valve with a 60-inch riser as manufactured by Gheen Irrigation Works, Inc. Model No. 7015 or approved equal. The fitting shall be epoxy coated.

G. Valve Opener. All valve openers shall be 90 degree aluminum valve opener with a ring lock that connects to the riser valve. Each turnout shall have one valve opener.

H. Payment. Costs for providing the valves and hardware to install the valves shall be included in the applicable bid item where a valve has been specified.

PART 5 – WORKMANSHIP

5.01 EXCAVATION

A. General. The Contractor shall be responsible for obtaining a One Call confirmation number from NM One Call prior to any excavation. A trench shall be excavated in accordance with the Drawings and Specifications.

B. Safety. All safety procedures shall be followed during excavation including adequate trench shoring, personnel safety, and barricades on open trenches.

C. Survey. Two elevation benchmarks are provided on each end of the project. All survey requirements are furnished by the Contractor.

D. Trench Width. The trench shall have a minimum width of the pipe diameter plus 8-inches on each side with the pipe centered in the trench. Up to the top of the pipe, the trench shall not be wider than the diameter of the pipe plus 12 inches on each side.

E. Trench Depth. Unless otherwise specified, all pipe shall have a minimum cover depth of 3 feet.

F. Grade. Grade shall be controlled such that when the pipe is installed the invert elevation shall not deviate from that shown on Drawings by more than 0.1 ft.

G. Dewatering. If dewatering is necessary in order to keep the bottom of the trench free of water, a pump shall be used to pump water out of the trench and disposed of into as allowed by permitting. In areas requiring dewatering, the contractor shall over-excavate the trench by 6-inches to allow for the placement of clean, washed gravel foundation to support the pipe

H. Trench Bottom Preparation. The bottom of the trench shall be clean and free from protruding stones larger than ½ inch in diameter, hard lumps, angular stones, or abrasive material, to allow the pipe to lie directly on earth in the bottom of the trench.

I. Safety. All appropriate and applicable safety precautions and regulations shall be followed during excavation, including trench shoring or sloped trench walls for protection of workers where required. Open trenches shall be clearly marked with appropriate barricades when close to public access. All national, state and tribal safety regulations shall be followed.

J. Payment. All costs associated with excavation per the Specifications and the Drawings shall be included in the applicable bid item.

5.02 HDPE PIPE INSTALLATION

A. Handling. During installation, pipe shall be handled carefully to avoid any damage. Any damaged pipe during trenching and installation shall be replaced by the Contractor at the expense of the Contractor. Any debris in the pipe shall be removed prior to installation. During assembly, pipe ends shall not be left open when installation is not active at the open end. Keep the pipe ends blocked to prevent entry of foreign matter that might clog the system when flushing.

B. Heat Fusion Joining. Joints between plain end pipes and fittings shall be made by butt fusion. The butt fusion procedures used shall be procedures that are recommended by the pipe and fitting Manufacturer. The Contractor shall have a minimum of one year experience installing large diameter HDPE pipe and shall ensure that persons making heat fusion joints have received training in the Manufacturer's recommended procedure. The Contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12 months before commencing construction. External and internal beads shall not be removed.

C. Butt Fusion of Unlike Wall Thickness. Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and are not different in wall thickness by more than one Standard DR, for example, SDR 13.5 to SDR 17, or SDR 11 to SDR 13.5. Transitions between unlike wall thickness greater than one SDR shall be made with a transition nipple (a short length of the heavier wall pipe with one end machined to the lighter wall). SDR's for polyethylene pipe are 7.3, 9, 11, 13.5, 17, 21, 26, 32.5 and 41.

D. Field Cutting. Pipe ends should be squarely cut to 90°± 5°. Do not use bar chain lubrication if cutting pipe with a chainsaw.

E. Pipe Joining. The joining of the pipe shall be accomplished according to the manufacturer's specifications. Assemble the joints in as straight an alignment as possible. The manufacturer's recommended maximum joint deflection shall not be exceeded at any time. ASTM standards say that fusion is generally not recommended below -4°F without special provisions. Follow all guidelines set forth in ASTM F2620.

F. Pipe Repair. Damaged portions of the HDPE pipe may be repaired using electrofusion repair saddles, or if the damage is sufficiently extensive a section of pipe may be cut out and removed.

G. Transition to PVC Pipe. HDPE pipe shall be connected to PVC pipe using steel reducing couplings such as the Romac Style RC400 or approved equal. The coupling shall be wrapped in plastic visqueen sealed on the ends with duct tape.

H. Payment. All costs associated with pipe installation per the Specifications and Drawings shall be included in Bid Item 3.

5.03 PVC PIPE INSTALLATION

A. Handling. During installation, pipe shall be handled carefully to avoid any damage. Any damaged pipe during trenching and installation shall be replaced by the Contractor at the expense of the Contractor. Any debris in the pipe shall be removed prior to installation. During assembly, pipe ends shall not be left open when installation is not active at the open end. Keep the pipe ends blocked to prevent entry of foreign matter that might clog the system when flushing.

B. Field Cutting. Where it is necessary to make field cuts in the pipe at fitting locations, the pipe may be cut using a hand saw, or power saw with a fine toothed blade or abrasive disk. Care should be taken to avoid chipping the pipe. If the pipe is chipped

or cracked, it shall be re-cut to remove the damage area. After cutting, the pipe end shall be beveled to match the factory provided spigot end using a beveling tool, wood rasp, or power grinder. Prior to cutting or beveling, the pipe should be marked on its entire cut line to assure a straight cut. After cutting and beveling, the proper spigot penetration depth shall be marked on the pipe prior to assembly.

C. Pipe Assembly. The assembly of the gasket jointed pipe shall be accomplished according to the manufacturer's specifications. Only manufacturer recommended lubricant shall be used. The gasket race, gasket, bell and spigot shall be thoroughly cleaned before assembly. Install the gasket prior to lubrication. Lubricate and assemble according to manufacturer's recommendations. Do not "bottom" the spigot in the bell during assembly. The proper depth of penetration will be marked on the pipe by the manufacturer. Assemble the joints in as straight an alignment as possible. The manufacturer's recommended maximum joint deflection shall not be exceeded at any time.

D. Elbows. Unless specified, all direction changes shall be accomplished with a pre-fabricated steel elbow. Turnouts shall be accomplished as shown on the drawings.

E. Fitting Installation. Manufacturer directions shall be followed. All fittings shall be inspected prior to back fill.

F. Thrust Blocks. Thrust blocks are required for all horizontal tees, elbows, and termination ends. Concrete used for thrust blocks shall be a minimum 3,000 psi mix. The thrust block shall be poured so that the specified bearing area specified is achieved. A minimum distance of 1 ft between the pipe and the undisturbed trench wall shall be maintained. Thrust blocks shall not be backfilled until 24 hours after they have been poured. .

G. Payment. All costs associated with installation of the 36-inch PVC Helium Siphon shall be included in Bid Item 3. All costs associated with installation of the 6-inch PVC School Lateral shall be included in Bid Item 10.

5.04 PVC PIPE CONNECTION TO EXISTING SIPHON INLET TRANSITION STRUCTURE

A. General. At the siphon inlet on the east side of the arroyo, new 36-inch PVC pipe will be connected to the existing concrete structure.

B. Connect Pipe to Siphon Inlet. The Contractor will design the connection of the new PVC pipe to the existing concrete structure.

C. Trash screen. The Contractor shall design, fabricate and install a trash screen on the upstream side of the inlet that matches the existing inlet structure.

D. Backfill. The new connection shall be backfilled and compacted to 95 percent density a standard proctor.

E. Payment. All costs associated with pipe installation per the Specifications and

Drawings shall be included in Bid Item 8.

5.05 NEW SIPHON OUTLET TRANSITION STRUCTURE AND CONNECTION TO PVC PIPE

A. General. A new siphon outlet transition structure shall be constructed that will be the connection between the termination of the PVC pipe and the beginning of the existing earthen canal.

B. Construct Outlet Transition Structure. The structure as shown on the drawings shall include a 36-inch to 24-inch reducer, a 24-inch shut-off valve, a 14-inch diameter orifice plate for reducing pressure, a 24-inch compression coupler, a 36-inch to 24-inch reducer and a pipe that is inserted into the new concrete structure. The 24-inch pipe shall be carbon steel properly protected underground from corrosion.

C. Concrete structure. The concrete structure shall be designed, furnished and installed by the contractor on a suitable foundation and with an energy dissipation wall as shown on the drawings. The concrete structure shall be configured provide a safe transition for flow to the earthen canal.

D. Payment. All costs associated with the outlet transition structure per the Specifications and Drawings shall be included in Bid Item 6.

5.06 BACKFILL

A. General. Backfill shall follow shortly after the installation of the PVC pipe. The bedding material placed within the haunches of the pipe and at least 12 inches above the top of the pipe shall be free from stones larger than 1 inch in diameter, angular stones, abrasive or frozen material, and free of debris or other organic materials. The backfill material shall be placed in a manner that minimizes voids throughout the trench but particularly around the pipe. Backfill below the haunches shall be compacted in 6-inch lifts to 85% of standard proctor. The final backfill (from at least 12" above the crown of the pipe to the top of the trench) shall be free from stones larger than 4 inches in diameter, clumps of frozen soil, rubble or other such material. In most cases, the material that was originally excavated can be used for final backfill. Following backfill of the trench, the surface shall be re-graded to the original ground surface with the trenched area mounded to allow for backfill settlement.

B. Saturated Area. For locations where the PVC pipe is in saturated areas, the bedding shall be clean crushed 1-inch gravel or chips, with a gradation as follows:

Passing 1-inch Sieve.....100%
Passing ¾-inch Sieve.....90-100%
Passing 38-inch sieve.....20-55%
Passing #4 Sieve.....0-10%
Passing #8 Sieve.....0-8%

C. Unsaturated Area. For locations where the PVC pipe is in unsaturated areas, the backfill shall be compacted to 85% of standard proctor below the haunches, and 80% of standard proctor above the haunches.

D. Structural Backfill. All structural backfill shall be compacted to a density of 95% of standard proctor.

E. Payment. The cost for backfilling and surface re-grading shall be included in the applicable bid item.

5.07 BLOW-OUT STRUCTURE

A. General. Two blowout structures for draining and accessing the pipe shall be installed. The structure shall be able to gravity discharge the siphon for water located above the ground elevation of the drain. The remaining water in the drain below the ground elevation shall be pumped out.

B. Payment. The cost for the drain shall be included in Bid Item 3.

5.08 PIPELINE CONCRETE WEIGHT

A. General. A precast concrete weight shall be placed every 10 feet throughout the San Juan River crossing and the secondary channel crossing. The purpose of the weight is to prevent the pipe from floating when empty.

B. Payment. The cost for concrete cap shall be included in Bid Item 6.

5.09 SITE RESTORATION

A. General. The entire construction site shall be restored to original or better conditions.

B. Fields. Locations within fields shall be graded to original condition so that the pipe does not form a barrier to surface irrigation operations. The Contractor shall disk the disturbed ground once completed.

C. Payment. The cost for site restoration shall be included in Bid Item 3.

5.10 ROAD CROSSINGS

A. General. Helium Lateral Pipeline crosses Bluff Road as shown on the Drawings. All workmanship and materials shall conform to the Bureau of Indian Affairs Road Department standards. If the geology allows for it, the crossing shall be accomplished by direct boring the road to the grades and elevations shown in the approved design. Pipe that is damaged during unloading, handling or installation shall be replaced as directed by the Engineer at the expense of the Contractor.

B. Permit. The Contractor shall apply to the Bureau of Indian Affairs for a road crossing permit. The Contractor shall comply with the road crossing permit.

C. Bore Installation. The steel casing pipe shall be installed to the proper alignment and grade as shown in the approved design by direct boring. No open cut installation will be allowed within the highway right-of-way if a bore can be reasonably accomplished. The steel pipe shall be installed such that there is no annular space between the pipe and the ground through which the pipe is installed.

D. HDPE Pipe Installation. Once the steel casing has been installed, the Contractor shall insert the 36-inch HDPE pipe through the steel casing. All fuses joints shall be completed and visually inspected to ensure the joint has been fused prior to installation.

E. Transition to PVC pipe. The HDPE pipe shall be joined to the PVC pipe on each side of the steel casing five feet from the end of the casing. The pipes shall be joined by a repair coupler specifically designed to join two pipes with different diameters and materials. The coupling shall be wrapped and sealed with plastic visqueen and duct tape.

F. Utility Markers. 60-inch long by 3.75-inch fiberglass purple posts (for irrigation) shall be placed on the edge of the highway right-of-way marking the location of the pipeline once the pipeline has been backfilled and graded.

G. Payment. All costs associated with installation of the road crossing per the Specifications and Drawings shall be included in Bid Item 8.

5.11 RIVER CROSSING

A. General. Helium Siphon Pipeline crosses the San Juan River as shown on the Drawings. The existing siphon has a 40-inch coal tar epoxy lined steel pipe. It is NNDWR's intent that this section of pipe may be utilized as a sleeve to insert a new 36-inch HDPE pipe through, thus avoiding the permitting and costs of constructing a new crossing. If this is not possible, then the Contractor shall design and install a new crossing.

B. Investigation. During the design process, the Contractor shall excavate each end of the existing siphon on the river and investigate the integrity of the existing steel pipe. If the steel pipe is found to be usable, then it may be used as a sleeve. If the steel pipe remains uncertain, then the pipe will be abandoned and a new crossing is to be designed by the Contractor.

C. Permits. The Contractor shall be responsible for obtaining a Section 401 permit from Navajo EPA and a Section 404 permit from the US Corps of Army Engineers if a new crossing has to be completed.

D. Crossing. The Contractor may design either a bore or an open cut crossing based on geology and permitting. The Contractor shall select a sleeve suitable for slipping the 36-inch HDPE pipe.

E. HDPE Pipe Installation. Once the sleeve has been installed, the Contractor shall insert the 36-inch HDPE pipe through the sleeve. All fuses joints shall be completed and visually inspected to ensure the joint has been fused prior to installation. HDPE pipe shall be installed for the length of the river crossing plus 200 feet on each side of the river.

F. Transition to PVC pipe. The HDPE pipe shall be joined to the PVC pipe on each side of the sleeve five feet from the end of the sleeve. The pipes shall be joined by a repair

coupler specifically designed to join two pipes with different diameters and materials. The coupling shall be wrapped and sealed with plastic visqueen and duct tape.

G. Dewatering. The Contractor shall be responsible for all dewatering of the project area for the duration of the project.

H. Payment. The Contractor shall submit all costs associated with completing the river crossing investigation and then subsequent insertion of the HDPE pipe into the existing sleeve in Bid Item 5. If the investigations conclude that the siphon cannot be used, then the Contractor shall submit the costs for designing, permitting, and completing a new river crossing in Bid Item ADD 5. Bid Item ADD 5 is only implemented in addition to Bid Item 5 in the event a new crossing is installed.

5.12 TURNOUTS

A. General. The Contractor shall design and install turnouts as shown on the Drawings. All turnout locations shall be finalized during the design process in consultation with the permit holder whom is served by the turnout.

B. A turnout consists of a reducing tee, an isolation gate valve, conveyance pipe to the field, an air vent on a riser, and a riser valve with a valve turner.

C. Fitting Installation. Manufacturer directions shall be followed. All fittings shall be inspected prior to back fill.

D. Thrust Blocks. Thrust blocks are required for all horizontal tees, elbows, and termination ends. Concrete used for thrust blocks shall be a minimum 3,000 psi mix. The thrust block shall be poured so that the specified bearing area specified is achieved. A minimum distance of 1 ft between the pipe and the undisturbed trench wall shall be maintained. Thrust blocks shall not be backfilled until 24 hours after they have been poured. .

E. Payment. All costs associated with installation of the turnouts shall be included in Bid Item 9

5.13 SAFETY

A. Safety rope. A safety rope upstream of the trash screen with floating buoys shall be installed to prevent persons who have fallen into the canal from floating onto the screen.

B. Safety ladder. A ladder shall be installed upstream of the trash screen in conjunction of the safety rope to allow a person to climb out of the canal without venturing onto the trash screen.

C. Payment. The cost for the safety rope and safety ladder shall be included in the applicable Bid Item.

5.11 SECURITY FENCE

A. General. For security and safety purposes, a commercial grade fence should be designed and installed around the new outlet structure and the existing intake channel

and intake channel. The security fences shall be installed, in accordance with the ASTM F567 standards.

B. Payment. The cost for the security fence shall be included in the applicable Bid Item.

END OF SECTION

PART 6 – PIPE ABANDONMENT (IF AUTHORIZED BY THE OWNER)

6.01 GENERAL

A. General. Abandoning the pipe in certain locations may be authorized under this scope of work if construction funding is available. The Owner shall notify the Contractor in writing if this scope of work is to be executed.

B. Scope of Work. The scope of work to abandon pipe includes all mobilization, traffic control, barriers, excavation,, cutting, welding, concrete pumping, backfill, and restoration necessary to abandon the pipe as shown in the drawings and specifications.

C. Public Safety. The Contractor is to safe-guard the safety of the public during the completion of this scope of work. This includes all traffic control, barriers, and access to the works. Any damage to individuals and property associated with this scope of work shall be the responsibility of the Contractor.

D. Site Conditions, Preparations, and Restorations. All provisions of Section 3 of these Specifications apply.

E. Payment. All costs associated with abandoning the pipe as described by the specifications and drawings (See Appendix G of the Conceptual Design Report) shall be included in ADD 10 of the Bid Schedule.

6.02 FINAL DESIGN

A. General. The Contractor shall complete the final design of the Pipe Abandonment according to the Conceptual Design (See Appendix G of the Conceptual Design Report) per Section 2 of these specifications.

B. Payment. All costs associated with abandoning the pipe as described by the specifications and drawings shall be included in ADD 10 of the Bid Schedule.

6.03 MATERIALS

A. General. 4.01 of these Specifications apply.

B. Cellular Concrete. Cellular Concrete used to seal the pipe sections shall adhere to ASTM C869 and texted according to ASTM C796. The specifications shall be:
   a. Cast Density: 32 PCF
   b. 28 day minimum compressive strength: 120 psi
   c. Minimum Bearing Capacity: 8.6 tons/ft^2
   d. Elastizill PS or approved equal.

C. Payment. All costs associated with abandoning the pipe as described by the specifications and drawings shall be included in ADD 10 of the Bid Schedule.

BID SCHEDULE

No.	Description	Qty	Unit	Unit Cost	Extension
1	Design project per Drawings and Specifications	1	ea		
2	Mobilization and Demobilization	1	ea		
3	Furnish and install 36-inch PVC pipe and fittings not specified in Bid Schedule per Drawings and Specifications	11,302	ft		
4	Furnish and install blowout structure per the Drawings and Specifications	2	ea		
5	Furnish and install the San Juan River crossing using the existing siphon per Drawings and Specifications	1	ea		
6	Furnish and install concrete outlet transition structure per Drawings and Specifications	1	ea		
7	Tie-in 36-inch PVC pipe to inlet structure per Drawings and Specifications	1	ea		
8	Furnish and install road crossing per Drawings and Specifications	1	ea		
9	Furnish and install turnouts per Drawings and Specifications	7	ea		
10	Furnish and install the 6-inch PVC school lateral pipeline.	4,810	ft		
				Sub-total	
				Navajo Nation Business Activity Tax (5%)	
				Total	
ADD 5	Design, permit, and install a new crossing of the San Juan River if the existing siphon is not suitable for using as a sleeve. OPTION 5 is in addition to Bid Item 5 and is initiated in the case a new crossing is required.	1	ea		
ADD 10	Design, permit, and abandon existing pipe.	1,200	ft		

APPENDIX C – SURVEY DATA

1	2101612.336	2468413.925	4957.966	SCP
2	2110281.652	2471858.701	4990.232	SCP
3	2103409.62	2465059.085	4914.059	SCP
4	2105412.247	2468820.399	4886.159	scp
5	2104866.329	2467833.017	4892.873	scp
6	2108995.152	2471102.056	4950.618	scp
7	2109055.809	2471161.802	4954.299	ng
8	2109055.769	2471161.862	4954.215	scp
9	2109055.759	2471161.866	4954.256	scp
999	2105412.315	2468820.45	4886.11	NG
1000	2103441.397	2464828.294	4914.553	ng
1001	2103475.513	2465101.637	4911.67	ng
1002	2103530.253	2465386.537	4911.058	ng
1003	2103706.408	2465746.432	4909.329	ng
1004	2103795.36	2465922.851	4907.357	ng
1005	2103886.326	2466098.253	4905.554	ng
1006	2103983.547	2466275.808	4904.515	ng
1007	2103388.155	2465047.874	4913.782	ng
1008	2104010.797	2466326.165	4904.06	ng
1009	2104068.551	2466456.296	4903.614	ng
1010	2104193.671	2466694.359	4900.502	ng
1011	2104251.258	2466812.598	4899.229	ng
1012	2104268.377	2466846.251	4899.108	ng
1013	2104341.03	2466989.504	4897.536	ng
1014	2104456.063	2467168.947	4895.094	ng
1015	2104497.488	2467307.458	4894.103	ng
1016	2104730.293	2467614.001	4891.865	ng
1017	2104760.04	2467662.511	4891.875	ng
1018	2104884.859	2467820.626	4891.678	ng
1019	2104953.446	2467899.86	4891.21	ng
1020	2105024.11	2468063.945	4890.074	ng
1021	2105069.151	2468229.782	4888.674	ng
1022	2105101.817	2468359.101	4887.925	ng
1023	2105115.061	2468478.351	4888.054	ng
1024	2105137.609	2468678.81	4887.98	ng
1374	2110148.214	2471647.916	4979.267	
1375	2110143.423	2471659.652	4982.102	
1376	2110140.962	2471669.779	4984.373	
1377	2110127.579	2471666.925	4984.844	
1378	2110125.529	2471661.295	4981.831	ng
1379	2110118.438	2471654.437	4978.096	ng
1380	2110107.888	2471651.675	4976.788	ng
1381	2110102.828	2471658.639	4976.77	ng
1382	2110083.766	2471649.552	4977.106	ng
1383	2110072.837	2471642.164	4976.791	ng
1384	2110048.772	2471629.49	4975.266	ng
1385	2110021.775	2471613.459	4974.423	ng

1386	2109996.834	2471605.718	4972.837 ng
1387	2109960.578	2471574.948	4971.28 ng
1388	2109911.929	2471531.388	4969.387 ng
1389	2109690.345	2471437.143	4964.18 ng
1390	2109525.048	2471366.844	4961.667 ng
1391	2109180.128	2471212.136	4962.631 ng
1392	2109180.134	2471212.108	4962.62 ng
1393	2109175.213	2471212.396	4962.631 ng
1394	2109168.065	2471215.167	4958.837 ng
1395	2109136.645	2471214.594	4956.8 ng
1396	2109130.498	2471215.455	4956.299 ng
1397	2109093.864	2471199.918	4951.179 ng
1398	2109094.726	2471170.429	4952.47 ng
1399	2109080.359	2471161.217	4950.53 ng
1400	2109064.91	2471153.033	4949.464 ng
1401	2109059.46	2471148.013	4948.289 ng
1402	2109071.451	2471140.672	4950.974 ng
1403	2109041.489	2471129.602	4949.731 ng
1404	2109032.888	2471119.544	4946.66 ng
1405	2109026.606	2471113.418	4946.254 ng
1406	2109022.701	2471104.658	4950.978 ng
1407	2108998.685	2471116.513	4950.756 ng
1408	2108973.98	2471129.391	4950.084 ng
1409	2108952.941	2471130.883	4950.02 ng
1410	2108957.355	2471120.663	4949.631 ng
1411	2109015.099	2471124.272	4943.242 ng
1412	2109003.996	2471135.63	4939.14 ng
1413	2109010.161	2471143.92	4940.042 ng
1414	2108985.187	2471148.996	4933.474 ng
1415	2108986.347	2471159.037	4932.868 ng
1416	2108964.861	2471165.045	4926.942 ng
1417	2108952.116	2471160.3	4924.084 ng
1418	2108938.893	2471168.222	4919.616 ng
1419	2108913.824	2471163.614	4913 ng
1420	2108902.626	2471151.233	4908.284 ng
1421	2108895.033	2471159.253	4907.129 ng
1422	2108896.498	2471145.219	4905.029 ng
1423	2108891.19	2471135.01	4900.917 ng
1424	2108879.719	2471148.824	4902.113 ng
1425	2108886.516	2471121.944	4895.168 ng
1426	2108863.194	2471112.215	4893.241 ng
1427	2108790.708	2471100.955	4887.997 ng
1428	2108763.378	2471086.1	4886.675 ng
1429	2108700.826	2471066.861	4886.021 ng
1430	2109993.567	2471605.982	4972.713 ng
1431	2109978.005	2471612.994	4972.497 ng
1432	2110007.994	2471590.065	4972.877 ng

1433	2109963.804	2471557.363	4971.163	ng
1434	2109963.764	2471557.373	4971.144	ng
1435	2109941.558	2471574.412	4970.96	ng
1436	2109924.174	2471588.025	4970.985	ng
1437	2109881.953	2471564.169	4969.794	ng
1438	2109890.691	2471542.682	4969.479	ng
1439	2109904.172	2471525.328	4969.258	ng
1440	2109858.102	2471496.653	4968.132	ng
1441	2109838.573	2471516.599	4968.107	ng
1442	2109820.49	2471537.524	4968.177	ng
1443	2109771.332	2471516.753	4967.03	ng
1444	2109778.169	2471488.269	4966.606	ng
1445	2109785.367	2471466.237	4966.367	ng
1446	2109717.932	2471420.43	4964.675	ng
1447	2109694.268	2471444.609	4964.673	ng
1448	2109675.827	2471467.272	4964.785	ng
1449	2109621.274	2471435.422	4963.723	ng
1450	2109630.946	2471407.172	4963.365	ng
1451	2109646.337	2471374.587	4963.161	ng
1452	2109574.324	2471340.48	4961.829	ng
1453	2109553.609	2471366.002	4961.884	ng
1454	2109539.129	2471387.199	4962.174	ng
1455	2109515.052	2471407.869	4962.469	ng
1456	2109442.555	2471378.126	4961.692	ng
1457	2109451.887	2471318.646	4961.366	ng
1458	2109458.928	2471290.018	4961.184	ng
1459	2109382.342	2471268.291	4961.101	ng
1460	2109356.427	2471298.331	4961.273	ng
1461	2109334.847	2471321.778	4961.443	ng
1462	2109267.553	2471291.54	4961.58	ng
1463	2109263.102	2471242.471	4961.246	ng
1464	2109259.826	2471207.261	4960.96	ng
1465	2109210.397	2471195.374	4961.628	ng
1466	2109214.197	2471222.511	4961.923	ng
1467	2109218.048	2471244.108	4962.269	ng
1468	2107658.022	2470736.733	4880.308	ng
1469	2107670.219	2470706.525	4880.421	ng
1470	2107690.349	2470668.906	4880.177	ng
1471	2107705.541	2470626.784	4880.071	ng
1472	2107631.973	2470653.875	4880.507	ng
1473	2107631.06	2470619.574	4880.736	fenceline
1474	2107604.366	2470660.427	4880.485	+ fenceline
1475	2107556.673	2470667.271	4881.043	fenceline
1476	2107521.65	2470672.018	4881.199	fenceline
1477	2107497.304	2470698.789	4881.616	fenceline
1478	2107456.888	2470744.029	4881.689	end fenceline
1479	2107569.972	2470724.357	4880.464	ng

1480	2107643.904	2470774.805	4880.003	ng
1481	2107774.854	2470671.849	4879.387	ng
1482	2107823.221	2470719.806	4880.687	ng
1483	2107777.251	2470726.157	4880.794	ng
1484	2107734.732	2470739.649	4879.33	ng
1485	2107708.77	2470760.126	4878.874	ng
1486	2107819.195	2470840.211	4880.811	ng
1487	2107880.817	2470750.859	4880.616	ng
1488	2107949.784	2470706.568	4880.508	ng
1489	2102617.916	2464449.164	4942.734	concrete
1490	2102619.052	2464453.294	4942.689	concrete
1491	2105412.264	2468820.597	4886.038	ng
1492	2105412.248	2468820.388	4886.15	ng
1493	2105447.877	2469122.534	4880.127	ng
1494	2105543.898	2469173.651	4880.349	ng
1495	2105545.405	2469187.53	4877.325	ng
1496	2105545.231	2469193.408	4877.21	ng
1497	2105547.105	2469206.252	4879.964	ng
1498	2105604.01	2469243.701	4880.311	ng
1499	2105660.105	2469301.96	4879.744	ng
1500	2105722.531	2469341.222	4879.773	ng
1501	2105736.802	2469353.69	4880.725	ng
1502	2105748.566	2469365.432	4878.871	ng
1503	2105761.887	2469374.478	4879.257	ng
1504	2105777.16	2469398.464	4880.478	ng
1505	2105825.687	2469438.889	4880.002	ng
1506	2105920.336	2469498.928	4880.514	ng
1507	2105927.696	2469497.411	4880.474	ng
1508	2106038.167	2469585.711	4880.946	ng
1509	2106117.775	2469652.307	4879.971	ng
1510	2106127.275	2469649.288	4881.613	ng
1511	2106235.02	2469738.956	4882.04	ng
1512	2106257.967	2469759.962	4882.077	ng
1513	2106394.257	2469865.786	4881.744	ng
1514	2106489.476	2469942.927	4881.666	ng
1515	2106599.218	2470021.17	4879.829	ng
1516	2106605.117	2470023.437	4879.799	ng
1517	2106643.64	2470051.919	4880.753	ng
1518	2106708.006	2470109.477	4881.519	ng
1519	2106759.361	2470155.381	4881.748	ng
1520	2106775.106	2470170.048	4881.596	ng
1521	2106782.48	2470183.063	4880.392	ng
1522	2106795.979	2470210.361	4881.001	ng
1523	2106859.31	2470222.849	4880.924	ng
1524	2106918.639	2470278.406	4880.205	ng
1525	2106927.229	2470281.35	4880.296	ng
1526	2107186.868	2470473.265	4880.757	ng

1527	2107248.911	2470535.145	4880.041	ng
1528	2107226.712	2470563.632	4880.483	ng
1529	2107303.693	2470632.644	4880.23	ng
1530	2102630.831	2464439.873	4942.297	concrete
1531	2102634.708	2464455.401	4942.331	concrete
1532	2102619.273	2464452.391	4936.735	outlet
1533	2102618.482	2464449.635	4936.702	outlet
1534	2102644.174	2464452.156	4942.1	gate
1535	2102647.468	2464451.015	4942.114	gate
1536	2102653.479	2464444.624	4941.832	concrete
1537	2102652.476	2464440.507	4941.878	concrete
1538	2102655.103	2464440.295	4937.865	concrete
1539	2102655.057	2464440.26	4938.046	concrete
1540	2102656.393	2464443.528	4937.981	concrete
1541	2102659.326	2464442.832	4938.085	concrete
1542	2102658.184	2464439.544	4938.216	concrete
1543	2102658.17	2464439.119	4942.197	concrete
1544	2102659.119	2464443.266	4942.223	concrete
1545	2102673.797	2464439.482	4936.292	concrete
1546	2102674.117	2464438.896	4931.492	concrete
1547	2102673.9	2464435.602	4931.313	concrete
1548	2102673.158	2464435.463	4936.422	concrete
1549	2102689.247	2464431.263	4936.167	concrete
1550	2102697.214	2464423.408	4936.241	concrete
1551	2102690.257	2464435.495	4936.238	concrete
1552	2102696.88	2464437.363	4936.252	concrete
1553	2102699.3	2464430.751	4933.655	gs
1554	2102701.121	2464416.687	4937.816	tob
1555	2102689.735	2464367.538	4938.685	gs
1556	2102740.795	2464349.031	4936.808	gs
1557	2102746.047	2464408.191	4936.648	top
1558	2102746.849	2464419.697	4932.898	inv
1559	2102765.211	2464413.296	4931.527	inv
1560	2102765.029	2464412.846	4935.587	concrete
1561	2102759.303	2464413.962	4935.291	concrete
1562	2102809.274	2464403.768	4928.539	inv
1563	2102805.05	2464385.82	4934.888	top
1564	2102788.666	2464330.262	4934.781	gs
1565	2102865.163	2464308.11	4932.636	gs
1566	2102879.616	2464370.303	4932.459	top
1567	2102888.56	2464380.972	4927.73	inv
1568	2102929.428	2464344.73	4927.794	inv
1569	2102929.413	2464334.557	4931.261	top
1570	2102885.391	2464290.877	4931.528	gs
1571	2102945.841	2464314.529	4927.201	gs
1572	2102938.748	2464312.186	4929.483	top
1573	2102889.788	2464292.85	4931.665	gs

1574	2102879.974	2464218.499	4931.747	gs
1575	2102919.81	2464220.562	4931.218	top
1576	2102948.631	2464221.169	4925.583	inv
1577	2102947.164	2464221.658	4928.535	top
1578	2102949.742	2464146.963	4925.429	inv
1579	2102942.9	2464143.937	4928.408	top
1580	2102885.364	2464128.011	4931.889	gs
1581	2102883.881	2464049.21	4930.98	gs
1582	2102921.534	2464042.136	4931.639	top
1583	2102943.254	2464038.211	4925.892	inv
1584	2102942.89	2463978.984	4925.969	inv
1585	2102931.075	2463973.683	4930.24	top
1586	2102891.943	2463964.083	4930.583	gs
1587	2102889.779	2463912.744	4932.174	gs
1588	2102941.687	2463909.92	4931.108	top
1589	2102952.121	2463922.631	4925.723	inv
1590	2102968.615	2463866.478	4925.869	inv
1591	2102961.12	2463864.078	4929.492	top
1592	2102912.413	2463841.438	4931.71	gs
1593	2102927.399	2463769.566	4932.022	gs
1594	2102993.765	2463768.421	4930.34	top
1595	2103010.405	2463772.405	4925.182	inv
1596	2103029.304	2463724.895	4925.49	inv
1597	2103050.012	2463676.234	4924.653	inv
1598	2103035.67	2463668.417	4930.036	top
1599	2102973.807	2463636.518	4931.841	gs
1600	2103005.498	2463545.666	4931.843	gs
1601	2103068.149	2463579.316	4929.919	top
1602	2103083.446	2463583.894	4925.065	inv
1603	2103103.437	2463521.998	4924.719	inv
1604	2103087.188	2463515.452	4929.939	top
1605	2103042.402	2463509.762	4930.933	gs
1606	2103040.02	2463435.493	4931.895	gs
1607	2103113.6	2463439.718	4930.15	top
1608	2103126.42	2463438.516	4925.218	inv
1609	2103141.641	2463387.279	4924.392	inv
1610	2103129.316	2463387.754	4928.702	top
1611	2103080.901	2463370.637	4930.528	gs
1612	2103091.408	2463288.845	4930.349	gs
1613	2103137.848	2463295.164	4929.631	top
1614	2103150.869	2463297.77	4925.137	inv
1615	2103158.01	2463242.499	4924.747	inv
1616	2103142.837	2463240.19	4930.124	top
1617	2103105.415	2463220.94	4930.576	gs
1618	2103105.817	2463147.579	4930.884	gs
1619	2103111.331	2463122.595	4930.642	fence
1620	2103132.957	2463125.542	4930.624	fence

1621	2103145.532	2463082.05	4930.767	fence
1622	2103155.325	2463144.427	4930.313	top
1623	2103171.648	2463149.959	4924.357	inv
1624	2103176.688	2463095.542	4924.385	inv
1625	2103183.339	2463040.291	4924.482	inv
1626	2103165.695	2463040.047	4929.918	top
1627	2103158.764	2463098.547	4930.083	top
1628	2103170.327	2463010.726	4930.348	top
1629	2103165.496	2463010.294	4930.603	fence
1630	2103183.681	2462941.505	4928.919	fence
1631	2103194.363	2462957.342	4924.266	inv
1632	2103201.225	2462922.657	4924.006	inv
1633	2103197.919	2462900.338	4928.356	fence
1634	2103176.515	2462868.49	4929.937	fence
1635	2103163.235	2462847.145	4930.455	fence
1636	2103201.139	2462888.238	4928.424	top
1637	2103212.668	2462881.553	4924.249	inv
1638	2103235.732	2462818.696	4923.84	inv
1639	2103224.312	2462806.542	4930.301	top
1640	2103183.144	2462791.583	4930.406	gs
1641	2103212.409	2462710.464	4930.25	gs
1642	2103252.885	2462709.676	4927.954	top
1643	2103261.412	2462709.085	4923.019	inv
1644	2103273.761	2462658.313	4922.942	inv
1645	2103264.649	2462643.14	4927.495	top
1646	2103212.219	2462635.076	4930.29	gs
1647	2103213.151	2462562.062	4931.208	gs
1648	2103278.599	2462564.898	4927.569	top
1649	2103287.789	2462568.38	4923.172	inv
1650	2103296.864	2462526.2	4922.69	inv
1651	2103287.161	2462520.579	4928.118	top
1652	2103235.865	2462505.984	4931.168	gs
1653	2103244.833	2462409.898	4935.998	gs
1654	2103303.9	2462420.343	4930.607	top
1655	2103316.783	2462418.186	4922.91	inv
1656	2103329.98	2462359.55	4922.751	inv
1657	2103338.953	2462302.157	4922.85	inv
1658	2103353.642	2462237.902	4922.666	inv
1659	2103340.984	2462234.457	4929.426	top
1660	2103324.534	2462293.877	4933.176	top
1661	2103311.343	2462361.766	4932.941	top
1662	2103264.933	2462337.331	4937.298	gs
1663	2103300.379	2462309.82	4934.292	gs
1664	2103322.285	2462274.331	4928.927	gs
1665	2103302.321	2462273.389	4926.638	gs
1666	2103278.195	2462311.628	4925.457	gs
1667	2103281.576	2462238.955	4926.419	gs

1668	2103289.996	2462152.881	4927.67	gs
1669	2103351.994	2462168.561	4927.915	top
1670	2103361.728	2462170.455	4922.476	inv
1671	2103358.991	2462122.259	4922.577	inv
1672	2103348.575	2462128.086	4926.288	top
1673	2103283.153	2462095.429	4925.778	fence
1674	2103297.437	2462025.521	4925.91	fence
1675	2103338.386	2462037.577	4925.872	top
1676	2103344.643	2462035.891	4922.641	inv
1677	2103306.75	2461982.521	4926.427	fence
1678	2103338.519	2461976.125	4925.819	top
1679	2103346.844	2461980.666	4922.424	inv
1680	2103358.566	2461941.926	4921.934	inv
1681	2103347.693	2461933.719	4926.158	top
1682	2103319.437	2461921.388	4925.183	fence
1683	2103326.7	2461885.844	4925.05	fence
1684	2103372.708	2461885.212	4927.103	top
1685	2103383.068	2461892.234	4921.583	inv
1686	2103355.842	2461824.01	4924.547	gs
1687	2103400.721	2461790.867	4924.778	gs
1688	2103412.693	2461849.994	4926.571	top
1689	2103416.605	2461860.428	4922.138	inv
1690	2103441.976	2461841.341	4921.086	inv
1691	2103454.194	2461832.95	4919.293	inlet
1692	2103436.311	2461829.982	4926.164	top
1693	2103458.522	2461825.511	4925.645	top
1694	2103460.085	2461846.033	4926.366	top
1695	2103476.712	2461866.785	4925.829	gs
1696	2103439.833	2461901.008	4924.028	gs
1697	2103421.659	2461876.472	4926.682	top
1698	2103446.674	2461854.772	4926.009	top
1699	2103439.236	2461849.755	4921.946	inv
1700	2103416.218	2461866.279	4921.869	inv
1701	2103388.565	2461889.25	4921.295	inv
1702	2103393.303	2461907.466	4927.192	top
1703	2103415.62	2461936.485	4925.103	gs
1704	2103390.327	2461979.893	4925.6	gs
1705	2103364.887	2461971.161	4926.753	top
1706	2103356.963	2461968.581	4922.398	inv
1707	2103346.445	2462012.156	4922.784	inv
1708	2103358.805	2462012.551	4926.767	top
1709	2103391.227	2462025.769	4924.53	gs
1710	2103405.65	2462062.009	4923.518	gs
1711	2103361.985	2462066.55	4926.399	top
1712	2103350.663	2462068.083	4922.874	inv
1713	2103358.698	2462108.747	4922.314	inv
1714	2103367.374	2462106.445	4926.477	top

1715	2103400.973	2462102.066	4924.274	gs
1716	2103414.234	2462177.184	4925.545	gs
1717	2103373.739	2462183.184	4927.153	top
1718	2103364.163	2462182.122	4922.958	inv
1719	2103353.739	2462247.602	4923.01	inv
1720	2103364.032	2462250.268	4927.768	top
1721	2103406.182	2462254.251	4927.331	gs
1722	2103403.866	2462336.563	4926.402	gs
1723	2103350.983	2462319.131	4928.047	top
1724	2103341.7	2462317.263	4923.011	inv
1725	2103334.558	2462363.331	4923.22	inv
1726	2103343.59	2462362.808	4928.083	top
1727	2103393.589	2462374.975	4926.318	gs
1728	2103388.424	2462420.087	4926.172	gs
1729	2103339.517	2462401.655	4928.955	top
1730	2103326.155	2462401.83	4923.362	inv
1731	2103318.632	2462439.3	4922.942	inv
1732	2103336.836	2462443.404	4930.37	top
1733	2103381.114	2462447.824	4925.668	top
1734	2103380.431	2462449.53	4925.753	gs
1735	2103369.597	2462504.912	4925.361	gs
1736	2103324.391	2462496.414	4929.628	top
1737	2103312.805	2462489.964	4923.637	inv
1738	2103301.431	2462529.55	4922.931	inv
1739	2103316.822	2462532.696	4929.15	top
1740	2103361.08	2462546.947	4923.382	gs
1741	2103352.993	2462617.405	4923.107	gs
1742	2103300.094	2462610.099	4928.156	top
1743	2103288.487	2462610.706	4923.442	inv
1744	2103280.484	2462649.899	4923.107	inv
1745	2103294.83	2462654.77	4929.685	top
1746	2103341.216	2462668.79	4923.15	gs
1747	2103325.766	2462725.235	4923.764	gs
1748	2103281.792	2462716.492	4929.621	top
1749	2103267.709	2462714.834	4923.726	inv
5000	2103310.834	2464876.873	4918.095	pp
5001	2103310.468	2464882.726	4917.412	edg rd
5002	2103314.208	2464899.101	4917.455	edg rd
5003	2103358.142	2464892.529	4915.865	edg rd
5004	2103368.56	2464897.489	4915.08	edg rd
5005	2103376.414	2464911.74	4914.47	edg rd
5006	2103386.478	2464909.215	4914.349	edg rd
5007	2103386.095	2464894.132	4914.915	edg rd
5008	2103390.764	2464886.567	4915.053	edg rd
5009	2103437.093	2464878.558	4913.317	edg rd
5010	2103485.673	2464872.898	4912.041	edg rd
5011	2103508.913	2464844.357	4912.571	pp

5012	2103507.179	2464825.612	4912.029	gwa
5013	2103505.151	2464821.979	4912.698	gwa
5014	2103505.427	2464819.21	4912.627	gwa
5015	2103484.083	2464855.992	4912.369	edg rd
5016	2103435.527	2464863.217	4913.505	edg rd
5017	2103388.111	2464869.938	4915.118	edg rd
5018	2103356.361	2464875.446	4916.01	edg rd
5019	2103307.988	2464864.212	4917.714	gwa
5020	2103306.495	2464860.714	4918.116	gwa
5021	2103411.187	2464834.485	4915.511	topo
5022	2103412.864	2464841.641	4914.806	topo
5023	2103414.112	2464847.504	4912.497	topo
5024	2103414.46	2464849.683	4912.456	topo
5025	2103416.273	2464856.984	4914.476	topo
5026	2103417.346	2464863.643	4913.443	topo
5027	2103442.765	2464859.105	4912.651	topo
5028	2103441.58	2464852.095	4914.286	topo
5029	2103439.498	2464844.837	4911.37	topo
5030	2103434.684	2464829.59	4914.788	topo
5031	2103436.705	2464835.958	4914.655	topo
5032	2103414.581	2464795.529	4913.225	ir
5033	2103408.264	2464768.77	4913.566	topo
5034	2103415.2	2464910.659	4913.306	topo
5035	2103427.453	2465109.25	4912.991	topo
5036	2103425.714	2465109.259	4912.502	topo
5037	2103422.035	2465109.365	4913.491	topo
5038	2103414.245	2465263.842	4913.6	mwy
5039	2103433.026	2465265.253	4912.569	topo
5040	2103434.813	2465269.537	4912.564	topo
5041	2103500.973	2465398.858	4911.181	topo
5042	2103590.641	2465577.216	4910.145	topo
5043	2103642.923	2465752.16	4911.044	smh
5044	2103681.035	2465755.87	4909.796	topo
5045	2103771.238	2465932.096	4907.818	topo
5046	2103447.713	2465458.961	4912.869	smh
5047	2103371.785	2464754.02	4915.479	smh
5048	2103772.236	2465931.957	4907.847	ng
5049	2103861.036	2466111.637	4906.279	ng
5050	2103951.015	2466288.875	4905.008	ng
5051	2104041.941	2466467.72	4904.104	ng
5052	2104112.33	2466611.351	4902.081	ng
5053	2104220.453	2466828.965	4900.526	ng
5054	2104307.643	2467006.937	4898.279	ng
5055	2104389.078	2467131.992	4896.073	ng
5056	2104473.673	2467290.386	4894.3	ng
5057	2104544.186	2467447.043	4893.258	ng
5058	2104647.7	2467600.128	4893.555	ng

5059	2104733.815	2467684.068	4892.864	ng
5060	2104854.319	2467842.968	4893.612	ng
5061	2104920.472	2467920.219	4892.55	ng
5062	2104989.679	2468073.279	4892.164	ng
5063	2105034.066	2468238.153	4891.451	ng
5064	2105161.424	2468305.911	4887.169	ng
5065	2105156.581	2468905.753	4888.314	ng
5066	2105182.022	2468888.995	4887.632	ng
5067	2104168.928	2466852.684	4902.863	ng
5068	2104157.438	2466855.093	4900.572	ng
5069	2104146.178	2466860.713	4905.08	ng
5070	2104139.807	2466867.112	4900.709	ng
5071	2103414.709	2467313.603	4925.526	ng
5072	2103594.904	2467252.611	4921.201	ng
5073	2103581.307	2467231.563	4921.028	ng
5074	2103611.557	2467226.206	4920.543	ng
5075	2103642.309	2467214.134	4920.713	ng
5076	2103655.253	2467183.273	4920.305	ng
5077	2103696.501	2467140.384	4919.443	ng
5078	2103759.667	2467159.986	4919.959	ng
5079	2103768.918	2467142.895	4919.298	ng
5080	2103823.325	2467117.884	4918.997	ng
5081	2103811.923	2467086.147	4918.357	ng
5082	2103980.398	2466981.626	4913.45	ng
5083	2104048.916	2466938.834	4916.114	ng
5084	2104099.161	2466919.401	4915.705	ng
5085	2104117.613	2466951.313	4915.793	ng
5086	2104115.941	2466908.76	4905.65	ng
5087	2104126.833	2466901.593	4904.065	ng
5088	2104136.652	2466893.902	4899.055	ng
5089	2104140.064	2466901.61	4898.967	ng
5090	2104122.947	2466921.857	4905.135	ng
5091	2104237.735	2466895.083	4899.017	ng
5092	2105896.755	2468260.068	4883.169	ng
5093	2105146.248	2467802.422	4888.175	ng
5094	2105147.037	2467797.145	4880.971	ir
5095	2104865.561	2467833.924	4892.788	ng
5096	2104866.299	2467833.023	4892.87	ng
5097	2104866.299	2467833.023	4892.87	ng
5098	2104227.9	2466888.038	4899.246	ng
5099	2104212.856	2466858.533	4899.678	ng
5100	2104212.381	2466906.563	4900.705	ng
5101	2104201.034	2466919.945	4900.506	ng
5102	2104208.378	2466916.459	4902.538	ng
5103	2104194.327	2466939.519	4904.33	ng
5104	2104177.021	2466946.56	4898.963	ng
5105	2104162.919	2466951.048	4899.095	ng

5106	2104152.365	2466957.983	4903.92 ng
5107	2104143.109	2466961.186	4904.553 ng
5108	2104149.719	2466923.527	4899.052 ng
5109	2105055.073	2468365.165	4892.196 ng
5110	2105071.74	2468482.258	4892.232 ng
5111	2105084.331	2468582.583	4891.131 ng
5112	2105094.175	2468687.723	4891.353 ng
5113	2105103.995	2468789.217	4891.214 ng
5114	2105122.51	2468909.298	4890.199 ng
5115	2105239.687	2468927.439	4887.656 ng
5116	2105122.462	2468909.162	4890.161 ng
5117	2105161.488	2468903.828	4888.295 ng
5118	2105161.649	2468963.527	4888.407 ng
5119	2105182.795	2468957.714	4888.485 ng
5120	2105200.195	2468972.449	4883.142 ng
5121	2105257.529	2469007.171	4881.49 ng
5122	2105299.732	2469045.098	4880.55 ng
5123	2105354.864	2469115.733	4880.885 ng
5124	2105376.706	2469125.746	4880.153 ng
5125	2105426.372	2469150.791	4880.279 ng
5126	2105486.017	2469180.348	4880.467 ng
5127	2105485.8	2469185.323	4876.485 ng
5128	2105515.334	2469204.856	4880.562 ng
5129	2105514.435	2469196.29	4877.187 ng
5130	2105584.318	2469268.822	4879.881 ng
5131	2105641.305	2469315.218	4879.961 ng
5132	2105691.638	2469351.754	4879.015 ng
5133	2105718.067	2469372.109	4880.989 ng
5134	2105729.035	2469379.956	4878.96 ng
5135	2105752.656	2469403.439	4879.216 ng
5136	2105802.3	2469433.723	4881.263 ng
5137	2105834.493	2469462.491	4879.945 ng
5138	2105872.293	2469492.735	4880.654 ng
5139	2105886.173	2469484.24	4879.22 ng
5140	2105890.952	2469481.1	4880.997 ng
5141	2105898.608	2469499.527	4879.668 ng
5142	2105891.31	2469505.545	4881.681 ng
5143	2105878.812	2469518.74	4879.992 ng
5144	2105919.139	2469552.573	4880.031 ng
5145	2105944.767	2469552.902	4880.193 ng
5146	2105972.838	2469578.096	4880.994 ng
5147	2106016.354	2469605.14	4880.783 ng
5148	2106045.755	2469633.962	4882.04 ng
5149	2106050.693	2469617.654	4882.298 ng
5150	2106074.545	2469643.836	4879.857 ng
5151	2106098.201	2469675.286	4879.267 ng
5152	2106109.678	2469687.773	4879.631 ng

5153	2106121.431	2469687.269	4881.514 ng
5154	2106178.238	2469729.791	4882.737 ng
5155	2106213.556	2469766.073	4882.294 ng
5156	2106244.731	2469766.541	4882.184 ng
5157	2106313.65	2469837.505	4881.431 ng
5158	2106377.959	2469881.619	4882.195 ng
5159	2106421.07	2469932.11	4882.134 ng
5160	2106504.72	2469984.824	4880.861 ng
5161	2106576.319	2470031.418	4880.736 ng
5162	2106595.795	2470051.695	4880.666 ng
5163	2106603.147	2470054.855	4879.738 ng
5164	2106609.462	2470057.107	4880.67 ng
5165	2106639.807	2470084.823	4881.539 ng
5166	2106688.91	2470128.307	4881.556 ng
5167	2106738.561	2470160.06	4881.195 ng
5168	2106755.379	2470178.589	4882.47 ng
5169	2106770.309	2470193.342	4880.505 ng
5170	2106790.164	2470221.019	4880.822 ng
5171	2106794.471	2470226.787	4879.094 ng
5172	2106799.877	2470230.229	4878.937 ng
5173	2106808.852	2470233.902	4881.319 ng
5174	2106845.459	2470252.541	4881.2 ng
5175	2106913.128	2470308.888	4880.551 ng
5176	2106931.078	2470320.323	4880.394 ng
5177	2106949.996	2470335.291	4881.231 ng
5178	2106984.107	2470378.983	4880.912 ng
5179	2107040.351	2470401.666	4881.169 ng
5180	2107075.683	2470423.57	4880.506 ng
5181	2107123.301	2470468.578	4881.154 ng
5182	2107164.102	2470500.884	4881.594 ng
5183	2107208.903	2470532.2	4880.557 ng
5184	2107238.514	2470563.159	4880.374 ng
5185	2107277.749	2470584.001	4881.157 ng
5186	2107297.622	2470632.54	4880.466 ng
5187	2107303.091	2470632.164	4880.394 ng
5188	2107300.694	2470599.179	4880.238 ng
5189	2107256.048	2470540.069	4880.239 ng
5190	2107337.954	2470564.123	4880.963 ng
5191	2107354.971	2470574.995	4880.367 ng
5192	2107360.823	2470579.776	4879.682 ng
5220	2110100.063	2471680.206	4977.699 ng
5221	2110081.653	2471674.917	4977.096 ng
5222	2110008.411	2471632.066	4974.597 ng
5223	2110120.875	2471687.156	4984.108 ng
5224	2110110.397	2471685.529	4980.747 ng
5225	2109935.492	2471585.934	4971.043 ng
5226	2109866.822	2471557.008	4969.191 ng

5227	2109762.987	2471514.205	4966.762 ng
5228	2109641.254	2471466.732	4964.326 ng
5229	2109463.344	2471378.63	4961.161 ng
5230	2109216.156	2471238.192	4962.117 ng
5231	2109236.082	2471235.468	4961.317 ng
5232	2109228.735	2471201.934	4961.092 ng
5233	2109211.169	2471200.344	4961.598 ng
5234	2109190.842	2471241.698	4963.579 ng
5235	2109181.528	2471244.247	4963.968 ng
5236	2109173.436	2471247.725	4959.232 ng
5237	2109139.354	2471244.264	4957.409 ng
5238	2109117.3	2471244.231	4953.412 ng
5239	2109104.397	2471241.101	4952.543 ng
5240	2108995.616	2471100.809	4950.376 ng
5241	2109063.096	2471153.195	4949.533 ng
5242	2109052.943	2471160.916	4953.368 ng
5243	2109063.551	2471165.868	4955.896 ng
5244	2109072.297	2471181.306	4955.937 ng
5245	2109063.746	2471179.22	4952.629 ng
5246	2109054.122	2471170.921	4950.775 ng
5247	2109038.995	2471160.204	4948.308 ng
5248	2109039.433	2471165.543	4946.664 ng
5249	2109032.625	2471172.129	4941.879 ng
5250	2109012.475	2471164.053	4937.994 ng
5251	2108992.728	2471159.264	4935.479 ng
5252	2108992.649	2471171.39	4929.286 ng
5253	2108990.371	2471174.558	4928.801 ng
5254	2108952.217	2471174.693	4922.82 ng
5255	2108934.478	2471174.15	4917.877 ng
5256	2108894.736	2471168.788	4907.845 ng
5257	2108894.226	2471172.692	4905.473 ng
5258	2108877.077	2471162.769	4902.419 ng
5259	2108859.492	2471159.719	4898.632 ng
5260	2108860.417	2471138.782	4896.939 ng
5261	2108819.674	2471134.724	4892.076 ng
5262	2108779.358	2471123.02	4888.436 ng
5263	2108782.063	2471128.078	4886.584 ng
5264	2108753.904	2471109.71	4886.817 ng
5265	2108687.653	2471086.316	4885.913 ng
5266	2108681.337	2471091.3	4883.406 ng
5267	2108678.686	2471088.625	4881.383 ng
5268	2108681.142	2471086.961	4885.446 ng
5269	2108675.595	2471079.112	4885.388 ng
5270	2108673.968	2471079.603	4882.233 ng
5271	2108651.151	2471058.024	4885.92 ng
5272	2108649.257	2471063.393	4885.323 ng
5273	2108648.618	2471065.273	4881.306 ng

5274	2108627.92	2471047.032	4885.782 ng
5275	2108623.221	2471044.492	4882.788 ng
5276	2108635.527	2471031.254	4885.896 ng
5277	2108638.098	2471022.664	4885.562 ng
5278	2108638.813	2471019.823	4884.213 ng
5279	2108622.757	2471010.024	4884.846 ng
5280	2108623.565	2471005.283	4883.169 ng
5281	2108599.68	2471007.477	4886.056 ng
5282	2108606.088	2470999.474	4883.048 ng
5283	2108596.775	2471013.489	4886.244 ng
5284	2108591.733	2471015.62	4883.978 ng
5285	2108590.518	2471023.978	4885.19 ng
5286	2108584.668	2471032.201	4885.272 ng
5287	2108575.724	2471025.204	4884.747 ng
5288	2108565.605	2471017.129	4883.933 ng
5289	2108572.263	2471007.303	4882.749 ng
5290	2108570.354	2470993.298	4882.73 ng
5291	2108551.623	2471002.953	4882.658 ng
5292	2108609.785	2471036.914	4884.158 ng
5293	2108718.449	2471126.492	4885.71 ng
5294	2108716.972	2471135.947	4887.058 ng
5295	2102698.391	2464437.532	4935.167 ng
5296	2102703.605	2464460.538	4937.279 ng
5297	2102707.215	2464484.485	4936.777 ng
5298	2102726.7	2464478.029	4936.591 ng
5299	2102725.327	2464454.285	4936.262 ng
5300	2102721.025	2464428.198	4934.781 ng
5301	2102720.62	2464426.353	4933.847 ng
5302	2102741.772	2464421.967	4932.811 ng
5303	2102742.495	2464424.248	4934.038 ng
5304	2102742.675	2464427.722	4935.348 ng
5305	2102748.227	2464450.709	4935.68 ng
5306	2102774.316	2464454.152	4935.471 ng
5307	2102773.948	2464438.183	4934.878 ng
5308	2102771.28	2464416.231	4933.15 ng
5309	2102795.92	2464420.986	4933.799 ng
5310	2102799.994	2464438.12	4934.333 ng
5311	2102804.588	2464452.141	4934.824 ng
5312	2102827.868	2464445.901	4934.42 ng
5313	2102825.247	2464431.496	4934.178 ng
5314	2102822.871	2464417.077	4934.218 ng
5315	2102837.237	2464410.567	4931.704 ng
5316	2102837.01	2464407.708	4930.302 ng
5317	2102835.9	2464402.918	4929.5 ng
5318	2102835.524	2464401.415	4928.114 ng
5319	2102828.014	2464403.424	4928.396 ng
5320	2102821.834	2464404.178	4928.286 ng

5321	2102822.149	2464404.938	4929.736 ng
5322	2102815.536	2464404.868	4928.478 ng
5323	2102814.374	2464406.482	4929.58 ng
5324	2102808.316	2464408.485	4928.594 ng
5325	2102809.001	2464409.615	4929.768 ng
5326	2102803.333	2464409.768	4928.732 ng
5327	2102803.339	2464412.086	4929.489 ng
5328	2102800.665	2464409.532	4928.411 ng
5329	2102842.669	2464398.476	4928.382 ng
5330	2102855.205	2464395.255	4928.1 ng
5331	2102856.049	2464396.646	4929.175 ng
5332	2102859.229	2464393.585	4928.108 ng
5333	2102860.046	2464395.048	4929.292 ng
5334	2102863.352	2464392.614	4928.238 ng
5335	2102863.987	2464394.232	4929.305 ng
5336	2102866.117	2464393.096	4929.083 ng
5337	2102865.527	2464391.886	4927.962 ng
5338	2102865.785	2464399.238	4929.705 ng
5339	2102857.17	2464401.577	4929.754 ng
5340	2102844.597	2464405.243	4930.359 ng
5341	2102835.095	2464406.843	4929.845 ng
5342	2102838.224	2464418.658	4935.09 ng
5343	2102858.177	2464411.029	4934.798 ng
5344	2102858.723	2464413.074	4935.491 ng
5345	2102862.873	2464428.511	4933.933 ng
5346	2102866.75	2464440.122	4933.741 ng
5347	2102891.444	2464433.864	4932.8 ng
5348	2102890.003	2464421.104	4933.281 ng
5349	2102886.75	2464406.326	4933.904 ng
5350	2102885.804	2464403.146	4934.59 ng
5351	2102884.553	2464400.087	4932.359 ng
5352	2102890.916	2464382.576	4927.47 ng
5353	2102891.417	2464383.712	4928.609 ng
5354	2102895.498	2464389.475	4929.556 ng
5355	2102896.093	2464379.855	4927.931 ng
5356	2102896.953	2464381.605	4929.127 ng
5357	2102900.739	2464388	4929.675 ng
5358	2102909.436	2464383.024	4929.966 ng
5359	2102906.545	2464376.357	4929.164 ng
5360	2102906.066	2464375.05	4927.988 ng
5361	2102910.708	2464371.947	4928.168 ng
5362	2102911.458	2464373.196	4929.128 ng
5363	2102915.177	2464370.885	4928.612 ng
5364	2102914.039	2464369.574	4928.381 ng
5365	2102916.388	2464372.488	4928.932 ng
5366	2102919.487	2464367.509	4928.499 ng
5367	2102918.437	2464366.055	4928.377 ng

5368	2102922.795	2464368.807	4928.926 ng
5369	2102927.689	2464357.644	4928.536 ng
5370	2102930.639	2464359.838	4929.444 ng
5371	2102932.341	2464360.29	4929.909 ng
5372	2102933.901	2464362.228	4930.602 ng
5373	2102936.168	2464365.04	4931.848 ng
5374	2102929.284	2464369.814	4930.74 ng
5375	2102932.208	2464374.295	4932.263 ng
5376	2102914.232	2464386.15	4932.17 ng
5377	2102915.435	2464386.994	4932.803 ng
5378	2102916.845	2464389.532	4932.53 ng
5379	2102929.26	2464409.682	4932.25 ng
5380	2102934.248	2464426.59	4930.787 ng
5381	2102954.442	2464388.171	4930.735 ng
5382	2102937.204	2464370.605	4931.445 ng
5383	2102934.284	2464367.674	4931.668 ng
5384	2102931.339	2464364.966	4930.396 ng
5385	2102930.698	2464353.655	4928.702 ng
5386	2102933.655	2464355.777	4929.879 ng
5387	2102940.768	2464358.158	4931.786 ng
5388	2102973.514	2464358.339	4929.874 ng
5389	2102978.882	2464362.085	4928.305 ng
5390	2102993.516	2464375.272	4927.932 ng
5391	2102993.944	2464337.717	4927.833 ng
5392	2102987.512	2464335.287	4928.536 ng
5393	2102981.423	2464332.204	4930.028 ng
5394	2102961.849	2464320.622	4929.926 ng
5395	2102958.459	2464320.195	4931.461 ng
5396	2102955.46	2464319.545	4930.121 ng
5397	2102949.721	2464316.841	4928.866 ng
5398	2102948.996	2464316.824	4927.829 ng
5399	2102988.949	2464282.894	4928.758 ng
5400	2102968.123	2464279.227	4929.33 ng
5401	2102965.419	2464278.145	4930.487 ng
5402	2102961.642	2464277.474	4928.924 ng
5403	2102955.828	2464277.63	4928.525 ng
5404	2102953.667	2464293.143	4928.969 ng
5405	2102952.1	2464293.043	4926.83 ng
5406	2102953.403	2464281.766	4926.368 ng
5407	2102955.701	2464281.411	4928.463 ng
5408	2102990.09	2464228.191	4929.157 ng
5409	2102966.545	2464226.016	4929.761 ng
5410	2102963.486	2464225.799	4930.519 ng
5411	2102960.499	2464226.063	4929.322 ng
5412	2102953.624	2464225.435	4928.42 ng
5413	2102951.719	2464225.408	4925.902 ng
5414	2102988.632	2464171.829	4928.475 ng

5415	2102969.813	2464168.05	4929.329 ng
5416	2102967.485	2464167.696	4930.302 ng
5417	2102963.958	2464168.294	4929.099 ng
5418	2102959.147	2464166.638	4927.183 ng
5419	2102958.24	2464167.421	4926.352 ng
5420	2102983.744	2464087.679	4928.544 ng
5421	2102967.417	2464086.424	4929.234 ng
5422	2102963.156	2464085.271	4930.191 ng
5423	2102959.38	2464085.585	4928.835 ng
5424	2102956.579	2464085.24	4927.59 ng
5425	2102954.642	2464083.861	4926.253 ng
5426	2102981.539	2463994.516	4928.286 ng
5427	2102965.712	2463985.048	4928.988 ng
5428	2102961.83	2463983.654	4929.866 ng
5429	2102957.954	2463982.976	4928.283 ng
5430	2102955.16	2463982.695	4926.982 ng
5431	2103003.241	2463909.125	4928.502 ng
5432	2102981.697	2463899.824	4928.643 ng
5433	2102978.601	2463897.97	4929.063 ng
5434	2102975.144	2463896.476	4928.23 ng
5435	2102972.456	2463895.555	4926.511 ng
5436	2103046.783	2463795.478	4928.836 ng
5437	2103024.066	2463784.898	4928.514 ng
5438	2103021.219	2463783.714	4928.908 ng
5439	2103020.005	2463783.73	4928.742 ng
5440	2103018.671	2463783.061	4927.592 ng
5441	2103017.644	2463782.585	4926.817 ng
5442	2103038.655	2463730.575	4926.253 ng
5443	2103041.528	2463731.496	4928.331 ng
5444	2103043.897	2463732.616	4928.438 ng
5445	2103070.295	2463741.127	4928.579 ng
5446	2103096.2	2463668.141	4927.962 ng
5447	2103068.683	2463665.41	4928.167 ng
5448	2103065.143	2463664.472	4925.933 ng
5449	2103122.844	2463593.79	4927.849 ng
5450	2103094.812	2463589.196	4927.87 ng
5451	2103093.015	2463584.713	4925.671 ng
5452	2103096.073	2463587.58	4927.962 ng
5453	2103149.36	2463514.549	4928.1 ng
5454	2103121.776	2463507.342	4927.995 ng
5455	2103117.59	2463505.995	4925.753 ng
5456	2103134.318	2463502.198	4928.755 ng
5457	2103133.624	2463501.78	4930.094 ng
5458	2103130.047	2463500.248	4930.469 ng
5459	2103128.511	2463498.675	4929.27 ng
5460	2103129.229	2463467.15	4925.675 ng
5461	2103132.56	2463467.27	4927.958 ng

5462	2103137.57	2463467.867	4928.589 ng
5463	2103146.259	2463433.9	4928.851 ng
5464	2103142.347	2463433.883	4927.858 ng
5465	2103134.83	2463432.903	4924.718 ng
5466	2103184.955	2463369.202	4928.042 ng
5467	2103168.314	2463367.925	4928.671 ng
5468	2103165.743	2463367.344	4929.959 ng
5469	2103162.968	2463367.023	4929.806 ng
5470	2103160.83	2463367.567	4928.625 ng
5471	2103197.491	2463271.101	4927.66 ng
5472	2103181.805	2463264.761	4927.684 ng
5473	2103178.319	2463263.703	4929.527 ng
5474	2103173.719	2463262.463	4929.508 ng
5475	2103172.516	2463262.011	4928.327 ng
5476	2103168.81	2463261.049	4928.201 ng
5477	2103166.66	2463259.703	4926.355 ng
5478	2103165.184	2463258.527	4925.505 ng
5479	2103224.489	2463068.511	4928.19 ng
5480	2103203.663	2463061.302	4928.783 ng
5481	2103200.407	2463059.931	4930.141 ng
5482	2103197.715	2463059.821	4928.465 ng
5483	2103193.922	2463056.506	4927.413 ng
5484	2103191.738	2463055.788	4926.187 ng
5485	2103256.036	2462922.186	4925.856 ng
5486	2103225.593	2462929.146	4927.741 ng
5487	2103222.555	2462926.716	4929.535 ng
5488	2103219.81	2462925.676	4929.123 ng
5489	2103217.913	2462925.015	4928.123 ng
5490	2103207.557	2462920.638	4926.463 ng
5491	2103205.884	2462920.943	4924.61 ng
5492	2103206.21	2462919.05	4927.055 ng
5493	2103222.504	2462910.275	4928.215 ng
5494	2103222.879	2462910.726	4929.282 ng
5495	2103225.257	2462911.276	4928.932 ng
5496	2103226.648	2462911.923	4928.268 ng
5497	2103256.026	2462923.212	4925.881 ng
5498	2103212.882	2462906.518	4927.981 ng
5499	2103210	2462904.392	4926.984 ng
5500	2103212.709	2462902.195	4926.362 ng
5501	2103211.452	2462900.647	4923.798 ng
5502	2103217.985	2462900.489	4927.075 ng
5503	2103230.558	2462892.283	4928.164 ng
5504	2103231.35	2462892.148	4929.534 ng
5505	2103233.173	2462893.066	4929.313 ng
5506	2103238.698	2462894.848	4927.754 ng
5507	2103262.349	2462894.874	4926.759 ng
5508	2103305.899	2462777.953	4923.777 ng

5509	2103292.295	2462775.313	4927.285 ng
5510	2103272.05	2462780.051	4928.202 ng
5511	2103268.55	2462777.234	4927.914 ng
5512	2103259.647	2462773.294	4923.863 ng

APPENDIX D – SOIL LOGS

APPENDIX D – SOIL LOGS

KELLER-BLIESNER ENGINEERING, LLC

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INSPECTION SHEET

Job: Helium GeoTech # 1 **Date:** 07/31/2015

Inspector: Gary Jordan **Contractor:** SJRDWUI

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical x Other: Soil Texture

Equipment: Backhoe

Labor: SJRDWUI

Safety Observation:

x Adequate ☐ Needs Improvement _____

explain

Measurements:

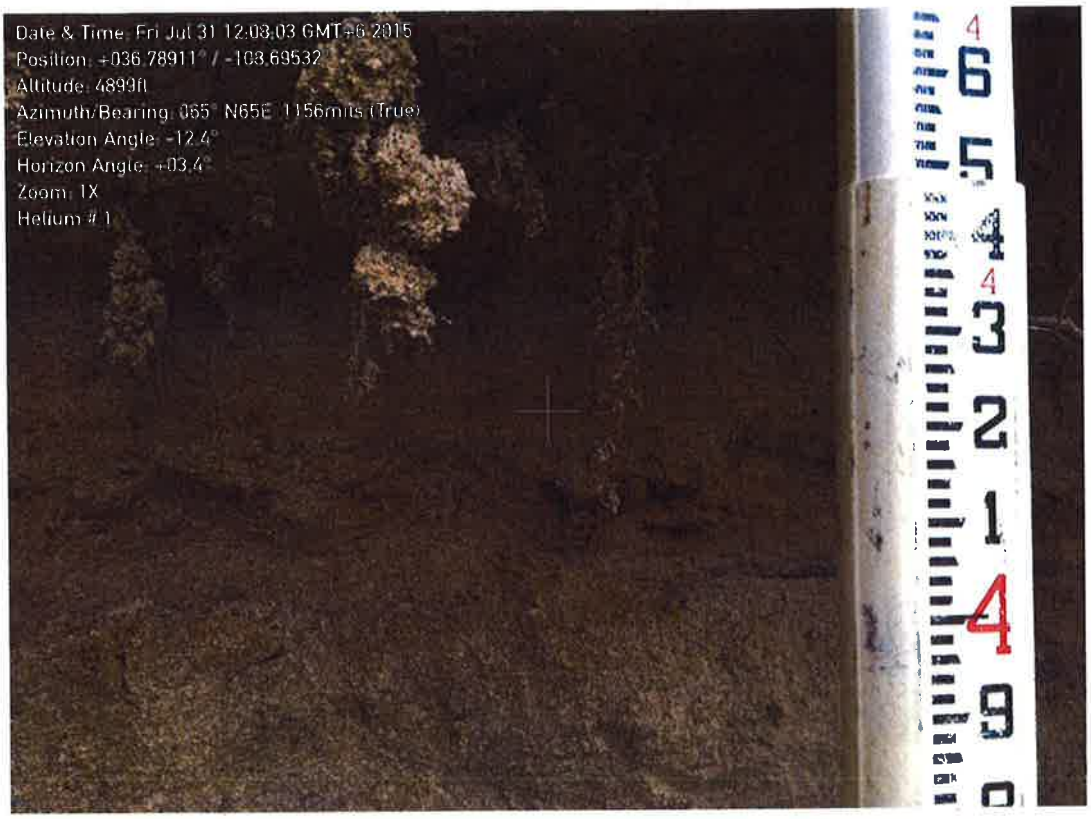
Station	Depth	Soil Texture	Measured	Comment
N36.73666* W108.20278*				
	1'	Loamy Sand w/ gravel layer		.4' thick gravel and cobble layer
	2'	Coarse Sand w/ gravel layer		.4' thick gravel layer
	3'	Coarse sand w/ gravel layer		.3 thick gravel layer
	4'	Coarse sand		Water table
	5'	Coarse loamy sand w/ stones		Mostly sand with some cobble and a few stones
	6'	Coarse loamy sand w/ stones		Mostly sand with some cobbles and a few stones

Work Completed: Dig 1 hole with backhoe and refill at completion of job. The gate to the South side of river was locked

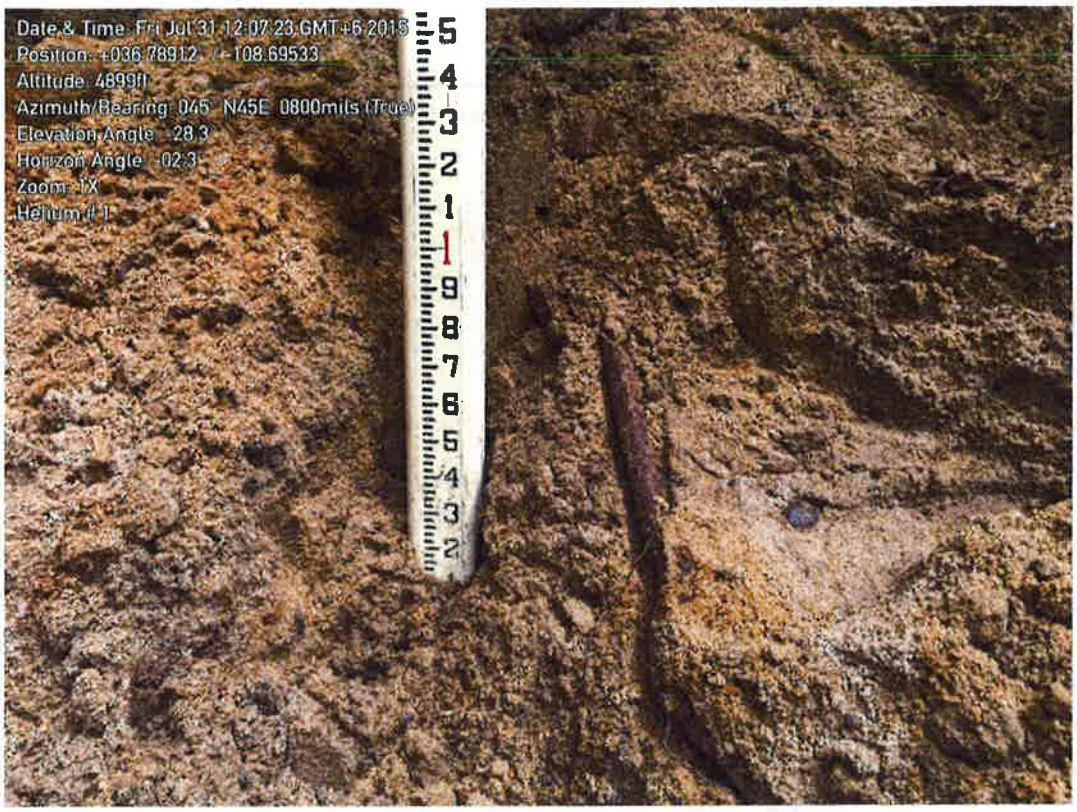
Comments: Dig with backhoe on the North side San Juan River on the pipeline route and Investigate soil texture.

Pictures: _____

Surface to 2'


Date & Time: Fri Jul 31 12:08:03 GMT+6 2015
Position: +036.78911° / -108.69532°
Altitude: 4899ft
Azimuth/Bearing: 055° N65E 1156mils (True)
Elevation Angle: -12.4°
Horizon Angle: +03.4°
Zoom: 1X
Helium # 1


Date & Time: Fri Jul 31 12:08:07 GMT+6 2015
Position: +036.78911° / -108.69532°
Altitude: 4899ft
Azimuth/Bearing: 055° N55E 0978mils (True)
Elevation Angle: -03.1°
Horizon Angle: -00.1°
Zoom: 1X
Helium # 1


Date,& Time: Fri Jul 31 12:07:23 GMT+6 2015
Position: +036.78912 / -108.69533
Altitude: 4899ft
Azimuth/Bearing: 045° N45E 0800mils (True)
Elevation Angle: -28.3°
Horizon Angle: 02.3°
Zoom: 1X
Helium # 1
5
4
3
2
1
9
8
7
6
5
4
3
2

6' depth

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INSPECTION SHEET

Job: Helium #13 **Date:** 20150615

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.78197* W108.70232*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay
2'				Clay
3'				Silty clay
4'				Silty clay
5'				Silty clay

Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of the sample.

Click here to enter text.

Click here to enter text.

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INSPECTION SHEET

Job: Helium #15 **Date:** 06/15/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.78099* W108.70545*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay
2'				Clay
3'				Clay Loam
4'				Clay loam
5'				Clay loam

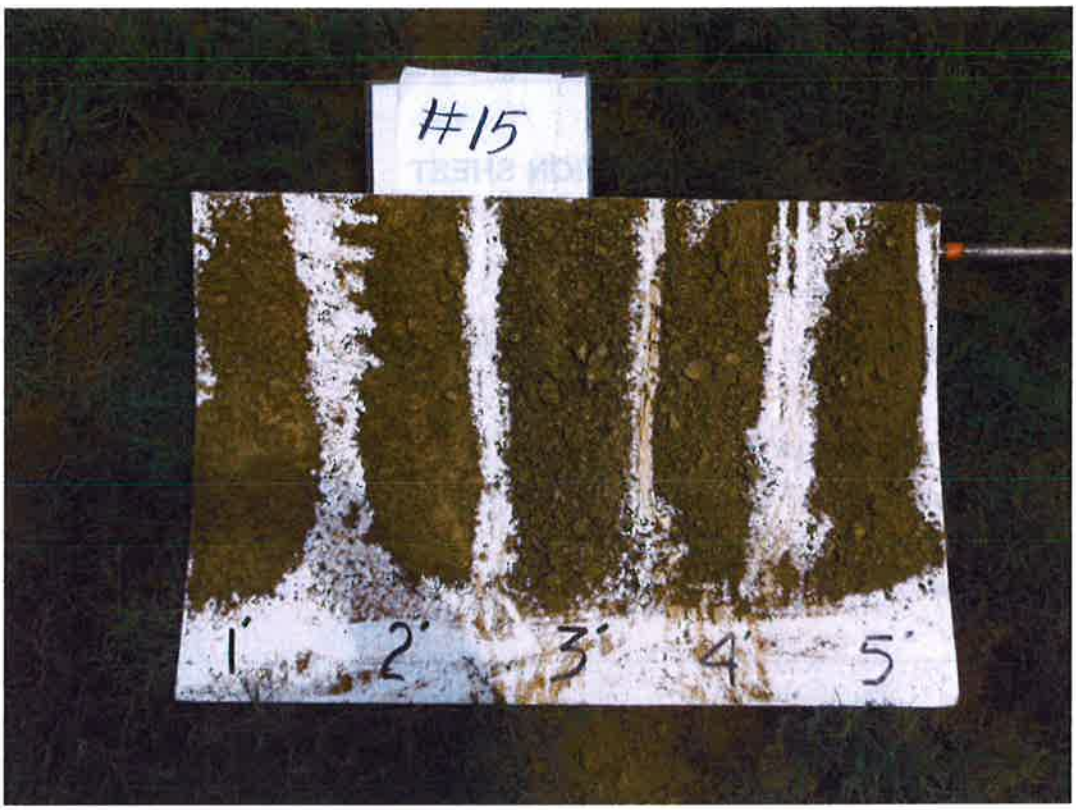
Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of the samples.



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INSPECTION SHEET

Job: Helium #17 **Date:** 06/15/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77955* W108.70835*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay
2'				Clay
3'				Clay
4'				Silty clay loam w/ some gravel up to 1" .
5'				Sandy clay loam w/ some gravel up to 1".

Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of samples.

Click here to enter text.

Click here to enter text.

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INSPECTION SHEET

Job: Helium #21 soil texture **Date:** 06/14/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77765* W108.71289*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay Loam
2'				Silty clay loam
3'				Silty clay loam
4'				Clay
5'				Clay loam

Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of the samples.

Click here to enter text.

Click here to enter text.

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INSPECTION SHEET

Job: Helium # 24 **Date:** 06/14/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77669* W108.71608*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay loam
2'				Clay loam
3'				Sandy loam
4'				Sandy loam
5'				Sandy clay loam

Work Completed: _____

_____

Comments: _____

_____

Pictures: Top end of samples in the photo is the deeper end of samples.

Click here to enter text.

Click here to enter text.

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INSPECTION SHEET

Job: Helium #27 **Date:** 06/14/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77359* W108.71454*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Clay loam
2'				Loam w/ a few gravel up to 1.25"
3'				Loam
4'				Clay loam
5'				Sandy clay loam

Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of the samples.

Click here to enter text.

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INSPECTION SHEET

Job: Helium #29 **Date:** 06/14/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77239* W108.71147*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Sandy loam
2'				Sandy clay loam
3'				Clay loam
4'				Sandy loam
5'				Sandy loam

Work Completed: _____

_____

Comments: _____

_____

Pictures: The top end of the soil samples in the photo is the deep end of the samples.

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Click here to enter text.

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INSPECTION SHEET

Job: Helium #33 **Date:** 06/14/2015

Inspector: Gary Jordan **Contractor:** _____

Work Type (*check all that apply*)

☐ Pipeline ☐ Earthwork ☐ Electrical ☐ Mechanical **x** Other: _____

Location: N36.77058* W108.70532*

Labor: _____

Safety Observation:

☐ Adequate ☐ Needs Improvement _____
explain

Measurements:

Station	Location	Design	Measured	Comment
1'				Silty clay loam
2'				Silty clay loam
3'				Silty loam
4'				Silty clay loam
5'				Silty loam

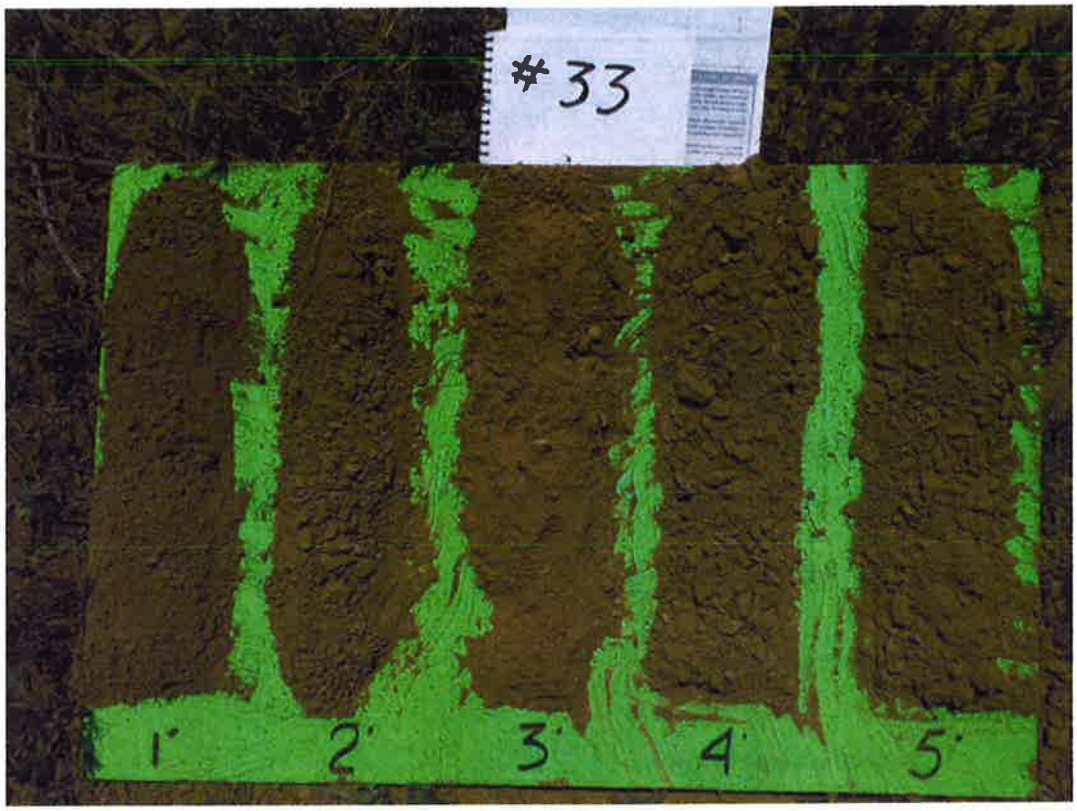
Work Completed: _____

_____

Comments: _____

_____

Pictures: The top of soil samples in the photo is the deep end of the samples.



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APPENDIX E – HELIUM SIPHON PREFERRED ROUTE SELECTION

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Memorandum

To: Rudy Keedah, Bureau of Indian Affairs
David Tallman, Navajo Nation Department of Water Resources
Marlin Saggboy, Navajo Nation Department of Water Resources
From: Mike Isaacson, Keller-Bliesner Engineering, LLC
Date: April 14, 2016
RE: Selection of preferred route for Helium Siphon

On April 13, 2016, two route options for the replacement of Helium Siphon were presented to decision makers in a meeting held in Gallup, NM at 12PM. The review presentation is enclosed The following were in attendance either in person or via teleconferencing:

Name	Organization	Attendance
Pearl Chamberlin	BIA	In person
Rudy Keedah	BIA	In person
Najam Tariq	NNDWR	In person
David Tallman	NNDWR	In person
Marlin Saggboy	NNDWR	Via Teleconference
Michele Tsosie	NNDWR	Via Teleconference
Mike Isaacson	Keller-Blienser Engineering	In person

The two route options presented are as follows:

1. Keep existing route (white line on presentation). Replace the first 5,800 ft of pipeline through the saturated areas. Use the existing pipe to slip-line a new, smaller pipe in the developed areas south of the saturated area. Discharge into Helium Lateral at the existing location.
2. Abandon pipe in developed areas and construct the pipe in a new route next to the farm land (Yellow line on presentation). This option replaces the pipe until it crosses the river and then routes to the farm land presently served by Helium Lateral. The discharge point will be next to the Dine College demonstration farm.

A third option was derived and discussed during the meeting that routed the pipe through the developed areas via existing roads rather than slip-lining new pipe in the existing pipe that is located directly underneath existing structures. All three of these options were discussed and summarized in the matrix below.

Option 2 was selected primarily because it fits better with current and future land uses. The thought was that this pipeline would better serve the irrigated land if it is next to the land. Turnouts may be placed along the pipe to serve adjacent fields with pressurized irrigation water.

Marlin Saggboy did suggest that the route be modified to avoid impacting more riparian lands. His suggestion was to utilize the existing pipe route until the pipeline approaches the bluffs on the south side of the river. The pipeline will then route westward to the new farmland. The review team all agreed with this modification.

Decision Matrix for Helium Siphon Route

Issue	Option 1	Option 2	Option 3
Description	Keep existing pipe in developed areas and slip-line new, smaller pipe	Abandon existing pipe through developed areas and construct new route along the farmland	Re-route the pipeline through the developed areas so that it doesn't lie directly underneath existing structures
NEPA Compliance	This will trigger at least an EA due to having an effect on public safety and impacting low-income residents	This will trigger at least an EA due to the route change. There also may be a cultural resource site along the route that needs to be monitored during construction	This will trigger at least an EA due to the route change.
Right-of-Way	The option will have to resolve the conflict between developed infrastructure directly on-top of the house and other home site leases	This option will require obtaining new right-of-way. We have verbal agreements from impacted farm permit holders and the chapter	This option will require obtaining new right-of-way. We have not researched this.
CCSD School Irrigation	No change to current configuration	This option requires pressurizing Helium Siphon and constructing a small pipeline to the school.	No change to current configuration
Current land development	Recent land development has now separated the pipe from the land	This option will place the pipe adjacent to the command area of the pipeline	Recent land development has now separated the pipe from the land
Future Land Uses	Shiprock Chapter is considering a road where the current lateral is meaning that it would have to be piped and move the discharge.	No impact	Shiprock Chapter is considering a road where the current lateral is meaning that it would have to be piped and move the discharge.
Costs	$1.5M	$1.5M	Not determined

The consensus of the group was to go with Option 2.

David Tallman,Civil Engineer Marlin Saggboy, Supervisor Michael Isaacson, PE

Najam Tariq, TCOB Director Rudy Keedah, BIA-AOTR

RESOLUTION OF THE SHIPROCK CHAPTER
SHIPROCK, NAVAJO NATION

SUPPORTING THE REPLACEMENT OF THE HELIUM SIPHON AS A PART OF THE SAN JUAN RIVER NAVAJO IRRIGATION REHABILITATION PROJECT

WHEREAS:

1. The Shiprock Chapter of the Navajo Nation acts on this resolution pursuant to the authority conferred on the Chapter through Navajo Nation Code Title 26, Chapter 1. Section B. Purpose, which states, "Through adoption of this Act, the Navajo Nation Council delegates to Chapters governmental authority with respect to local matters consistent with Navajo Law, including custom and tradition; and the inclusivity provided by the Diné Fundamental Law, in that "it is entirely appropriate for the government itself to openly observe these fundamental laws", and
2. The Navajo Nation Department of Water Resources Technical, Construction and Operations Branch is responsible for the operation and maintenance of the Hogback Irrigation Canal System, and
3. The 40-inch steel Helium Siphon was constructed to provide irrigation water to 951 acres of permitted farmland located on the south side of the San Juan River, the siphon failed in 2000 and has not been repaired, and
4. The Shiprock Irrigation Department conducted an engineering assessment of the siphon in 2003 and concluded that the steel siphon pipe had exceeded its life expectancy and required replacement, and
5. The Navajo Nation Department of Water Resources received a $15.4M authorization from Congress to rehabilitate the Hogback-Gad ii ahi Irrigation Project, and
6. The Navajo Nation Department of Water Resources contracted with Keller-Bliesner Engineering, LLC to complete a design for replacement of the Helium Siphon, and
7. The Keller-Bliesner Engineering firm has completed a design which was presented to the Shiprock Chapter membership on May 11, 2016.

NOW, THEREFORE, BE IT RESOLVED THAT:

The Shiprock Chapter membership hereby supports the replacement of the Helium Siphon as a part of the San Juan River Navajo Irrigation Rehabilitation Project.

Motioned by: Charley P. Joe Seconded by: Bertha Etcitty

CERTIFICATION

We hereby certify that the foregoing resolution was presented and considered at a duly called Chapter meeting at which a quorum was present and that the same was approved by a vote of 29 in favor, -0- opposed and 8 abstentions on this 15th day of May, 2016.

Duane H. Yazzie, President

Tommie Yazzie, Vice President

Dr. J. Kaibah Begay, Secretary/Treasurer

Tom Chee, Council Delegate

APPENDIX F – HELIUM SIPHON DESIGN REVIEW MEMO

Helium Siphon Review
February 25, 2016
Agenda

1. Introduction and Objective
2. Existing Situation
3. Alternatives
   a) Route
   b) Pipe Material
   c) River Crossing
4. Selection
   a) Route — Alternative Selected _____
      i) Keep existing alignment.
      ii) Modified Route.
   b) Pipe Material — Alternative Selected _____
      i) Steel
      ii) HDPE
   c) River Crossing — Alternative Selected _____
      i) Bore – Not feasible because of cobble
      ii) Open Cut
      iii) Slip line existing pipe
5. Design Concepts
6. Next Steps

Selection and Concurrence:

Shiprock Irrigation Supervisor: _____
Marlin Saggboy, Shiprock Irrigation

NNDWR TCOB Engineer: _____
David Tallman, NNDWR-TCOB

BIA ATOR: _____
Rudy Keedah, BIA-ATOR

Engineer of Record: _____
Michael Isaacson, Keller-Bliesner Engineering, LLC

Navajo Nation Concurrence _____
Najam Tariq, NNDWR – TCOB Director

KELLER-BLIESNER ENGINEERING, LLC

www.kelbli.com • Phone 435.753.5651 • Fax 435.753.6139 • 78 East Center, Logan, Utah 84321

To: David Tallman, NNDWR
From: Mike Isaacson, Keller-Bliesner Engineering, LLC
Date: April 12, 2016
RE: Helium Siphon, May 9, 2016 Design Review Minutes

Attendance:
David Tallman, NNDWR
Marlin Saggboy, NNDWR
Michele Tsosie, NNDWR
Rudy Keedah, BIA
Mike Isaacson, Keller-Blienser Engineering, LLC

1. Introductions were made and the meeting convened about 11:00 AM in Shiprock Irrigation.
2. Review of route selection completed on April 14th. Meeting minutes approving of the route selection was crafted and signed by the group. However, these minutes were lost and so they were reprinted out by Michele Tsosie and resigned by the group.
3. The new route was shown and agreed upon.
4. Discussion of Helium lateral earthen canal and flume capacity. Marlin Saggboy said that the siphon probably can wash out the canal. Safety's need to be implemented to the siphon design to ensure that the canal is not washed out.
5. Discussion of the current turnout at Hogback Canal for Helium Siphon. This turnout is much too large for the flow. Shiprock Irrigation years ago placed limits on the turnout to prevent washing out the downstream inlet. Marlin Saggboy requested that this turnout be replaced with a smaller gate appropriately sized for the flow.
6. Marlin Saggboy requested that safety railings be installed around the inlet to the siphon to protect workers while cleaning the inlet.
7. Rudy Keedah asked that a comparison between PVC and HDPE be made before selecting HDPE. This is the pipe material currently being used in the design.
8. Keller-Bliesner provided an overview of the abandonment plan which is to pump cellular concrete in a 1200 ft section of Helium Siphon. There was much discussion on the need to do such a length with the consensus that we couldn't predict the future on whether or not somebody was going to build on top o the siphon. Rudy requested that estimated for other methods of abandoning pipe be derived, estimated, and compared to the current proposed method.
9. Resolution of support going before Shiprock chapter on May 11, 2016 at 6:00 PM.

Michael Isaacson _____ David Tallman _____ Marlin Saggboy _____ Rudy Keedah _____

KELLER-BLIESNER ENGINEERING, LLC

www.kelbli.com • Phone 435.753.5651• Fax 435.753.6139 • 78 East Center, Logan, Utah 84321

To: David Tallman, NNDWR
From: Mike Isaacson, Keller-Bliesner Engineering, LLC
Date: October 19, 2016
RE: Helium Siphon, October 13, 2016, 90% Review Conceptual of Design Review Minutes

Attendance:
David Tallman, NNDWR
Wayne Williams, BIA
Marlin Saggboy, NNDWR (by phone)
Michelle Begay, BIA
Pearl Chamberlin, BIA
Rudy Keedah, BIA
Francis Johnson, NNDWR
Mike Isaacson, Keller-Blienser Engineering, LLC

Location/Time:
BIA – Navajo Region Office Conference. 10 AM – 12:30 PM

1. Introductions were made and brief background of the project was given.
2. Project timeline reviewed by Mike Isaacson.
3. Alignment route reviewed.
4. Discussion on analysis for selecting piping material. The two options presented were HDPE and PVC. PVC has an obvious economical advantage and is suitable for this job. The engineering recommended that PVC be specified with the exceptions of the river crossing and the road crossings. Marlin Saggboy recommended that HDPE be used from 200 ft each site of the river because of the dewatering requirements next to the river. The sturdier HDPE will lessen the chance of having to re-excavate the pipe to repair it. The group agreed with the recommendation to use PVC except for the river crossing (200 ft each side) and the road crossing. Rudy Keedah suggested that the cost estimate for the project be revised to have PVC as the main material and HDPE for the crossings.
5. Discussed the river crossing plan of requiring the design-build contractor to investigate the existing 42-inch steel siphon underneath the river to determine if it may be used as a sleeve for the new pipe. The method would be to excavate each end, dewater the pits, cut the pipe on both ends, and explore the pipe section underneath the river with a camera. If the camera doesn't reveal any obstacle, then a cable or rope could be threaded through the existing pipe to pull a smaller steel pipe through to clean it out. Once clean, the new 36-inch HDPE pipe can be pulled though and remain in place. Alternatively, a 30-inch HDPE pipe may also work for this section. If the pipe insertion doesn't work, then the pipe can be pulled back and used for the new river crossing. After much discussion, the group decided this plan was worth pursuing.

6. A discussion on the contracting language required to make the river crossing plan work. The contract would have to require the contractor to investigate the pipe first and try to utilize it. If this was not successful, then the contractor would be paid to actually divert the river and install the pipe. Keller-Blienser was going to revise the contract language with the comments provided during the meeting and then have BIA and NNDWR review again.
7. Pearl Chamberlin suggested that the abandonment plan for Helium Siphon in the residential neighborhood be inserted into the contract as an option in order to take advantage of any savings generated from this project or other projects. If this item is included into the contract, then it will be simple to implement should funds become available. The group agreed with this suggestion.
8. Dine College Shiprock Demonstration Farm project was briefly discussed. This work rehabilitating Helium Siphon has resulted in Dine College choosing to invest in their farm.

Michael Isaacson	David Tallman	Marlin Saggboy	Rudy Keedah

APPENDIX G – ABANDONMENT PLAN HELIUM SIPHON

Abandonment Plan
Helium Siphon

Prepared for

Navajo Nation Department of Water Resources
PO Box 678
Fort Defiance, AZ 86504

Prepared by

Keller-Bliesner Engineering, LLC
78 East Center
Logan, UT 84321

April 25, 2016

Keller-Bliesner Engineering, LLC
78 East Center
Logan, Utah 84321
435-753-5651 (435-753-6139 Fax)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BACKGROUND

The Helium Siphon has not been functional for about 10 years. While in operation, the siphon served almost 1,000 acres on the south side of Shiprock. The existing siphon is a 40-inch steel coal tar pipeline approximately 9,750 feet long. The siphon is fed by the Hogback Canal, crosses the San Juan River, and discharges into the Helium Lateral (Figure 1).

When the Helium Siphon was originally constructed, a right-of-way or easement was not obtained. Over the last 10-15 years, significant development has occurred along portions of the siphon alignment. This development includes the Diné College, NTUA field yard, NNDWR field yard, and multiple residential homes. The new Helium Siphon alignment will be rerouted outside the developed area so that it is adjacent to the farm land served by the siphon. The existing siphon located in the developed area will be abandoned in place. To avoid ground subsidence in the developed area, this siphon abandonment plan describes how the existing siphon will be filled with cellular concrete for the section shown in Figure 2.

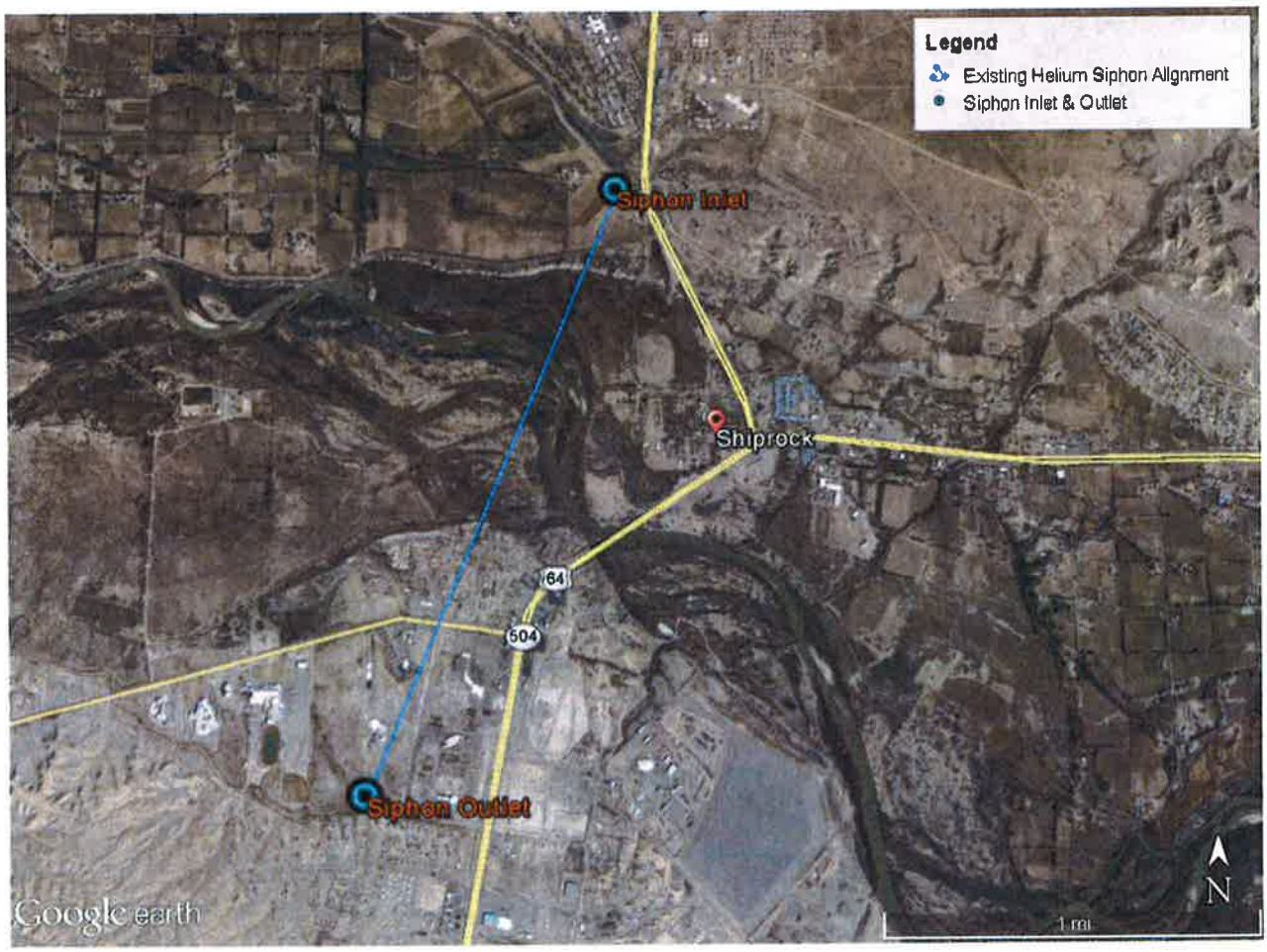

Figure 1. Existing Helium Siphon Alignment

Figure 2. Helium Siphon Section to be Filled with Cellular Concrete

METHODOLOGY

There is a 1,200 ft section of the Helium Siphon that will be filled with 120 psi cellular concrete or approved equal. This 1,200 ft section will be split into two sections of approximately 600 ft each. The approximate location of the beginning, midpoint, and end access points are shown in Figure 2. These access points are approximate locations that require approval by nearby home owners plus cultural and biological clearance. The siphon alignment shown in Figures 1 and 2 is approximate and will require field investigation to locate the siphon.

At each access point, a 5 to 10 ft section shall be cut out of the siphon and two bulk heads shall be installed. At each end of the two 600 ft sections to be filled with cellular concrete one steel 2-inch injection port and one steel 2-inch vent port shall be installed.

Two contractors will be used on this project. The first shall locate the three access points, cut a 5-10 ft section at each access point, install six bulk heads (two at each access point), and install the four 2-inch vent ports and four 2-inch injection ports near the bulk heads at each end of the two 600 ft siphon sections. The first contractor can be NNDWR Shiprock Irrigation if so desired.

The second contractor shall be responsible for providing all necessary materials, equipment, and labor necessary to fill the two 600 ft 40-inch pipe sections with cellular concrete in accordance with the following specifications:

- Cellular concrete specifications
  - Cast density: 32 PCF
  - 28 day minimum compressive strength: 120 psi
  - Minimum bearing capacity: 8.6 tons/ft^2
  - Elastizill PS 120 or approved equal
- Each of the two 600 ft pipe sections shall be filled in one continuous process until the cellular concrete is observed at the proper level at each of the two vents.
- The Contractor shall maintain proper cast density throughout the entire grouting process. The density shall be checked at least once per hour during concrete pumping.
- The cellular concrete and all necessary labor, materials, equipment, and supervision for the installation of the fill shall be provided by the Contractor. The cellular concrete concentrate shall comply with ASTM C869 and tested in accordance with ASTM C796.
- During placement of the initial batches for each siphon section, the density shall be checked and the mix adjusted as required to obtain the specified cast density at the point of placement. All tests required to maintain quality assurance shall be at the expense of the Contractor.
- The contractor shall verify complete void filling by monitoring the volume and density placed.
- Portland Cement. Shall conform to ASTM C-150 Type I, II or III and shall conform to Elastizell specificaitons or approved equal.
- Water. Shall be clean and free of deleterious materials.

COST ESTIMATE

The total estimated cost for filling the 1,200 ft section of the siphon with the specified cellular concrete is $60,690 (Table 1). This section to be abandoned is near or directly below several existing homes and Highway 64 so this project is a high priority. The Diné College is also very close to the existing siphon. However, during construction of the college the portion of the siphon closest to the college buildings was encased in concrete. Although not included in this project, for safety and surface water runoff reasons, it is recommended that the abandoned siphon outlet also be sealed off.

Table 1. Cost Estimate to Abandon and Fill 1,200 Feet of Helium Siphon with Cellular Concrete

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
Mob./Demob.	Lump Sum	-	$3,500	$3,500
Locate and Excavate Pipe	3	EA	$500	$1,500
Cut and Remove 5-10 ft Section of Siphon	3	EA	$1,000	$3,000
Weld Bulkheads on 40" Steel Pipe	6	EA	$750	$4,500
Expose Top of Siphon, Clean, and Weld Two Steel 2-inch Injection Ports	4	EA	$300	$1,200
Inject Cellular Concrete to Fill Voids	388	$/CY	$100	$38,800
Contingency				$5,300
Total				**$57,800**
Navajo Nation Business Activity Tax				**$2,890**
Grand Total				**$60,690**