Plains CO_2 Reduction (PCOR) Partnership
Energy & Environmental Research Center (EERC)

PIPELINE COST AND CO_2 TRANSPORT CONSIDERATIONS BASED ON THREE HYPOTHETICAL PIPELINES IN THE PCOR PARTNERSHIP INITIATIVE REGION

White Paper

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PIPELINE COST AND CO_2 TRANSPORT CONSIDERATIONS BASED ON THREE HYPOTHETICAL PIPELINES IN THE PCOR PARTNERSHIP INITIATIVE REGION

EXECUTIVE SUMMARY

The Energy & Environmental Research Center's (EERC's) Plains CO_2 Reduction (PCOR) Partnership Initiative investigated the scale-up challenge in the commercial deployment of pipelines for the transport of captured CO_2 to the storage site through three hypothetical pipelines within the PCOR Partnership Initiative region. Each pipeline targeted the delivery of CO_2 to either enhanced oil recovery (EOR) projects or for geologic storage in a saline reservoir.

The results of the investigations confirmed that several items can affect the cost of the pipeline—both in terms of installed cost and future operational costs associated with the pipeline—and developed a better understanding of the magnitude of these impacts. The items investigated in the hypothetical routes include the following:

i. Pipe sizing (16-, 20-, 24-, 30-, 36-, or 42-in.)
ii. Change in elevation
iii. Pipeline length
iv. Number of booster pumps (0, 1, 2, 3 for Routes A and B, 4+ for Route C)
v. Pipeline operating pressure (2190 or 2700 psig)

Items ii through v above impact the sizing of the pipe necessary to deliver the amount of CO_2 on each pipeline system and must be considered in concert to determine the most cost-effective option.

To aid with the investigation, Resolute Engineering (Resolute), through its membership in the PCOR Partnership, provided detailed analysis of three hypothetical projects in terms of routes, cost of the pipeline and associated pump stations, and pipeline hydraulics. Resolute provided four options for each of the pipeline routes: baseline, direct, colocation, and avoid impacts.

Through Resolute's work, a detailed picture of the routing of the three hypothetical pipelines was obtained that provided pipe sizing; estimate of the duration and spend rate for major items associated with pipeline construction, such as estimated project schedule, cost schedules for client costs, engineering, environmental permitting and compliance, right of way (ROW) acquisition, survey, pipeline construction and inspection, material delivery, lidar and photography, geotechnical study, and nondestructive testing (NDT); as well as an overall cost versus schedule.

In addition, the EERC supplemented Resolute's information with the U.S. Department of Energy Fossil Energy/National Energy Technology Laboratory CO_2 transport cost model to complete the evaluation of each pipeline investigated (National Energy Technology Laboratory, 2018). This study on the pipeline systems revealed challenges that a pipeline system will face:

- Pipeline cost estimates and the cost drivers
- Cost and hydraulics optimization
- Temperature effects on the pipeline capacity and maximum injection pressure at an injection well

For a base volume, i.e., the expected amount of CO_2 to be transported through the pipeline, the major cost drivers for a CO_2 pipeline system were determined by the volume of the CO_2 being transported, the length and elevation changes throughout the pipeline route (not necessarily the net change in elevation between the inlet and terminus that the pipeline has), the initial and final conditions of the CO_2 stream being transported, and the price of steel. Each of these items impacts the cost of a CO_2 system and needs to be evaluated to determine the optimum design with the least cost. A summary of the recommended designs for each of the hypothetical pipeline routes are shown in Table ES-1.

Table ES-1. Recommended Pipeline Sizing Routes to Transport the Base Capacity on Three Hypothetical Pipelines

Hypothetical Pipeline Route	Minimum Cost (millions of dollars)	CO_2 Transport Capacity, million metric tons per year (MMtpy)	Inlet Pressure, psig	Length, miles	Pipeline Outside Diameter (OD), in.	No. of Pump Stations
A	$167	4.3	2700	110	16	0
B	$252	10	2190	110–120	20	2
C	$4560	20	2700	1000	30	6

Also, consideration should be given to upsizing the pipeline to handle additional volumes of CO_2. To this point, and using the findings from Route A as an example, the costs for upsizing the pipeline from the baseline of 16-in. OD to 20-, 24-, or 30-in. OD with the corresponding increase in CO_2 transport capabilities are reflected in Table ES-2.

Table ES-2. Pipeline Cost and Transport Capabilities as Compared to Baseline System

Nominal Pipeline OD, in.	Max. CO_2 Transport Capacity, MMtpy	Pipeline Cost, $MM	% Cost above Baseline	% Max. CO_2 Transport Capacity above Baseline	Cost per MMtpy of CO_2 Transported
16	5.0	167.1	Baseline	Baseline	$33.42
20	8.9	195.8	17.2	78	$22.00
24	14.1	247.2	47.9	182	$17.53
30	25.3	372.0	122.6	406	$14.70

To minimize the cost of the pipeline system while optimizing the hydraulics of the system, the addition of pump stations should be considered. With the installation of pump stations, the pipeline diameter may be reduced, which would save on the capital cost of the pipeline system. However, the cost of the pump stations and their corresponding operating cost should be considered over the life of the project to determine the best overall options for the pipeline system. Also, special considerations on the pump stations will need to provide for the dry nature of the CO_2 stream—both in terms of the water content and lubricity of the CO_2 stream. Seasonal ground temperatures will change the dew point of the CO_2 stream, and the CO_2 stream will need to be dehydrated to the extent that free water will not condense out of the CO_2 stream regardless of the season. In addition, special bearings will need to be used in the pump systems to provide the operation of the pumps without a lubricating fluid as CO_2 is considered a dry or nonlubricating fluid.

Since the exit temperature of the CO_2 stream from the pipeline may not reach the ground temperature at the terminus of the pipeline, especially during the heat of the summer, additional consideration should be given as to how the exiting conditions of the CO_2 stream may impact the downstream operations such as injectivity into the injection wells. The addition of pump stations further compounds the possibility of hotter exiting temperatures of the CO_2 stream as the pump will add heat back into the pipeline from the pressurization process of the pumps. The temperature change will greatly depend on the density of the CO_2 stream into the pump system but will ultimately add heat back into the pipeline system.

Based on this study, the design of a CO_2 transport pipeline requires the balancing of many factors affecting the pipeline system. In this way, the overall cost and operational expenses associated with the pipeline system will yield the most cost-effective solution.

Reference

National Energy Technology Laboratory, 2018, FE/NETL Transport Cost Model: U.S. Department of Energy, Last Update 2018 (Version 2b), www.netl.doe.gov/research/energy-analysis/search-publications/vuedetails?id=543 (accessed 2021).

PIPELINE COST AND CO_2 TRANSPORT CONSIDERATIONS BASED ON THREE HYPOTHETICAL PIPELINES IN THE PCOR PARTNERSHIP INITIATIVE REGION

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership Initiative is one of four projects operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Initiative to Accelerate CCUS (carbon capture, utilization, and storage). The PCOR Partnership Initiative region encompasses ten U.S. states and four Canadian provinces in the upper Great Plains and northwestern regions of North America. The PCOR Partnership Initiative is led by the Energy & Environmental Research Center (EERC) with support from the University of Wyoming and the University of Alaska Fairbanks and includes stakeholders from the public and private sectors. The goal of this joint government–industry effort is to identify and address regional capture, transport, use, and storage challenges facing commercial deployment of CCUS throughout the PCOR Partnership region. A subtask in the project includes identifying the region's scale-up challenges (i.e., financial, technical, and policy) and areas where technology breakthrough and/or advancement could provide significant improvement for geologic CO_2 sequestration projects (storage projects). One such scale-up challenge is the commercial deployment of pipelines for the transport of captured CO_2 to the storage site.

This white paper reviews the objectives and findings from three hypothetical pipeline systems targeted to deliver anthropogenic CO_2 from potential capture sources to enhanced oil recovery (EOR) or sequestration projects within the PCOR Partnership region. Each of the pipeline systems targets a CO_2 volume, starting location (inlet), and destination (delivery point). These theoretical systems provide detailed pipeline system characteristics and costs from which cost drivers associated with commercial-scale CO_2 pipeline transport for CCUS projects may be identified.

A key assumption for this review of the pipeline systems is that the CO_2 delivered to the inlet of the pipeline will meet industry standards for CO_2 pipeline systems, such as those specified by Kinder Morgan (Ricketson, 2020) and others, and will meet the designed inlet pressures of 2190 and 2700 psig. No additional cost was included for the CO_2 to meet industry standards, and the reviews only include the costs associated with the pipeline system: from inlet to delivery point. Additional considerations such as pressurization of the CO_2 stream to match inlet conditions of 2190 or 2700 psig were not included, nor were any costs included for the delivery of the CO_2 downstream of the delivery point or pressurization above the designed exit pressure of 1700 psig.

Project Goals and Objectives

The two goals of this work are to i) examine pipeline costs for the transport of anthropogenic CO_2 from potential capture sources to delivery points located in the PCOR Partnership region and ii) perform a sensitivity analysis of the estimated pipeline costs to several critical design variables (inputs).

The objectives of this work are to provide detailed CO_2 pipeline cost estimates and perform hydraulic reviews for three hypothetical pipeline routes within the PCOR Partnership region and summarize the CO_2 pipeline capital and operating costs for pump stations as a function of the following design constraints:

- Pipe sizing (16-, 20-, 24-, 30-, 36-, or 42-in.)
- Change in elevation
- Pipeline length
- Number of booster pumps (0, 1, 2, 3 for Routes A and B, 4+ for Route C)
- Pipeline design pressure (2190 or 2700 psig)

The CO_2 pipeline cost estimates and hydraulic reviews were performed by Resolute Engineering (Resolute) through the PCOR Partnership and further supplemented by the EERC using the DOE Fossil Energy (FE)/NETL CO_2 transport cost model ("NETL Model") (National Energy Technology Laboratory, 2018). Selected design and cost estimates for pump systems were provided by third parties.

Pipeline Routes

Three hypothetical pipeline routes were selected for this review to target the effect that pipeline length, change in elevation, effects of design pressure, number of booster pump installations, and length of pipeline would have on the volume capability and cost of the pipeline. In addition, several runs were made focusing on the criteria shown in Project Goals and Objectives to highlight the impact that pump installations would have online-sizing, transport volume, and cost.

Each of the three pipeline routes are discussed individually in respective sections of this report and each reflects a total of four potential routes: i) baseline, ii) direct route, iii) colocation with other lines, and iv) avoid impacts. These routes are indicated in the following figures by red, green, yellow, and blue lines, respectively. The baseline route provided the initial review of the line for comparisons to the other potential routes. The direct route, as its name implies, was the most direct path found while honoring the commitment of bypassing critical or congested areas such as cities or other areas of concern. The colocation route looked for opportunities to adjoin previously constructed pipelines, utility corridors, or other similar construction where a pipeline could be installed within the affected area and limit the exposure of disturbing new ground. Finally, the avoid impacts route was to provide a pipeline route that bypassed as many sensitive areas as possible to reduce the impact to these areas. While each route was based on public information, a detailed review of the pipeline route would be required prior to the selection of any specific route for implementation. As noted above, these three hypothetical pipeline systems were created to illustrate detailed costs associated with commercial-scale CO_2 pipeline transport for CCUS projects and do not reflect actual pipeline routes currently under consideration.

Route A – Center, North Dakota, to Watford City, North Dakota

Route A targeted the transport of 4.3 million metric tons per year (MMtpy) of anthropogenic CO_2 through a 110-mile pipeline to supply the Bakken petroleum system area near Watford, North Dakota (Figure 1). Two (2) of the four potential routes encountered and passed through the Little Missouri National Grasslands (LMNG) within an existing pipeline corridor, shortening the distance by approximately 2 to 3 miles as compared with bypassing LMNG. The net change in elevation[1] for this route was approximately 35 feet lower at the delivery point as compared to the elevation at the inlet.

This pipeline also shows distinct elevations through the route that warrant review. First, the pipeline has a low point of 1794' at approximately 25 miles from the inlet. With the inlet elevation at 2165', the inlet pressure to the pipeline would need to be reduced by approximately 120 psig, or a heavier wall thickness pipe would need to be installed in this section to compensate for the hydrostatic head of the CO_2 at the low point to ensure that the pressure of the pipeline does not exceed the design rating at this juncture.

Second, this route also has a high point of approximately 2577' at approximately 80 miles from the inlet to the pipeline. The high point is in an area where the pipeline has an incline of approximately 415 feet over ~60 miles from the low point of the pipeline. Since this high point will reduce the pressure of the pipeline in this area, it should be investigated to ensure that the CO_2 remains in a supercritical phase.

Third, a second low point of approximately 1900' at ~90 miles downstream of the pipeline inlet corresponds to the crossing of the Little Missouri River. The change in elevation seen in this area from the high point a few miles upstream to this low point warrants consideration because of the sensitive area of the crossing as well as the change in the pressure of the pipeline that occurs within this area.

Route B – Killdeer, North Dakota, to Baker, Montana

Route B targeted the transport of 10 MMtpy of anthropogenic CO_2 as a take-off from Route A near Killdeer, North Dakota, and delivering the CO_2 to the Baker, Montana, area for possible use in EOR operations or further transport. All but the direct route followed similar paths and had lengths of approximately 120 miles, while the direct path had a length of approximately 110 miles. The net change in elevation for this route was approximately 780 feet, with a maximum elevation of approximately 3330 feet before dropping down to an elevation of approximately 3070 feet at the terminus of the line (Figure 2).

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[1] Net change in elevation refers to the difference between the elevation at the terminus less the elevation at the inlet of the pipeline. However, because the net change in elevation is based only on the elevations of the inlet and terminus of the line, the entire pipeline route should be reviewed for high or low points or other areas of concern (crossings, corridors, etc.) as these can affect the design and operation of the line.

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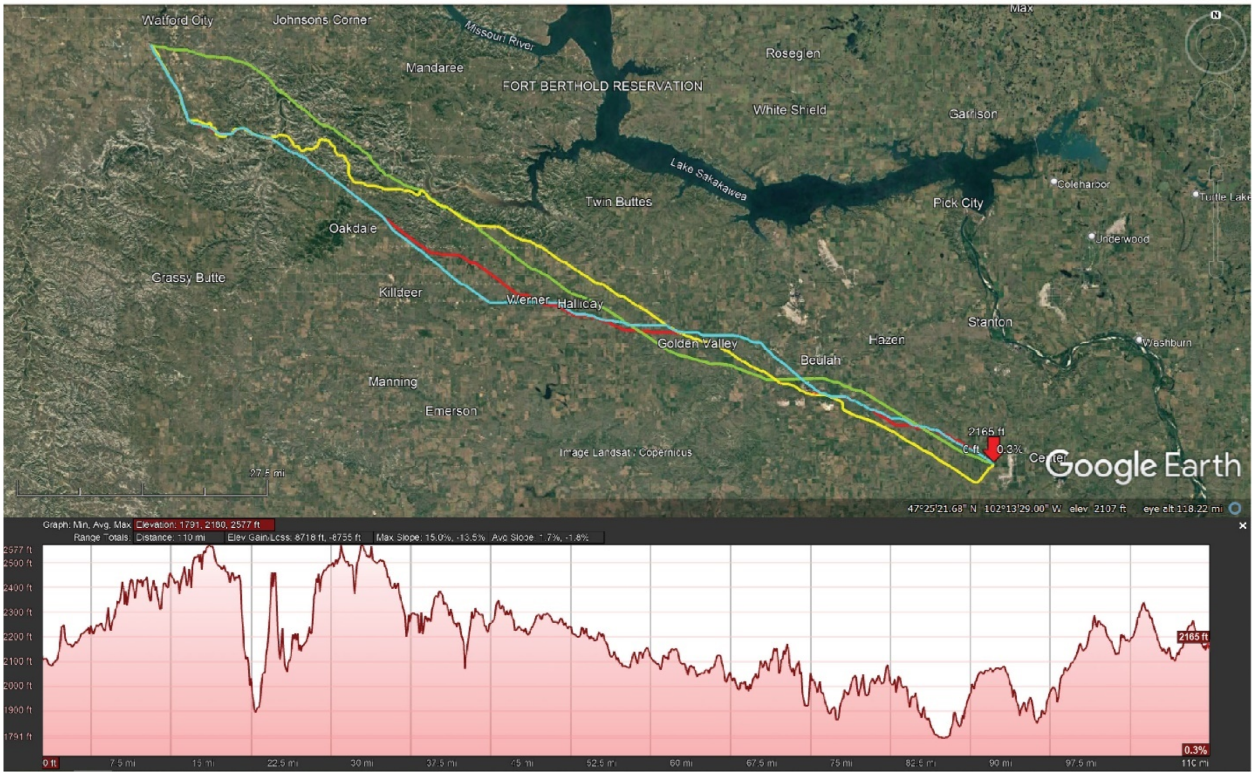

Figure 1. Pipeline routes and elevation of Baseline system in Route A – Center, North Dakota, in the south to Watford City, North Dakota, in the north. The Center elevation is at the right end of the elevation profile.

Like Route A, this pipeline route had a low point elevation below the inlet elevation. At approximately 4.5 miles from the inlet, the elevation of the pipeline is approximately 56’ lower than the inlet. Although this low point is not as drastic as the low point in Route A, it still warrants consideration on limiting the inlet pressure by approximately 20 psig.

In addition, the pipeline has a maximum elevation of 3330 feet at approximately 112 miles from the inlet. This change in elevation of approximately 1060 feet results in a loss of pressure in the pipeline of ~335 psig because of the increase in elevation alone.

In addition, two of the pipeline routes passed within ~15 miles of oil fields that may hold EOR potential and, therefore, could offer the ability to offtake some of the CO_2 from this line.

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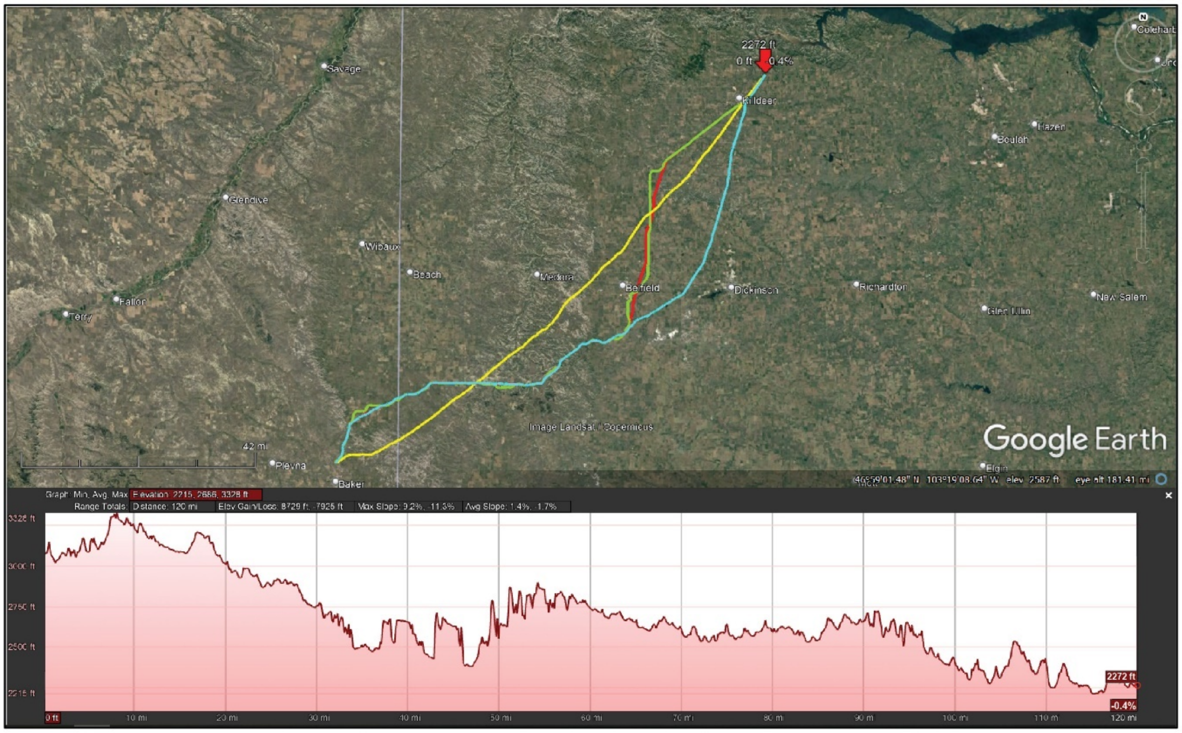

Figure 2. Pipeline route elevation profile for Baseline system in Route B – Killdeer, North Dakota, in the north to Baker, Montana, in the south. Killdeer elevation is at the right end of the elevation profile.

Route C – Missouri to Montana

Route C targeted the transport of 20 MMtpy of anthropogenic CO_2 from sources beginning near Kansas City, Missouri, and other industrial sources along the route, for delivery near Lambert, Montana, for use in EOR operations or storage in geologic formations in the area. This line is the longest and largest of the three pipeline routes considered, having a length of approximately 1064 miles and a net change in elevation of approximately 1605 feet. This line does climb to an elevation of 5316 feet at approximately 677 miles from the inlet, before dropping back down to an elevation of 2338 feet at the terminus of the line (Figure 3).

As with Routes A and B, this pipeline path showed a low point elevation below the inlet elevation. For this route, the low elevation is at approximately 2.2 miles from the inlet. However, as compared to other two routes, the elevation change from the inlet at 735 feet to the low point is not as steep, resulting in only an approximately 11’ reduction in elevation. Because of the limited amount of elevation change, this low point is not as drastic as in the other routes, resulting in a potential increase in pressure of approximately 3.5 psig higher than the inlet; nevertheless, further consideration regarding this potential change is warranted.

In addition, this pipeline route has a maximum elevation of 5316 feet at approximately 688 miles from the inlet. This change in elevation of approximately 4581 feet results in a loss of

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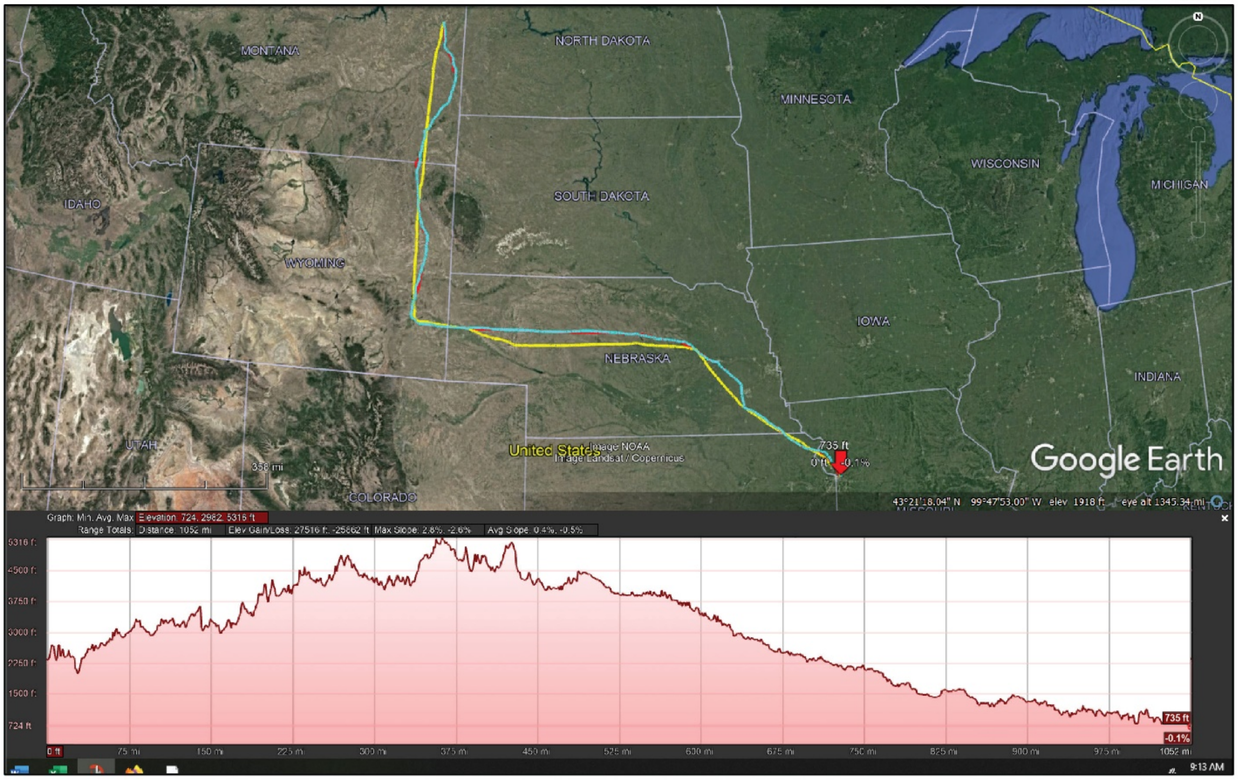

Figure 3. Pipeline routes for Route C – Kansas City, Missouri, in the south to Lambert, Montana, in the north. Kansas City elevation is at the right end of the elevation profile.

pressure in the pipeline of ~1450 psig because of the increase in elevation alone and may allow the CO_2 stream to no longer be in a supercritical state. However, since this pipeline is anticipated to require pumps to limit the OD (outside diameter) and cost of the pipeline, a detailed evaluation on the location of the pumps and the hydrostatic change of the CO_2 would be required to fully assess the change in the CO_2 stream through this change in elevation.

METHODS

After identifying the pipeline Routes A, B, and C, engineering calculations were conducted to quantify pipeline costs based on the design constraints for each route.

Pipeline Cost Estimates and Hydraulic Reviews

Through their membership in the PCOR Partnership, Resolute provided the pipeline routes, cost estimates, and hydraulic reviews for each of the pipelines under consideration. Resolute used public data and in-house and commercial software to provide the route selection, modeling, and cost estimates for the each of the pipelines. In addition, Resolute provided detailed project summaries and cost estimates for pump stations based on the size of the pipeline, design pressures (2190 or 2700 psig), and CO_2 volume for each route.

The detailed project summaries included the following throughout the design and construction of the project:

- Estimated total project cost
- Estimated project schedule
- Estimated client internal costs
- Estimated cost and schedule for engineering support
- Estimated cost and schedule for environmental work
- Estimated cost and schedule for the right-of-way (ROW) acquisition
- Estimated cost and schedule of survey work on ROW
- Estimated cost and schedule for pipeline inspection work
- Estimated cost, design, and schedule for materials utilized in project (mainline pipe, bore pipe, pipe bends, valve stations and valving required, power drops for motor-operated valves (MOVs), and sites or launchers and receivers)
- Estimated cost and schedule for construction activities
- Estimated cost and schedule for lidar/photography required for the pipeline
- Estimated cost and schedule for geotech study
- Estimated cost and schedule for nondestructive testing (NDT)
- Estimated overall cost versus schedule

An example of these reports is included in Appendix A. The reports provided a preliminary and detailed examination of the needs of the pipeline for each of the routes considered.

Supplemental Calculations

While Resolute provided much of the information concerning the pipeline routes and estimated cost, some supplemental information was provided by the EERC. For example, the EERC supplemented Resolute information using the NETL Model (National Energy Technology Laboratory, 2018). The NETL Model was used to provide the additional information required to complete the review of the pipeline sizes and pump station requirements set out earlier.

NETL Model

The NETL Model supports the DOE mission advancing the energy security of the United States. Within this model, equations were developed in prior years to provide a cost estimate for pipelines based on reviews of previous pipeline installations for a geographic area within the United States. The NETL Model corrects the cost estimates to 2018 dollars by using industrial inflation factors. For the routes that are included in this report, the NETL Model was updated to a 2019 cost estimate to provide a better estimate for a future project than the current or past years. The NETL Model was not updated to 2020 or 2021 because of the unique impacts of the COVID-19 pandemic. Regarding 2020, the COVID-19 pandemic both reduced the workload and depressed the pricing of materials and labor. Throughout 2021, the beginning of the recovery from the pandemic resulted in a surge of work that produced a spike in pricing from a higher cost of labor and shortage of materials.

Additional Calculations

In addition to the modeling that Resolute provided, third-party vendors were contacted and provided cost estimate and capacity for pumps used within the pipeline systems. The information provided by the third-party vendors is included in the pipeline designs and cost estimates.

RESULTS

For all pipeline routes considered, the "no-pump" option for each of the pipeline pressures was used as the baseline for comparisons. In this way, the effect of using pumps could be evaluated both in terms of total cost for the construction of the line as well as a comparison with the operational cost of the pumps included for each of the design pressures considered.

Route A Costs and Hydraulics

The path of Route A, an estimate of its cost, and a summary of the hydraulics associated with it were determined. Table 1 summarizes the Route A results for the required inlet pressure and maximum CO_2 capacity based on a pressure of 1700 psig at the terminus of the line.

For Route A, the recommended pipe sizing would be16-in. OD with a 2700-psig design pressure for the rate of 4.3 MMtpy with no pumps installed on the pipeline (green highlighted row in Table 1). However, if there is a need for a volume greater than 5 MMtpy, then a larger line size or the addition of pump stations should be considered for this route. Since the 16-in. OD specifications and all larger pipeline sizes achieved the target CO_2 volume of 4.3 MMtpy, Table 1 does not include additional cases for pump stations. Additionally, the maximum volume shown for each line reflects the volume that the line can transport based on a maximum inlet pressure of 2700 psig.

In addition, this system highlights the finding that the amount of CO_2 that a pipeline can transport is magnified with larger OD pipe. However, the cost difference and amount of CO_2 transported between the 16-in.-OD line and the larger OD lines are presented in Table 2 both in terms of cost and as a percentage increase over the 16-in.-OD baseline.

Table 1. Summary of the Results from the Hydraulic Review for Route A

Pipe OD	Number of Pump Stations	Required Inlet Pressure[1]	Net Change in Pressure	Inlet Temp.	Exit Temp.	Net Temp. Change	Estimated Cost of Pipeline	Max. CO_2 Volume[2]
in.		psig	psig	°F	°F	°F	$MM	MMtpy
16	0	2434	734	115	83.9	31.1	167.1	5.0
20	0	1942	242	115	89.8	25.2	195.8	8.9
24	0	1792	92	115	92.1	22.9	247.2	14.1
30	0	1721	21	115	92.6	22.4	372.0	25.3

[1] Required inlet pressure reflects pressure required to transport the base volume of 4.3 MMtpy for the OD of the line.
[2] Max. CO_2 volumes reflect the maximum amount of CO_2 that can be transported at 2700 psig.

Table 2. Pipeline Cost and Transport Capabilities as Compared to Baseline System

Nominal Pipeline OD, in.	Max CO_2 Transport Capacity, MMtpy	Pipeline Cost, $MM	% Cost above Baseline	% Max. CO_2 Transport Capacity above Baseline	Cost per MMtpy of CO_2 Transported
16	5.0	167.1			$33.42
20	8.9	195.8	17.2	78	$22.00
24	14.1	247.2	47.9	182	$17.53
30	25.3	372.0	122.6	406	$14.70

Route B Costs and Hydraulics

Information from Resolute and data from the NETL Model were used for the hydraulic evaluation of this route. Table 3 summarizes the Route B results for a pressure of 1700 psig at the terminus of the line.

Table 3. Summary of the Results from the Hydraulic Review for Route B

Pipe OD, in.	Number of Pump Stations	Required Inlet Pressure,[1] psig	Net Change in Pressure, psig	Inlet Temp., °F	Exit Temp., °F	Net Temp. Change, °F	Estimated Cost of Pipeline and Pump Stations, $MM	Max. CO_2 Volume,[2] MMtpy
16	0	EMDP[3]						4.1
20	0	EMDP[3]						7.3
24	0	2526	826	115	83.3	31.7	340.9	11.5
30	0	2146	446	115	86.9	28.1	447.2	20.7
16	1	EMDP[3]						5.9
20	1	2380	680	115	90.9	24.1	270.8	11.2
24	1	1954	254	115	94.4	20.6	307.7	10.0
30	1	1737	37	115	97.3	17.7	452.6	17.8
16	2	EMDP[3]						7.6
20	2	2190	409	115	97.1	17.9	252.0	10.0
24	2	1810	110	115	99.1	15.9	312.8	13.7
30	2	1669	-31[5]	115	100.6	14.4	458.0	24.5
16	3	2746[4]	1046	115	103.6	11.4	231.0	9.8
20	3	2012	312	115	99.5	15.5	256.7	10.4
24	3	1779	79	115	100.3	14.7	317.8	16.7
30	3	1660	-40 [5]	115	101.1	13.9	463.4	29.8

1 Required inlet pressure reflects pressure required to transport the base volume of 10 MMtpy for the OD of the line with the number of pumps indicated.

2 Max. CO_2 volumes reflects the maximum amount of CO_2 that can be transported at either 2190 or 2700 psig based on the required inlet pressure or the maximum volume the pipeline can handle at 2700 psig if the inlet pressure exceeds 2700 psig.

3 EMDP: line pressure for this run exceeds the maximum design pressure considered of 2700 psig to deliver 10 MMtpy.

4 This run is shown since the required inlet pressure is <100 psig over the design pressure of 2700 psig. Detailed review or cooling of the CO_2 may reduce the pressure needed to a value that would make this design a viable alternative.

5 Negative pressures shown for the Net Change in Pressure is the result of spacing pump stations along the pipeline to provide a pressure at the terminus of 1700 psig. In these cases, the required inlet pressure for these runs was lower than the exiting pressure, which resulted in a negative net change in pressure.

For Route B and a rate of 10 MMtpy, the recommended pipe sizing would be a 20-in.-OD line with a 2190-psig design pressure and two pump stations if only 10 MMtpy is required (green highlighted rows in Table 3). However, regarding the 20-in. OD and one pump for the 2380-psig required pressure (blue highlighted row in Table 3), an evaluation should be considered to determine the cost associated with pressurizing the CO_2 stream to this pressure, designing the pipeline to 2700-psig criteria, and whether the additional CO_2 capacity of the line would warrant the additional cost of the line. Additionally, if there is a need for a volume greater than approximately 11 MMtpy, then a larger line size or the addition of more pump stations should be considered for this route.

Route C Costs and Hydraulics

Information from Resolute and data from the NETL Model were used for the hydraulic evaluation on this route. Because of the large volume and the length of the line, this route requires large-diameter pipe in comparison to the other two routes. While a no-pump installation is achievable using a minimum of 48-in.-OD pipe, the cost of the line is very high, at an estimated $8B. With the addition of pump stations, the OD of the line is reduced along with the total estimated cost for the line, although the cost is still in the range of $4B to $7B. A summary of the results from the hydraulic study is shown in Table 4.

Based on the required inlet pressure and the overall cost of the line, the recommended pipe sizing would be 30-in. OD with a 2700-psig design pressure and six pump stations to deliver the CO_2 volume 20 MMtpy (green highlighted row in Table 3). However, because of the high cost of this line and the number of pump stations required to minimize the OD of the line, a detailed evaluation will need to be performed that includes the operational cost of the pump systems as well as the maximum capacity of the line for that application.

DISCUSSION

Key CO_2 Transport Cost Drivers

The design of any system requires a detailed evaluation that honors the parameters that the design must meet. For the CO_2 pipeline systems reviewed in this report, several design considerations affect the cost of the pipeline system: volume of CO_2 transported, length of the pipeline, elevation changes along the pipeline route, initial and final conditions of the CO_2 stream, and the price of steel. Each of these items is discussed further below.

Volume of CO_2 Transported

The volume of CO_2 transported (along with the elevation change in the line and conditions of the CO_2) greatly dictates the size of the pipeline that is required. With higher CO_2 volumes, a larger OD pipeline would be required to move the volume of CO_2 down the pipeline and limit the associated pressure drop. Ultimately, each pipeline size has its limitations, with and without pumps installed, where the pipeline reaches its maximum capacity to transport CO_2 through the pipeline.

Table 4. Summary of the Results from the Hydraulic Review for Route C

Pipe OD, in.	Number of Pump Stations	Estimate of Pump HP[1]	Required Inlet Pressure,[2] psig	Net Change in Pressure, psig	Inlet Temp., °F	Exit Temp.,[3] °F	Net Temp. Change, °F	Estimated Cost of Pipeline and Pump Stations, $MM	Max. CO_2 Volume,[4] MMtpy
48	0	–	2690	990	115			7,965	20.1
42	1	10,058	2452	752	115			7,718	24.3
36	2	23,041	2617	917	115			6,775	20.9
36	3	26,642	2393	693	115			6,813	24.8
30	4	51,100	2789[5]	1089	115	85	30	4,547	20.0
36	4	29,739	2257	557	115			6,822	28.3
42	4	23,668	2142	442	115			6,180	27.7
30	5	66,778	2745 [5]	1045	115			4,554	20.0
36	5	32,038	2164	464	115			6,831	20.6
30	6	74,868	2601	901	115			4,561	21.2
36	6	40,753	2142	442	115			5,517	22.6

[1] Estimate of pump HP based on power costs provided by NETL Model or as provided by Resolute.

[2] Required inlet pressure reflects pressure required to transport the base volume of 20 MMtpy for the OD of the line with the number of pumps indicated.

[3] Exit temperature shown is based on modelling from Resolute. Because of time limitations, no further results were obtained.

[4] Max. CO_2 volumes reflects the maximum amount of CO_2 that can be transported at either 2190 or 2700 psig based on the required inlet pressure, or the maximum volume the pipeline can handle at 2700 psig if the inlet pressure exceeded 2700 psig.

[5] These runs are shown since the required inlet pressure is <100 psig over the maximum design pressure of 2700 psig. Detailed review or cooling of the CO_2 may reduce the pressure needed to a value that would make this design a viable alternative.

Figure 4 shows the estimated maximum CO_2 volumes for Routes A, B, and C as a function of pipe OD and number of pump stations. For Route A, while the 16-in. pipe OD achieved the design target of 4.3 MMtpy, expanding the pipeline OD to 20, 24, or 30 in. would increase the maximum CO_2 volumes from 5.0 to 8.9, 14.1, and 25.3 MMtpy, respectively (an increase of 78%, 182%, and 406%, respectively). Similarly, for Route B, expanding the pipeline OD from 16 in. to 20, 24, or 30 in. would increase the maximum CO_2 volumes from 4.1 to 7.3, 11.5, and 20.7 MMtpy, respectively, when there are zero pump stations. Adding pump stations increases the maximum CO_2 volume within each pipe OD size. For example, the 24-in. Route B line with zero pumps and the 20-in. Route B line with two pumps both have a maximum CO_2 volume of 10 MMtpy. Lastly, as shown in the figure, the interplay between inlet pressure and number of pump stations also affects the maximum CO_2 volumes. For example, for Route C, the 36-in. pipe OD with four pump stations (28.5 MMtpy) had a greater maximum CO_2 volume than the 42-in. pipe OD with four pump stations (27.7 MMtpy) because the inlet pressure for the 36-in. pipe OD (2257 psig) was greater than the inlet pressure for the 42-in. pipe OD (2142 psig) (Table 4). However, there are additional cost considerations for the pump stations to provide the higher pressure and should be included within the review of the system.

Pipeline Length and Elevation Changes

The length of the pipeline limits the volume of CO_2 transported because of longer lengths of line and the resulting differential pressure (dP) between the inlet and the delivery point. In general, as the line lengthens, the volume that the pipeline could transport decreases, and larger pipeline sizes are required for the volume of CO_2 under consideration.

In each of the three pipeline routes considered in this study, topographic relief between the inlet and terminus of the line, as well as throughout the length of the pipeline, was evident (see Figures 1–3). Some of the elevation changes may require adaptions to the operation of the line (see Pipeline Routes). For example, a low point in the line could limit the maximum pressure at the inlet, while high point elevations can dictate a limit to the operating pressure of the line or for the selection of pipe used. This is especially true for Route C, which reached the highest elevation before dropping down and reducing the net elevation change based on the terminus of the line. Like a low elevation, the high point in elevation would need to be considered during the design of the line such that the pressure to lift the CO_2 to the high point both during the initial fill of the line and during routine operations, as well as when the line is static, can be accommodated by the pipe.

The interplay of pipeline length and elevation changes along the route both factor into the maximum CO_2 volumes that can be supported by the pipeline system. For example, Routes A and B were similar lengths of approximately 120 miles. However, Route B had 780 feet of net elevation change (rise) as compared to −35 feet of net elevation change (fall) for Route A. Consequently, similar pipe OD lines for Routes A and B had different maximum CO_2 volumes. The maximum CO_2 volumes, without pumps installed on the pipeline, for Route A pipe ODs of 24 and 30 in. were 14.1 and 25.3 MMtpy, respectively, while the maximum CO_2 volumes for Route B pipe ODs of 24 and 30 in. were 11.5 and 20.7 MMtpy, respectively (Figure 5). Therefore, Route B had an approximately 18% reduction in the maximum CO_2 volumes for the equivalent Route A pipe ODs.

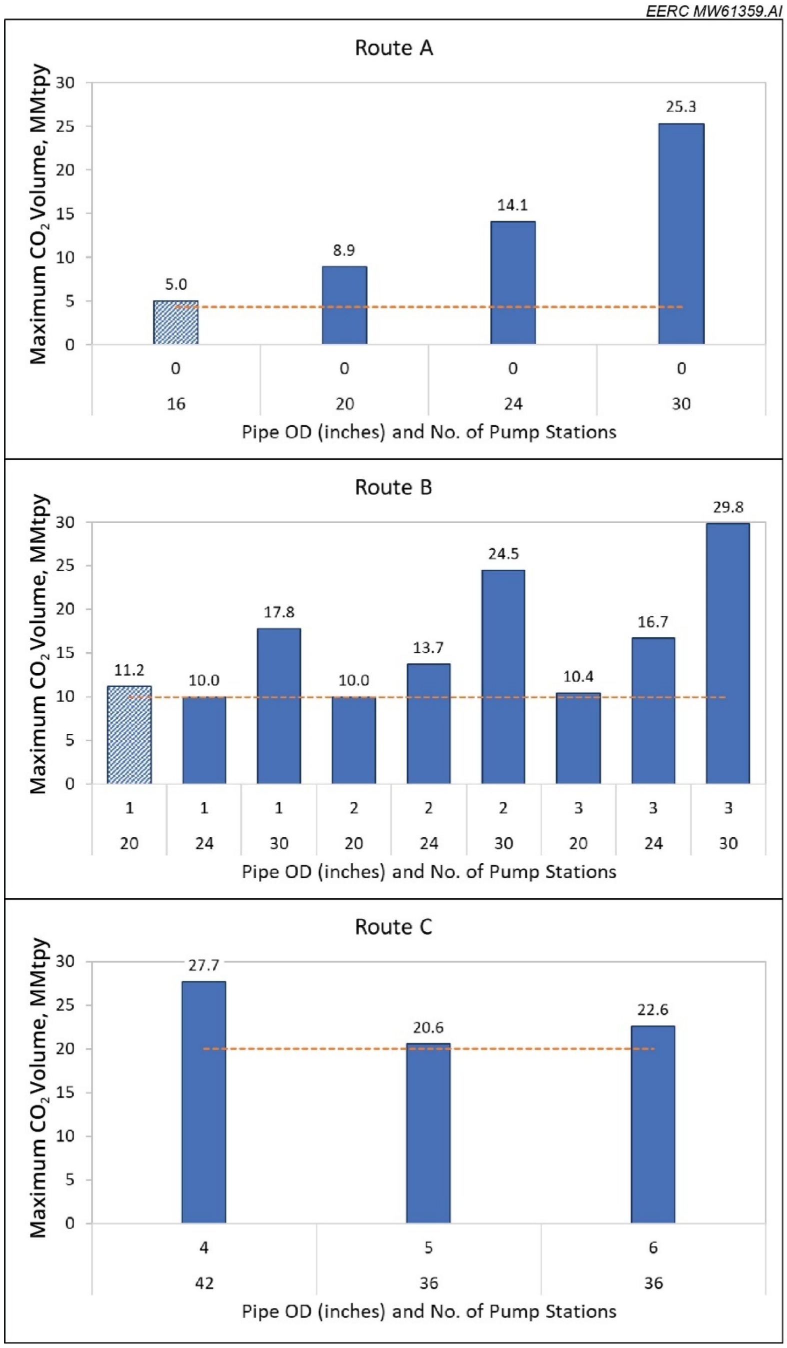

Figure 4. Maximum CO_2 volumes for Route A (top), Route B (middle), and Route C (bottom) as a function of pipe OD and number of pump stations.[2] The orange horizontal line in each panel shows the design targets of 4.3, 10, and 20 MMtpy for Routes A, B, and C, respectively. Solid bars reflect a design pressure of 2190 psig; crosshatched bars reflect a design pressure of 2700 psig.

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[2] Max. CO_2 volumes reflects the maximum amount of CO_2 that can be transported at either 2190 or 2700 psig based on the required inlet pressure, or the maximum volume the pipeline can handle at 2700 psig if the required inlet pressure exceeds 2700 psig.

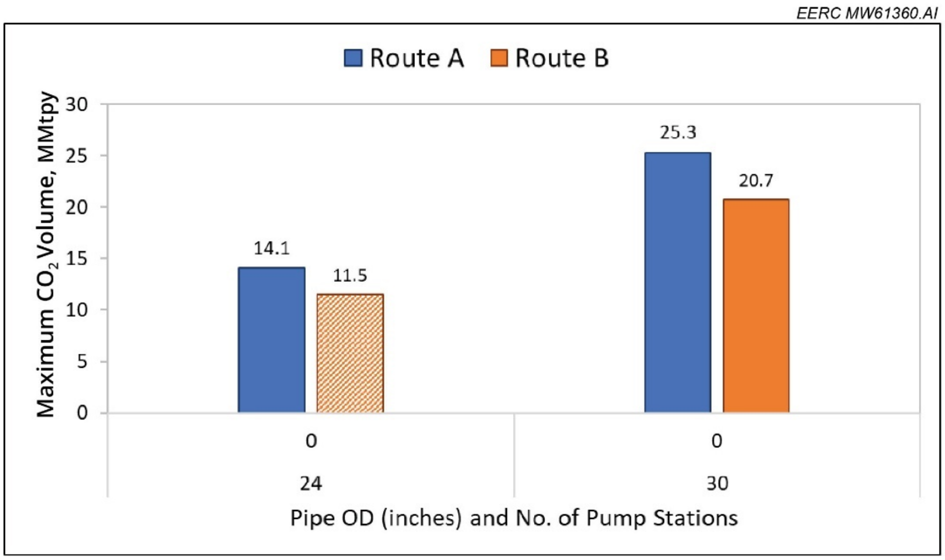

Figure 5. Comparison of maximum CO_2 volumes for Routes A and B for equivalent pipe OD sizes and zero pump stations. Solid bars reflect a design pressure of 2190 psig, and the crosshatched bar reflects a design pressure of 2700 psig.

Initial and Final Conditions of the CO_2 Stream

The inlet conditions of the CO_2 will also affect the size of the pipeline used. For example, if the inlet pressure is too low, then a larger pipeline OD or the addition of pump stations may be required to transport the required volume of CO_2, both of which will increase the cost of the line. Similarly, if the inlet temperature of the CO_2 is too high, for example during summer conditions, a larger pipeline diameter may be required because of the lower density of the CO_2. This is particularly true for Route C, where the volume of CO_2 transported through the line is reduced as the temperature becomes elevated, as referenced in Figure 6 (based on NETL CO_2 Transport Model with average pipeline temperatures shown). For Route C, an average pipeline temperature of 65°F provides an estimated maximum rate of approximately 22.7 MMtpy, whereas an average pipeline temperature of 100°F provides an estimated maximum rate of approximately 21.0 MMtpy (7.5% decrease).

The exiting conditions of the CO_2 at the delivery point will also dictate the size of the line required. If the exiting pressure is too high (resulting in a lower dP through the line as compared to the inlet conditions), then the size of the line may need to be larger to handle the volume of CO_2 required. Additionally, if the pressure is too low where the CO_2 is no longer in a dense phase (for the exiting temperature), then the pipeline may not have the ability to transport the required volume of the CO_2.

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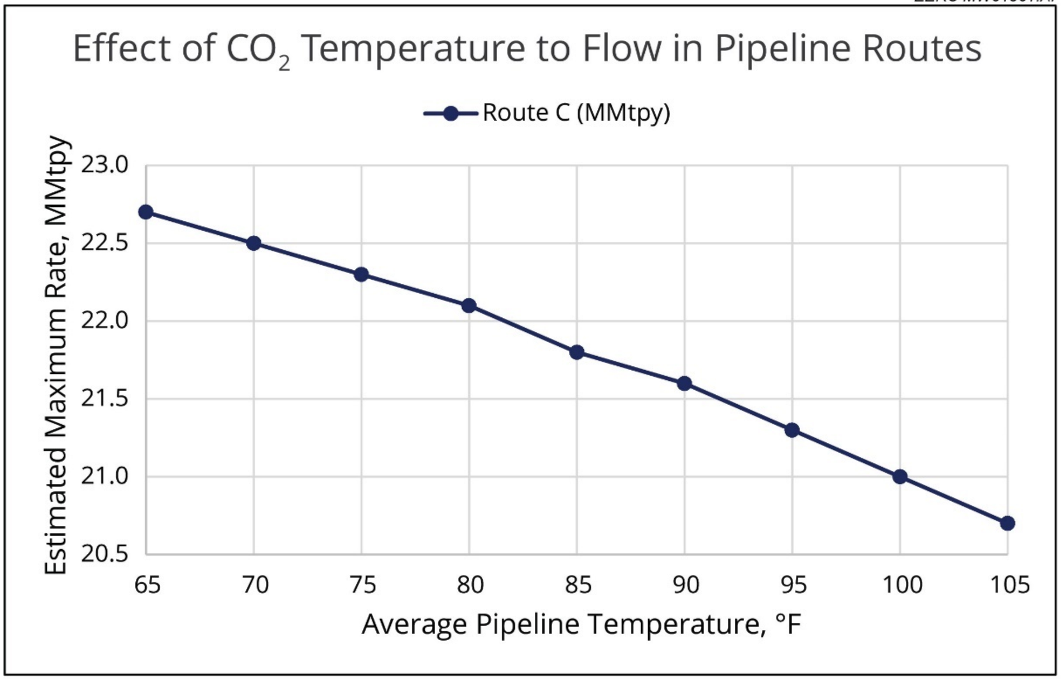

Figure 6. Effects of average pipeline temperature of maximum rate transported for Route C (based on NETL Model with average PL temperatures shown).[3]

Price of Steel

Figures 7 and 8 provide a summary on the historical price of plate steel and scrap, respectively, since 2002 (as provided at SteelBenchmarking.com, 2021). Because of the reduced demand for steel associated with the shutdowns from the COVID-19 pandemic in 2020, the price of steel has seen a dramatic uptick in 2021 resulting from the subsequent surge in demand for steel products during recovery from the pandemic. For example, the price of plate steel in 2018–2019 was less than $1200 per metric ton; however, in October 2021, the price increased to $2013 per metric ton – an increase of about 68%.

Similarly, the price of scrap steel rose from $225, $273, and $320 per ton for heavy melting, shredded scrap, and #1 busheling, respectively, delivered to a U.S. mill in May of 2020 and reached a peak of $466, $503, and $655 per ton in June and July of 2021, resulting in an increase of 207%, 184%, and 205% as compared to the pricing in May 2020 for these products. Prices as of October 11, 2021, have since declined to $422, $463, and $586 per ton, but remain elevated as compared to the previous 10 years of pricing (2011 to 2021) for these products.

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[3] Figure 6 reflects the estimated maximum volume for Route C based on the NETL Model and the average temperature shown in the graph. Figure 6 is for reference only based on the parameters of Route C to highlight the effect that temperature can have on the volume of CO_2 transported through a pipeline.

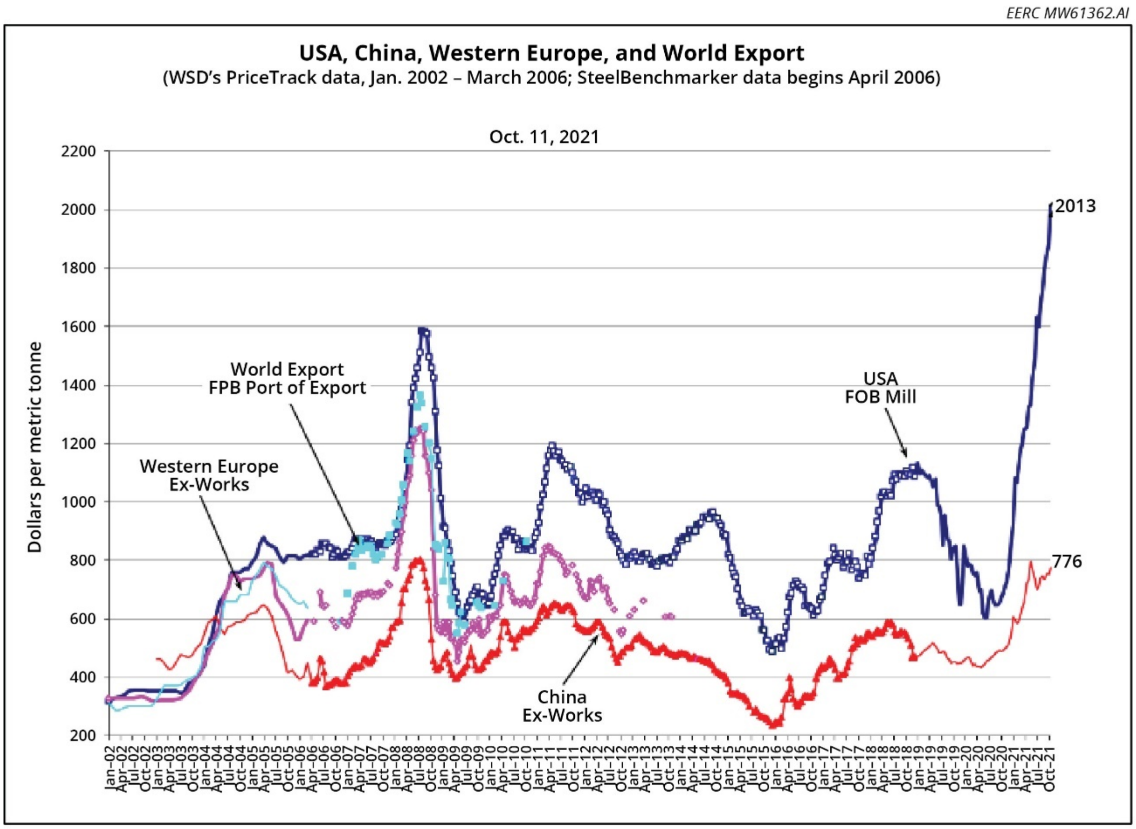

Figure 7. Price of plate steel – January 2002 to October 2021 (as provided at SteelBenchmarking.com, 2021).

Because of the recent spike in the price of steel and the uncertainty of when the pricing would return to normal levels, consideration should be given to the price and the delivery of steel pipe when evaluating the cost of a pipeline.

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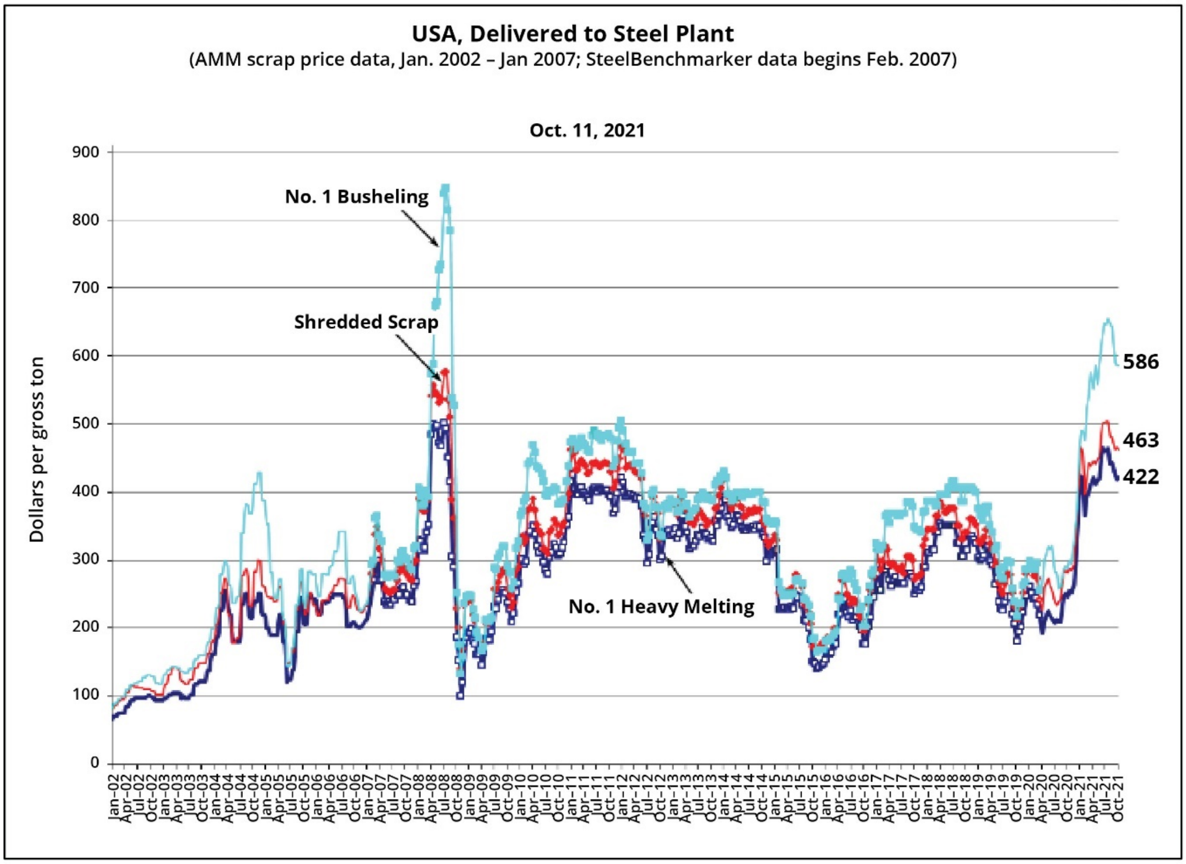

Figure 8. Price of scrap steel – January 2002 to October 2021 (as provided at SteelBenchmarking.com, 2021).

Cost–Hydraulics Optimization Considerations

As demonstrated for Route C, the installation of pump stations can reduce the overall cost of the pipeline system and, possibly, provide a buffer to allow for a higher volume of CO_2 to be transported in the event additional volumes become available or demand increases. In addition, with the variations in ambient temperatures from summer to winter, using pumps with variable-frequency drives (VFDs) will enable the pumps to operate efficiently and deliver the CO_2 at the lower overall power cost throughout the year.

Pipeline OD Versus Pump Installations

As demonstrated in Routes B and C, pipeline booster pump installations generally allow for reducing the OD of the pipeline. This is due to a higher pressure drop realized through the system, which, in turn, allows for a higher volume being transported through the pipeline. Additionally, since the CO_2 stream is transported as a supercritical fluid, some heating of the CO_2 stream will be realized with the addition of pump stations. The amount of heat generated in the pumps depends greatly on the inlet density of the CO_2 stream to the pumps. The higher the density of the CO_2 that is delivered to the pumps, the lower the temperature increase that would be realized.

Pump station installations should be considered for optimizing the pipeline system but will need to be evaluated based on the cost of the pump stations, the added heat load to the system, and the added operational expense and upkeep of the pumps. In many cases, the savings from the reduction in the OD of the pipeline will more than pay for the operational expenses associated with the pumps throughout the life of the project. However, each system is different and will require a detailed analysis on what the best option is for the system in consideration.

Figure 9 shows an example for Route B, where the pipe OD and number of pumps are sorted in order of maximum CO_2 volume (least to greatest maximum CO_2 volume going from left-to-right, left-hand *y*-axis) and the total pipeline system cost (pipeline plus pump stations) divided by the maximum CO_2 volume to express "cost per metric ton of CO_2" on the right-hand *y*-axis. Based on the NETL Model and as shown in the figure, the addition of pump stations can lead to a lower relative cost with comparable maximum CO_2 volume. For example, a 20-in. pipe OD with one pump station has an estimated maximum CO_2 volume of 11.2 MMtpy and a cost per metric ton of \$24.18, whereas a 24-in. pipe OD with zero pump stations has an estimated maximum CO_2 volume of 11.5 MMtpy (2.7% increase) and a cost per metric ton of \$29.64 (22.6% increase). A similar phenomenon occurs between a 24-in. pipe OD with three pump stations and a 30-in. pipe OD with one pump station. These examples highlight the interplay between pipe OD and pump stations and its importance in optimizing pipeline system costs and hydraulics.

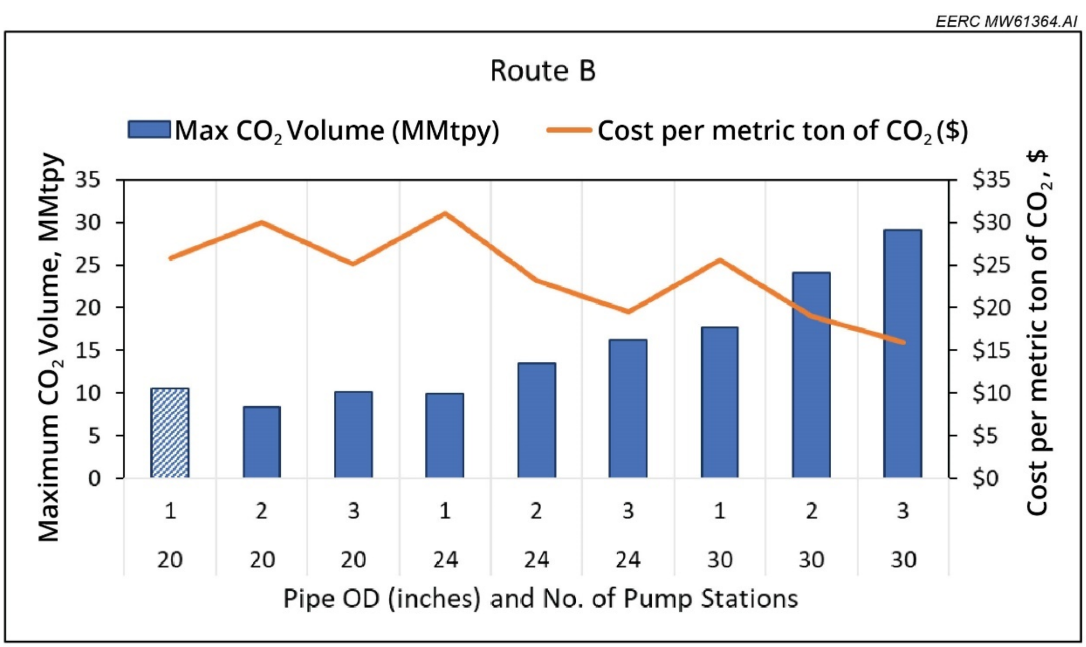

Figure 9. Line plot showing the Route B estimates of the maximum CO_2 volume (left *y*-axis) and cost per metric ton of CO_2 (right *y*-axis) as a function of the pipe OD and number of pumps. Solid bars reflect a design pressure of 2190 psig, and the crosshatched bar reflects a design pressure of 2700 psig.

Pipeline Installation Cost Versus Operational Cost with Pumps

A major theme of this report focuses on the volume of the CO_2 that can be transported in the pipeline system. In general, the volume of CO_2 that the pipeline can transport will increase with an increase in the OD of the pipe or the addition of pump stations along the route. However, with higher flow, the operational cost of the pumps installed will be higher. Also, the higher the pipeline pressure, the higher the operational cost of the pumps will be. In the cases evaluated in this report, 2190 or 2700 psig, the operational cost of the pumps at the higher pressure of 2700 psig was approximately double that at 2190 psig. The operational cost of the pump system(s) does impact the long-term cost of the project, and as a result, the total cost of the system should be fully evaluated over the life of the project to determine the optimal system for the project under consideration.

Pump Considerations

Pumps have been used to pressurize CO_2 streams for many years. While different styles of pumps can be used for pressurizing CO_2, centrifugal pumps are generally used for this service because of their ability to accept a varying range of densities and to operate effectively with the use of VFDs. The centrifugal pumps are generally constructed in a horizontal arrangement which allows for easy access to the major pieces of the equipment: motor, pump staging, and/or thrust chambers. Because of this, the downtime associated with changing out equipment is minimized and generally completed with 1 or 2 days.

A concern for pressurizing CO_2 streams is that they are inherently dry: both in terms of the water content and lubricity. Specifically, the CO_2 streams are required to be dehydrated (typically 30 lb per MMscfd as indicated by Kinder Morgan, but each project will require an assessment to determine the maximum water content allowed) to ensure no free water will be condensed out of the stream, which would pose a risk of corrosion to the carbon steel equipment because of the formation of carbonic acid. The pipeline system being evaluated should include a detailed analysis on the temperatures of the stream to determine how dry the CO_2 stream will need to be to ensure water is not condensed out during operation or shut in of the line.

In terms of lubricity, CO_2 streams do not offer the lubricity of other fluids such as water or oils. Because of this, the bearings within centrifugal pumps require special materials that will allow the bearing faces to rotate against each other without the overheating that can result in failures of the bearings. Resulting from the low lubricity of a CO_2 stream, special bearings are required to utilize pumps in CO_2 applications.

Lessons Learned for the PCOR Partnership

Overall, any pipeline design requires the careful consideration of many factors–detailed design parameters such as the CO_2 volume, pipeline pressure, and pipeline inlet and exit conditions and the effects to the CO_2 stream, elevation changes throughout the length of the line, route considerations, and pumping needs, to name a few. Each of these factors can affect the choice of pipe size and pressure rating and will need to be reviewed together to define the optimum line sizing, i.e., the line size necessary for the transport of the required volumes of CO_2 volume while minimizing the overall cost of the line both in terms of construction cost and long-term operational cost of installed pumping equipment. This study identified the key CO_2 transport cost drivers and cost–hydraulics optimization considerations. Two additional insights gained by this study, which provide valuable "lessons learned" for the PCOR Partnership, include i) pressure–temperature effects on pipeline sizing and maximum injection pressure and ii) an understanding of the similarities and differences between the NETL Model and the more detailed engineering estimates performed by Resolute. These lessons learned are discussed in more detail in the remainder of this section.

Pressure–Temperature Effects

The investigation of the pipeline routes used an inlet CO_2 temperature of 115°F. This temperature was used to model the maximum temperature during summer conditions. Integral to this temperature selection was the assumption that the captured CO_2 from an anthropogenic source would be delivered at elevated temperature and cooled with aerial coolers with a 10°F approach[4] to the ambient temperature. What became evident through the detailed designs provided by Resolute was that the exiting temperature of the CO_2 from the pipeline did not reach the estimated ambient ground temperature of 60° to 65°F anticipated during the peak of the summer for this section of the PCOR Partnership region. The modeling data that Resolute provided showed the following key relationships:

1. The larger the OD of the pipeline, which required a lower inlet pressure, the higher the exiting temperature of the CO_2.

2. Increasing the number of pump stations resulted in a higher exit temperature of the CO_2. This is due to the pumps adding heat to the CO_2 stream from pressurization which can ultimately result in a higher exiting temperature.

Figure 10 summarizes the results from Resolute's model runs and shows the exit temperature of the CO_2 (outlet temperature) from the pipeline based on pipe OD, flow rate, number of pump stations, and inlet pressure. As shown in the figure, the outlet temperatures for Routes A and B, range from 83.9° to 92.6°F and 83.3° to 103.6°F, respectively. Route C shows an outlet temperature of 84.7°F for the model run provided by Resolute. In all cases, the outlet temperatures are significantly greater than the estimated ground temperature of 60° to 65°F anticipated during the peak of the summer for the North Dakota area. Because the temperature of the CO_2 may not reach the ground temperature upon exiting the pipeline at the delivery point or, possibly, even at the injection wells, special consideration to the density of the CO_2 at the wellhead of the injection well is necessary. If the temperature is too high, the density of the CO_2 will be reduced and may affect the volume of the CO_2 injected. Because of this, the maximum injection pressure set for the

[4] A 10-degree approach refers to how cool the fluid will be exiting the coolers as compared to the maximum ambient design temperature. For example, if the maximum ambient temperature is 90°F, then the fluid exiting the coolers would be 100°F at this temperature. The difference between the exiting temperature of the fluid from the coolers and the maximum ambient temperature defines the approach to ambient conditions. Also, when the ambient temperature is cooler than the designed maximum temperature, the fluid being cooled can show a higher temperature drop at the exit of the coolers, resulting in a higher degree of cooling of the fluid stream.

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Route	PL Length (miles)	Pipe Sizing (inches OD)	Flow (MMtonnes/yr) (base)	Number of Pump Stations	Delta Elevation (feet)	Inlet Pressure (psig)	Outlet Pressure (psig)	Outlet Temperature (°F)	Density of CO_2 at Outlet (lb/ft^3)	State of CO_2 at Outlet	PL Design for Volume (psig)
A	110	16	4.3	0	-35	2434	1700	83.9	51.03	Liquid	2700
A	110	20	4.3	0	-35	1942	1700	89.8	49.42	Supercritical	2190
A	110	24	4.3	0	-35	1792	1700	92.1	48.74	Supercritical	2190
A	110	30	4.3	0	-35	1721	1700	92.6	48.59	Supercritical	2190
B	120	24	10	0	765	2526	1700	83.3	51.19	Liquid	2700
B	120	30	10	0	765	2146	1700	86.9	50.23	Liquid	2190
B	120	20	10	1	765	2380	1700	90.9	49.10	Supercritical	2700
B	120	24	10	1	765	1954	1700	94.4	48.04	Supercritical	2190
B	120	30	10	1	765	1737	1700	97.3	47.12	Supercritical	2190
B	120	20	10	2	765	2109	1700	97.1	47.18	Supercritical	2190
B	120	24	10	2	765	1810	1700	99.1	46.51	Supercritical	2190
B	120	30	10	2	765	1669	1700	100.6	46.00	Supercritical	2190
B	120	16	10	3	765	2746 [1]	1700	103.6	44.91	Supercritical	2700
B	120	20	10	3	765	2012	1700	99.5	46.38	Supercritical	2190
B	120	24	10	3	765	1779	1700	100.3	46.10	Supercritical	2190
B	120	30	10	3	765	1660	1700	101.1	45.82	Supercritical	2190
C	1,064	30	20	4	1638	2789 [1]	1700	84.7	50.82	Liquid	2700

[1] This run is shown since the inlet pressure is <100 psig over the maximum design pressure of 2700 psig. Detailed review or cooling of the CO_2 may reduce the pressure needed where this design would be a viable alternative.

Figure 10. Estimated exit temperature from model runs made by Resolute.

injection well(s) should account for the seasonal temperature effects of the CO_2 stream and how the density of the CO_2 may impact the injection rate to the well. In some cases, the reduced density of the CO_2 stream because of the higher temperature may require reduced injection rates to remain within the injection pressure constraints. Higher injection pressure may offset some of the reduction in density associated with higher temperatures, but increasing the injection pressure would require further evaluation to determine how much additional pressure may be allowed in the injection pressure authorized by the regulating body.

In addition to wellhead impacts, Figure 11 illustrates the effect that the average pipeline temperature has on the volume of CO_2 that the pipeline can transport, as calculated by the NETL Model, for Routes A, B, and C. While the temperature effects would not be expected to significantly affect Routes A and B (essentially a constant maximum CO_2 rate from 65° to 105°F), temperature would make a significant difference for Route C. For example, at 65°F, Route C would have a maximum CO_2 rate of 22.7 MMtpy, while at 105°F, the maximum CO_2 rate would decrease to 20.7 MMtpy (8.8% decrease).

To estimate the addition of heat to the CO_2 stream from pressurization, the commercial program HYSYS was used to estimate the discharge temperature rise from the pressurization using a pump or compressor for the method of pressurization and with two different equations of state. The extent of these temperature increases is shown in Figure 12. The HYSYS data highlight the need to consider the effect that pressurization will have on the CO_2 stream and how the higher discharge temperatures will affect the flow of the CO_2 stream through the pipeline system.

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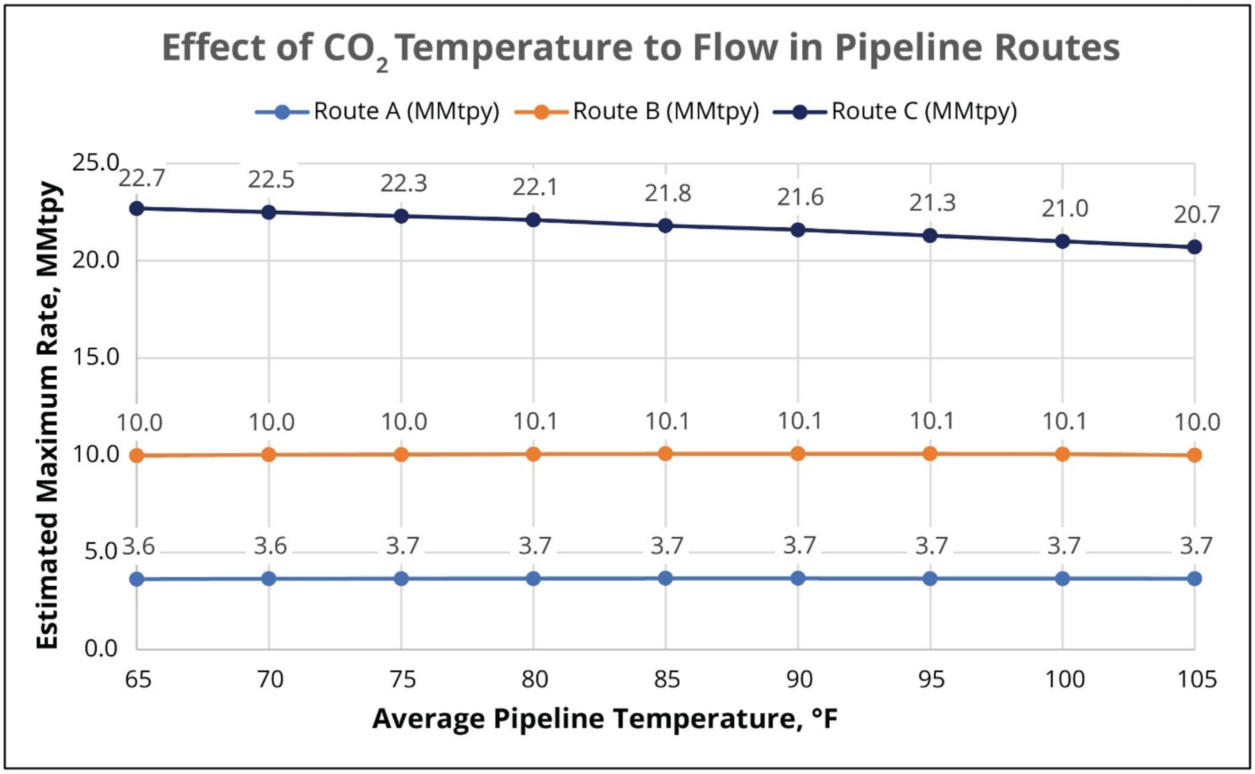

Figure 11. Effect of CO_2 temperature on flow in pipeline Route C (NETL Model results, 2700-psig pipeline pressure).

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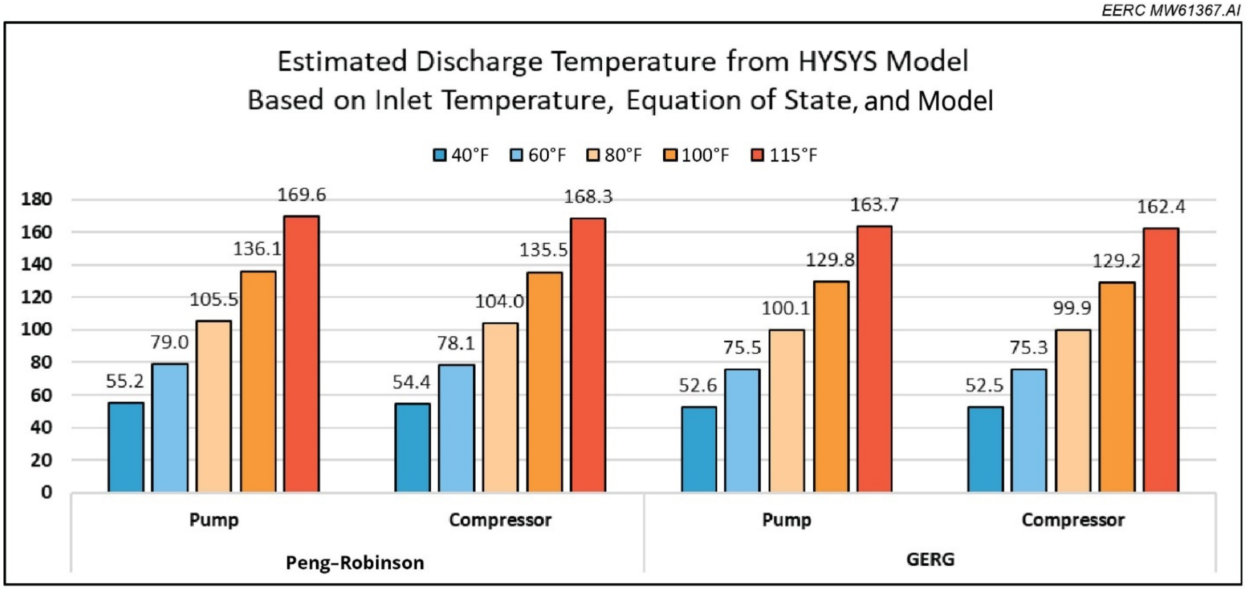

Figure 12. Estimated discharge pressure from inlet temperatures from 1500 to 2700 psig.

Pipeline Sizing

The sizing of a pipeline system will depend on the differential pressure that the line will undergo. The differential pressure that the line experiences is impacted by the volume of the transported fluid, length of the line, elevation changes, temperature and pressure of the fluid, and pump station siting. Each of these items impacts the differential pressure that the fluid will undergo while it courses through the line, which dictates the size of the line to utilize the available differential pressure. Some general statements can be made regarding these effects as provided below.

Design Challenge	**Solution or Result from Design Challenge**
Higher Transport Volume	Possibly larger diameter of pipe, addition of pump stations
Longer Pipeline Length	Possibly larger diameter of pipe, addition of pump stations
Net Elevation Increase (rise) along Pipeline Route	The entire pipeline route will need to be fully reviewed to determine the true impact that the elevation change will have on the pipe design used in the pipeline as a rise in elevation will result in a reduction in the pressure of the pipeline as the pipeline increases in elevation. In addition, in the section(s) of pipe that have a net elevation rise, a detailed review on the pressure of the pipeline at the apex(es) of the rise will need to be reviewed to ensure that the CO_2 remains in a supercritical phase during static and dynamic pipeline conditions.
Net Elevation Decrease (fall) along Pipeline Route	Possibly smaller diameter of pipe. The entire pipeline route will need to be fully reviewed to determine the true impact that the elevation change will have on the pipe design used in the pipeline as a fall in elevation will result in an increase in the pressure of the pipeline as the pipeline decreases in elevation. In addition, in the section(s) of pipe that have a net elevation fall, a detailed review on the pressure of the pipeline at the low point(s) of the line will need to be reviewed to ensure that the pressure of the CO_2 stream does not overpressure the section of the pipeline where the low point occurs during static and dynamic pipeline conditions

Continued . . .

Design Challenge	Solution or Result from Design Challenge
Higher Temperature of the Transported Fluid	Possibly larger diameter of pipe. Depending on the temperature, the strength of the pipe may need to be modified to accommodate the temperature.
Low Temperature of the Transported Fluid	Detailed design review for pipe diameter as it may require larger or smaller diameter of pipe dependent on the conditions of the fluid.
Higher Pipeline Operating Pressure	Possibly smaller diameter of pipe due to the availability of higher differential pressure through the pipeline.
Lower Pipeline Operating Pressure	Possibly larger diameter of pipe due to the availability of a lower differential pressure through the pipeline.
Incorporating Pump Stations	Possibly smaller diameter of pipe
Pump Station Operating Costs	Balance of pipeline OD with the addition of pump stations to optimize the flow through the pipeline while minimizing the overall cost of the pipeline that includes the cost for the construction of the line and the operational expenses associated with the pump stations for the life of the project.

Comparisons Between NETL (2018) and Resolute Estimates

The NETL Model is a generic, scoping-level estimation tool, whereas the Resolute modeling estimates represent engineering-level cost details based on the project-specific considerations. The estimates and details that Resolute presented incorporate their knowledge and cost information, supported by in-house and commercial software, while the NETL Model reflects calculations based on a multitude of regional projects, representing both short and long distances and varying pipeline diameters.

The NETL Model provides a good scoping level for a pipeline review. However, the NETL Model may not reflect accurate costs of some major items such as pipe and ROW costs; it does provide a good overall cost estimate for the overall cost estimate of a pipeline system.

Resolute provided a highly detailed report concerning the particulars of the pipeline systems under consideration. Similar to the NETL Model, Resolute provided cost estimates for the major items of the pipeline such as materials, labor, ROW, and other costs associated with a pipeline project. However, Resolute provided much more detailed information such as timelines for work and expenditures associated with construction, ROW acquisition, surveying, etc. An example of the level of detail provided by Resolute is shown in Appendix A. For this review, Resolute provided a total of 24 detailed reports for the three pipeline routes of interest. For each pipeline route, these reports provide information for a range of pipeline diameters at pipeline pressures of

2190 and 2700 psig. The detailed information provided by the Resolute analysis provides an excellent foundation for specifying an optimal pipeline system design for the transport of captured CO_2 to a geologic storage site.

SUMMARY

Cost estimates and hydraulic reviews were performed for three hypothetical CO_2 pipeline routes, varying in lengths from approximately 100 to 1100 miles, with the capability of transporting from 4.3 million to 20 million metric tons per year of CO_2. This study was conducted by Resolute Engineering through the PCOR Partnership and further supplemented by the EERC using the FE/NETL CO_2 Transport Cost Model. The conclusions of this study are summarized here regarding the pipeline cost estimates and cost drivers, the cost–hydraulics optimization, and pressure–temperature effects on pipeline sizing and maximum injection pressure. Lastly, the similarities and differences between the NETL Model and the more detailed engineering estimates performed by Resolute are briefly documented.

Pipeline Cost Estimates and Cost Drivers

The minimum costs for the three hypothetical pipeline routes ranged from $167 MM to $4,560 MM, as summarized in Table 5.

Table 4. Summary of Findings on Hypothetical Pipeline Routes

Hypothetical Pipeline Route	Minimum Cost, $MM	CO_2 Transport Capacity, MMtpy	Inlet Pressure, psig	Length, miles	PL OD, in./no. of pump stations
A	167	4.3	2700	110	16/0
B	252	10	2190	110–120	20/2
C	4,560	20	2700	1000	30/6

The primary cost drivers for these pipelines were the volume of CO_2 transported, the length of the pipeline, elevation changes along the pipeline route, initial and final conditions of the CO_2 stream, the number of pump stations required, and the price of steel. The relative impacts of these various drivers are as follows:

- Volume of CO_2 transported – ultimately, each pipeline size has a maximum capacity to transport CO_2, which increases with pipeline diameter. For example, while the 16-in. pipe OD achieved the design capacity of 4.3 MMtpy for Route A, expanding the pipeline OD to 20, 24, or 30 in. would increase the maximum CO_2 capacity to 8.9, 14.1, and 25.3 MMtpy, respectively (representing increases of 78%, 182%, and 406%), while requiring an additional capital spend of $28.7 MM, $80.1 MM, and $204.9 MM, respectively (representing increases of 17%, 48%, and 123%). Adding pump stations would generally increase the maximum capacity for each pipe OD.

- Pipeline length and elevation changes – the interplay of pipeline length and elevation changes along the pipeline routes both factor into the maximum CO_2 volumes that can be transported by the pipeline system. For example, Routes A and B were similar in length, i.e., approximately 110 to 120 miles. However, Route B had 780 feet of net elevation change compared to -35 feet of net elevation change for Route A. Consequently, similar pipe OD lines for Routes A and B had different maximum CO_2 volumes: Route B had approximately 18% lower maximum CO_2 volumes for the equivalent Route A pipe ODs.

- Initial and final conditions of the CO_2—the inlet pressure and temperature of the CO_2—will also affect the size of the pipeline that is needed. For example, if the inlet pressure is too low, then a larger pipeline or pump stations may be required to transport the required volume of CO_2, both of which will increase the cost of the line. Similarly, if the inlet temperature of the CO_2 is too high, for example during summer conditions, a larger pipeline diameter may be required because of the lower density of the CO_2. This impact is demonstrated for Route C, where the volume of CO_2 transported through the line is reduced as the temperature becomes elevated. More specifically, an average pipeline temperature of 65°F provided an estimated maximum rate of approximately 22.7 MMtpy, whereas an average pipeline temperature of 100°F provided an estimated maximum rate of approximately 21.0 MMtpy (i.e., a decrease of 7.5%).

- Number of pump stations required – the volume that a pipeline can transport is increased with the addition of pump stations. Based on the planned volume for a pipeline, the cost of the pump stations will add cost to the pipeline (initial capital cost and ongoing operational costs) but, in many cases, allows for the reduction in pipeline OD. The reduction of the OD of the pipeline may more than offset the cost of adding pump stations to the pipeline system. Therefore, to determine the optimum design of the pipeline system, the capital cost and lifetime operational cost of the use of pump stations should be performed as part of the evaluation of the design of the pipeline system.

- Price of steel – the price of steel has fluctuated dramatically in 2020 and 2021 because of the reduced demand of steel during the height of the COVID-19 pandemic and the subsequent surge in demand as recovery from the pandemic began to occur. For example, the price of plate steel increased about 55% from 2018 to 2019 (less than $1200 per metric ton) to July 2021 ($1856 per metric ton). Similarly, the price of scrap (i.e., heavy melting, shredded scrap, and #1 busheling) delivered to a U.S. mill increased 207%, 184%, and 205% for these products, respectively, from May of 2020 to June/July of 2021. These swings in the price of steel are significant when the cost of a CO_2 pipeline is estimated.

Cost–Hydraulics Optimization

The installation of pump stations can reduce the overall cost of the pipeline system and, possibly, provide a buffer to allow for a higher volume of CO_2 to be transported in the event additional volumes become available or demand increases. In addition, with the variations in ambient temperatures from summer to winter, the use of pumps with VFDs will enable the pumps to operate more efficiently and deliver the CO_2 at a lower overall power cost throughout the year.

Some key considerations to be considered during the optimization of the costs and hydraulics of a CO_2 pipeline were addressed in this report and are summarized below:

- Pipeline diameter versus pump installations – the interplay between pipe OD and pump stations and its importance in optimizing pipeline system costs and hydraulics were demonstrated in this report. For Route B, it was shown that the addition of pump stations can lead to a lower relative cost with comparable maximum CO_2 volume: 1) a 20-in. pipe OD with one pump station had an estimated maximum CO_2 volume of 11.2 MMtpy and a cost per metric ton of $24.18, whereas a 24-in. pipe OD with zero pump stations had an estimated maximum CO_2 volume of 11.5 MMtpy (2.7% increase) and a cost per metric ton of $29.64 (22.6% increase) and 2) a similar result was observed when comparing a 24-in. pipe OD with three pump stations and a 30-in. pipe OD with one pump station.

- Pipeline installation costs versus operational cost with pumps – in general, the volume of CO_2 that the pipeline can transport will increase with the addition of pump stations along the route. However, with higher flow, the operational cost of the pumps will be higher. Also, the higher the pipeline pressure, the higher the operational cost of the pumps will be. In the cases evaluated in this report, i.e., inlet pressures of 2190 or 2700 psig, the operational cost of the pumps at 2700 psig was almost double that at 2190 psig. This result demonstrates that the operational cost of the pump system(s) will impact the long-term cost of the pipeline.

- Pump considerations – a general concern associated with pressurizing CO_2 streams is that they are inherently dry, both in terms of the water content and lubricity. Specifically, the CO_2 streams are required to be dehydrated (typically to 30 lb per MMscfd) to eliminate corrosion risks resulting from the condensation of free water from the stream. In addition, because the CO_2 stream does not provide lubricity, pump bearings should be made of materials that will allow the bearing faces to rotate against each other without overheating and resulting in the galling of the bearings. With regard to pump selection, centrifugal pumps are generally preferred for CO_2 pipelines because of their ability to accept a varying range of densities and to operate effectively with the use of VFDs. Furthermore, these pumps can be arranged such that downtime associated with changing out the equipment can be minimized. Because of the need to keep projects online as much as possible, redundant pumps or critical spares for the major equipment on the pumps should be considered as part of the project to minimize downtime with the pumps. Finally, a rise in the temperature of the CO_2 stream should be expected with the addition of pumps. The magnitude of the temperature rise will be greatly determined by the inlet conditions of the CO_2 stream at the suction of the pumps, along with the discharge pressure required.

Additional Insights Regarding Pressure–Temperature Effects

Additional insights regarding pressure–temperature effects on pipeline sizing and maximum injection pressure were also observed as part of this pipeline study.

Temperature Effects

For the design consideration of a constant inlet temperature of 115°F, the Resolute reviews predicted that the exiting temperature of the CO_2 from the pipeline would not reach the estimated ambient ground temperature of 60° to 65°F that was anticipated during the peak of the summer for these areas of North Dakota. More specifically, the model results of Resolute predict outlet temperatures for Routes A, B, and C that range from 83.9° to 92.6°F, 83.3° to 103.6°F, and 84.7° to 103.6°F, respectively. More generally, these modeling data revealed the following key relationships:

- The larger the OD of the pipeline, which requires a lower inlet pressure, the higher the exiting temperature of the CO_2 will be.

- Increasing the number of pump stations will yield a higher exit temperature of the CO_2 because of heating of the CO_2 stream during pressurization (see Figure 10).

In addition to wellhead impacts, the study illustrated the effect that temperature has on the volume of CO_2 that a pipeline can transport. As calculated by the NETL Model, for Routes A, B, and C, the temperature effects are not expected to significantly affect Routes A and B (essentially a constant maximum CO_2 rate from 65° to 105°F); however, the temperature is projected to make a significant difference for Route C, where a maximum CO_2 rate of 22.7 MMtpy is projected at 65°F versus 20.7 MMtpy at 105°F (8.8% decrease).

Maximum Injection Pressure

Because the temperature of the CO_2 may not reach the ground temperature upon exiting the pipeline at the delivery point or, possibly, even at the injection wells, special consideration to the density of the CO_2 at the wellhead of the injection well is necessary. If the temperature is too high, the density of the CO_2 will be reduced and may affect the volume of the CO_2 injected. These observations suggest that the maximum injection pressure set for the injection well(s) should be adjusted to account for the seasonal temperature effects of the CO_2 stream and the impact of these temperature effects on the maximum CO_2 injection rate. In some cases, the lower density of the CO_2 stream because of the higher temperature may require reduced injection rates to remain within the injection pressure constraints of any permits. Higher injection pressure may offset some of the reduction in density associated with higher temperatures, but increasing the injection pressure would require further evaluation to determine how much additional pressure may be allowed in the injection pressure authorized by the regulating body.

Comparisons Between NETL (2018) and Resolute Model Estimates

The NETL Model provides a generic scoping-level estimation for a pipeline route. The NETL Model is based on a multitude of regional projects, both short and long distances, and with varying diameters. The NETL Model escalates the cost of the major items based on various inflation factors – through public and subscription services.

Resolute provided detailed reports that represent engineering-level cost details based on pipeline-specific considerations. The estimates and level of detail that Resolute presented incorporate Resolute's in-house knowledge, cost information, and commercial software. Resolute provided a total of 24 detailed reports for the three hypothetical pipeline routes chosen for this review. Because of the detail provided, Resolute's analysis provides an excellent foundation for an initial review for the pipeline system design for the transport of captured CO_2 to a geologic storage site or enhanced recovery project.

REFERENCES

National Energy Technology Laboratory, 2018, FE/NETL Transport Cost Model: U.S. Department of Energy, Last Update 2018 (Version 2b), www.netl.doe.gov/research/energy-analysis/search-publications/vuedetails?id=543 (accessed 2021).

Ricketson, D.D., 2020, CCUS roadshow: Washington, D.C., Workshop, January 28, 2020, p. 10.

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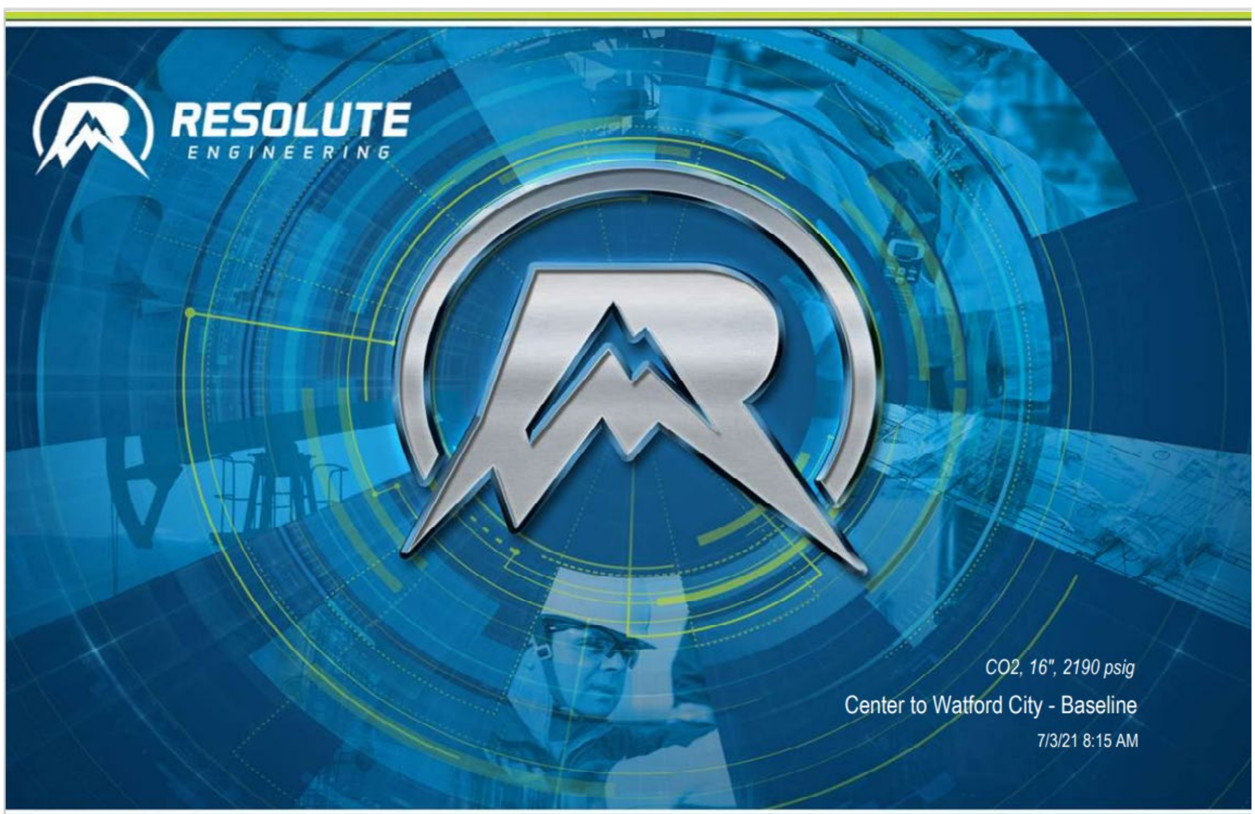
APPENDIX A

EXAMPLE OF DETAILED REPORT SUBMITTED BY RESOLUTE ENGINEERING



Center to Watford City - Baseline
CO2, 16", 2190 psig
Inputs used to develop the project estimate
V 1.0098

Construction Start Date Desired	6/15/2023
Rural-Urban	4 - Mild to Medium congestion- Roads every mile
Terrain	5- Up to 900' per mile, 9.7 degree
Construction-Season	6 - 210 days, Northern USA and Low Elevation
Accessability	7-Access Roads every 3 miles
Rock Hardness - Ditching	4- Track hoe, Fast
Tree/Forest Impact	3- Breast height diameter, LT 6", Sparse
Range-Land	6 - Medium growth, good fencing
Hay-Land	6 - good growth, tame hay
Farm-Land	4- Medium, clay, little organics
Residential-Land	5- Lower Standard
Industrial-Land	4- Low end standard
Commercial-Land	5- Mid Standard
Boom-or-Bust-Time	6- Medium, Slightly higher than Average Cost
Segment-Length	9.1- Optimum Segment Length, 75 or more miles
Distance-to-Housing	6- 50 miles
Rock Hardness - Boring	7- Medium Hardness Rock, GT 10 Min per foot
Cobble Impact - Rock	5- LT 12" diameter, impact with delay
Landowner Support	5- Self Benefit 5, Support to developer 6
Landowner Group Strength	6- Less than 25% of Landowners in Groups
Engineering Support Level	7- Above Medium Support Level to Client
Environmental Impact	5- Medium Impact
Existing Utility Crossings	2- MinLow Crossings
Parallel within UG Utility Corridor	3- Low Impact (Prox & Dist)Parallel
Sales Tax State	North Dakota - 6.55%
Pipe Freight %	8.00%
Misc. Materials Freight %	10.00%
Double Ditch	2 - Double Ditch - Trench Only, 18" deep max.
HDD Bore Type/Composition	HDD, Rock
Slick/Road Bore Composition	Slick Bore, Rock

DOT 192- Class 1	0.0	Miles
DOT 192- Class 2	0.0	Miles
DOT 192- Class 3	0.0	Miles
DOT 192- Class 4	0.0	Miles
DOT 195	110.4	Miles
Gathering or Transmission	T	
Angle of Bends for Estimating length	30	
Induction Bend Radius	4d	
Launcher/Receiver Size	20	
Flange ANSI Rating	4 ANSI 900 - 2220 psi	
Pipe Type	1 - ERW	
Main Line Pipe Size	16	
Steel Grade	65,000	
Pressure	2,190	
Corrosion Allowance	0/32	
Condemnation Rights, Y or N	Y	
	%	Miles
Farm Land	11.06%	12.2
Range Land	64.77%	71.5
Hay Land	13.02%	14.4
Trees/Forest	7.42%	8.2
Residential	2.34%	2.6
Commercial	0.00%	0.0
Industrial	0.00%	0.0
Lake Crossings	1.39%	1.5
Total Percent and Miles	100%	110.4
Ft of Concrete Weight on Main Line Pipe	0	0.0
Rock %	70.2%	77.5
% of trench requiring padding	100.0%	110.4
% of padding that is foreign fill	0.00%	0.0
% of trench requiring rock shield	5.00%	5.5
Rivers, Qty	2	0.0
Railroads, Qty	2	0.0
Ave River Crossing Length(FT)	1,079	0.4
Ave RR Crossing Length(FT)	782	0.3
Environmental Bore Footage	6.83%	7.5

Lidar/Photography	Lidar and Photography
Environmental Permitting	1 Nationwide Twelve
Valve Type	2 - Ball
Valves Actuated(River- Auto-Yes)	Yes
Main Line Primary Pipe Coating	1 - FBE 14 -16 mils
Main Line Secondary Pipe Coating	2 - None
Bore Pipe - Primary	1 - FBE 14 -16 mils
Bore Pipe - Secondary	1 - ARO
Joint Coating	2 - Two Part Epoxy
Bend Coating, to order pipe	2 - Bare
Bend Coating, After bending	1 - FBE 14 -16 mils
Pipe Length	4 Quad
Union Area	No
If Union, Strength of Union	3 - Lower Medium
Expedite Survey Effort	N
Drainage Tile Quantity(Each)	0
Drainage Tile Cost Each	5 - Medium
AC Mitigation(Miles)	1.6
Environmental Acres Disturbed	2
Cost per Acre	$ 17,500
Multiplier to each disturbed Acre	2
5" x 8' x 16', Each (25% of Const. Mats)	7.5
Construction Mats, 8" x 4' x 18', Each	30
Relocate Mats Each	30
Other Client Adjustments	
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0

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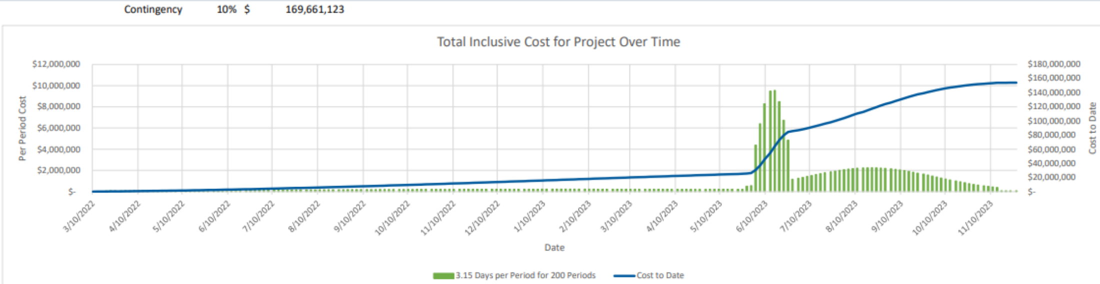
Center to Watford City - Baseline
CO2, 16", 2190 psig
Total Inclusive Cost Estimate
V 1.0098

		% of TIC	Cost per Mile	Cost per Inch Mile	Cost per Foot	Cost per Rod	With Contingency
Construction	$ 67,197,578	44%	$ 608,894	$ 38,056	$ 115.32	$ 1,903	$ 73,917,336
Survey	$ 6,079,438	3.9%	$ 55,087	$ 3,443	$ 10.43	$ 172	$ 6,687,382
ROW	$ 14,789,054	9.6%	$ 134,007	$ 8,375	$ 25.38	$ 419	$ 16,267,960
Inspection	$ 2,080,269	1.3%	$ 18,850	$ 1,178	$ 3.57	$ 59	$ 2,288,296
Lidar/Photography	$ 128,721	0.1%	$ 1,166	$ 73	$ 0.22	$ 4	$ 141,593
Engineering	$ 6,758,590	4.4%	$ 61,241	$ 3,828	$ 11.60	$ 191	$ 7,434,449
Geotech Study	$ 31,228	0.02%	$ 283	$ 18	$ 0.05	$ 1	$ 34,351
NDT	$ 543,986	0.4%	$ 4,929	$ 308	$ 0.93	$ 15	$ 598,385
Environmental	$ 4,290,318	2.8%	$ 38,876	$ 2,430	$ 7.36	$ 121	$ 4,719,350
Client Internal Costs	$ 760,510	0.5%	$ 6,891	$ 431	$ 1.31	$ 22	$ 836,561
Pipe Materials	$ 49,520,006	32%	$ 448,713	$ 28,045	$ 84.98	$ 1,402	$ 54,472,007
Valve Site Materials	$ 1,125,229	0.7%	$ 10,196	$ 637	$ 1.93	$ 32	$ 1,237,752
Launcher/Receiver Materials	$ 684,532	0.4%	$ 6,203	$ 388	$ 1.17	$ 19	$ 752,985
Tie In Materials	$ 247,925	0.2%	$ 2,247	$ 140	$ 0.43	$ 7	$ 272,717
Misc. Materials	$ -	0.0%	$ -	$ -	$ -	$ -	$ -
Total	$ 154,237,385	100%	$ 1,397,584	$ 87,349	$ 264.69	$ 4,367	$ 169,661,123
Contingency 10%	$ 169,661,123						



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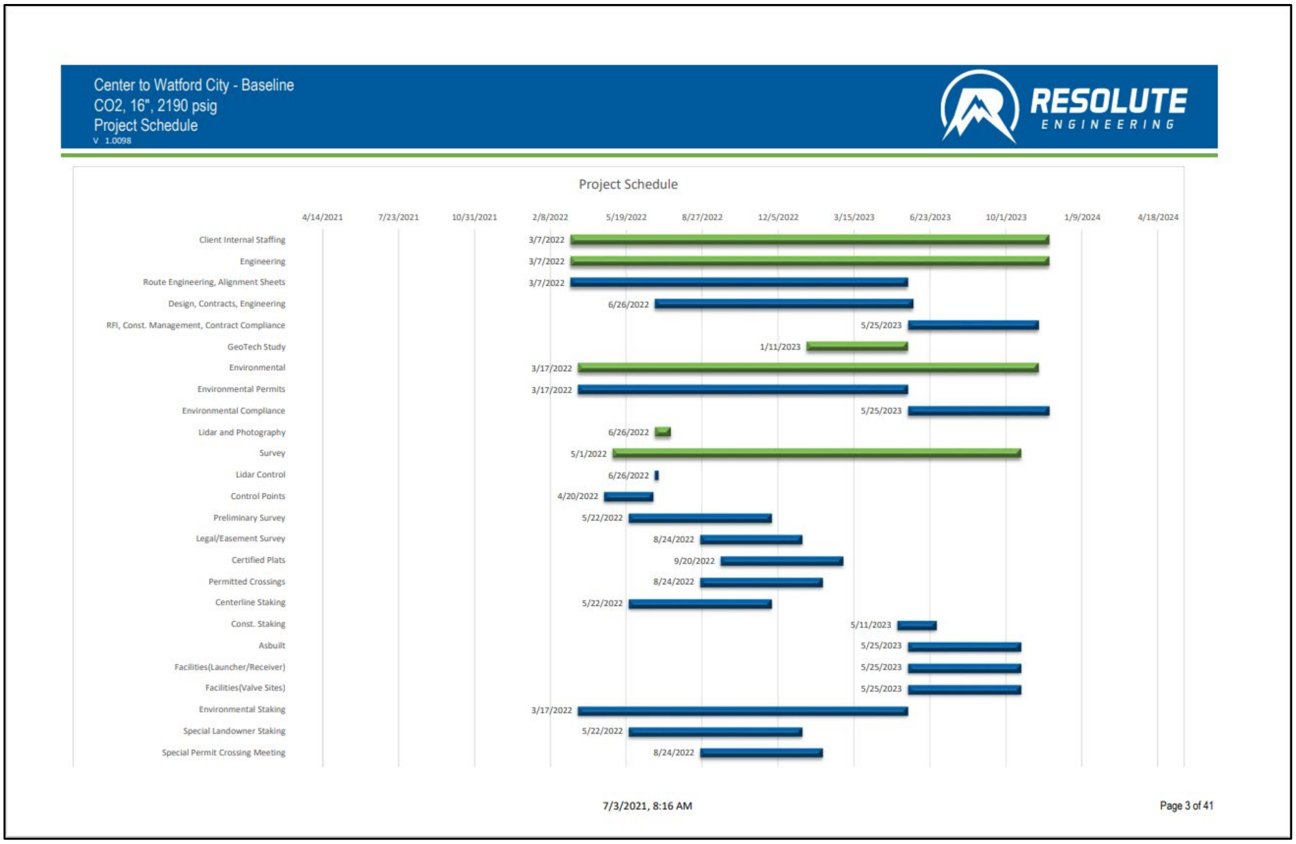
Center to Watford City - Baseline
CO2, 16", 2190 psig
Project Schedule
V 1.0098
RESOLUTE
ENGINEERING
Project Schedule
4/14/2021
7/23/2021
10/31/2021
2/8/2022
5/19/2022
8/27/2022
12/5/2022
3/15/2023
6/23/2023
10/1/2023
1/9/2024
4/18/2024
Client Internal Staffing 3/7/2022
Engineering 3/7/2022
Route Engineering, Alignment Sheets 3/7/2022
Design, Contracts, Engineering 6/26/2022
RFI, Const. Management, Contract Compliance 5/25/2023
GeoTech Study 1/11/2023
Environmental 3/17/2022
Environmental Permits 3/17/2022
Environmental Compliance 5/25/2023
Lidar and Photography 6/26/2022
Survey 5/1/2022
Lidar Control 6/26/2022
Control Points 4/20/2022
Preliminary Survey 5/22/2022
Legal/Easement Survey 8/24/2022
Certified Plats 9/20/2022
Permitted Crossings 8/24/2022
Centerline Staking 5/22/2022
Const. Staking 5/11/2023
Asbuilt 5/25/2023
Facilities(Launcher/Receiver) 5/25/2023
Facilities(Valve Sites) 5/25/2023
Environmental Staking 3/17/2022
Special Landowner Staking 5/22/2022
Special Permit Crossing Meeting 8/24/2022
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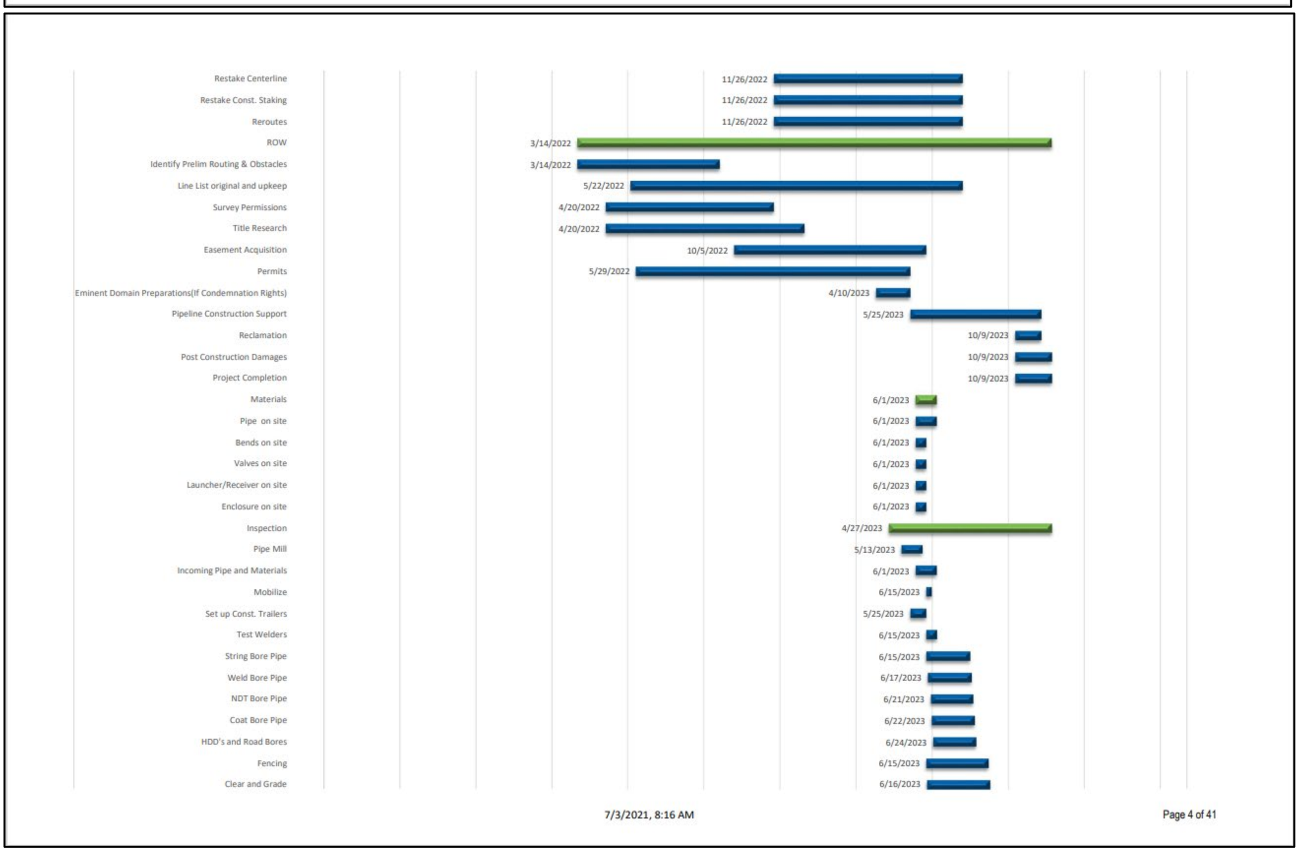
Restake Centerline 11/26/2022
Restake Const. Staking 11/26/2022
Reroutes 11/26/2022
ROW 3/14/2022
Identify Prelim Routing & Obstacles 3/14/2022
Line List original and upkeep 5/22/2022
Survey Permissions 4/20/2022
Title Research 4/20/2022
Easement Acquisition 10/5/2022
Permits 5/29/2022
Eminent Domain Preparations(If Condemnation Rights) 4/10/2023
Pipeline Construction Support 5/25/2023
Reclamation 10/9/2023
Post Construction Damages 10/9/2023
Project Completion 10/9/2023
Materials 6/1/2023
Pipe on site 6/1/2023
Bends on site 6/1/2023
Valves on site 6/1/2023
Launcher/Receiver on site 6/1/2023
Enclosure on site 6/1/2023
Inspection 4/27/2023
Pipe Mill 5/13/2023
Incoming Pipe and Materials 6/1/2023
Mobilize 6/15/2023
Set up Const. Trailers 5/25/2023
Test Welders 6/15/2023
String Bore Pipe 6/15/2023
Weld Bore Pipe 6/17/2023
NDT Bore Pipe 6/21/2023
Coat Bore Pipe 6/22/2023
HDD's and Road Bores 6/24/2023
Fencing 6/15/2023
Clear and Grade 6/16/2023
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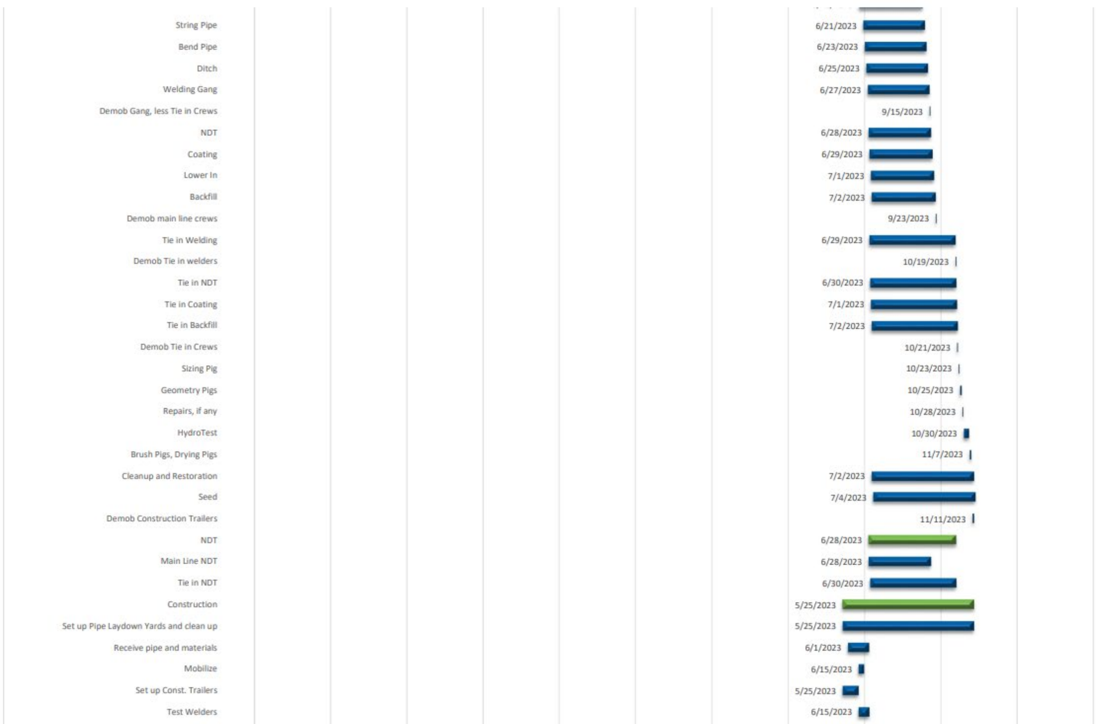

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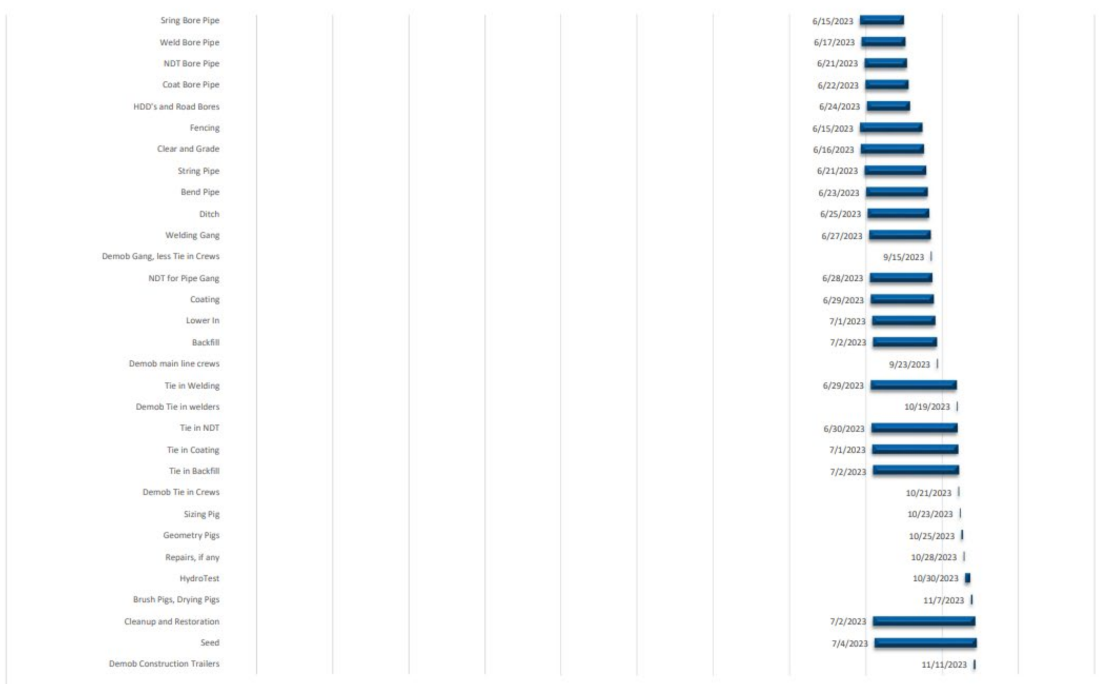

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CO2, 16", 2190 psig

Internal Cost Estimate:

Internal Cost Estimate: $ 760,510

Potential Support Groups within: CO2, 16", 2190 psig

1 Project Manager
2 Electrical SME
3 Mechanical SME
4 Design Management
5 Environmental Manager
6 Procurement
7 Construction Management
8 Project Personnel

Client Internal Schedule

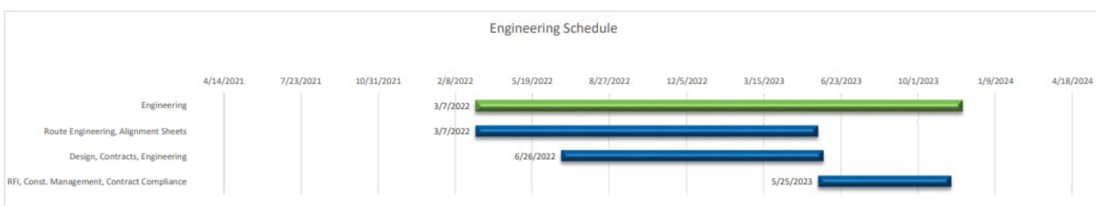
Client Internal Cost Schedule

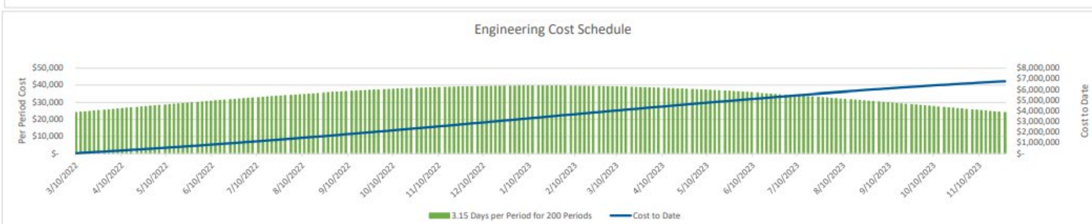
Engineering Estimate: $ 6,758,590

Potential Tasks depending on Client Request:

1 Identify Client Goals
2 Review online data for wetlands, city incorporated boundaries, BLM, environmentally sensitive, or other land issues.
3 Use Google for general routing.
4 Prepare initial and ongoing Design Basis documents.
5 Review client MSA requirements for all contractors to allow all contracts to effectively merge into the MSA format.
6 Identify capable contractors and subcontractors to provide additional services to the client.
7 Prepare Bidding and Contract/Sub-Contract for Survey.
8 Prepare Bidding and Contract/Sub-Contract for Geotech Studies.
9 Prepare Bidding and Contract/Subcontract for cathodic protection installations.
10 Prepare Bidding and Construction Contract for General Contractor.
11 Prepare Bidding and Contract/SubContract document for NDT.
12 Prepare Bidding and Contract/SubContract document for Lidar, Aerial Photography, Hyperspectral imagery, and other aerial services.
13 Prepare Bidding and Contract/SubContract document for ROW Services.
14 Prepare and manage RFQ, PO, evaluations, comparisons, logistics, freight, hotshot, and other evaluations for specification and delivery of mainline pipe, valves, bore pipe, coatings, valve sites, launcher/receiver sites, and other material management duties.
15 Prepare Bidding and Contract/SubContract document, and daily report templates for each discipline, for Field Inspection Services.
16 Prepare Bidding and Contract/SubContract document for Environmental Permitting and Public Relations Services.
17 Prepare Bidding and Contract/SubContract document for Collaboration and Online ESRI Server Application Services.
18 Perform Engineering, Design, Project Management and Construction Management for Contractors and Subcontractors to provide Owner Engineering Services as required.
19 Provide Project Administration for contract management, invoicing review and tracking, support of document preparations, and other project related tasks.
20 Attend Client Project Meetings and provide status documentation.
21 Provide Mapping Services for Autocad, ESRI, BlueSky, Lightning, AutoTurn, Lightning Permit, or other mapping services.
22 Prepare base model in AutoCad or ESRI and update as the project proceeds.
23 Within the base model, manage running line, work space and easement requirements, input of survey data and plat documents from surveyor, alignment sheet creation, and other mapping functions.
24 Enter preliminary data, and maintain ESRI Server applications for Collaboration.
25 Provide Project Management and Construction Management to perform field reviews for constructability.
26 Provide Project Management, Construction Management and Field Representation to assist in management of and documentation requirements for Inspection, Survey, ROW, Environmental, Geotech, NDT, General Contractor, and other service providers.
27 Provide Project Management to assist with Collaboration Software compliance, training, and use.
28 Perform bid meetings, analysis of bids to equalize during evaluations, and assist or manage selection of contractors and subcontractors.
29 Perform bid walks as required.
30 Prepare status reports on all contractors and disciplines.
31 Function as a central office for the project as required. Effectively manage all data and communications between the groups to ensure that collaboration, cooperation, and accuracy is included in day to day operations.

32 Review data from all incoming sources, incorporate that data into all disciplines, and documents to continually build the project plan and contracts as the project progresses.
33 Assist Environmental with the preparation of FERC or other permitting documentation.
34 Incorporate daily changes from field survey data of section corner and plat information into the base model.
35 Prepare alignment sheets in lightning or bluesky.
36 Provide route change and other data to all groups to maintain awareness of status. Collaboration software can be used.
37 Provide construction management and field review of all difficult installation areas, and to review work space for construction yards, sideslopes, turn arounds, pipe yards, and other work space and constructability issues.
38 Provide reproduction and delivery of bidding documents, field construction documentation, alignment sheets, and updates to the stakeholders of the project.
39 Prepare HDD Drawings for Rivers, RR Crossings, Lakes, or other obstacles.
40 Prepare Launcher/Receiver/Valve Site Drawings, which may include fence details, Power drop for MOV's, SCADA/radio systems, Accumulators, grading, access roads, approach permit drawings, including mechanical, civil, I&E drawings.
41 Prepare Hydrotest plans. Determine water source and disposal locations. Include these in general contractor packages.
42 Prepare cleaning and dehydration plans, bid documents, and contracts or subcontracts for this pipeline work.
43 Prepare RFI(Request for Information) systems and respond to the questions for all disciplines.
44 Provide complete project scheduling, and project controls using Primavera, Microsoft project, and TILOS as required.
45 Provide cost reports for client management requirements showing status, progression, and earned value for the project.
46 Review household density to analyze classification of area for dot 192
47 Provide population density maps
48 Perform HCA study
49 Review the (PIR) potential impact radius
50 Manage the valve location placements
51 Laydown yard selection and sizing requirements
52 Side slope terrain study analysis
53 Planimetric data, route refinement, paralleling railroads, powerlines.
54 Manage Bluesky seed file, data dictionary, and survey shot code list.
55 Assign test station locations, aerial marker placement.
56 Manage cathodic rectifier installations, anode placements, isolation flange locations.
57 Manage the mitigation of AC currents in power line corridors.
58 Prepare cleaning, drying, purging, and commissioning plans.
59 Management of geometry pig runs, data review, replacement requirements, and documention of this process.
60 Tracking major equipment with GPS as required.
61 Access Road Management and documentation

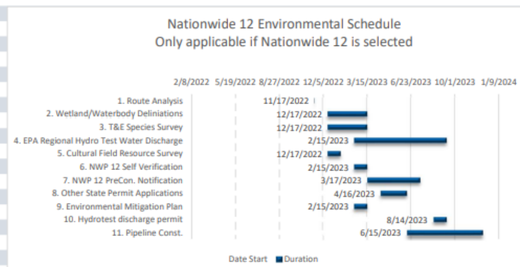


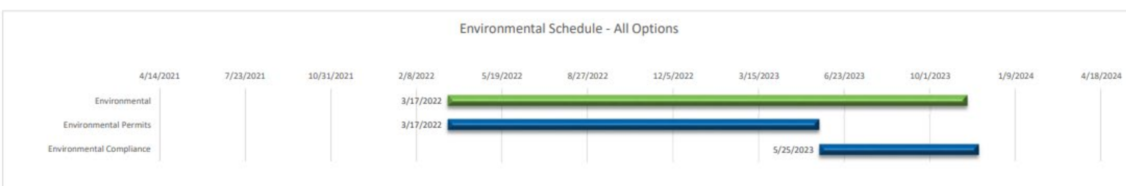


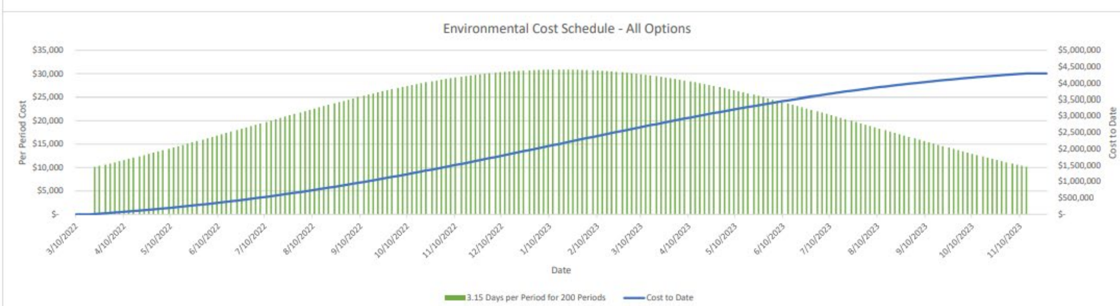
Center to Watford City - Baseline
CO_2, 16", 2190 psig
Environmental Estimate
V 1.0098

RESOLUTE ENGINEERING

Environmental Permit Type	1 Nationwide Twelve	Total Labor Cost: $	4,220,318
		Environmental Acres Disturbed Mitigation Cost: $	70,000
Process to Follow			
1. Route Analysis		Total Cost: $	4,290,318
2. Wetland/Waterbody Deliniations			
3. T&E Species Survey			
4. EPA Regional Hydro Test Water Discharge			
5. Cultural Field Resource Survey			
6. NWP 12 Self Verification			
7. NWP 12 PreCon. Notification			
8. Other State Permit Applications			
9. Environmental Mitigation Plan			
10. Hydrotest discharge permit			
11. Pipeline Const.			







Center to Watford City - Baseline
CO_2, 16", 2190 psig
ROW Estimate
V 1.0098

RESOLUTE ENGINEERING

ROW Total Estimate $ 14,789,054

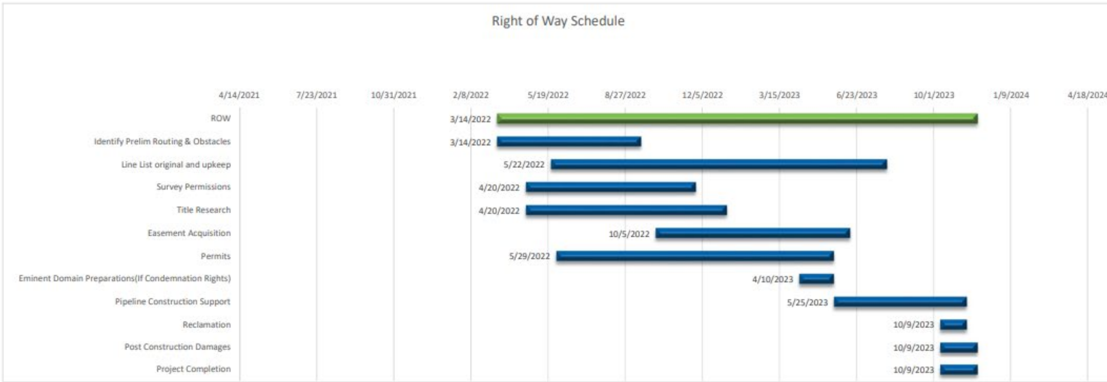
Easement Width	50.00 Ft - Wide	T	Gathering or Transmission
Temp Work Space - On Average, turnarounds, bore boxes, etc..	33.38 Ft - Wide		
Total Work Space	83.38 Ft - Wide		
Plats	260 Qty		
Permanent Easement Per Mile	6.06 Acres/Mile		
Temp Work Space Per Mile	4.05 Acres/Mile		
Total Work Space Per Mile	10.79 Acres/Mile		

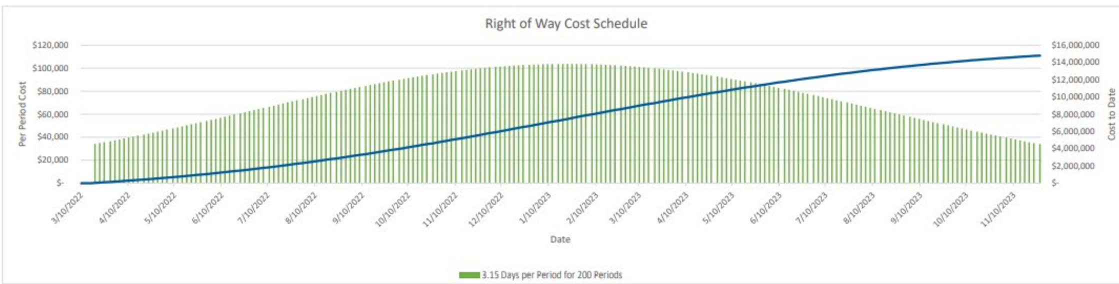
	$/Acre	Yrs	$/Rod	$/Ft	Qty	Line Total
Rent Non Irrigated Crop Land for Year	$ 161 $/Acre	4 Yrs	$ 5.10 $/Rod	$ 0.31 $/Ft	132	$ 85,064
Rent Pasture Land for Year	$ 119 $/Acre	4 Yrs	$ 3.75 $/Rod	$ 0.23 $/Ft	771	$ 366,672
Rent Hay Land for Year	$ 157 $/Acre	4 Yrs	$ 4.94 $/Rod	$ 0.30 $/Ft	155	$ 97,098
Value to purchase Easement Non Irrigated Crop Land	$ 9,068 $/Acre		$ 171.73 $/Rod	$ 10.41 $/Ft	74	$ 671,001
Value to purchase Easement Pasture Land	$ 11,003 $/Acre		$ 208.40 $/Rod	$ 12.63 $/Ft	433	$ 4,766,836
Value to Purchase Easement Hay Land	$ 13,248 $/Acre		$ 250.92 $/Rod	$ 15.21 $/Ft	87	$ 1,153,809
						$ -
Rent Tree/Forest/Hunting Land	$ 38 $/Acre		$ 1.20 $/Rod	$ 0.07 $/Ft	88	$ 6,743
Value to purchase Easement Tree/Forest/Hunting Land	$ 12,738 $/Acre		$ 241.25 $/Rod	$ 14.62 $/Ft	50	$ 632,279
						$ -
Value to purchase Residential Land	$ 54,582 $/Acre		$ 1,034 $/Rod	$ 62.65 $/Ft	16	$ 853,463
Note: Resod, or refurbish residential land is in construction tab.						$ -
						$ -
Value to purchase Easement Industrial Land	$ 51,543 $/Acre		$ 976 $/Rod	$ 59.16 $/Ft	0	$ -
Note: Resod, concrete, or refurbish Industrial land is in construction tab.						$ -
						$ -
Value to purchase Easement Commercial Land	$ 336,608 $/Acre		$ 6,375 $/Rod	$ 386 $/Ft	0	$ -
Note: Resod, concrete, pave, or refurbish Commercial land is in construction tab.						$ -
						$ -
Lake Crossings, Damages	$ 319 $/Acre		$ 10.06 $/Rod	$ 0.61 $/Ft	17	$ 10,521
Lake Crossings - Purchase Easesment/Permit	$ 12,153 $/Acre		$ 230.16 $/Rod	$ 13.95 $/Ft	9	$ 112,687

Purchase Easement			$ 8,190,075
Damages Paid by Renting Land			$ 566,097
Legal Condemnation Costs	15.00% Condemn	$ 25,000 Each	$ 975,473
NOTE: Only costs to courthouse steps.			
No costs for actual hearings or settlements			

		Qty				Total
	Permit Labor	Qty				
	Lake Crossing Permits	2	$ 15,150			$ 30,300
	Road Crossing Permits	101	$ 398			$ 40,073
	RailRoad Crossing Permits	2	$ 13,770			$ 27,540
	River Crossing Permits	2	$ 11,460			$ 22,920
	County Road Use Permits	3	$ 14,940			$ 44,820
	Permit Fees					
	Lake Crossing Permits	2	$ 2,500			$ 5,000
	Road Crossing Permits	101	$ 100			$ 10,059
	RailRoad Crossing Permits	2	$ 1,000			$ 2,000
	River Crossing Permits	2	$ 1,000			$ 2,000
	County Road Use Permits (Per Mile)	110	$ 7,299			$ 805,518
		# Employee				
	Permit Expenses	Days				
	Lake Crossing Permits	75	$ 34,508			$ 34,508
	Road Crossing Permits	101	$ 46,279			$ 46,279
	RailRoad Crossing Permits	75	$ 34,508			$ 34,508
	River Crossing Permits	75	$ 34,508			$ 34,508
	County Road Use Permits	113	$ 51,761			$ 51,761
Title Reports	# of Plats	260	$ 350.00			$ 91,044
Market Study, Appraisal	Miles	110.4	$ 200.00			$ 22,072
	Plat Acquisition Labor	260.1	$ 7,548			$ 1,963,540
			cost per unit		$/day/employee	
	Expenses for the Labor	Employee Days		unit		
	Travel Expense	3888	$ 80.00	$/day	$ 80.00	$ 311,056
	Per diem	3888	$ 210.10	$/day	$ 210.10	$ 816,910
	Misc	3888	$ 20.00	$/day	$ 20.00	$ 77,764
	Cell Phone	3888	$ 7.00	$/day	$ 7.00	$ 27,217
	Field office Costs	3888	$ 15.00	$/day	$ 15.00	$ 58,323
	Mileage	3888	$ 0.59	$/mile		
	Computers	3888	$ 10.00	$/day	$ 10.00	$ 38,882
	Miles Per Day	3888	$ 200.00	Miles/day	$ 118.00	$ 458,807

Total, Labor	$ 2,129,193
Labor Expenses	$ 1,990,523
Permit Fees	$ 824,576
Easement Damages	$ 566,097
Easment Purchases	$ 8,190,075
Subcontracts	$ 113,116
Misc.	$ -
Total	$ 14,789,054





Center to Watford City - Baseline
CO2, 16", 2190 psig
Survey Estimate
V 1.0098

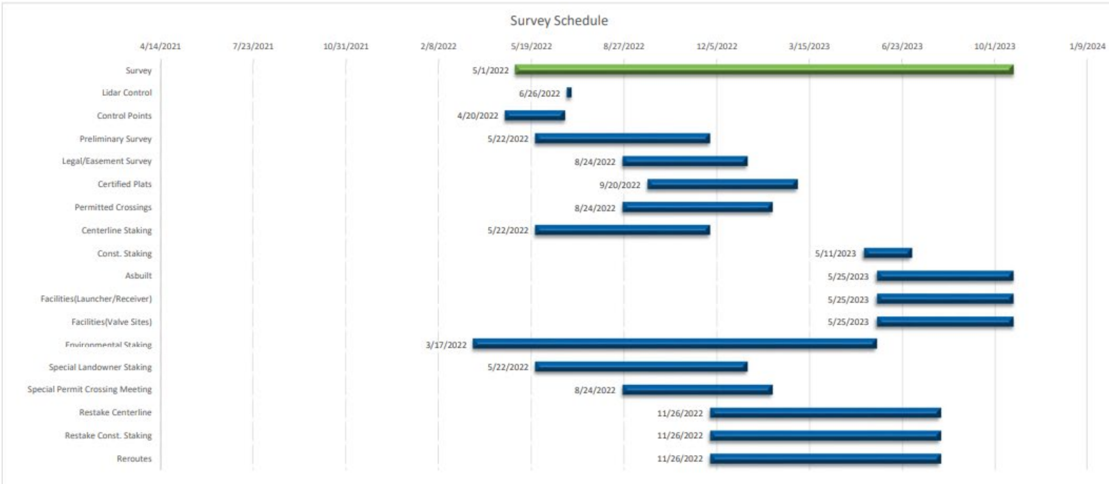
RESOLUTE ENGINEERING

Total Survey Estimate	$	6,079,438
Pipeline		
Control Points	$	63,733
Preliminary Survey	$	669,043
Legal/Easement Survey	$	414,801
Certified Plats	$	254,162
Permitted Crossings	$	131,579
Centerline Staking	$	280,005
Const. Staking	$	471,431
Asbuilt	$	1,827,924
(Control) Lidar and Photography	$	32,720
Subtotal Bid Price	$	4,145,397
Facilities		
Facilities(Launcher/Receiver)	$	94,710
Facilities(Valve Sites)	$	162,426
Subtotal Bid Price	$	257,136
Expected Adders		
Environmental Staking	$	173,499
Special Landowner Staking	$	223,060
Special Permit Crossing Meeting	$	61,542
Restake Centerline	$	279,482
Restake Const. Staking	$	200,922
Reroutes	$	738,400
(From Misc. Tab) Miscellaneous	$	-
Subtotal	$	1,676,905
Misc. Adders		
Misc.	$	-

Control Point Spacing	3.62	Miles Apart
Control Point Speed per Crew	5.13	Miles per Day
Prelim Survey Crew Speed	0.61	Miles Per Day
Prelim Survey Stake Spacing	106	Feet
% of Miles needing Env. Support	28%	Percent of Land
Beginning Tracts per mile	2.36	Tracts per Mile
Permit Crossings per day	7.19	Per 2 Man Crew
Certified Plats Per Day for RPLS	2.87	Plats per Day
Centerline Staking every	149	Feet
Asbuilt Crews per Spread	4.39	Per Spread
Hours Per Day	10.44	Hrs Per Day
Topo Survey per launcher/reciever	5.67	Days
Const. Staking for launcer/reciever	3.27	Days
Asbuilt for Launcher/Receiver	2.27	Days
Topo Survey per valve site	1.70	Days
Const. Staking for valve site	1.09	Days
Asbuilt survey for valve site	1.13	Days
Environmental Staking	44%	Percent of total Centerline Staking
Special Landowner Staking	63%	Percent of total Centerline Staking
Special Permit Crossing Meeting	49%	Percent of total permit survey
Restake Centerline	96%	Percent of total centerline staking
Restake Const. Staking	50%	Percent of total const. staking
Reroutes	34%	Percent of total route, all catagories
Legal Easement Survey Speed	1.20	Miles/Day
Miles/Day/Crew Member	85.9	Miles/Day/Crew Member
Mileage Cost	$ 0.59	$/Mile
Centerline Staking Speed	1.36	Miles/Day
Construction Staking Speed	0.99	Miles/Day
Hours Per Plat for Cadd	4.96	Hrs of Cadd Per Platt
Court House Records	3.00	Hrs per Plat
Per Diem	$ 205.77	Per Diem
Asbuilt Delays, percentage of const. days	21%	Asbuilt crew delay percentage of const. days
Total Plat Count	260	Entire Route

NOTE: Crews include vehicles, but not mileage.

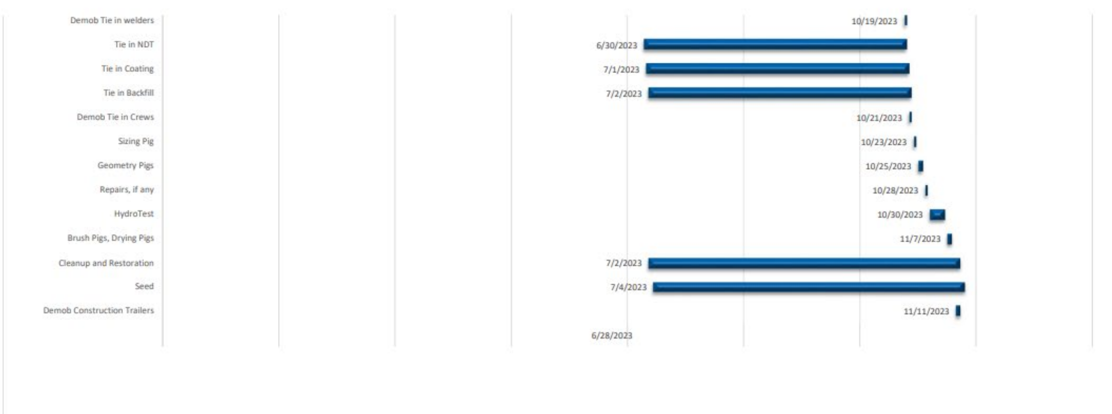
	Qty				Day Rate
Two Man Survey Crew					$ 2,357
Two person Crew	2	$ 65.00	$ 130	$ 1,358	
Per Diem	2	$ 205.77	$ 480	$ 560	
GPS Receiver	1	$ 25.00	$ 25	$ 261	
Miles	86	$ 0.59	$ 51	$ 102	
ATV	1	$ 52.22	$ 52	$ 52	
Three Man Survey Crew					$ 3,113
Three person Crew	3	$ 55.00	$ 165	$ 1,723	
Per Diem	3	$ 205.77	$ 720	$ 840	
GPS Receiver	1	$ 25.00	$ 25	$ 261	
Miles	86	$ 0.59	$ 51	$ 153	
ATV	2	$ 52.22	$ 104	$ 104	
Four Man Survey Crew					$ 3,765
Four person Crew	4	$ 50.00	$ 200	$ 2,089	
Per Diem	4	$ 205.77	$ 960	$ 1,120	
GPS Receiver	1	$ 25.00	$ 25	$ 261	
Miles	86	$ 0.59	$ 51	$ 204	
ATV	2	$ 52.22	$ 104	$ 104	
RPLS	$ 172	$/HR	$ 1,800	$/Day	
Field Supervisor	$ 113	$/HR	$ 1,181	$/Day	
Survey Tech	$ 108	$/HR	$ 1,125	$/Day	
CADD Tech	$ 71	$/HR	$ 738	$/Day	
Admin	$ 70	$/HR	$ 731	$/Day	
Court House Plats/Records Clerk	$ 92	$/HR	$ 956	$/Day	

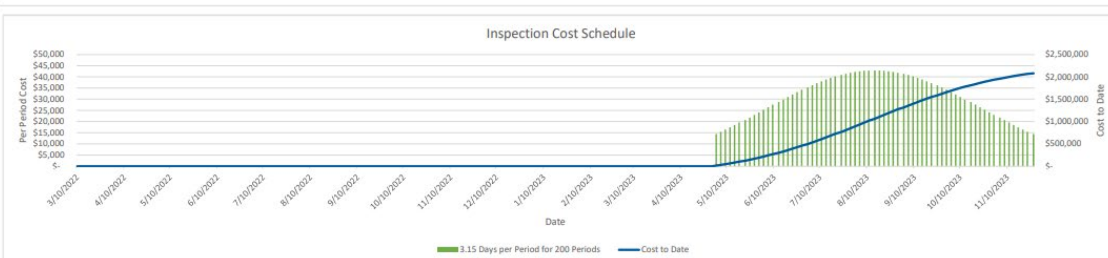


Inspection Estimate	$ 2,080,269	
Spread Quantity	1	Total
Spread Speed	8661	Ft/Day
Spread Length Average	111	Miles/spread

Title	Qty	Units	Spread Count	Total Insp.	Weeks Required	Cost per Week	Weekly Title Cost per Spread	Weekly Spread Cost per Title	Cost per Spread	All Spreads Cost per Title
Project Const. Manager	1	Per Spread	1	1	27.6	$ 8,683	$ 8,683	$ 8,683	$ 239,536	$ 239,536
Chief Inspector	1	Per Spread	1	1	24.6	$ 7,220	$ 7,220	$ 7,220	$ 177,517	$ 177,517
Materials Manager	0	Per Spread	1	0	0.0	$ 7,600	$ -	$ -	$ -	$ -
Assistant Chief Inspector	1	Per Spread	1	1	22.1	$ 8,384	$ 8,384	$ 8,384	$ 185,176	$ 185,176
Spread Coordinator	0	Per Spread	1	0	0.0	$ 8,384	$ -	$ -	$ -	$ -
One Man Chief	0	Per Spread	1	0	0.0	$ 8,384	$ -	$ -	$ -	$ -
Sr Welding Inspector	0	Per Spread	1	0	0.0	$ 7,544	$ -	$ -	$ -	$ -
Pipe/Welding Inspector (CWI)	1	Per Spread	1	1	0.0	$ 7,544	$ 7,544	$ 7,544	$ -	$ -
Lead Environmental Inspector	0	Per Spread	1	0	0.0	$ 7,264	$ -	$ -	$ -	$ -
Lead Utility Inspector	0	Per Spread	1	0	0.0	$ 7,264	$ -	$ -	$ -	$ -
Welding Inspector (Non-CWI)	7	Per Spread	1	7	13.3	$ 7,264	$ 50,848	$ 50,848	$ 678,149	$ 678,149
Coating Inspector (NACE Certified)	2	Per Spread	1	2	0.0	$ 6,984	$ 13,968	$ 13,968	$ -	$ -
NDT/NDE Inspector	0	Per Spread	1	0	0.0	$ 6,984	$ -	$ -	$ -	$ -
Safety Inspector	0	Per Spread	1	0	0.0	$ 6,984	$ -	$ -	$ -	$ -
Electrical and Instrument Inspector	0	Per Spread	1	0	0.0	$ 6,984	$ -	$ -	$ -	$ -
Utility Inspector	5	Per Spread	1	5	19.4	$ 6,424	$ 32,120	$ 32,120	$ 622,704	$ 622,704
Civil Inspector	0	Per Spread	1	0	0.0	$ 6,424	$ -	$ -	$ -	$ -
Field Office Manager/Clerk	1	Per Spread	1	1	20.1	$ 4,984	$ 4,984	$ 4,984	$ 100,113	$ 100,113
Material Clerk	0	Per Spread	1	0	0.0	$ 5,584	$ -	$ -	$ -	$ -
Mill Inspector	1	Per Spread	1	1	11.0	$ 6,984	$ 6,984	$ 6,984	$ 77,075	$ 77,075
						Total		$ 133,751	$ 2,003,194	$ 2,080,269
						Misc:				$ -
						Grand Total				$ 2,080,269


Inspection Schedule
12/5/2022
1/24/2023
3/15/2023
5/4/2023
6/23/2023
8/12/2023
10/1/2023
11/20/2023
1/9/2024
Inspection 4/27/2023
Pipe Mill 5/13/2023
Incoming Pipe and Materials 6/1/2023
Mobilize 6/15/2023
Set up Const. Trailers 5/25/2023
Test Welders 6/15/2023
String Bore Pipe 6/15/2023
Weld Bore Pipe 6/17/2023
NDT Bore Pipe 6/21/2023
Coat Bore Pipe 6/22/2023
HDD's and Road Bores 6/24/2023
Fencing 6/15/2023
Clear and Grade 6/16/2023
String Pipe 6/21/2023
Bend Pipe 6/23/2023
Ditch 6/25/2023
Welding Gang 6/27/2023
Demob Gang, less Tie in Crews 9/15/2023
NDT 6/28/2023
Coating 6/29/2023
Lower In 7/1/2023
Backfill 7/2/2023
Demob main line crews 9/23/2023
Tie in Welding 6/29/2023


Demob Tie in welders 10/19/2023
Tie in NDT 6/30/2023
Tie in Coating 7/1/2023
Tie in Backfill 7/2/2023
Demob Tie in Crews 10/21/2023
Sizing Pig 10/23/2023
Geometry Pigs 10/25/2023
Repairs, if any 10/28/2023
HydroTest 10/30/2023
Brush Pigs, Drying Pigs 11/7/2023
Cleanup and Restoration 7/2/2023
Seed 7/4/2023
Demob Construction Trailers 11/11/2023
6/28/2023


Inspection Cost Schedule
Per Period Cost
$50,000
$45,000
$40,000
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
Cost to Date
3/10/2022
4/10/2022
5/10/2022
6/10/2022
7/10/2022
8/10/2022
9/10/2022
10/10/2022
11/10/2022
12/10/2022
1/10/2023
2/10/2023
3/10/2023
4/10/2023
5/10/2023
6/10/2023
7/10/2023
8/10/2023
9/10/2023
10/10/2023
11/10/2023
Date
3.15 Days per Period for 200 Periods
Cost to Date

Materials wo/Frt & Tax	$	45,670,976
Freight	$	3,614,271
Tax	$	2,974,365
Material w/Frt & Tax	$	52,259,612

Pipe Type Selected 1 - ERW

Cost Per Ton, Bare Pipe $ 2,100.00

Main Line Pipe	OD	SMYS	Prim Coating	Sec. Coating	WT	Final Miles w/Cont	Final Ft w/Cont	lb per Foot	sq ft per Foot	Pipe Type	Pipe Only Cost per Foot	Primary Coating Cost per Foot	Second Layer Coating Cost per Foot	Total Pipe and Coating Cost per Foot	Total Pipe Only	Total Coating Only	Total Pipe and Coating No Tax or Freight	6.55% Sales Tax	8.00% Freight Costs	Total with Tax and Freight
1 DOT 192- Class 1	16	65000	1 - FBE 14 -16 mils	0	0.375	0.0	0	63	4.19	1 - ERW	$ 66	$ 4.52	$ -	$ 70.29	$ -	$ -	$ -	$ -	$ -	$ -
2 DOT 192- Class 2	16	65000	1 - FBE 14 -16 mils	0	0.469	0.0	0	78	4.19	1 - ERW	$ 82	$ 4.52	$ -	$ 86.28	$ -	$ -	$ -	$ -	$ -	$ -
3 DOT 192- Class 3	16	65000	1 - FBE 14 -16 mils	0	0.656	0.0	0	108	4.19	1 - ERW	$ 113	$ 4.52	$ -	$ 117.51	$ -	$ -	$ -	$ -	$ -	$ -
4 DOT 192- Class 4	16	65000	1 - FBE 14 -16 mils	0	0.688	0.0	0	113	4.19	1 - ERW	$ 118	$ 4.52	$ -	$ 122.77	$ -	$ -	$ -	$ -	$ -	$ -
5 DOT 195	16	65000	1 - FBE 14 -16 mils	0	0.375	100.7	531,675	63	4.19	1 - ERW	$ 66	$ 4.52	$ -	$ 70.29	$ 34,967,989	$ 2,405,243	$ 37,373,232	$ 2,447,947	$ 2,989,859	$ 42,811,037
Totals						100.7	531,675							SubTotal	$ 34,967,989	$ 2,405,243	$ 37,373,232	$ 2,447,947	$ 2,989,859	$ 42,811,037

Bore Pipe	OD	SMYS	Prim Coating	Sec. Coating	WT	Final Miles w/Cont	Final Ft w/Cont	lb per Foot	sq ft per Foot	Pipe Type	Pipe Only Cost per Foot	Primary Coating Cost per Foot	Second Layer Coating Cost per Foot	Total Pipe and Coating Cost per Foot	Total Pipe Only	Total Coating Only	Total Pipe and Coating No Tax or Freight	6.55% Sales Tax	8.00% Freight Costs	Total with Tax and Freight
1 DOT 192- Class 1	16	65000	1 - FBE 14 -16 mils	1 - ARO	0.469	0.0	0	78	4.19	1 - ERW	$ 82	$ 4.52	$ 16	$ 102.08	$ -	$ -	$ -	$ -	$ -	$ -
2 DOT 192- Class 2	16	65000	1 - FBE 14 -16 mils	1 - ARO	0.656	0.0	0	108	4.19	1 - ERW	$ 113	$ 4.52	$ 16	$ 133.30	$ -	$ -	$ -	$ -	$ -	$ -
3 DOT 192- Class 3	16	65000	1 - FBE 14 -16 mils	1 - ARO	0.656	0.0	0	108	4.19	1 - ERW	$ 113	$ 4.52	$ 16	$ 133.30	$ -	$ -	$ -	$ -	$ -	$ -
4 DOT 192- Class 4	16	65000	1 - FBE 14 -16 mils	1 - ARO	0.688	0.0	0	113	4.19	1 - ERW	$ 118	$ 4.52	$ 16	$ 138.56	$ -	$ -	$ -	$ -	$ -	$ -
5 DOT 195	16	65000	1 - FBE 14 -16 mils	1 - ARO	0.469	10.6	56,198	78	4.19	1 - ERW	$ 82	$ 4.52	$ 16	$ 102.08	$ 4,594,826	$ 1,141,706	$ 5,736,532	$ 375,743	$ 458,923	$ 6,571,197
Totals						10.6	56,198							SubTotal	$ 4,594,826	$ 1,141,706	$ 5,736,532	$ 375,743	$ 458,923	$ 6,571,197

Pipe for Bending	OD	SMYS	Prim Coating	Sec. Coating	WT	Final Miles w/Cont	Final Ft w/Cont	lb per Foot	sq ft per Foot	Pipe Type	Pipe Only Cost per Foot	Primary Coating Cost per Foot	Qty of Bends	Total Pipe and Coating Cost per Foot	Total Pipe Only	Total Coating Only	Total Pipe and Coating No Tax or Freight	6.55% Sales Tax	8.00% Freight Costs	Total with Tax and Freight
1 DOT 192- Class 1	16	65000	2 - Bare	0	0.438	0.0	0	73	4.19	1 - ERW	$ 77		0	$ 76.51	$ -	$ -	$ -	$ -	$ -	$ -
2 DOT 192- Class 2	16	65000	2 - Bare	0	0.656	0.0	0	108	4.19	1 - ERW	$ 113		0	$ 112.98	$ -	$ -	$ -	$ -	$ -	$ -
3 DOT 192- Class 3	16	65000	2 - Bare	0	0.75	0.0	0	122	4.19	1 - ERW	$ 128		0	$ 128.38	$ -	$ -	$ -	$ -	$ -	$ -
4 DOT 192- Class 4	16	65000	2 - Bare	0	0.812	0.0	0	132	4.19	1 - ERW	$ 138		0	$ 138.43	$ -	$ -	$ -	$ -	$ -	$ -
5 DOT 195	16	65000	2 - Bare	0	0.438	0.1	359	73	4.19	1 - ERW	$ 77		48	$ 76.51	$ 27,482	$ -	$ 27,482	$ 1,800	$ 2,199	$ 31,480
Totals						0.1	359						48	SubTotal	$ 27,482	$ -	$ 27,482	$ 1,800	$ 2,199	$ 31,480
Pipe Sub Total															$ 39,590,296	$ 3,546,949	$ 43,137,245	$ 2,825,490	$ 3,450,980	$ 49,413,715

Induction Bend	SMYS	Coating	OD	WT	Qty Bends	Angle	Each Side Tan. feet	FT Bend Zone Length	FT Length of Bend	Price Per Bend	Line Item Total	6.55% Bend Tax	10.00% Bend Freight	Total with Tax and Freight
1 DOT 192- Class 1	65000	1 - FBE 14 -16 mils	16	0.438	0	45	2	4.1888	8.189	$ 1,890	$ -	$ -	$ -	$ -
2 DOT 192- Class 2	65000	1 - FBE 14 -16 mils	16	0.656	0	45	2	4.1888	8.189	$ 1,890	$ -	$ -	$ -	$ -
3 DOT 192- Class 3	65000	1 - FBE 14 -16 mils	16	0.75	0	45	2	4.1888	8.189	$ 1,890	$ -	$ -	$ -	$ -
4 DOT 192- Class 4	65000	1 - FBE 14 -16 mils	16	0.812	0	45	2	4.1888	8.189	$ 1,890	$ -	$ -	$ -	$ -
5 DOT 195	65000	1 - FBE 14 -16 mils	16	0.438	48	45	2	4.1888	8.189	$ 1,890	$ 91,199	$ 9,120	$ 5,974	$ 106,292
Totals					48						$ 91,199	$ 9,120	$ 5,974	$ 106,292

Main Line Valve Site	Grade	ANSI	Wall Thickness	OD	Qty Per Per Site	Actuated	Qty of Sites	Unit Price	Per Unit 6.55% Tax	Per Unit 10.00% Freight	Total Price per Site	6.55% Tax	10.00% Freight	Total with Tax and Freight
1 Induction Bend, Bare	65000		Varies by Class	16	2		10	$ 2,517	$ 165	$ 252	$ 5,866	$ 1,648	$ 2,516.63	$ 58,663
2 Induction Bend, Coated	65000		Varies by Class	16	2		10	$ 2,554	$ 167	$ 255	$ 5,953	$ 1,673	$ 2,553.68	$ 59,526
3 Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	10	$ 47,197	$ -	$ -	$ -	$ -	$ -	$ -
4 Expanding Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	10	$ 60,412	$ -	$ -	$ -	$ -	$ -	$ -
5 Ball Valve		4 ANSI 900 - 2220 psi		16	1	Yes	10	$ 30,109	$ 1,972	$ 3,011	$ 35,091	$ 19,721	$ 30,108.50	$ 350,915
6 Check Valve		4 ANSI 900 - 2220 psi		16	0		10	$ 20,963	$ -	$ -	$ -	$ -	$ -	$ -
7 Flanges, bolts, and gaskets		4 ANSI 900 - 2220 psi		16	2		10	$ 605	$ 40	$ 61	$ 1,411	$ 396	$ 605.29	$ 14,109
8 Motor Starter Panel					1		10	$ 20,101	$ 1,317	$ 2,010	$ 23,428	$ 13,166	$ 20,101.43	$ 234,282
Totals									$ 3,661	$ 5,589	$ 71,750	$ -	$ -	$ 717,495

Upstream River Valve Site	Grade	ANSI	Wall Thickness	OD	Qty Per Site	Actuated	Qty of Sites	Unit Price	Per Unit 6.55% Tax	Per Unit 10.00% Freight	Total Price per Site	6.55% Tax	10.00% Freight	Total with Tax and Freight
1 Induction Bend, Bare	65000		Varies by Class	16	2		2	$ 2,517	$ 165	$ 252	$ 5,866	$ 329.68	$ 503	$ 11,733
2 Induction Bend, Coated	65000		Varies by Class	16	2		2	$ 2,554	$ 167	$ 255	$ 5,953	$ 334.53	$ 511	$ 11,905
3 Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	2	$ 47,197	$ -	$ -	$ -	$ -	$ -	$ -
4 Expanding Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	2	$ 60,412	$ -	$ -	$ -	$ -	$ -	$ -
5 Ball Valve		4 ANSI 900 - 2220 psi		16	1	Yes	2	$ 30,109	$ 1,972	$ 3,011	$ 35,091	$ 3,944.21	$ 6,022	$ 70,183
6 Check Valve		4 ANSI 900 - 2220 psi		16	0		2	$ 20,963	$ -	$ -	$ -	$ -	$ -	$ -
7 Flanges, bolts and gaskets		4 ANSI 900 - 2220 psi		16	2		2	$ 605	$ 40	$ 61	$ 1,411	$ 79.29	$ 121	$ 2,822
8 Motor Starter Panel					1		2	$ 20,101	$ 1,317	$ 2,010	$ 23,428	$ 2,633.29	$ 4,020	$ 46,856
9 SCADA Bldg					1		2	$ 35,000	$ 2,293	$ 3,500	$ 40,793	$ 4,585.00	$ 7,000	$ 81,585
Totals									$ 5,953	$ 9,089	$ 112,542	$ 11,906	$ 18,177	$ 225,084

Power Drops for MOVs	Qty of Sites	Unit Price	Per Unit Tax	Per Unit Freight	Total Price per Site	Tax	Freight	Total with Tax and Freight
1 Power Drops for MOVs	16	$ 40,000	$ 2,620	$ -	$ 42,620	$ 41,920	$ -	$ 681,920

Downstream River Valve Site	Grade	ANSI	Wall Thickness	OD	Qty Per Site	Actuated	Qty of Sites	Unit Price	6.55% Tax per Site	10.00% Freight per Site	Price per Site	6.55% Tax	10.00% Freight	Total with Tax and Freight
1 Induction Bend, Bare	65000		Varies by Class	16	2		2	$ 2,517	$ 165	$ 252	$ 5,866	$ 330	$ 503	$ 11,733
2 Induction Bend, Coated	65000		Varies by Class	16	2		2	$ 167	$ 11	$ 17	$ 390	$ 22	$ 33	$ 780
3 Gate Valve		4 ANSI 900 - 2220 psi	0	16	0	Yes	2	$ 47,197	$ -	$ -	$ -	$ -	$ -	$ -
4 Expanding Gate Valve		4 ANSI 900 - 2220 psi	0	16	0	Yes	2	$ 60,412	$ -	$ -	$ -	$ -	$ -	$ -
5 Ball Valve		4 ANSI 900 - 2220 psi	0	16	1	Yes	2	$ 30,109	$ 1,972	$ 3,011	$ 35,091	$ 3,944	$ 6,022	$ 70,183
6 Check Valve		4 ANSI 900 - 2220 psi	0	16	1		2	$ 20,963	$ 1,373	$ 2,096	$ 24,433	$ 2,746	$ 4,193	$ 48,865
7 Flanges, bolts, gaskets			0	16	3		2	$ 605	$ 40	$ 61	$ 2,116	$ 79	$ 121	$ 4,233
8 Motor Starter Panel			0		1		2	$ 20,101	$ 1,317	$ 2,010	$ 23,428	$ 2,633	$ 4,020	$ 46,856
Totals									$ 4,877	$ 7,446	$ 91,325	$ 9,755	$ 14,892	$ 182,650

Launcher/Receiver Sites	Grade	ANSI	Wall Thickness	OD	Qty Per Site	Actuated	Qty of L or R Barrels	Per Site PreTax Price	6.55% Per Site Tax	10.00% Per Site Freight	Total Price per Site	6.55% Tax	10.00% Freight	Total with Tax and Freight
1 Quick Open Enclosure		4 ANSI 900 - 2220 psi		20	1		4	$ 27,600	$ 1,808	$ 2,760	$ 32,167	$ 7,231	$ 11,040	$ 128,669
2 Misc. materials					1		4	$ 48,315	$ 3,165	$ 4,832	$ 56,311	$ 12,659	$ 19,326	$ 225,246
3 Main Line Size Flange, with bolts and gaskets		4 ANSI 900 - 2220 psi		16	6		4	$ 605	$ 40	$ 61	$ 4,233	$ 159	$ 242	$ 16,931
4 Flange at launcher size, with bolts and gaskets		4 ANSI 900 - 2220 psi		20	2		4	$ 999	$ 65	$ 100	$ 2,329	$ 262	$ 400	$ 9,316
5 Induction Bend, Bare	65000		Varies by Class	16	1		4	$ 2,517	$ 165	$ 252	$ 2,933	$ 659	$ 1,007	$ 11,733
6 Induction Bend, Coated	65000		Varies by Class	16	1		4	$ 2,554	$ 167	$ 255	$ 2,976	$ 669	$ 1,021	$ 11,905
7 Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	4	$ 47,197	$ -	$ -	$ -	$ -	$ -	$ -
8 Expanding Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	4	$ 60,412	$ -	$ -	$ -	$ -	$ -	$ -
9 Ball Valve		4 ANSI 900 - 2220 psi		16	2	Yes	4	$ 30,109	$ 1,972	$ 3,011	$ 70,183	$ 7,888	$ 12,043	$ 280,732
Totals									$ 7,382	$ 11,270	$ 171,133	$ 29,527	$ 45,079	$ 684,532

Tie Ins	Grade	ANSI	Wall Thickness	OD	Qty Per Site	Actuated	Qty of Sites	Unit Price	6.55% Tax	10.00% Freight	Price per Site	6.55% Tax	10.00% Freight	Total with Tax and Freight
1 Induction Bend, Bare	65000		Varies by Class	16	2		2	$ 2,517	$ 165	$ 252	$ 5,866	$ 659.36	$ 1,006.65	$ 11,733
2 Induction Bend, Coated	65000		Varies by Class	16	2		2	$ 2,554	$ 167	$ 255	$ 5,953	$ 669.06	$ 1,021.47	$ 11,905
3 Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	2	$ 47,197	$ -	$ -	$ -	$ -	$ -	$ -
4 Expanding Gate Valve		4 ANSI 900 - 2220 psi		16	0	Yes	2	$ 30,109	$ -	$ -	$ -	$ -	$ -	$ -
5 Ball Valve		4 ANSI 900 - 2220 psi		16	1	Yes	2	$ 60,412	$ 3,957	$ 6,041	$ 70,411	$ 7,914.04	$ 12,082.50	$ 140,822
6 Check Valve				16	0		2	$ 20,963	$ -	$ -	$ -	$ -	$ -	$ -
7 Flanges, bolts, and gaskets				16	2		2	$ 605	$ 40	$ 61	$ 1,411	$ 158.59	$ 242.12	$ 2,822
8 Motor Starter Panel					1		2	$ 20,101	$ 1,317	$ 2,010	$ 23,428	$ 2,633.29	$ 4,020.29	$ 46,856
9 Misc. Tie in Material					1		2	$ 14,495	$ 949	$ 1,449	$ 16,893	$ 1,898.79	$ 2,898.92	$ 33,787
Totals									$ 6,595	$ 10,068	$ 123,962	$ 13,933	$ 21,271.94	$ 247,925

	Total without Tax/Freight	6.55% Tax	10.00% Freight	Total with Tax and Freight
Miscellaneous Materials	$ -	$ -	$ -	$ -

Center to Watford City - Baseline
CO2, 16", 2190 psig
Construction Estimate
V 1.0098

RESOLUTE ENGINEERING

Construction Estimate $ 67,197,578

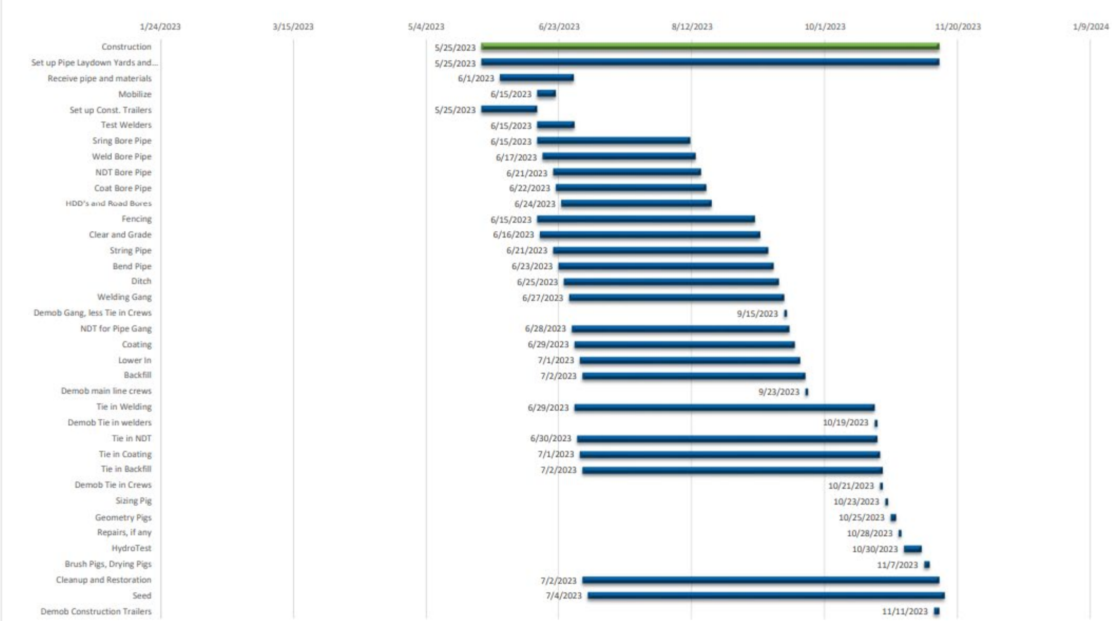
Spread Quantity 1
Cost of Base Lay $/Diameter Inch/Ft $ 2.57
Pipe Gang Ave. Prod. Rate/day (ft) 8,661

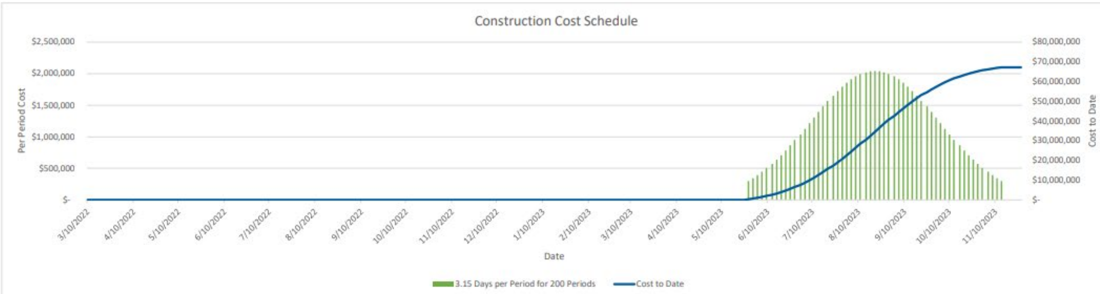
Facility Estimate						Line Item
Definition	Units	Quantity		Cost/Unit		Cost
1 Valve Site	Each	14	$	68,576	$	960,063
2 Launcher or Receiver	Each	4	$	167,258	$	669,033
3 Tie In, No Metering	Each	2	$	89,149	$	178,297
4	Each	0	$	-	$	-
5	Each	0	$	-	$	-
6	Each	0	$	-	$	-
					$	1,807,393

Pipeline Estimate	Units	Quantity		Cost/Unit		Line Item Cost
1 Base Lay	Foot	584,773	$	41.08	$	24,021,042
ROW Clearing and Grading	7%		$	2.88	$	-
Pipe Stringing and Bending	10%		$	4.11	$	-
Ditching	13%		$	5.34	$	-
Welding	30%		$	12.32	$	-
Lowering In	7%		$	2.88	$	-
Tie In	13%		$	5.34	$	-
Backfill	6%		$	2.46	$	-
Hydrotest and Cleanup	14%		$	5.75	$	-
Total %	100%		$	41.08	$	-
2 HDD, Standard	Foot	0	$	237.78	$	-
3 HDD, Rock	Foot	43,530	$	503.03	$	21,896,753
4 HDD, Cobble	Foot	0	$	374.50	$	-
5 Slick Bore, Standard	Foot	0	$	237.78	$	-
6 Slick Bore, Rock	Foot	12140	$	503.03	$	6,106,550
7 Slick Bore, Gravel/Cobble	Foot	0	$	349.53	$	-
8 Double Ditch	Foot	552,942	$	0.85	$	472,295
9 Rock Ditch	Foot	373,475	$	5.73	$	2,141,801
10 Hammer Hoe, Rock	Cubic Foot	42,057	$	13.55	$	569,979
11 Padding, Padding Machine	Foot	526,672	$	3.77	$	1,987,239
12 Padding, Foreign Fill	Foot	0	$	44.09	$	-
13 Rock Shield, Tuff-n-Nuff	Ft	26584	$	17.00	$	452,027
14 Concrete Weighting	FT	0	$	76.24	$	-
15 Hay Bales, 16"x24"x36"	Each	4,180	$	18.88	$	78,923
16 Erosion Control Blanket	Sq Ft	172,729	$	0.62	$	107,727

Pipeline Estimate						Line Item
Definition	Units	QTY		Cost/Unit		Cost
17 8" Waddle	Foot	37,865	$	12.48	$	472,687
18 Silt Fence	Foot	28,686	$	12.54	$	359,765
19 Mulch	Acre	61	$	3,054	$	186,327
20 Set H Braces, Fencing	Set	101	$	1,557	$	156,827
21 Safety Fence	Foot	3,431	$	7.84	$	26,898
22 Snow Fence	Foot	1,747	$	10.55	$	18,434
23 Tree Clearing	Acres	79	$	10,800	$	857,708
24		0	$	-	$	-
25 Test Station	Each	68	$	368	$	25,006
26 Seeding	Acre	869	$	1,738	$	1,510,506
27 Rectifier	Each	3	$	48,644	$	145,933
28 Move Around, Entire Spread	Each	4.8	$	183,988	$	879,882
29 Standby Day, Entire Spread	Each	4	$	129,422	$	523,711
30 Repair Industrial and Commercial	Acre	0	$	874	$	-
31 Geometry Pigs	Each	1	$	66,991	$	66,991
32 Day of running drying pigs	Each	0.25	$	61,704	$	15,426
33 Line Markers	Each	176	$	254	$	44,857
34 Hydrotest, Purch, Haul, Disch.	BBLS	131,642	$	2.94	$	387,284
35 Utility Crossings	Each	116	$	9,991	$	1,163,789
36 Blast and Coat Joints	Each	8,772	$	56.00	$	491,209
37 AC Mitigation	Miles	2	$	55,182	$	88,291
38 Drainage Tile	Each	0	$	2,778	$	-
39 Traffic Control	LS	3	$	16,000	$	41,280
40 Cattle Guard	Each	18	$	4,750	$	84,883
41 Reduced Work Space	LF	408	$	20.00	$	8,152
42 Laminated Mat, 6" x 8' x 16'	Each	0	$	650	$	-
43 Construction Mat, 8" x 4' x 18'	Each	0	$	525	$	-
44 Relocate Mat	Each	0	$	138	$	-
					$	65,390,185
Misc. See Const. Sect. of Misc. Worksheet	See Detail	1	$	-	$	-
				Grand Total =	$	67,197,578

Construction Schedule

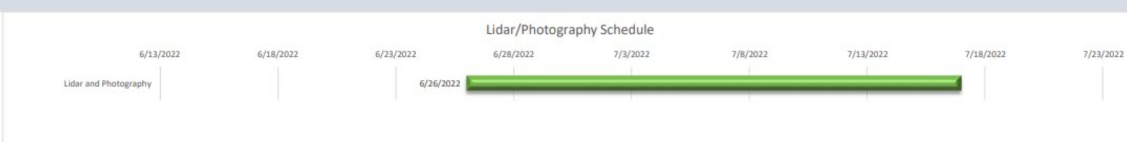


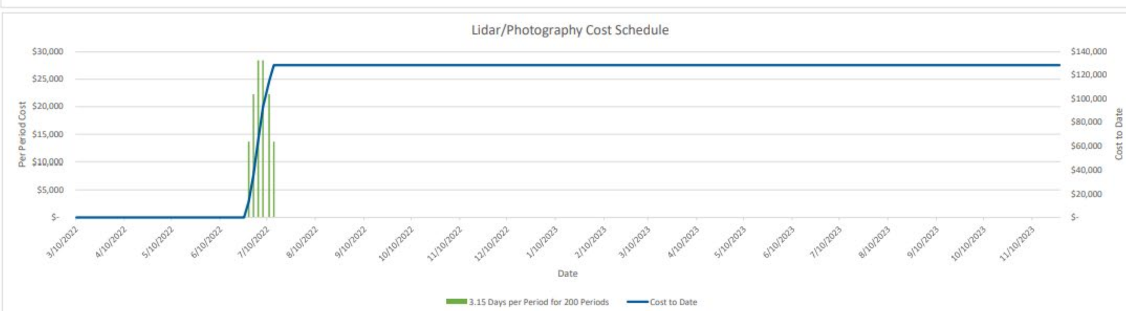


Center to Watford City - Baseline
CO_2, 16", 2190 psig
Lidar/Photography Estimate
V 1.0098

RESOLUTE ENGINEERING

Lidar/Photography Cost Estimate:	$ 128,721
Lidar/Photography work requested:	Lidar and Photography
Project Mileage Length:	110.36
Flight, Photos, Report, and Data	

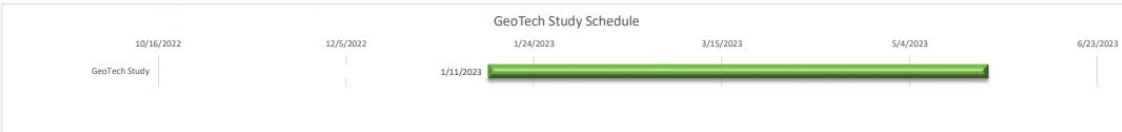


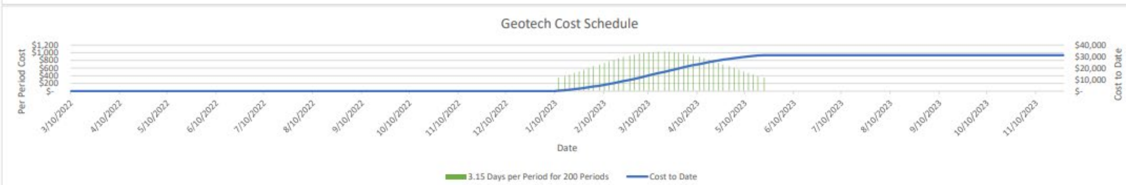


Center to Watford City - Baseline
CO_2, 16", 2190 psig
Geotech Study Estimate
V 1.0098

RESOLUTE ENGINEERING

Geotech Study Estimate	$ 31,228		
River Drills	2.0	Pipeline Field Total Cost	$ 11,602
Total Project Miles	110.4	Pipeline Study Total Cost	$ 3,626
Miles Per Study	76.1	Launcher/Receiver Field Study	$ 10,000
Total Studies	1.5	Launcher/Reciever Reports	$ 6,000
Pipeline Field Cost per Study	$ 8,000		
Pipeline Report Cost per Study	$ 2,500	Sub-Total	$ 31,228
Launcher/Receiver Field Study	$ 5,000	Geotech Misc.	$ -
Launcher/Receiver Report	$ 1,500	Total	$ 31,228
Launcher/Receiver Sites	4		
Sites/Day	2		
Days field study	2		
Reports	4		

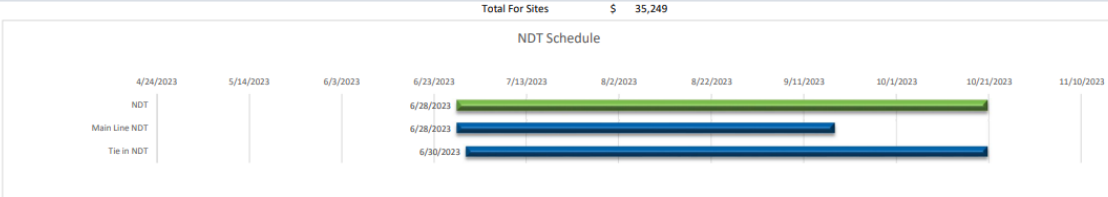


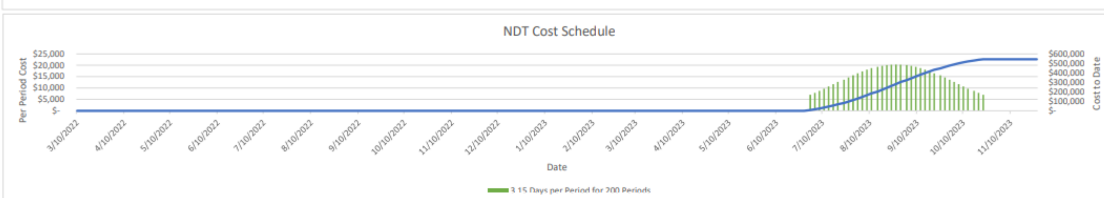


Center to Watford City - Baseline
CO_2, 16", 2190 psig
NDT Estimate
V 1.0098

RESOLUTE ENGINEERING

NDT Cost Estimate:	$ 543,986				
Total Welds on Main Line	8,772	Cost per Valve Site	$ 1,707	4 man Crawler Crew Day Rate	$ 2,690
Ave. Length of Pipe Each	70	Cost per Launcher Receiver Site	$ 1,943	2 man Crew Day Rate	$ 1,550
Quantity of Spreads	1	Cost per Tie in Site	$ 1,786	NDT Crew Quantity, Average	2.69
Main Line Pipe Gang Days per Spread	68			Crew Cost per Spread	$370,714
Tie In Weld Crew Days per Spread	93	Total Cost for Valve Sites	$ 23,903		
Quantity of Valve Sites	14	Total Cost for Launcher Receiver Sites	$ 7,774	Pipe Size	16
Quantity of Launcher Receiver Sites	4	Total Cost for Tie in Sites	$ 3,572	Film Cost per Weld	$ 15.74
Tie In Sites	2			Film Cost Main Line	$ 138,023
		Total For Sites	$ 35,249		





Center to Watford City - Baseline
CO_2, 16", 2190 psig
Cost vs Schedule, Cost Per Period
V 1.0098

RESOLUTE ENGINEERING

Period Number	Date	Client Internal Staffing	Engineering	GeoTech Study	Environmental	Lidar and Photo	Survey	ROW	Material	Inspection	NDT	Construction	Total per Period
0	03/07/22												
1	03/10/22	$ 2,709	$ 24,075	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 26,784
2	03/13/22	$ 2,736	$ 24,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,050
3	03/16/22	$ 2,763	$ 24,554	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,317
4	03/19/22	$ 2,790	$ 24,793	$ -	$ -	$ -	$ -	$ 34,054	$ -	$ -	$ -	$ -	$ 61,637
5	03/22/22	$ 2,817	$ 25,032	$ -	$ 10,139	$ -	$ -	$ 34,833	$ -	$ -	$ -	$ -	$ 72,821
6	03/25/22	$ 2,844	$ 25,271	$ -	$ 10,377	$ -	$ -	$ 35,621	$ -	$ -	$ -	$ -	$ 74,113
7	03/29/22	$ 2,870	$ 25,510	$ -	$ 10,618	$ -	$ -	$ 36,419	$ -	$ -	$ -	$ -	$ 75,417
8	04/01/22	$ 2,897	$ 25,748	$ -	$ 10,862	$ -	$ -	$ 37,225	$ -	$ -	$ -	$ -	$ 76,733
9	04/04/22	$ 2,924	$ 25,986	$ -	$ 11,109	$ -	$ -	$ 38,041	$ -	$ -	$ -	$ -	$ 78,060
10	04/07/22	$ 2,951	$ 26,224	$ -	$ 11,358	$ -	$ -	$ 38,866	$ -	$ -	$ -	$ -	$ 79,399
11	04/10/22	$ 2,977	$ 26,461	$ -	$ 11,611	$ -	$ -	$ 39,700	$ -	$ -	$ -	$ -	$ 80,749
12	04/13/22	$ 3,004	$ 26,697	$ -	$ 11,866	$ -	$ -	$ 40,542	$ -	$ -	$ -	$ -	$ 82,109
13	04/16/22	$ 3,031	$ 26,933	$ -	$ 12,123	$ -	$ -	$ 41,392	$ -	$ -	$ -	$ -	$ 83,479
14	04/20/22	$ 3,057	$ 27,169	$ -	$ 12,384	$ -	$ -	$ 42,250	$ -	$ -	$ -	$ -	$ 84,860
15	04/23/22	$ 3,084	$ 27,403	$ -	$ 12,646	$ -	$ -	$ 43,116	$ -	$ -	$ -	$ -	$ 86,249
16	04/26/22	$ 3,110	$ 27,637	$ -	$ 12,911	$ -	$ -	$ 43,990	$ -	$ -	$ -	$ -	$ 87,648
17	04/29/22	$ 3,136	$ 27,870	$ -	$ 13,179	$ -	$ -	$ 44,871	$ -	$ -	$ -	$ -	$ 89,056
18	05/02/22	$ 3,162	$ 28,103	$ -	$ 13,449	$ -	$ -	$ 45,759	$ -	$ -	$ -	$ -	$ 90,472
19	05/05/22	$ 3,188	$ 28,334	$ -	$ 13,721	$ -	$ 16,155	$ 46,653	$ -	$ -	$ -	$ -	$ 108,052
20	05/09/22	$ 3,214	$ 28,564	$ -	$ 13,995	$ -	$ 16,581	$ 47,555	$ -	$ -	$ -	$ -	$ 109,909
21	05/12/22	$ 3,240	$ 28,794	$ -	$ 14,271	$ -	$ 17,012	$ 48,462	$ -	$ -	$ -	$ -	$ 111,779
22	05/15/22	$ 3,266	$ 29,022	$ -	$ 14,549	$ -	$ 17,450	$ 49,375	$ -	$ -	$ -	$ -	$ 113,662
23	05/18/22	$ 3,291	$ 29,249	$ -	$ 14,828	$ -	$ 17,893	$ 50,294	$ -	$ -	$ -	$ -	$ 115,556
24	05/21/22	$ 3,317	$ 29,476	$ -	$ 15,110	$ -	$ 18,342	$ 51,218	$ -	$ -	$ -	$ -	$ 117,462
25	05/24/22	$ 3,342	$ 29,700	$ -	$ 15,393	$ -	$ 18,796	$ 52,147	$ -	$ -	$ -	$ -	$ 119,378
26	05/27/22	$ 3,367	$ 29,924	$ -	$ 15,677	$ -	$ 19,256	$ 53,080	$ -	$ -	$ -	$ -	$ 121,304
27	05/31/22	$ 3,392	$ 30,146	$ -	$ 15,963	$ -	$ 19,721	$ 54,017	$ -	$ -	$ -	$ -	$ 123,240
28	06/03/22	$ 3,417	$ 30,367	$ -	$ 16,250	$ -	$ 20,191	$ 54,959	$ -	$ -	$ -	$ -	$ 125,184
29	06/06/22	$ 3,442	$ 30,587	$ -	$ 16,538	$ -	$ 20,665	$ 55,904	$ -	$ -	$ -	$ -	$ 127,136
30	06/09/22	$ 3,466	$ 30,805	$ -	$ 16,827	$ -	$ 21,145	$ 56,851	$ -	$ -	$ -	$ -	$ 129,094
31	06/12/22	$ 3,491	$ 31,021	$ -	$ 17,117	$ -	$ 21,629	$ 57,802	$ -	$ -	$ -	$ -	$ 131,059
32	06/15/22	$ 3,515	$ 31,236	$ -	$ 17,408	$ -	$ 22,117	$ 58,755	$ -	$ -	$ -	$ -	$ 133,030

33	06/18/22	$ 3,539	$ 31,449	$ -	$ 17,700	$ -	$ 22,609	$ 59,709	$ -	$ -	$ -	$ -	$ 135,005
34	06/22/22	$ 3,563	$ 31,660	$ -	$ 17,991	$ -	$ 23,105	$ 60,665	$ -	$ -	$ -	$ -	$ 136,984
35	06/25/22	$ 3,586	$ 31,870	$ -	$ 18,284	$ -	$ 23,604	$ 61,623	$ -	$ -	$ -	$ -	$ 138,966
36	06/28/22	$ 3,610	$ 32,078	$ -	$ 18,576	$ 13,646	$ 24,107	$ 62,580	$ -	$ -	$ -	$ -	$ 154,597
37	07/01/22	$ 3,633	$ 32,284	$ -	$ 18,869	$ 22,268	$ 24,613	$ 63,538	$ -	$ -	$ -	$ -	$ 165,205
38	07/04/22	$ 3,656	$ 32,488	$ -	$ 19,161	$ 28,446	$ 25,122	$ 64,496	$ -	$ -	$ -	$ -	$ 173,368
39	07/07/22	$ 3,678	$ 32,690	$ -	$ 19,453	$ 28,446	$ 25,634	$ 65,452	$ -	$ -	$ -	$ -	$ 175,354
40	07/11/22	$ 3,701	$ 32,890	$ -	$ 19,745	$ 22,268	$ 26,148	$ 66,408	$ -	$ -	$ -	$ -	$ 171,160
41	07/14/22	$ 3,723	$ 33,088	$ -	$ 20,037	$ 13,646	$ 26,664	$ 67,362	$ -	$ -	$ -	$ -	$ 164,519
42	07/17/22	$ 3,745	$ 33,283	$ -	$ 20,327	$ -	$ 27,182	$ 68,313	$ -	$ -	$ -	$ -	$ 152,851
43	07/20/22	$ 3,767	$ 33,477	$ -	$ 20,617	$ -	$ 27,701	$ 69,263	$ -	$ -	$ -	$ -	$ 154,825
44	07/23/22	$ 3,789	$ 33,668	$ -	$ 20,906	$ -	$ 28,222	$ 70,209	$ -	$ -	$ -	$ -	$ 156,793
45	07/26/22	$ 3,810	$ 33,858	$ -	$ 21,194	$ -	$ 28,743	$ 71,151	$ -	$ -	$ -	$ -	$ 158,755
46	07/29/22	$ 3,831	$ 34,044	$ -	$ 21,480	$ -	$ 29,265	$ 72,089	$ -	$ -	$ -	$ -	$ 160,710
47	08/02/22	$ 3,852	$ 34,229	$ -	$ 21,765	$ -	$ 29,788	$ 73,023	$ -	$ -	$ -	$ -	$ 162,657
48	08/05/22	$ 3,872	$ 34,410	$ -	$ 22,049	$ -	$ 30,310	$ 73,952	$ -	$ -	$ -	$ -	$ 164,594
49	08/08/22	$ 3,892	$ 34,590	$ -	$ 22,331	$ -	$ 30,833	$ 74,875	$ -	$ -	$ -	$ -	$ 166,521
50	08/11/22	$ 3,912	$ 34,767	$ -	$ 22,610	$ -	$ 31,354	$ 75,792	$ -	$ -	$ -	$ -	$ 168,436
51	08/14/22	$ 3,932	$ 34,941	$ -	$ 22,888	$ -	$ 31,875	$ 76,703	$ -	$ -	$ -	$ -	$ 170,339
52	08/17/22	$ 3,951	$ 35,113	$ -	$ 23,163	$ -	$ 32,394	$ 77,607	$ -	$ -	$ -	$ -	$ 172,228
53	08/20/22	$ 3,970	$ 35,282	$ -	$ 23,436	$ -	$ 32,912	$ 78,503	$ -	$ -	$ -	$ -	$ 174,102
54	08/24/22	$ 3,989	$ 35,448	$ -	$ 23,707	$ -	$ 33,427	$ 79,391	$ -	$ -	$ -	$ -	$ 175,961
55	08/27/22	$ 4,007	$ 35,611	$ -	$ 23,975	$ -	$ 33,940	$ 80,270	$ -	$ -	$ -	$ -	$ 177,803
56	08/30/22	$ 4,025	$ 35,772	$ -	$ 24,240	$ -	$ 34,451	$ 81,140	$ -	$ -	$ -	$ -	$ 179,627
57	09/02/22	$ 4,043	$ 35,930	$ -	$ 24,501	$ -	$ 34,958	$ 82,001	$ -	$ -	$ -	$ -	$ 181,433
58	09/05/22	$ 4,060	$ 36,084	$ -	$ 24,760	$ -	$ 35,462	$ 82,851	$ -	$ -	$ -	$ -	$ 183,218
59	09/08/22	$ 4,077	$ 36,236	$ -	$ 25,015	$ -	$ 35,962	$ 83,691	$ -	$ -	$ -	$ -	$ 184,982
60	09/12/22	$ 4,094	$ 36,385	$ -	$ 25,267	$ -	$ 36,458	$ 84,520	$ -	$ -	$ -	$ -	$ 186,724
61	09/15/22	$ 4,111	$ 36,531	$ -	$ 25,515	$ -	$ 36,949	$ 85,338	$ -	$ -	$ -	$ -	$ 188,443
62	09/18/22	$ 4,127	$ 36,674	$ -	$ 25,759	$ -	$ 37,436	$ 86,143	$ -	$ -	$ -	$ -	$ 190,138
63	09/21/22	$ 4,142	$ 36,813	$ -	$ 25,999	$ -	$ 37,917	$ 86,936	$ -	$ -	$ -	$ -	$ 191,807
64	09/24/22	$ 4,158	$ 36,950	$ -	$ 26,235	$ -	$ 38,393	$ 87,715	$ -	$ -	$ -	$ -	$ 193,450
65	09/27/22	$ 4,173	$ 37,083	$ -	$ 26,466	$ -	$ 38,862	$ 88,481	$ -	$ -	$ -	$ -	$ 195,066
66	09/30/22	$ 4,187	$ 37,213	$ -	$ 26,693	$ -	$ 39,326	$ 89,234	$ -	$ -	$ -	$ -	$ 196,653
67	10/04/22	$ 4,202	$ 37,340	$ -	$ 26,916	$ -	$ 39,782	$ 89,971	$ -	$ -	$ -	$ -	$ 198,211
68	10/07/22	$ 4,216	$ 37,463	$ -	$ 27,134	$ -	$ 40,231	$ 90,694	$ -	$ -	$ -	$ -	$ 199,738
69	10/10/22	$ 4,229	$ 37,583	$ -	$ 27,346	$ -	$ 40,673	$ 91,401	$ -	$ -	$ -	$ -	$ 201,233
70	10/13/22	$ 4,242	$ 37,700	$ -	$ 27,554	$ -	$ 41,108	$ 92,093	$ -	$ -	$ -	$ -	$ 202,697
71	10/16/22	$ 4,255	$ 37,813	$ -	$ 27,757	$ -	$ 41,534	$ 92,768	$ -	$ -	$ -	$ -	$ 204,126
72	10/19/22	$ 4,267	$ 37,923	$ -	$ 27,954	$ -	$ 41,951	$ 93,426	$ -	$ -	$ -	$ -	$ 205,522
73	10/22/22	$ 4,279	$ 38,029	$ -	$ 28,146	$ -	$ 42,360	$ 94,068	$ -	$ -	$ -	$ -	$ 206,882
74	10/26/22	$ 4,291	$ 38,132	$ -	$ 28,332	$ -	$ 42,759	$ 94,691	$ -	$ -	$ -	$ -	$ 208,206
75	10/29/22	$ 4,302	$ 38,231	$ -	$ 28,512	$ -	$ 43,149	$ 95,297	$ -	$ -	$ -	$ -	$ 209,492
76	11/01/22	$ 4,313	$ 38,327	$ -	$ 28,687	$ -	$ 43,530	$ 95,885	$ -	$ -	$ -	$ -	$ 210,741
77	11/04/22	$ 4,323	$ 38,419	$ -	$ 28,855	$ -	$ 43,900	$ 96,453	$ -	$ -	$ -	$ -	$ 211,951
78	11/07/22	$ 4,333	$ 38,508	$ -	$ 29,018	$ -	$ 44,259	$ 97,003	$ -	$ -	$ -	$ -	$ 213,121
79	11/10/22	$ 4,343	$ 38,593	$ -	$ 29,174	$ -	$ 44,608	$ 97,533	$ -	$ -	$ -	$ -	$ 214,250

80	11/14/22	$ 4,352	$ 38,674	$ -	$ 29,324	$ -	$ 44,945	$ 98,043	$ -	$ -	$ -	$ -	$ 215,338
81	11/17/22	$ 4,360	$ 38,751	$ -	$ 29,468	$ -	$ 45,272	$ 98,533	$ -	$ -	$ -	$ -	$ 216,384
82	11/20/22	$ 4,369	$ 38,825	$ -	$ 29,605	$ -	$ 45,586	$ 99,003	$ -	$ -	$ -	$ -	$ 217,387
83	11/23/22	$ 4,377	$ 38,895	$ -	$ 29,735	$ -	$ 45,889	$ 99,452	$ -	$ -	$ -	$ -	$ 218,347
84	11/26/22	$ 4,384	$ 38,961	$ -	$ 29,859	$ -	$ 46,179	$ 99,879	$ -	$ -	$ -	$ -	$ 219,262
85	11/29/22	$ 4,391	$ 39,023	$ -	$ 29,976	$ -	$ 46,457	$ 100,285	$ -	$ -	$ -	$ -	$ 220,133
86	12/02/22	$ 4,398	$ 39,082	$ -	$ 30,086	$ -	$ 46,723	$ 100,670	$ -	$ -	$ -	$ -	$ 220,958
87	12/06/22	$ 4,404	$ 39,137	$ -	$ 30,189	$ -	$ 46,975	$ 101,032	$ -	$ -	$ -	$ -	$ 221,736
88	12/09/22	$ 4,410	$ 39,188	$ -	$ 30,285	$ -	$ 47,214	$ 101,373	$ -	$ -	$ -	$ -	$ 222,468
89	12/12/22	$ 4,415	$ 39,235	$ -	$ 30,373	$ -	$ 47,440	$ 101,690	$ -	$ -	$ -	$ -	$ 223,153
90	12/15/22	$ 4,420	$ 39,278	$ -	$ 30,455	$ -	$ 47,652	$ 101,986	$ -	$ -	$ -	$ -	$ 223,790
91	12/18/22	$ 4,424	$ 39,317	$ -	$ 30,529	$ -	$ 47,851	$ 102,258	$ -	$ -	$ -	$ -	$ 224,379
92	12/21/22	$ 4,428	$ 39,352	$ -	$ 30,597	$ -	$ 48,035	$ 102,507	$ -	$ -	$ -	$ -	$ 224,919
93	12/25/22	$ 4,432	$ 39,384	$ -	$ 30,656	$ -	$ 48,205	$ 102,733	$ -	$ -	$ -	$ -	$ 225,411
94	12/28/22	$ 4,435	$ 39,412	$ -	$ 30,709	$ -	$ 48,361	$ 102,936	$ -	$ -	$ -	$ -	$ 225,853
95	12/31/22	$ 4,437	$ 39,435	$ -	$ 30,754	$ -	$ 48,503	$ 103,115	$ -	$ -	$ -	$ -	$ 226,245
96	01/03/23	$ 4,440	$ 39,455	$ -	$ 30,791	$ -	$ 48,630	$ 103,271	$ -	$ -	$ -	$ -	$ 226,587
97	01/06/23	$ 4,441	$ 39,471	$ -	$ 30,822	$ -	$ 48,742	$ 103,403	$ -	$ -	$ -	$ -	$ 226,879
98	01/09/23	$ 4,443	$ 39,483	$ -	$ 30,844	$ -	$ 48,840	$ 103,510	$ -	$ -	$ -	$ -	$ 227,120
99	01/12/23	$ 4,444	$ 39,490	$ 352	$ 30,859	$ -	$ 48,923	$ 103,595	$ -	$ -	$ -	$ -	$ 227,662
100	01/16/23	$ 4,444	$ 39,494	$ 389	$ 30,867	$ -	$ 48,991	$ 103,655	$ -	$ -	$ -	$ -	$ 227,840
101	01/19/23	$ 4,444	$ 39,494	$ 429	$ 30,867	$ -	$ 49,043	$ 103,691	$ -	$ -	$ -	$ -	$ 227,968
102	01/22/23	$ 4,444	$ 39,490	$ 470	$ 30,859	$ -	$ 49,081	$ 103,703	$ -	$ -	$ -	$ -	$ 228,047
103	01/25/23	$ 4,443	$ 39,483	$ 513	$ 30,844	$ -	$ 49,104	$ 103,691	$ -	$ -	$ -	$ -	$ 228,077
104	01/28/23	$ 4,441	$ 39,471	$ 557	$ 30,822	$ -	$ 49,111	$ 103,655	$ -	$ -	$ -	$ -	$ 228,056
105	01/31/23	$ 4,440	$ 39,455	$ 601	$ 30,791	$ -	$ 49,104	$ 103,595	$ -	$ -	$ -	$ -	$ 227,985
106	02/03/23	$ 4,437	$ 39,435	$ 645	$ 30,754	$ -	$ 49,081	$ 103,510	$ -	$ -	$ -	$ -	$ 227,863
107	02/07/23	$ 4,435	$ 39,412	$ 689	$ 30,709	$ -	$ 49,043	$ 103,403	$ -	$ -	$ -	$ -	$ 227,691
108	02/10/23	$ 4,432	$ 39,384	$ 733	$ 30,656	$ -	$ 48,991	$ 103,271	$ -	$ -	$ -	$ -	$ 227,466
109	02/13/23	$ 4,428	$ 39,352	$ 775	$ 30,597	$ -	$ 48,923	$ 103,115	$ -	$ -	$ -	$ -	$ 227,190
110	02/16/23	$ 4,424	$ 39,317	$ 816	$ 30,529	$ -	$ 48,840	$ 102,936	$ -	$ -	$ -	$ -	$ 226,863
111	02/19/23	$ 4,420	$ 39,278	$ 854	$ 30,455	$ -	$ 48,742	$ 102,733	$ -	$ -	$ -	$ -	$ 226,482
112	02/22/23	$ 4,415	$ 39,235	$ 890	$ 30,373	$ -	$ 48,630	$ 102,507	$ -	$ -	$ -	$ -	$ 226,050
113	02/26/23	$ 4,410	$ 39,188	$ 922	$ 30,285	$ -	$ 48,503	$ 102,258	$ -	$ -	$ -	$ -	$ 225,565
114	03/01/23	$ 4,404	$ 39,137	$ 951	$ 30,189	$ -	$ 48,361	$ 101,986	$ -	$ -	$ -	$ -	$ 225,027
115	03/04/23	$ 4,398	$ 39,082	$ 975	$ 30,086	$ -	$ 48,205	$ 101,690	$ -	$ -	$ -	$ -	$ 224,436
116	03/07/23	$ 4,391	$ 39,023	$ 995	$ 29,976	$ -	$ 48,035	$ 101,373	$ -	$ -	$ -	$ -	$ 223,793
117	03/10/23	$ 4,384	$ 38,961	$ 1,011	$ 29,859	$ -	$ 47,851	$ 101,032	$ -	$ -	$ -	$ -	$ 223,097
118	03/13/23	$ 4,377	$ 38,895	$ 1,021	$ 29,735	$ -	$ 47,652	$ 100,670	$ -	$ -	$ -	$ -	$ 222,349
119	03/16/23	$ 4,369	$ 38,825	$ 1,026	$ 29,605	$ -	$ 47,440	$ 100,285	$ -	$ -	$ -	$ -	$ 221,550
120	03/20/23	$ 4,360	$ 38,751	$ 1,026	$ 29,468	$ -	$ 47,214	$ 99,879	$ -	$ -	$ -	$ -	$ 220,699
121	03/23/23	$ 4,352	$ 38,674	$ 1,021	$ 29,324	$ -	$ 46,975	$ 99,452	$ -	$ -	$ -	$ -	$ 219,797
122	03/26/23	$ 4,343	$ 38,593	$ 1,011	$ 29,174	$ -	$ 46,723	$ 99,003	$ -	$ -	$ -	$ -	$ 218,845
123	03/29/23	$ 4,333	$ 38,508	$ 995	$ 29,018	$ -	$ 46,457	$ 98,533	$ -	$ -	$ -	$ -	$ 217,845
124	04/01/23	$ 4,323	$ 38,419	$ 975	$ 28,855	$ -	$ 46,179	$ 98,043	$ -	$ -	$ -	$ -	$ 216,796
125	04/04/23	$ 4,313	$ 38,327	$ 951	$ 28,687	$ -	$ 45,889	$ 97,533	$ -	$ -	$ -	$ -	$ 215,699
126	04/07/23	$ 4,302	$ 38,231	$ 922	$ 28,512	$ -	$ 45,586	$ 97,003	$ -	$ -	$ -	$ -	$ 214,557

127	04/11/23	$ 4,291	$ 38,132	$ 890	$ 28,332	$ -	$ 45,272	$ 96,453	$ -	$ -	$ -	$ -	$ 213,370
128	04/14/23	$ 4,279	$ 38,029	$ 854	$ 28,146	$ -	$ 44,945	$ 95,885	$ -	$ -	$ -	$ -	$ 212,139
129	04/17/23	$ 4,267	$ 37,923	$ 816	$ 27,954	$ -	$ 44,608	$ 95,297	$ -	$ -	$ -	$ -	$ 210,865
130	04/20/23	$ 4,255	$ 37,813	$ 775	$ 27,757	$ -	$ 44,259	$ 94,691	$ -	$ -	$ -	$ -	$ 209,551
131	04/23/23	$ 4,242	$ 37,700	$ 733	$ 27,554	$ -	$ 43,900	$ 94,068	$ -	$ -	$ -	$ -	$ 208,197
132	04/26/23	$ 4,229	$ 37,583	$ 689	$ 27,346	$ -	$ 43,530	$ 93,426	$ -	$ -	$ -	$ -	$ 206,804
133	04/30/23	$ 4,216	$ 37,463	$ 645	$ 27,134	$ -	$ 43,149	$ 92,768	$ -	$ -	$ -	$ -	$ 205,375
134	05/03/23	$ 4,202	$ 37,340	$ 601	$ 26,916	$ -	$ 42,759	$ 92,093	$ -	$ 14,398	$ -	$ -	$ 218,308
135	05/06/23	$ 4,187	$ 37,213	$ 557	$ 26,693	$ -	$ 42,360	$ 91,401	$ -	$ 15,367	$ -	$ -	$ 217,779
136	05/09/23	$ 4,173	$ 37,083	$ 513	$ 26,466	$ -	$ 41,951	$ 90,694	$ -	$ 16,369	$ -	$ -	$ 217,249
137	05/12/23	$ 4,158	$ 36,950	$ 470	$ 26,235	$ -	$ 41,534	$ 89,971	$ -	$ 17,401	$ -	$ -	$ 216,718
138	05/15/23	$ 4,142	$ 36,813	$ 429	$ 25,999	$ -	$ 41,108	$ 89,234	$ -	$ 18,461	$ -	$ -	$ 216,186
139	05/18/23	$ 4,127	$ 36,674	$ 389	$ 25,759	$ -	$ 40,673	$ 88,481	$ -	$ 19,546	$ -	$ -	$ 215,650
140	05/22/23	$ 4,111	$ 36,531	$ 352	$ 25,515	$ -	$ 40,231	$ 87,715	$ -	$ 20,654	$ -	$ -	$ 215,109
141	05/25/23	$ 4,094	$ 36,385	$ -	$ 25,267	$ -	$ 39,782	$ 86,936	$ -	$ 21,781	$ -	$ -	$ 214,245
142	05/28/23	$ 4,077	$ 36,236	$ -	$ 25,015	$ -	$ 39,326	$ 86,143	$ -	$ 22,923	$ -	$ 297,281	$ 511,002
143	05/31/23	$ 4,060	$ 36,084	$ -	$ 24,760	$ -	$ 38,862	$ 85,338	$ -	$ 24,077	$ -	$ 341,990	$ 555,172
144	06/03/23	$ 4,043	$ 35,930	$ -	$ 24,501	$ -	$ 38,393	$ 84,520	$ 3,779,529	$ 25,238	$ -	$ 391,348	$ 4,383,502
145	06/06/23	$ 4,025	$ 35,772	$ -	$ 24,240	$ -	$ 37,917	$ 83,691	$ 5,734,889	$ 26,403	$ -	$ 445,469	$ 6,392,406
146	06/09/23	$ 4,007	$ 35,611	$ -	$ 23,975	$ -	$ 37,436	$ 82,851	$ 7,572,646	$ 27,566	$ -	$ 504,401	$ 8,288,492
147	06/13/23	$ 3,989	$ 35,448	$ -	$ 23,707	$ -	$ 36,949	$ 82,001	$ 8,701,783	$ 28,722	$ -	$ 568,117	$ 9,480,715
148	06/16/23	$ 3,970	$ 35,282	$ -	$ 23,436	$ -	$ 36,458	$ 81,140	$ 8,701,783	$ 29,867	$ -	$ 636,507	$ 9,548,443
149	06/19/23	$ 3,951	$ 35,113	$ -	$ 23,163	$ -	$ 35,962	$ 80,270	$ 7,572,646	$ 30,995	$ -	$ 709,370	$ 8,491,470
150	06/22/23	$ 3,932	$ 34,941	$ -	$ 22,888	$ -	$ 35,462	$ 79,391	$ 5,734,889	$ 32,102	$ -	$ 786,406	$ 6,730,010
151	06/25/23	$ 3,912	$ 34,767	$ -	$ 22,610	$ -	$ 34,958	$ 78,503	$ 3,779,529	$ 33,181	$ -	$ 867,210	$ 4,854,670
152	06/28/23	$ 3,892	$ 34,590	$ -	$ 22,331	$ -	$ 34,451	$ 77,607	$ -	$ 34,229	$ -	$ 951,274	$ 1,158,372
153	07/02/23	$ 3,872	$ 34,410	$ -	$ 22,049	$ -	$ 33,940	$ 76,703	$ -	$ 35,238	$ 7,003	$ 1,037,985	$ 1,251,201
154	07/05/23	$ 3,852	$ 34,229	$ -	$ 21,765	$ -	$ 33,427	$ 75,792	$ -	$ 36,205	$ 7,857	$ 1,126,627	$ 1,339,754
155	07/08/23	$ 3,831	$ 34,044	$ -	$ 21,480	$ -	$ 32,912	$ 74,875	$ -	$ 37,123	$ 8,757	$ 1,216,392	$ 1,429,414
156	07/11/23	$ 3,810	$ 33,858	$ -	$ 21,194	$ -	$ 32,394	$ 73,952	$ -	$ 37,989	$ 9,695	$ 1,306,383	$ 1,519,275
157	07/14/23	$ 3,789	$ 33,668	$ -	$ 20,906	$ -	$ 31,875	$ 73,023	$ -	$ 38,797	$ 10,664	$ 1,395,634	$ 1,608,357
158	07/17/23	$ 3,767	$ 33,477	$ -	$ 20,617	$ -	$ 31,354	$ 72,089	$ -	$ 39,543	$ 11,654	$ 1,483,121	$ 1,695,622
159	07/20/23	$ 3,745	$ 33,283	$ -	$ 20,327	$ -	$ 30,833	$ 71,151	$ -	$ 40,223	$ 12,651	$ 1,567,781	$ 1,779,994
160	07/24/23	$ 3,723	$ 33,088	$ -	$ 20,037	$ -	$ 30,310	$ 70,209	$ -	$ 40,832	$ 13,644	$ 1,648,535	$ 1,860,377
161	07/27/23	$ 3,701	$ 32,890	$ -	$ 19,745	$ -	$ 29,788	$ 69,263	$ -	$ 41,367	$ 14,619	$ 1,724,308	$ 1,935,680
162	07/30/23	$ 3,678	$ 32,690	$ -	$ 19,453	$ -	$ 29,265	$ 68,313	$ -	$ 41,826	$ 15,560	$ 1,794,054	$ 2,004,840
163	08/02/23	$ 3,656	$ 32,488	$ -	$ 19,161	$ -	$ 28,743	$ 67,362	$ -	$ 42,205	$ 16,454	$ 1,856,778	$ 2,066,846
164	08/05/23	$ 3,633	$ 32,284	$ -	$ 18,869	$ -	$ 28,222	$ 66,408	$ -	$ 42,502	$ 17,285	$ 1,911,562	$ 2,120,764
165	08/08/23	$ 3,610	$ 32,078	$ -	$ 18,576	$ -	$ 27,701	$ 65,452	$ -	$ 42,716	$ 18,039	$ 1,957,586	$ 2,165,758
166	08/11/23	$ 3,586	$ 31,870	$ -	$ 18,284	$ -	$ 27,182	$ 64,496	$ -	$ 42,844	$ 18,703	$ 1,994,147	$ 2,201,111
167	08/15/23	$ 3,563	$ 31,660	$ -	$ 17,991	$ -	$ 26,664	$ 63,538	$ -	$ 42,887	$ 19,265	$ 2,020,679	$ 2,226,247
168	08/18/23	$ 3,539	$ 31,449	$ -	$ 17,700	$ -	$ 26,148	$ 62,580	$ -	$ 42,844	$ 19,713	$ 2,036,767	$ 2,240,739
169	08/21/23	$ 3,515	$ 31,236	$ -	$ 17,408	$ -	$ 25,634	$ 61,623	$ -	$ 42,716	$ 20,039	$ 2,042,159	$ 2,244,328
170	08/24/23	$ 3,491	$ 31,021	$ -	$ 17,117	$ -	$ 25,122	$ 60,665	$ -	$ 42,502	$ 20,238	$ 2,036,767	$ 2,236,924
171	08/27/23	$ 3,466	$ 30,805	$ -	$ 16,827	$ -	$ 24,613	$ 59,709	$ -	$ 42,205	$ 20,304	$ 2,020,679	$ 2,218,609
172	08/30/23	$ 3,442	$ 30,587	$ -	$ 16,538	$ -	$ 24,107	$ 58,755	$ -	$ 41,826	$ 20,238	$ 1,994,147	$ 2,189,639
173	09/03/23	$ 3,417	$ 30,367	$ -	$ 16,250	$ -	$ 23,604	$ 57,802	$ -	$ 41,367	$ 20,039	$ 1,957,586	$ 2,150,433

174	09/06/23	$ 3,392	$ 30,146	$ -	$ 15,963	$ -	$ 23,105	$ 56,851	$ -	$ 40,832	$ 19,713	$ 1,911,562	$ 2,101,564
175	09/09/23	$ 3,367	$ 29,924	$ -	$ 15,677	$ -	$ 22,609	$ 55,904	$ -	$ 40,223	$ 19,265	$ 1,856,778	$ 2,043,746
176	09/12/23	$ 3,342	$ 29,700	$ -	$ 15,393	$ -	$ 22,117	$ 54,959	$ -	$ 39,543	$ 18,703	$ 1,794,054	$ 1,977,811
177	09/15/23	$ 3,317	$ 29,476	$ -	$ 15,110	$ -	$ 21,629	$ 54,017	$ -	$ 38,797	$ 18,039	$ 1,724,308	$ 1,904,693
178	09/18/23	$ 3,291	$ 29,249	$ -	$ 14,828	$ -	$ 21,145	$ 53,080	$ -	$ 37,989	$ 17,285	$ 1,648,535	$ 1,825,403
179	09/21/23	$ 3,266	$ 29,022	$ -	$ 14,549	$ -	$ 20,665	$ 52,147	$ -	$ 37,123	$ 16,454	$ 1,567,781	$ 1,741,007
180	09/25/23	$ 3,240	$ 28,794	$ -	$ 14,271	$ -	$ 20,191	$ 51,218	$ -	$ 36,205	$ 15,560	$ 1,483,121	$ 1,652,599
181	09/28/23	$ 3,214	$ 28,564	$ -	$ 13,995	$ -	$ 19,721	$ 50,294	$ -	$ 35,238	$ 14,619	$ 1,395,634	$ 1,561,279
182	10/01/23	$ 3,188	$ 28,334	$ -	$ 13,721	$ -	$ 19,256	$ 49,375	$ -	$ 34,229	$ 13,644	$ 1,306,383	$ 1,468,130
183	10/04/23	$ 3,162	$ 28,103	$ -	$ 13,449	$ -	$ 18,796	$ 48,462	$ -	$ 33,181	$ 12,651	$ 1,216,392	$ 1,374,196
184	10/07/23	$ 3,136	$ 27,870	$ -	$ 13,179	$ -	$ 18,342	$ 47,555	$ -	$ 32,102	$ 11,654	$ 1,126,627	$ 1,280,465
185	10/10/23	$ 3,110	$ 27,637	$ -	$ 12,911	$ -	$ 17,893	$ 46,653	$ -	$ 30,995	$ 10,664	$ 1,037,985	$ 1,187,850
186	10/14/23	$ 3,084	$ 27,403	$ -	$ 12,646	$ -	$ 17,450	$ 45,759	$ -	$ 29,867	$ 9,695	$ 951,274	$ 1,097,178
187	10/17/23	$ 3,057	$ 27,169	$ -	$ 12,384	$ -	$ 17,012	$ 44,871	$ -	$ 28,722	$ 8,757	$ 867,210	$ 1,009,181
188	10/20/23	$ 3,031	$ 26,933	$ -	$ 12,123	$ -	$ 16,581	$ 43,990	$ -	$ 27,566	$ 7,857	$ 786,406	$ 924,486
189	10/23/23	$ 3,004	$ 26,697	$ -	$ 11,866	$ -	$ 16,155	$ 43,116	$ -	$ 26,403	$ 7,003	$ 709,370	$ 843,615
190	10/26/23	$ 2,977	$ 26,461	$ -	$ 11,611	$ -	$ -	$ 42,250	$ -	$ 25,238	$ -	$ 636,507	$ 745,045
191	10/29/23	$ 2,951	$ 26,224	$ -	$ 11,358	$ -	$ -	$ 41,392	$ -	$ 24,077	$ -	$ 568,117	$ 674,118
192	11/01/23	$ 2,924	$ 25,986	$ -	$ 11,109	$ -	$ -	$ 40,542	$ -	$ 22,923	$ -	$ 504,401	$ 607,884
193	11/05/23	$ 2,897	$ 25,748	$ -	$ 10,862	$ -	$ -	$ 39,700	$ -	$ 21,781	$ -	$ 445,469	$ 546,457
194	11/08/23	$ 2,870	$ 25,510	$ -	$ 10,618	$ -	$ -	$ 38,866	$ -	$ 20,654	$ -	$ 391,348	$ 489,867
195	11/11/23	$ 2,844	$ 25,271	$ -	$ 10,377	$ -	$ -	$ 38,041	$ -	$ 19,546	$ -	$ 341,990	$ 438,070
196	11/14/23	$ 2,817	$ 25,032	$ -	$ 10,139	$ -	$ -	$ 37,225	$ -	$ 18,461	$ -	$ 297,281	$ 390,956
197	11/17/23	$ 2,790	$ 24,793	$ -	$ -	$ -	$ -	$ 36,419	$ -	$ 17,401	$ -	$ -	$ 81,402
198	11/20/23	$ 2,763	$ 24,554	$ -	$ -	$ -	$ -	$ 35,621	$ -	$ 16,369	$ -	$ -	$ 79,306
199	11/23/23	$ 2,736	$ 24,314	$ -	$ -	$ -	$ -	$ 34,833	$ -	$ 15,367	$ -	$ -	$ 77,250
200	11/27/23	$ 2,709	$ 24,075	$ -	$ -	$ -	$ -	$ 34,054	$ -	$ 14,398	$ -	$ -	$ 75,236

RESOLUTE ENGINEERING

Period Number	Date	Client Internal Staffing	Engineering	GeoTech Study	Environmental	Lidar and Photo	Survey	ROW	Material	Inspection	NDT	Construction	Project Cumulative Total
0	03/07/22												
1	03/10/22	$ 2,709	$ 24,075	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 26,784
2	03/13/22	$ 5,445	$ 48,389	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 53,834
3	03/16/22	$ 8,208	$ 72,943	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 81,151
4	03/19/22	$ 10,998	$ 97,736	$ -	$ -	$ -	$ -	$ 34,054	$ -	$ -	$ -	$ -	$ 142,787
5	03/22/22	$ 13,814	$ 122,768	$ -	$ 10,139	$ -	$ -	$ 68,886	$ -	$ -	$ -	$ -	$ 215,608
6	03/25/22	$ 16,658	$ 148,039	$ -	$ 20,517	$ -	$ -	$ 104,507	$ -	$ -	$ -	$ -	$ 289,721
7	03/29/22	$ 19,529	$ 173,549	$ -	$ 31,135	$ -	$ -	$ 140,926	$ -	$ -	$ -	$ -	$ 365,138
8	04/01/22	$ 22,426	$ 199,297	$ -	$ 41,997	$ -	$ -	$ 178,151	$ -	$ -	$ -	$ -	$ 441,871
9	04/04/22	$ 25,350	$ 225,283	$ -	$ 53,105	$ -	$ -	$ 216,193	$ -	$ -	$ -	$ -	$ 519,931
10	04/07/22	$ 28,301	$ 251,507	$ -	$ 64,464	$ -	$ -	$ 255,059	$ -	$ -	$ -	$ -	$ 599,330
11	04/10/22	$ 31,278	$ 277,968	$ -	$ 76,074	$ -	$ -	$ 294,758	$ -	$ -	$ -	$ -	$ 680,078
12	04/13/22	$ 34,282	$ 304,665	$ -	$ 87,940	$ -	$ -	$ 335,300	$ -	$ -	$ -	$ -	$ 762,187
13	04/16/22	$ 37,313	$ 331,598	$ -	$ 100,063	$ -	$ -	$ 376,692	$ -	$ -	$ -	$ -	$ 845,666
14	04/20/22	$ 40,370	$ 358,767	$ -	$ 112,447	$ -	$ -	$ 418,942	$ -	$ -	$ -	$ -	$ 930,526
15	04/23/22	$ 43,454	$ 386,170	$ -	$ 125,093	$ -	$ -	$ 462,059	$ -	$ -	$ -	$ -	$ 1,016,775
16	04/26/22	$ 46,564	$ 413,807	$ -	$ 138,004	$ -	$ -	$ 506,049	$ -	$ -	$ -	$ -	$ 1,104,424
17	04/29/22	$ 49,700	$ 441,678	$ -	$ 151,183	$ -	$ -	$ 550,919	$ -	$ -	$ -	$ -	$ 1,193,480
18	05/02/22	$ 52,862	$ 469,780	$ -	$ 164,632	$ -	$ -	$ 596,678	$ -	$ -	$ -	$ -	$ 1,283,952
19	05/05/22	$ 56,050	$ 498,114	$ -	$ 178,353	$ -	$ 16,155	$ 643,332	$ -	$ -	$ -	$ -	$ 1,392,004
20	05/09/22	$ 59,264	$ 526,679	$ -	$ 192,347	$ -	$ 32,736	$ 690,886	$ -	$ -	$ -	$ -	$ 1,501,913
21	05/12/22	$ 62,504	$ 555,473	$ -	$ 206,618	$ -	$ 49,748	$ 739,348	$ -	$ -	$ -	$ -	$ 1,613,692
22	05/15/22	$ 65,770	$ 584,495	$ -	$ 221,167	$ -	$ 67,198	$ 788,723	$ -	$ -	$ -	$ -	$ 1,727,353
23	05/18/22	$ 69,062	$ 613,744	$ -	$ 235,995	$ -	$ 85,092	$ 839,017	$ -	$ -	$ -	$ -	$ 1,842,909
24	05/21/22	$ 72,378	$ 643,220	$ -	$ 251,105	$ -	$ 103,434	$ 890,235	$ -	$ -	$ -	$ -	$ 1,960,371
25	05/24/22	$ 75,720	$ 672,920	$ -	$ 266,497	$ -	$ 122,230	$ 942,381	$ -	$ -	$ -	$ -	$ 2,079,749
26	05/27/22	$ 79,087	$ 702,844	$ -	$ 282,175	$ -	$ 141,486	$ 995,461	$ -	$ -	$ -	$ -	$ 2,201,054
27	05/31/22	$ 82,480	$ 732,991	$ -	$ 298,138	$ -	$ 161,207	$ 1,049,479	$ -	$ -	$ -	$ -	$ 2,324,294
28	06/03/22	$ 85,897	$ 763,358	$ -	$ 314,387	$ -	$ 181,398	$ 1,104,438	$ -	$ -	$ -	$ -	$ 2,449,477
29	06/06/22	$ 89,339	$ 793,944	$ -	$ 330,926	$ -	$ 202,063	$ 1,160,341	$ -	$ -	$ -	$ -	$ 2,576,613
30	06/09/22	$ 92,805	$ 824,749	$ -	$ 347,753	$ -	$ 223,208	$ 1,217,193	$ -	$ -	$ -	$ -	$ 2,705,707
31	06/12/22	$ 96,295	$ 855,770	$ -	$ 364,870	$ -	$ 244,836	$ 1,274,995	$ -	$ -	$ -	$ -	$ 2,836,767
32	06/15/22	$ 99,810	$ 887,005	$ -	$ 382,278	$ -	$ 266,953	$ 1,333,750	$ -	$ -	$ -	$ -	$ 2,969,796
33	06/18/22	$ 103,349	$ 918,454	$ -	$ 399,978	$ -	$ 289,562	$ 1,393,459	$ -	$ -	$ -	$ -	$ 3,104,802

34	06/22/22	$ 106,912	$ 950,114	$ -	$ 417,969	$ -	$ 312,666	$ 1,454,124	$ -	$ -	$ -	$ -	$ 3,241,786
35	06/25/22	$ 110,498	$ 981,984	$ -	$ 436,253	$ -	$ 336,270	$ 1,515,747	$ -	$ -	$ -	$ -	$ 3,380,752
36	06/28/22	$ 114,107	$ 1,014,062	$ -	$ 454,829	$ 13,646	$ 360,377	$ 1,578,327	$ -	$ -	$ -	$ -	$ 3,535,349
37	07/01/22	$ 117,740	$ 1,046,346	$ -	$ 473,698	$ 35,915	$ 384,990	$ 1,641,865	$ -	$ -	$ -	$ -	$ 3,700,553
38	07/04/22	$ 121,396	$ 1,078,833	$ -	$ 492,859	$ 64,361	$ 410,113	$ 1,706,361	$ -	$ -	$ -	$ -	$ 3,873,922
39	07/07/22	$ 125,074	$ 1,111,523	$ -	$ 512,312	$ 92,807	$ 435,746	$ 1,771,813	$ -	$ -	$ -	$ -	$ 4,049,275
40	07/11/22	$ 128,775	$ 1,144,413	$ -	$ 532,057	$ 115,075	$ 461,894	$ 1,838,221	$ -	$ -	$ -	$ -	$ 4,220,435
41	07/14/22	$ 132,498	$ 1,177,500	$ -	$ 552,094	$ 128,721	$ 488,558	$ 1,905,583	$ -	$ -	$ -	$ -	$ 4,384,954
42	07/17/22	$ 136,243	$ 1,210,784	$ -	$ 572,421	$ 128,721	$ 515,739	$ 1,973,896	$ -	$ -	$ -	$ -	$ 4,537,805
43	07/20/22	$ 140,010	$ 1,244,261	$ -	$ 593,038	$ 128,721	$ 543,440	$ 2,043,159	$ -	$ -	$ -	$ -	$ 4,692,630
44	07/23/22	$ 143,799	$ 1,277,929	$ -	$ 613,944	$ 128,721	$ 571,662	$ 2,113,367	$ -	$ -	$ -	$ -	$ 4,849,423
45	07/26/22	$ 147,609	$ 1,311,787	$ -	$ 635,138	$ 128,721	$ 600,405	$ 2,184,518	$ -	$ -	$ -	$ -	$ 5,008,178
46	07/29/22	$ 151,440	$ 1,345,831	$ -	$ 656,619	$ 128,721	$ 629,670	$ 2,256,608	$ -	$ -	$ -	$ -	$ 5,168,889
47	08/02/22	$ 155,291	$ 1,380,060	$ -	$ 678,384	$ 128,721	$ 659,458	$ 2,329,631	$ -	$ -	$ -	$ -	$ 5,331,545
48	08/05/22	$ 159,163	$ 1,414,470	$ -	$ 700,433	$ 128,721	$ 689,769	$ 2,403,583	$ -	$ -	$ -	$ -	$ 5,496,139
49	08/08/22	$ 163,055	$ 1,449,060	$ -	$ 722,763	$ 128,721	$ 720,601	$ 2,478,459	$ -	$ -	$ -	$ -	$ 5,662,660
50	08/11/22	$ 166,967	$ 1,483,827	$ -	$ 745,374	$ 128,721	$ 751,955	$ 2,554,251	$ -	$ -	$ -	$ -	$ 5,831,096
51	08/14/22	$ 170,899	$ 1,518,768	$ -	$ 768,262	$ 128,721	$ 783,830	$ 2,630,954	$ -	$ -	$ -	$ -	$ 6,001,434
52	08/17/22	$ 174,850	$ 1,553,880	$ -	$ 791,425	$ 128,721	$ 816,224	$ 2,708,561	$ -	$ -	$ -	$ -	$ 6,173,662
53	08/20/22	$ 178,820	$ 1,589,162	$ -	$ 814,862	$ 128,721	$ 849,136	$ 2,787,063	$ -	$ -	$ -	$ -	$ 6,347,764
54	08/24/22	$ 182,809	$ 1,624,610	$ -	$ 838,568	$ 128,721	$ 882,563	$ 2,866,454	$ -	$ -	$ -	$ -	$ 6,523,725
55	08/27/22	$ 186,816	$ 1,660,221	$ -	$ 862,543	$ 128,721	$ 916,503	$ 2,946,724	$ -	$ -	$ -	$ -	$ 6,701,528
56	08/30/22	$ 190,841	$ 1,695,993	$ -	$ 886,783	$ 128,721	$ 950,954	$ 3,027,864	$ -	$ -	$ -	$ -	$ 6,881,156
57	09/02/22	$ 194,884	$ 1,731,922	$ -	$ 911,284	$ 128,721	$ 985,912	$ 3,109,865	$ -	$ -	$ -	$ -	$ 7,062,588
58	09/05/22	$ 198,945	$ 1,768,007	$ -	$ 936,044	$ 128,721	$ 1,021,374	$ 3,192,716	$ -	$ -	$ -	$ -	$ 7,245,806
59	09/08/22	$ 203,022	$ 1,804,243	$ -	$ 961,059	$ 128,721	$ 1,057,336	$ 3,276,407	$ -	$ -	$ -	$ -	$ 7,430,788
60	09/12/22	$ 207,116	$ 1,840,628	$ -	$ 986,326	$ 128,721	$ 1,093,794	$ 3,360,928	$ -	$ -	$ -	$ -	$ 7,617,513
61	09/15/22	$ 211,227	$ 1,877,159	$ -	$ 1,011,840	$ 128,721	$ 1,130,743	$ 3,446,265	$ -	$ -	$ -	$ -	$ 7,805,956
62	09/18/22	$ 215,354	$ 1,913,833	$ -	$ 1,037,599	$ 128,721	$ 1,168,179	$ 3,532,408	$ -	$ -	$ -	$ -	$ 7,996,094
63	09/21/22	$ 219,496	$ 1,950,646	$ -	$ 1,063,598	$ 128,721	$ 1,206,096	$ 3,619,344	$ -	$ -	$ -	$ -	$ 8,187,901
64	09/24/22	$ 223,654	$ 1,987,596	$ -	$ 1,089,833	$ 128,721	$ 1,244,489	$ 3,707,059	$ -	$ -	$ -	$ -	$ 8,381,352
65	09/27/22	$ 227,827	$ 2,024,679	$ -	$ 1,116,299	$ 128,721	$ 1,283,351	$ 3,795,541	$ -	$ -	$ -	$ -	$ 8,576,417
66	09/30/22	$ 232,014	$ 2,061,892	$ -	$ 1,142,992	$ 128,721	$ 1,322,676	$ 3,884,774	$ -	$ -	$ -	$ -	$ 8,773,070
67	10/04/22	$ 236,216	$ 2,099,232	$ -	$ 1,169,908	$ 128,721	$ 1,362,458	$ 3,974,745	$ -	$ -	$ -	$ -	$ 8,971,281
68	10/07/22	$ 240,431	$ 2,136,695	$ -	$ 1,197,042	$ 128,721	$ 1,402,690	$ 4,065,439	$ -	$ -	$ -	$ -	$ 9,171,019
69	10/10/22	$ 244,660	$ 2,174,278	$ -	$ 1,224,389	$ 128,721	$ 1,443,363	$ 4,156,840	$ -	$ -	$ -	$ -	$ 9,372,252
70	10/13/22	$ 248,903	$ 2,211,978	$ -	$ 1,251,943	$ 128,721	$ 1,484,471	$ 4,248,933	$ -	$ -	$ -	$ -	$ 9,574,949
71	10/16/22	$ 253,158	$ 2,249,792	$ -	$ 1,279,700	$ 128,721	$ 1,526,005	$ 4,341,701	$ -	$ -	$ -	$ -	$ 9,779,075
72	10/19/22	$ 257,425	$ 2,287,715	$ -	$ 1,307,654	$ 128,721	$ 1,567,956	$ 4,435,127	$ -	$ -	$ -	$ -	$ 9,984,597
73	10/22/22	$ 261,704	$ 2,325,744	$ -	$ 1,335,799	$ 128,721	$ 1,610,316	$ 4,529,195	$ -	$ -	$ -	$ -	$ 10,191,479
74	10/26/22	$ 265,995	$ 2,363,876	$ -	$ 1,364,131	$ 128,721	$ 1,653,075	$ 4,623,886	$ -	$ -	$ -	$ -	$ 10,399,685
75	10/29/22	$ 270,297	$ 2,402,108	$ -	$ 1,392,643	$ 128,721	$ 1,696,225	$ 4,719,183	$ -	$ -	$ -	$ -	$ 10,609,177
76	11/01/22	$ 274,610	$ 2,440,435	$ -	$ 1,421,330	$ 128,721	$ 1,739,754	$ 4,815,068	$ -	$ -	$ -	$ -	$ 10,819,918
77	11/04/22	$ 278,933	$ 2,478,854	$ -	$ 1,450,186	$ 128,721	$ 1,783,654	$ 4,911,521	$ -	$ -	$ -	$ -	$ 11,031,869
78	11/07/22	$ 283,266	$ 2,517,362	$ -	$ 1,479,204	$ 128,721	$ 1,827,913	$ 5,008,524	$ -	$ -	$ -	$ -	$ 11,244,990
79	11/10/22	$ 287,609	$ 2,555,955	$ -	$ 1,508,378	$ 128,721	$ 1,872,521	$ 5,106,057	$ -	$ -	$ -	$ -	$ 11,459,240
80	11/14/22	$ 291,960	$ 2,594,628	$ -	$ 1,537,702	$ 128,721	$ 1,917,466	$ 5,204,100	$ -	$ -	$ -	$ -	$ 11,674,578

81	11/17/22	$ 296,321	$ 2,633,379	$ -	$ 1,567,170	$ 128,721	$ 1,962,738	$ 5,302,634	$ -	$ -	$ -	$ -	$ 11,890,962
82	11/20/22	$ 300,690	$ 2,672,204	$ -	$ 1,596,774	$ 128,721	$ 2,008,324	$ 5,401,636	$ -	$ -	$ -	$ -	$ 12,108,350
83	11/23/22	$ 305,066	$ 2,711,099	$ -	$ 1,626,509	$ 128,721	$ 2,054,213	$ 5,501,088	$ -	$ -	$ -	$ -	$ 12,326,697
84	11/26/22	$ 309,450	$ 2,750,060	$ -	$ 1,656,368	$ 128,721	$ 2,100,393	$ 5,600,967	$ -	$ -	$ -	$ -	$ 12,545,959
85	11/29/22	$ 313,841	$ 2,789,083	$ -	$ 1,686,344	$ 128,721	$ 2,146,850	$ 5,701,252	$ -	$ -	$ -	$ -	$ 12,766,091
86	12/02/22	$ 318,239	$ 2,828,165	$ -	$ 1,716,429	$ 128,721	$ 2,193,573	$ 5,801,922	$ -	$ -	$ -	$ -	$ 12,987,049
87	12/06/22	$ 322,643	$ 2,867,302	$ -	$ 1,746,618	$ 128,721	$ 2,240,548	$ 5,902,954	$ -	$ -	$ -	$ -	$ 13,208,785
88	12/09/22	$ 327,052	$ 2,906,489	$ -	$ 1,776,902	$ 128,721	$ 2,287,762	$ 6,004,327	$ -	$ -	$ -	$ -	$ 13,431,254
89	12/12/22	$ 331,467	$ 2,945,724	$ -	$ 1,807,275	$ 128,721	$ 2,335,202	$ 6,106,017	$ -	$ -	$ -	$ -	$ 13,654,407
90	12/15/22	$ 335,887	$ 2,985,002	$ -	$ 1,837,731	$ 128,721	$ 2,382,854	$ 6,208,003	$ -	$ -	$ -	$ -	$ 13,878,197
91	12/18/22	$ 340,311	$ 3,024,319	$ -	$ 1,868,260	$ 128,721	$ 2,430,705	$ 6,310,261	$ -	$ -	$ -	$ -	$ 14,102,576
92	12/21/22	$ 344,739	$ 3,063,671	$ -	$ 1,898,857	$ 128,721	$ 2,478,740	$ 6,412,768	$ -	$ -	$ -	$ -	$ 14,327,496
93	12/25/22	$ 349,171	$ 3,103,055	$ -	$ 1,929,513	$ 128,721	$ 2,526,945	$ 6,515,501	$ -	$ -	$ -	$ -	$ 14,552,906
94	12/28/22	$ 353,606	$ 3,142,467	$ -	$ 1,960,222	$ 128,721	$ 2,575,306	$ 6,618,437	$ -	$ -	$ -	$ -	$ 14,778,759
95	12/31/22	$ 358,043	$ 3,181,902	$ -	$ 1,990,976	$ 128,721	$ 2,623,809	$ 6,721,552	$ -	$ -	$ -	$ -	$ 15,005,004
96	01/03/23	$ 362,483	$ 3,221,357	$ -	$ 2,021,767	$ 128,721	$ 2,672,439	$ 6,824,823	$ -	$ -	$ -	$ -	$ 15,231,591
97	01/06/23	$ 366,924	$ 3,260,828	$ -	$ 2,052,589	$ 128,721	$ 2,721,182	$ 6,928,225	$ -	$ -	$ -	$ -	$ 15,458,469
98	01/09/23	$ 371,367	$ 3,300,310	$ -	$ 2,083,433	$ 128,721	$ 2,770,022	$ 7,031,736	$ -	$ -	$ -	$ -	$ 15,685,589
99	01/12/23	$ 375,811	$ 3,339,801	$ 352	$ 2,114,292	$ 128,721	$ 2,818,944	$ 7,135,330	$ -	$ -	$ -	$ -	$ 15,913,252
100	01/16/23	$ 380,255	$ 3,379,295	$ 741	$ 2,145,159	$ 128,721	$ 2,867,935	$ 7,238,985	$ -	$ -	$ -	$ -	$ 16,141,091
101	01/19/23	$ 384,699	$ 3,418,790	$ 1,170	$ 2,176,026	$ 128,721	$ 2,916,978	$ 7,342,676	$ -	$ -	$ -	$ -	$ 16,369,060
102	01/22/23	$ 389,143	$ 3,458,280	$ 1,640	$ 2,206,885	$ 128,721	$ 2,966,060	$ 7,446,378	$ -	$ -	$ -	$ -	$ 16,597,107
103	01/25/23	$ 393,585	$ 3,497,763	$ 2,153	$ 2,237,729	$ 128,721	$ 3,015,163	$ 7,550,069	$ -	$ -	$ -	$ -	$ 16,825,184
104	01/28/23	$ 398,027	$ 3,537,233	$ 2,710	$ 2,268,551	$ 128,721	$ 3,064,275	$ 7,653,724	$ -	$ -	$ -	$ -	$ 17,053,240
105	01/31/23	$ 402,467	$ 3,576,688	$ 3,311	$ 2,299,342	$ 128,721	$ 3,113,378	$ 7,757,318	$ -	$ -	$ -	$ -	$ 17,281,225
106	02/03/23	$ 406,904	$ 3,616,124	$ 3,956	$ 2,330,096	$ 128,721	$ 3,162,460	$ 7,860,829	$ -	$ -	$ -	$ -	$ 17,509,089
107	02/07/23	$ 411,339	$ 3,655,535	$ 4,645	$ 2,360,805	$ 128,721	$ 3,211,503	$ 7,964,231	$ -	$ -	$ -	$ -	$ 17,736,779
108	02/10/23	$ 415,770	$ 3,694,919	$ 5,378	$ 2,391,461	$ 128,721	$ 3,260,494	$ 8,067,502	$ -	$ -	$ -	$ -	$ 17,964,246
109	02/13/23	$ 420,199	$ 3,734,272	$ 6,153	$ 2,422,058	$ 128,721	$ 3,309,416	$ 8,170,617	$ -	$ -	$ -	$ -	$ 18,191,436
110	02/16/23	$ 424,623	$ 3,773,589	$ 6,969	$ 2,452,587	$ 128,721	$ 3,358,256	$ 8,273,553	$ -	$ -	$ -	$ -	$ 18,418,299
111	02/19/23	$ 429,042	$ 3,812,866	$ 7,823	$ 2,483,043	$ 128,721	$ 3,406,999	$ 8,376,287	$ -	$ -	$ -	$ -	$ 18,644,781
112	02/22/23	$ 433,457	$ 3,852,101	$ 8,713	$ 2,513,416	$ 128,721	$ 3,455,629	$ 8,478,794	$ -	$ -	$ -	$ -	$ 18,870,831
113	02/26/23	$ 437,867	$ 3,891,289	$ 9,635	$ 2,543,700	$ 128,721	$ 3,504,132	$ 8,581,052	$ -	$ -	$ -	$ -	$ 19,096,395
114	03/01/23	$ 442,271	$ 3,930,425	$ 10,586	$ 2,573,889	$ 128,721	$ 3,552,493	$ 8,683,037	$ -	$ -	$ -	$ -	$ 19,321,422
115	03/04/23	$ 446,668	$ 3,969,507	$ 11,561	$ 2,603,974	$ 128,721	$ 3,600,698	$ 8,784,728	$ -	$ -	$ -	$ -	$ 19,545,858
116	03/07/23	$ 451,060	$ 4,008,531	$ 12,556	$ 2,633,950	$ 128,721	$ 3,648,733	$ 8,886,100	$ -	$ -	$ -	$ -	$ 19,769,651
117	03/10/23	$ 455,444	$ 4,047,491	$ 13,567	$ 2,663,809	$ 128,721	$ 3,696,584	$ 8,987,132	$ -	$ -	$ -	$ -	$ 19,992,748
118	03/13/23	$ 459,820	$ 4,086,386	$ 14,588	$ 2,693,544	$ 128,721	$ 3,744,236	$ 9,087,802	$ -	$ -	$ -	$ -	$ 20,215,097
119	03/16/23	$ 464,189	$ 4,125,211	$ 15,614	$ 2,723,148	$ 128,721	$ 3,791,676	$ 9,188,087	$ -	$ -	$ -	$ -	$ 20,436,647
120	03/20/23	$ 468,549	$ 4,163,962	$ 16,640	$ 2,752,616	$ 128,721	$ 3,838,890	$ 9,287,966	$ -	$ -	$ -	$ -	$ 20,657,346
121	03/23/23	$ 472,901	$ 4,202,636	$ 17,661	$ 2,781,940	$ 128,721	$ 3,885,865	$ 9,387,418	$ -	$ -	$ -	$ -	$ 20,877,143
122	03/26/23	$ 477,244	$ 4,241,228	$ 18,672	$ 2,811,114	$ 128,721	$ 3,932,588	$ 9,486,421	$ -	$ -	$ -	$ -	$ 21,095,988
123	03/29/23	$ 481,577	$ 4,279,736	$ 19,667	$ 2,840,132	$ 128,721	$ 3,979,045	$ 9,584,954	$ -	$ -	$ -	$ -	$ 21,313,833
124	04/01/23	$ 485,900	$ 4,318,155	$ 20,642	$ 2,868,988	$ 128,721	$ 4,025,225	$ 9,682,997	$ -	$ -	$ -	$ -	$ 21,530,629
125	04/04/23	$ 490,213	$ 4,356,483	$ 21,593	$ 2,897,675	$ 128,721	$ 4,071,114	$ 9,780,530	$ -	$ -	$ -	$ -	$ 21,746,328
126	04/07/23	$ 494,515	$ 4,394,714	$ 22,515	$ 2,926,187	$ 128,721	$ 4,116,700	$ 9,877,533	$ -	$ -	$ -	$ -	$ 21,960,885
127	04/11/23	$ 498,806	$ 4,432,846	$ 23,405	$ 2,954,519	$ 128,721	$ 4,161,972	$ 9,973,986	$ -	$ -	$ -	$ -	$ 22,174,255

128	04/14/23	$ 503,085	$ 4,470,876	$ 24,259	$ 2,982,664	$ 128,721	$ 4,206,917	$ 10,069,871	$ -	$ -	$ -	$ -	$ 22,386,393
129	04/17/23	$ 507,352	$ 4,508,799	$ 25,075	$ 3,010,618	$ 128,721	$ 4,251,525	$ 10,165,168	$ -	$ -	$ -	$ -	$ 22,597,259
130	04/20/23	$ 511,607	$ 4,546,612	$ 25,850	$ 3,038,375	$ 128,721	$ 4,295,784	$ 10,259,860	$ -	$ -	$ -	$ -	$ 22,806,809
131	04/23/23	$ 515,849	$ 4,584,312	$ 26,583	$ 3,065,929	$ 128,721	$ 4,339,684	$ 10,353,927	$ -	$ -	$ -	$ -	$ 23,015,006
132	04/26/23	$ 520,078	$ 4,621,895	$ 27,272	$ 3,093,276	$ 128,721	$ 4,383,213	$ 10,447,353	$ -	$ -	$ -	$ -	$ 23,221,810
133	04/30/23	$ 524,294	$ 4,659,359	$ 27,918	$ 3,120,410	$ 128,721	$ 4,426,363	$ 10,540,121	$ -	$ -	$ -	$ -	$ 23,427,185
134	05/03/23	$ 528,496	$ 4,696,698	$ 28,518	$ 3,147,326	$ 128,721	$ 4,469,122	$ 10,632,214	$ -	$ 14,398	$ -	$ -	$ 23,645,493
135	05/06/23	$ 532,683	$ 4,733,911	$ 29,075	$ 3,174,019	$ 128,721	$ 4,511,482	$ 10,723,615	$ -	$ 29,765	$ -	$ -	$ 23,863,272
136	05/09/23	$ 536,856	$ 4,770,995	$ 29,588	$ 3,200,485	$ 128,721	$ 4,553,433	$ 10,814,309	$ -	$ 46,134	$ -	$ -	$ 24,080,521
137	05/12/23	$ 541,013	$ 4,807,944	$ 30,058	$ 3,226,720	$ 128,721	$ 4,594,967	$ 10,904,280	$ -	$ 63,535	$ -	$ -	$ 24,297,239
138	05/15/23	$ 545,156	$ 4,844,758	$ 30,487	$ 3,252,719	$ 128,721	$ 4,636,075	$ 10,993,514	$ -	$ 81,996	$ -	$ -	$ 24,513,425
139	05/18/23	$ 549,283	$ 4,881,431	$ 30,876	$ 3,278,478	$ 128,721	$ 4,676,748	$ 11,081,995	$ -	$ 101,542	$ -	$ -	$ 24,729,075
140	05/22/23	$ 553,393	$ 4,917,962	$ 31,228	$ 3,303,992	$ 128,721	$ 4,716,980	$ 11,169,710	$ -	$ 122,196	$ -	$ -	$ 24,944,183
141	05/25/23	$ 557,487	$ 4,954,347	$ 31,228	$ 3,329,259	$ 128,721	$ 4,756,762	$ 11,256,646	$ -	$ 143,977	$ -	$ -	$ 25,158,428
142	05/28/23	$ 561,565	$ 4,990,584	$ 31,228	$ 3,354,274	$ 128,721	$ 4,796,087	$ 11,342,789	$ -	$ 166,900	$ -	$ 297,281	$ 25,669,429
143	05/31/23	$ 565,625	$ 5,026,668	$ 31,228	$ 3,379,034	$ 128,721	$ 4,834,949	$ 11,428,127	$ -	$ 190,977	$ -	$ 639,271	$ 26,224,601
144	06/03/23	$ 569,668	$ 5,062,598	$ 31,228	$ 3,403,535	$ 128,721	$ 4,873,342	$ 11,512,647	$ 3,779,529	$ 216,216	$ -	$ 1,030,620	$ 30,608,104
145	06/06/23	$ 573,694	$ 5,098,369	$ 31,228	$ 3,427,775	$ 128,721	$ 4,911,259	$ 11,596,338	$ 9,514,418	$ 242,619	$ -	$ 1,476,089	$ 37,000,510
146	06/09/23	$ 577,701	$ 5,133,981	$ 31,228	$ 3,451,749	$ 128,721	$ 4,948,695	$ 11,679,190	$ 17,087,063	$ 270,184	$ -	$ 1,980,490	$ 45,289,002
147	06/13/23	$ 581,689	$ 5,169,428	$ 31,228	$ 3,475,456	$ 128,721	$ 4,985,644	$ 11,761,190	$ 25,788,846	$ 298,906	$ -	$ 2,548,606	$ 54,769,717
148	06/16/23	$ 585,659	$ 5,204,710	$ 31,228	$ 3,498,893	$ 128,721	$ 5,022,102	$ 11,842,331	$ 34,490,629	$ 328,773	$ -	$ 3,185,113	$ 64,318,160
149	06/19/23	$ 589,611	$ 5,239,823	$ 31,228	$ 3,522,056	$ 128,721	$ 5,058,064	$ 11,922,600	$ 42,063,274	$ 359,768	$ -	$ 3,894,484	$ 72,809,630
150	06/22/23	$ 593,542	$ 5,274,764	$ 31,228	$ 3,544,944	$ 128,721	$ 5,093,526	$ 12,001,991	$ 47,798,163	$ 391,870	$ -	$ 4,680,889	$ 79,539,639
151	06/25/23	$ 597,454	$ 5,309,530	$ 31,228	$ 3,567,555	$ 128,721	$ 5,128,484	$ 12,080,494	$ 51,577,692	$ 425,052	$ -	$ 5,548,099	$ 84,394,309
152	06/28/23	$ 601,347	$ 5,344,120	$ 31,228	$ 3,589,885	$ 128,721	$ 5,162,935	$ 12,158,100	$ 51,577,692	$ 459,280	$ -	$ 6,499,373	$ 85,552,681
153	07/02/23	$ 605,219	$ 5,378,531	$ 31,228	$ 3,611,934	$ 128,721	$ 5,196,875	$ 12,234,803	$ 51,577,692	$ 494,518	$ 7,003	$ 7,537,357	$ 86,803,882
154	07/05/23	$ 609,070	$ 5,412,759	$ 31,228	$ 3,633,699	$ 128,721	$ 5,230,302	$ 12,310,596	$ 51,577,692	$ 530,723	$ 14,860	$ 8,663,984	$ 88,143,636
155	07/08/23	$ 612,901	$ 5,446,803	$ 31,228	$ 3,655,180	$ 128,721	$ 5,263,214	$ 12,385,471	$ 51,577,692	$ 567,846	$ 23,617	$ 9,880,376	$ 89,573,049
156	07/11/23	$ 616,711	$ 5,480,661	$ 31,228	$ 3,676,374	$ 128,721	$ 5,295,608	$ 12,459,423	$ 51,577,692	$ 605,836	$ 33,312	$ 11,186,759	$ 91,092,324
157	07/14/23	$ 620,499	$ 5,514,329	$ 31,228	$ 3,697,280	$ 128,721	$ 5,327,483	$ 12,532,446	$ 51,577,692	$ 644,633	$ 43,977	$ 12,582,393	$ 92,700,681
158	07/17/23	$ 624,266	$ 5,547,806	$ 31,228	$ 3,717,897	$ 128,721	$ 5,358,837	$ 12,604,536	$ 51,577,692	$ 684,176	$ 55,630	$ 14,065,513	$ 94,396,303
159	07/20/23	$ 628,012	$ 5,581,090	$ 31,228	$ 3,738,224	$ 128,721	$ 5,389,669	$ 12,675,687	$ 51,577,692	$ 724,398	$ 68,282	$ 15,633,294	$ 96,176,297
160	07/24/23	$ 631,735	$ 5,614,178	$ 31,228	$ 3,758,261	$ 128,721	$ 5,419,980	$ 12,745,896	$ 51,577,692	$ 765,230	$ 81,926	$ 17,281,829	$ 98,036,675
161	07/27/23	$ 635,436	$ 5,647,067	$ 31,228	$ 3,778,006	$ 128,721	$ 5,449,768	$ 12,815,158	$ 51,577,692	$ 806,598	$ 96,544	$ 19,006,137	$ 99,972,355
162	07/30/23	$ 639,114	$ 5,679,757	$ 31,228	$ 3,797,459	$ 128,721	$ 5,479,033	$ 12,883,472	$ 51,577,692	$ 848,424	$ 112,105	$ 20,800,191	$ 101,977,196
163	08/02/23	$ 642,770	$ 5,712,245	$ 31,228	$ 3,816,620	$ 128,721	$ 5,507,776	$ 12,950,833	$ 51,577,692	$ 890,629	$ 128,559	$ 22,656,969	$ 104,044,042
164	08/05/23	$ 646,402	$ 5,744,528	$ 31,228	$ 3,835,489	$ 128,721	$ 5,535,998	$ 13,017,241	$ 51,577,692	$ 933,131	$ 145,844	$ 24,568,531	$ 106,164,806
165	08/08/23	$ 650,012	$ 5,776,606	$ 31,228	$ 3,854,065	$ 128,721	$ 5,563,699	$ 13,082,694	$ 51,577,692	$ 975,847	$ 163,884	$ 26,526,117	$ 108,330,564
166	08/11/23	$ 653,598	$ 5,808,476	$ 31,228	$ 3,872,349	$ 128,721	$ 5,590,880	$ 13,147,189	$ 51,577,692	$ 1,018,691	$ 182,587	$ 28,520,263	$ 110,531,675
167	08/15/23	$ 657,161	$ 5,840,136	$ 31,228	$ 3,890,340	$ 128,721	$ 5,617,544	$ 13,210,727	$ 51,577,692	$ 1,061,578	$ 201,851	$ 30,540,942	$ 112,757,921
168	08/18/23	$ 660,700	$ 5,871,585	$ 31,228	$ 3,908,040	$ 128,721	$ 5,643,692	$ 13,273,307	$ 51,577,692	$ 1,104,422	$ 221,564	$ 32,577,710	$ 114,998,661
169	08/21/23	$ 664,214	$ 5,902,821	$ 31,228	$ 3,925,448	$ 128,721	$ 5,669,325	$ 13,334,930	$ 51,577,692	$ 1,147,138	$ 241,603	$ 34,619,868	$ 117,242,989
170	08/24/23	$ 667,705	$ 5,933,842	$ 31,228	$ 3,942,565	$ 128,721	$ 5,694,448	$ 13,395,595	$ 51,577,692	$ 1,189,640	$ 261,841	$ 36,656,636	$ 119,479,913
171	08/27/23	$ 671,171	$ 5,964,646	$ 31,228	$ 3,959,392	$ 128,721	$ 5,719,061	$ 13,455,305	$ 51,577,692	$ 1,231,845	$ 282,145	$ 38,677,315	$ 121,698,521
172	08/30/23	$ 674,613	$ 5,995,233	$ 31,228	$ 3,975,931	$ 128,721	$ 5,743,168	$ 13,514,059	$ 51,577,692	$ 1,273,671	$ 302,383	$ 40,671,461	$ 123,888,160
173	09/03/23	$ 678,030	$ 6,025,600	$ 31,228	$ 3,992,180	$ 128,721	$ 5,766,772	$ 13,571,861	$ 51,577,692	$ 1,315,039	$ 322,422	$ 42,629,047	$ 126,038,593
174	09/06/23	$ 681,422	$ 6,055,746	$ 31,228	$ 4,008,143	$ 128,721	$ 5,789,876	$ 13,628,713	$ 51,577,692	$ 1,355,871	$ 342,135	$ 44,540,609	$ 128,140,157

175	09/09/23	$ 684,789	$ 6,085,670	$ 31,228	$ 4,023,821	$ 128,721	$ 5,812,485	$ 13,684,616	$ 51,577,692	$ 1,396,093	$ 361,399	$ 46,397,387	$ 130,183,903
176	09/12/23	$ 688,131	$ 6,115,371	$ 31,228	$ 4,039,213	$ 128,721	$ 5,834,602	$ 13,739,575	$ 51,577,692	$ 1,435,636	$ 380,103	$ 48,191,441	$ 132,161,713
177	09/15/23	$ 691,448	$ 6,144,846	$ 31,228	$ 4,054,323	$ 128,721	$ 5,856,230	$ 13,793,593	$ 51,577,692	$ 1,474,433	$ 398,142	$ 49,915,749	$ 134,066,406
178	09/18/23	$ 694,740	$ 6,174,096	$ 31,228	$ 4,069,151	$ 128,721	$ 5,877,375	$ 13,846,673	$ 51,577,692	$ 1,512,423	$ 415,427	$ 51,564,284	$ 135,891,809
179	09/21/23	$ 698,005	$ 6,203,118	$ 31,228	$ 4,083,700	$ 128,721	$ 5,898,040	$ 13,898,819	$ 51,577,692	$ 1,549,546	$ 431,881	$ 53,132,065	$ 137,632,816
180	09/25/23	$ 701,245	$ 6,231,912	$ 31,228	$ 4,097,971	$ 128,721	$ 5,918,231	$ 13,950,037	$ 51,577,692	$ 1,585,751	$ 447,442	$ 54,615,185	$ 139,285,415
181	09/28/23	$ 704,459	$ 6,260,476	$ 31,228	$ 4,111,965	$ 128,721	$ 5,937,952	$ 14,000,331	$ 51,577,692	$ 1,620,989	$ 462,060	$ 56,010,819	$ 140,846,694
182	10/01/23	$ 707,648	$ 6,288,810	$ 31,228	$ 4,125,686	$ 128,721	$ 5,957,208	$ 14,049,706	$ 51,577,692	$ 1,655,217	$ 475,705	$ 57,317,202	$ 142,314,823
183	10/04/23	$ 710,810	$ 6,316,913	$ 31,228	$ 4,139,135	$ 128,721	$ 5,976,004	$ 14,098,168	$ 51,577,692	$ 1,688,399	$ 488,356	$ 58,533,594	$ 143,689,020
184	10/07/23	$ 713,946	$ 6,344,783	$ 31,228	$ 4,152,314	$ 128,721	$ 5,994,347	$ 14,145,723	$ 51,577,692	$ 1,720,501	$ 500,009	$ 59,660,221	$ 144,969,484
185	10/10/23	$ 717,056	$ 6,372,420	$ 31,228	$ 4,165,225	$ 128,721	$ 6,012,240	$ 14,192,376	$ 51,577,692	$ 1,751,496	$ 510,674	$ 60,698,205	$ 146,157,334
186	10/14/23	$ 720,140	$ 6,399,824	$ 31,228	$ 4,177,871	$ 128,721	$ 6,029,690	$ 14,238,135	$ 51,577,692	$ 1,781,363	$ 520,369	$ 61,649,479	$ 147,254,512
187	10/17/23	$ 723,197	$ 6,426,992	$ 31,228	$ 4,190,255	$ 128,721	$ 6,046,702	$ 14,283,006	$ 51,577,692	$ 1,810,085	$ 529,126	$ 62,516,689	$ 148,263,692
188	10/20/23	$ 726,227	$ 6,453,925	$ 31,228	$ 4,202,378	$ 128,721	$ 6,063,283	$ 14,326,996	$ 51,577,692	$ 1,837,650	$ 536,983	$ 63,303,094	$ 149,188,178
189	10/23/23	$ 729,231	$ 6,480,623	$ 31,228	$ 4,214,244	$ 128,721	$ 6,079,438	$ 14,370,112	$ 51,577,692	$ 1,864,053	$ 543,986	$ 64,012,465	$ 150,031,793
190	10/26/23	$ 732,209	$ 6,507,083	$ 31,228	$ 4,225,854	$ 128,721	$ 6,079,438	$ 14,412,362	$ 51,577,692	$ 1,889,292	$ 543,986	$ 64,648,972	$ 150,776,838
191	10/29/23	$ 735,160	$ 6,533,307	$ 31,228	$ 4,237,213	$ 128,721	$ 6,079,438	$ 14,453,754	$ 51,577,692	$ 1,913,369	$ 543,986	$ 65,217,088	$ 151,450,956
192	11/01/23	$ 738,084	$ 6,559,293	$ 31,228	$ 4,248,321	$ 128,721	$ 6,079,438	$ 14,494,296	$ 51,577,692	$ 1,936,292	$ 543,986	$ 65,721,489	$ 152,058,841
193	11/05/23	$ 740,981	$ 6,585,041	$ 31,228	$ 4,259,183	$ 128,721	$ 6,079,438	$ 14,533,996	$ 51,577,692	$ 1,958,073	$ 543,986	$ 66,166,958	$ 152,605,298
194	11/08/23	$ 743,852	$ 6,610,551	$ 31,228	$ 4,269,801	$ 128,721	$ 6,079,438	$ 14,572,862	$ 51,577,692	$ 1,978,727	$ 543,986	$ 66,558,307	$ 153,095,165
195	11/11/23	$ 746,695	$ 6,635,822	$ 31,228	$ 4,280,179	$ 128,721	$ 6,079,438	$ 14,610,903	$ 51,577,692	$ 1,998,273	$ 543,986	$ 66,900,297	$ 153,533,235
196	11/14/23	$ 749,512	$ 6,660,855	$ 31,228	$ 4,290,318	$ 128,721	$ 6,079,438	$ 14,648,129	$ 51,577,692	$ 2,016,734	$ 543,986	$ 67,197,578	$ 153,924,190
197	11/17/23	$ 752,302	$ 6,685,648	$ 31,228	$ 4,290,318	$ 128,721	$ 6,079,438	$ 14,684,547	$ 51,577,692	$ 2,034,135	$ 543,986	$ 67,197,578	$ 154,005,593
198	11/20/23	$ 755,065	$ 6,710,201	$ 31,228	$ 4,290,318	$ 128,721	$ 6,079,438	$ 14,720,168	$ 51,577,692	$ 2,050,504	$ 543,986	$ 67,197,578	$ 154,084,899
199	11/23/23	$ 757,801	$ 6,734,516	$ 31,228	$ 4,290,318	$ 128,721	$ 6,079,438	$ 14,755,000	$ 51,577,692	$ 2,065,871	$ 543,986	$ 67,197,578	$ 154,162,149
200	11/27/23	$ 760,510	$ 6,758,590	$ 31,228	$ 4,290,318	$ 128,721	$ 6,079,438	$ 14,789,054	$ 51,577,692	$ 2,080,269	$ 543,986	$ 67,197,578	$ 154,237,385

Center to Watford City - Baseline
CO_2, 16", 2190 psig
Comment Section
V 1.0098

RESOLUTE ENGINEERING

Section	Comments
1 Input	Used only crossed flowlines for boring environmental. Only those that are not within 800' of each other. Used all named flowlines and 50% of unnamed flowlines due to that several flowlines are observed to be active in farming or hayland. They may be wet at times but extensive to include them all.Used only NHD waterbodies that were longer than 700' due to that flowlines are shown in waterbodies at times and would be counted twice. Two of these named flowlines were classified as rivers, so they show up as river crossing input
2 Input	Farm Land mileage comes from Barley - 0.23 miles, Canola - 0.12 miles, Corn - 0.63 miles, Dry Beans - 0.02 miles, Durum Wheat - 0.3 miles, Fallow/Idle Cropland - 0.7 miles, Flaxseed - 0.02 miles, Millet - 0.1 miles, Oats - 0.22 miles, Peas - 0.05 miles, Soybeans - 0.81 miles, Spring Wheat - 8.26 miles, Sunflower - 0.65 miles, Winter Wheat - 0.05 miles
3 Input	Range land mileage comes from Barron - 0.05 miles, and Grassland Pasture - 71.43 miles
4 Input	Residential comes from Developed - Low Intensity and Open Space
5 Input	Trees comes from Dedicous Forest, Evergreen Forest, Mixed Forest, and Shrubland
6 Input	Lake Crossings, including wetands, came from Open water, woody wetlands, and herbaceous wetlands
7 Input	Land Ownership is partially owned by Audubon Wetland Management District, Little Missouri National Grasslands, Little Missouri State Park, National Public and state Lands, and Sakakwea Recreation. There are BLM and USFS Grasing allotments,
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