

May 1, 2019

Executive Secretary
North Dakota Public Service Commission
State Capitol Building
Bismarck, ND 58505-0480

Re: System Safety & Integrity Plan
Case No. PU-17-295

Montana-Dakota Utilities Co. (Montana-Dakota), herewith submits a preliminary report regarding its System Safety and Integrity Plan (SSIP) in compliance with the North Dakota Public Service Commission's (Commission) Order issued in Case No. PU-17-295.

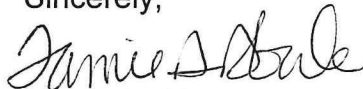
As noted within the report, Montana-Dakota's review of its 2019 SSIP has been completed and based on the risk ratio scores, replacement of early vintage steel pipe, including low pressure systems, will be initiated in Dickinson in 2019. The review of the responses to the Requests for Proposal for construction services is not yet fully completed and therefore 2019 estimated dollars to be spent on replacing mains and services identified as early vintage steel pipe is not available at this time.

The Company will update this report reflecting the final estimates for 2019 along with a proposed cost recovery tariff by July 15, 2019.

Montana-Dakota looks forward to continuing the discussion with the Commission regarding the Company's SSIP and will work with Staff to set up a meeting to discuss the 2019 results in further detail.

Please contact me at (701) 222-7856 or at Tamie.Aberle@mdu.com with any questions regarding this filing.

Sincerely,



Tamie A. Aberle
Director of Regulatory Affairs

Attachments
cc: PU-17-295 Service List

Service List - Electronic

Case No. PU-17-295

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**MONTANA-DAKOTA UTILITIES CO.
System Safety and Integrity Program
North Dakota
May 1, 2019 Preliminary Report**

Background

On July 21, 2017, Montana-Dakota Utilities Co. (Montana- Dakota) or (Company) filed an application to increase rates for natural gas service to provide additional revenue of \$5.9 million or a 5.4% increase in 2018 test year annual revenue at current rates with the North Dakota Public Service Commission (Commission). The Company's application was designated as Case No. PU-17-295.

On July 19, 2018, Montana-Dakota, Advocacy Staff and the Federal Executive Agencies filed a Settlement Agreement resolving all issues of the case except for the implementation of the Company's proposed System Safety and Integrity Program (SSIP) funding mechanism, under a proposed new rate schedule designated as Rate 94, for recovery of SSIP project costs.

On September 26, 2018 the Commission issued its Order in Case No. PU-17-295 approving the Settlement Agreement. The SSIP funding mechanism proposed by the Company under Rate 94 was not a part of the Settlement Agreement and the Commission did not approve the SSIP funding mechanism Rate 94. The Company was ordered to submit a detailed SSIP by May 1, 2019.

The Company herewith provides an update to the SSIP submitted as part of the gas rate case as required in the Commission's September 26, 2019 Order.

Integrity Management Program

Pursuant to Title 49 Part 192.1005, gas distribution operators such as Montana-Dakota, were required to develop and implement an integrity management program that must contain procedures for developing and implementing the following elements¹:

(a) Knowledge. An operator must demonstrate an understanding of its gas distribution system developed from reasonably available information.

(1) Identify the characteristics of the pipeline's design and operations and the environmental factors that are necessary to assess the applicable threats and risks to its gas distribution pipeline.

(2) Consider the information gained from past design, operations, and maintenance.

(3) Identify additional information needed and provide a plan for gaining that information over time through normal activities conducted on the pipeline (for example, design, construction, operations or maintenance activities).

(4) Develop and implement a process by which the IM program will be reviewed periodically and refined and improved as needed.

(5) Provide for the capture and retention of data on any new pipeline installed. The data must include, at a minimum, the location where the new pipeline is installed and the material of which it is constructed.

(b) Identify threats. The operator must consider the following categories of threats to each gas distribution pipeline: corrosion, natural forces, excavation damage, other outside force damage, material or welds, equipment failure, incorrect operations, and other concerns that could threaten the integrity of its pipeline. An operator must consider reasonably available information to identify existing and potential threats. Sources of data may include, but are not limited to,

¹ CFR §192.1007.

incident and leak history, corrosion control records, continuing surveillance records, patrolling records, maintenance history, and excavation damage experience.

(c) Evaluate and rank risk. An operator must evaluate the risks associated with its distribution pipeline. In this evaluation, the operator must determine the relative importance of each threat and estimate and rank the risks posed to its pipeline. This evaluation must consider each applicable current and potential threat, the likelihood of failure associated with each threat, and the potential consequences of such a failure. An operator may subdivide its pipeline into regions with similar characteristics (e.g., contiguous areas within a distribution pipeline consisting of mains, services and other appurtenances; areas with common materials or environmental factors), and for which similar actions likely would be effective in reducing risk.

(d) Identify and implement measures to address risks. Determine and implement measures designed to reduce the risks from failure of its gas distribution pipeline. These measures must include an effective leak management program (unless all leaks are repaired when found).

(e) Measure performance, monitor results, and evaluate effectiveness.

(1) Develop and monitor performance measures from an established baseline to evaluate the effectiveness of its IM program. An operator must consider the results of its performance monitoring in periodically re-evaluating the threats and risks. These performance measures must include the following:

(i) Number of hazardous leaks either eliminated or repaired as required by §192.703(c) of this subchapter (or total number of leaks if all leaks are repaired when found), categorized by cause;

(ii) Number of excavation damages;

(iii) Number of excavation tickets (receipt of information by the underground facility operator from the notification center);

(iv) Total number of leaks either eliminated or repaired, categorized by cause;

(v) Number of hazardous leaks either eliminated or repaired as required by §192.703(c) (or total number of leaks if all leaks are repaired when found), categorized by material; and

(vi) Any additional measures the operator determines are needed to evaluate the effectiveness of the operator's IM program in controlling each identified threat.

(f) Periodic Evaluation and Improvement. An operator must re-evaluate threats and risks on its entire pipeline and consider the relevance of threats in one location to other areas. Each operator must determine the appropriate period for conducting complete program evaluations based on the complexity of its system and changes in factors affecting the risk of failure. An operator must conduct a complete program re-evaluation at least every five years. The operator must consider the results of the performance monitoring in these evaluations.

(g) Report results. Report, on an annual basis, the four measures listed in paragraphs (e)(1)(i) through (e)(1)(iv) of this section, as part of the annual report required by §191.11. An operator also must report the four measures to the state pipeline safety authority if a state exercises jurisdiction over the operator's pipeline.

The Company has submitted its Distribution Integrity Management Program (DIMP) to the Commission's Pipeline Safety Staff since 2011 as required by CFR Title 49 Part 192.1007. The results of the metrics set forth in subsection (e) of CFR Title 49 Part 192.1007, are reviewed annually with the Commission's Pipeline Safety Staff at the time of the annual inspection.

As set forth above, the objective of the DIMP is to develop a model to assist in determining which areas of the gas distribution system to focus replacement,

maintenance, and repair efforts and resources due to known or predicted threats to the distribution system.

The model assesses nine different threat categories: Corrosion, Natural Forces, Equipment Failure, Material Failure, Excavation Damage, Incorrect Operation, Weld/Joint Failure, Outside Force, and Other all equally weighted.

A detailed geographical information system (GIS) map, with every piece or component that makes up the gas distribution system, both above and below ground, and with as much information about each piece as is available is used as the basis of the model. Scores for various factors were determined by a group of Company subject matter experts including engineers and field technicians.

The model sets a 50-foot by 50-foot grid to analyze all components. Each grid is then analyzed by eight individual sub-models with up to 150 calculations in each sub-model. This in turn produces a very comprehensive look at the entire system with each component compared equally to the others across the entire four state operating areas. In North Dakota, 23.4 million feet of pipe was analyzed with approximately 5.16 million calculations to support the risk model.

The DIMP results are used as an operational tool to aid in directing resources to reduce pipeline risks. The results are consistently analyzed to determine accelerated actions to the pipeline so that changes to resource planning and budgeting can be made to carry out the reduction in risks from pipeline threats.

The Company incorporated its DIMP requirements into a System Safety and Integrity Program (SSIP). The current SSIP, attached hereto as Exhibit 1 was submitted in Case No. PU-17-295 in MDU Hearing Exhibit No. 3, as part of the rebuttal testimony submitted by Patrick Darras, Vice President of Operations and Engineering and Services for Montana-Dakota. The SSIP provides an explanation of the DIMP model calculations, including the relative risk scores and the performance metrics.

The DIMP model data was updated in 2019, as it will be each year, by an internal Integrity Department group comprised of Subject Matter Experts where updates will be made each year to 1) document progress from the prior year and 2) reassess the risk attributed to each community to determine if the course of replacement should be modified for the upcoming construction year.

As discussed in Case No. PU-17-295, the Early Vintage Steel Pipe (EVSP) systems were primarily constructed with larger bore steel pipe for mains, ranging from 4" – 12" in diameter and either welded or often times joined by mechanical couplings. Low Pressure Distribution systems are primarily constructed with Early Vintage Steel Piping. Service lines were also constructed using steel pipe and connected to the distribution main with a combination of welding and mechanical means and finally meter sets were typically installed inside buildings in the Low-Pressure Distribution Systems. In a Low-Pressure Distribution System, the delivery pressure outside the home or business is equal to the pressure within the home or business and individual service regulators are not installed unlike distribution systems installed in more recent years

where the outside pressure is typically at 5-60 pounds of pressure and an individual regulator is used to reduce the pressure to 4 to 6 ounces before natural gas enters the premises. Although the practice was prevalent in earlier years, today's installation practices and materials are much more resilient.

The incident occurring in Merrimack Valley, Massachusetts on September 13, 2018 was a Low-Pressure Distribution System much like the Low-Pressure Systems present in portions of Montana-Dakota's distribution systems located in Bismarck, Mandan, Dickinson and Williston, North Dakota equating to 65 miles of distribution main and 5,315 service lines. Early Vintage Steel and Early Vintage Plastic Pipe low-pressure distribution systems are also present in portions of Montana-Dakota's service area in Montana, South Dakota and Wyoming.

As also discussed in the rate case, Montana-Dakota defines its Early Vintage Plastic Pipe as that plastic pipe installed prior to 1995. It is then further broken down into two categories, pre-1983 and post 1982. This break is significant because better resin began to be used in the manufacture of EVPP in 1983. Falling under the Early Vintage Plastic Pipe definition is a pipe type called "Aldyl A" that is present in Montana-Dakota's distribution systems. The National Transportation Safety Board has advised that there is a potential susceptibility of plastic pipe installed between 1960 and the early 1980's to premature failure due to brittle-like cracking.

The Company is partnering with the Gas Technology Institute to complete a study of the Early Vintage Plastic Pipe in order to 1) estimate the remaining life of this pipe and 2) quantify and incorporate relative risks associated with the Early Vintage Plastic Pipe into the DIMP. The Gas Technology Institute (GTI) is the leading research, development and training organization addressing energy and environmental challenges to enable a secure, abundant, and affordable energy future. For more than 75 years, GTI has been providing economic value to the natural gas industry and energy markets by developing technology-based solutions for industry, government, and consumers.

GTI's research initiatives address issues impacting the natural gas and energy markets across the industry's value chain—supply, delivery, and end use. GTI offers an integrated systems perspective to expand the supply of affordable energy, ensure a safe and reliable energy delivery infrastructure, and promote the efficient use of energy resources. To date, GTI programs have resulted in nearly 500 products, 750 licenses and more than 1,300 associated patents.

The GTI Scope of Work Framework for Montana-Dakota's project provided in Exhibit 2 and the Company's documentation of the Early Vintage Plastic Pipe study is provided as Exhibit 3. GTI has developed comprehensive risk models for plastic piping systems over the past decade through multiple proprietary projects funded by gas distribution companies across North America and several publicly available projects

sponsored by the Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA). The methods developed in these projects have been successfully deployed in several risk models that address multiple utility specific threats to plastic distribution systems.²

A sample process was established by GIS based on vintages and pipe size.³ Forty-four samples from within Montana-Dakota's service areas were submitted to GTI based on designated sample locations in North Dakota and Montana, as identified by GTI. See Exhibit 3. Of these samples, 22 were from 1973-1983 vintage, and 22 were from 1984-1993 vintage. In North Dakota the Badlands Region covers the area east of New Salem to the Montana border. The laboratory evaluation procedures are outlined in the GTI Scope of Work on Pages 4-5.

All samples were sent to GTI on April 12, 2019. GTI estimates sample study will take anywhere from 6 to 8 months upon receipt of the samples. The 1970-1972 EVPP was not included in the samples, as GTI has explained that enough research has been done on this vintage of pipe to support replacement.

2018 DIMP Projects

In calendar year 2018 the Company conducted Early Vintage Steel mains and service lines replacement projects in North Dakota in the communities of Glen Ullin, New Salem

² GTI *Method for Developing an Initial Risk Profile for Aldyl-A Piping Systems* issued March 16, 2018 (GTI Scope of Work), Page 2.

³ GTI Scope of Work, Page 4.

and Fairview and Early Vintage Plastic Pipe was replaced in Barlow and portions of Eldrige. The 2018 expenditures for the SSIP projects equated to approximately \$5.1 million. The projects in New Salem, Glen Ullin and Fairview will be completed in 2019.

2019 DIMP Projects

The Company is planning to start an EVSP and EVPP low pressure distribution system replacement project in Dickinson, North Dakota based on the 2019 Risk Ratio review explained above. A summary of the Risk Ratios attributable to each community in North Dakota is provided in Exhibit 4. As noted, 150.4 miles has been identified as requiring replacement. Given the amount of pipe to be replaced, the Dickinson SSIP is planned as a three to five-year project.

Montana-Dakota ensures that the costs of the projects are reasonable through 1) using a competitive bidding process with multiple contractors and 2) closely watching costs to stay within the budgeted amounts or determine why expenditures were different from the budget. The Request for Proposals were issued in early April 2019 and the bid proposals are under review.

Commission Advocacy Staff's witness Karl Pavlovic advocated that "MDU has not demonstrated that its 2018 SSIP infrastructure replacement projects will replace infrastructure that is "known for higher risks as identified by the Company's Distribution Integrity Management Plan." ⁴ The Company's plan set forth above considered the concerns identified by Advocacy Staff and the Commissioners during the technical hearing in Case No. PU-17-295 in development of a more thorough SSIP for

⁴ Karl Pavolich's direct testimony submitted in Case No. PU-17-295 at page 5.

consideration by the Commission for the future. There are several factors that provide for a clear basis for the Commission to determine a systematic pipeline replacement plan, and applicable rate recovery, is prudent and in the best interest of customers, including but not limited to the risk of EVSP, including low pressure distribution systems as identified based on the 2018 DIMP data used to rank risk and identify individual systems for replacement documented in this report and the Company's partnership with GTI in thoroughly analyzing and assessing the risk of the Early Vintage Plastic Pipe systems as also reported here. Regarding recovery of the costs necessary to systematically replacing the aging pipeline systems, the Company can file rate cases on an annual basis or a cost recovery mechanism may be employed to alleviate the cost and time burden associated with filing frequent rate cases.

SSIP Adjustment Mechanism Rate 94

SSIP Adjustment Mechanism Rate 94 was submitted in Case No. PU-17-295 as a means of providing cost recovery for the SSIP replacement projects and reflected an annual spend of approximately \$6 million for the current SSIP year. Commission Advocacy Staff and the other intervenors in the last rate case opposed the recovery mechanism and as noted above the proposed recovery mechanism was not a part of the Settlement Agreement.

Mr. Pavlovic identified several attributes that an acceptable accelerated recovery mechanism should have, including a filing fee for Commission use to assist in determining the prudence and reasonableness of the projects, a cap on the total annual cost recovery, a benchmark concerning Company earnings to trigger further review and

a requirement that after a certain period the project costs be taken out of the recovery mechanism and put into base rates.⁵

The Company is not opposed to including each of the items noted in the Commission's Order in its cost recovery mechanism. The timing of the Commission's Order and the filing deadline for this report to the Commission did not provide the time necessary to discuss the nuances of the recovery mechanism tariff with Staff however, the Company is committed to doing so as the Commission considers the systematic replacement plans identified today and as necessary into the future in order to meet the requirements set forth in Title 49 Part 192.1005 of Federal Code.

In summary, Montana-Dakota looks forward to presenting the information contained in this report to continue and expedite the effective and efficient replacement of the Company's aging natural gas systems in order to continue providing safe and reliable service to its customers.

⁵ Finding of Fact #19 of the North Dakota Public Service Commission's Order issued on September 26, 2018 in Case No. PU-17-295.

System Safety & Integrity Program (SSIP)



MDU/GPNG Engineering Department

Revision 1 – 3/15/2018



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PURPOSE OF SSIP

Develop a structured replacement program for early vintage steel pipeline (EVSP) and early vintage plastic pipeline (EVPP) natural gas distribution systems. Incidental to the pipe replacement, inside meter sets connected to the corresponding services will also be removed to a safer outside location.

DEFINITIONS

DIMP – Distribution Integrity Management Program

Early Vintage Plastic Pipe (EVPP) – Plastic mains, service lines, and associated fittings installed earlier than 1/1/1995.

- *Pre-1983: These pipelines include pipe installed prior to 1/1/1983 that may be susceptible to possible Low Ductile Inner Wall (LDIW) characteristics that can result in slow crack growth and slit failures¹, as documented by PHMSA–2004–19856.*
- *Post-1982: These pipelines were installed between 1/1/1983 and 12/31/1994 and are classified as EVPP to account for different inventory levels and rates of new material adoption among the varying districts in MDU/GPNG.*

Early Vintage Steel Pipe (EVSP) – Steel mains, service lines, and associated fittings installed earlier than 1/1/1970. These pipelines are being slated for replacement to eliminate aging and/or obsolete pipelines, bare steel or poorly coated pipe, pipe with unknown attributes or missing data, gas meters located indoors, and/or mechanical couplings and fittings.

DIMP MODEL CALCULATIONS

Total Relative Risk Calculation

Risk is the product of the likelihood of an event occurring multiplied by the consequence of the event, as shown in Equation 1.

*Equation 1. **Total Relative Risk Score = Total Likelihood Score x Consequence Factor***

The DIMP model sums the assigned likelihood scores for each threat to calculate a total likelihood factor within a 50-foot grid (raster). The same summing calculation is also done for each of the assigned consequence factors within the same 50-foot grid. The total Likelihood is then multiplied by the total consequence factor to establish a total relative risk score for the grid.

¹DEPARTMENT OF TRANSPORTATION Pipeline and Hazardous Materials Safety Administration [Docket No. PHMSA–2004–19856]



Example 1. DIMP Model Total Risk Score Calculation

Please note that example threat scores and consequence factors have been used to further clarify the calculation of total risk.

Table 1. Example Total Likelihood Score

THREAT	EXAMPLE THREAT SCORE		LIKELIHOOD FACTOR		LIKELIHOOD SCORE
Corrosion	0	X	0.7	=	0.0
Natural Forces	5	X	1.0	=	5.0
Excavation Damage	10	X	1.5	=	15.0
Other Outside Force Damage	15	X	0.9	=	13.5
Material, Weld or Joint Failure	20	X	Material: 0.9	=	18.0
	20	X	Weld/Joint Failure: 1.2		24.0
Equipment Failure	25	X	0.9	=	22.5
Incorrect Operation	30	X	1.0	=	30.0
Missing Data	35	X	1.5	=	52.5
Other	SME Determined	X	SME Determined	=	SME Determined
Total Likelihood Score					180.5

Table 2. Example Consequence Factor

CONSEQUENCE	EXAMPLE CONSEQUENCE SCORE		MODEL FACTOR*		CONSEQUENCE FACTOR
Population Density & Location	8	X	0.1	=	0.8
Potential Energy	2	X	0.1	=	0.2
Critical infrastructure Size & Location	10	X	0.3	=	3.0
Consequence Factor					4.0

*The model factor is used to scale the consequence factor, allowing stratification of total scores

Total Relative Risk Score = Total Likelihood Score (180.5) x Consequence Factor (4.0)

Total Relative Risk Score = 722

EXPLANATION OF PERFORMANCE METRICS

SSIP performance metrics are developed using DIMP outputs, as shown in Example 1, as well as SME input. This allows MDU to utilize measurable data that is consistent, repeatable, reproducible, and comparable. This data is transparent and scalable across entire MDU system. Leveraging SME expertise gives MDU flexibility to adapt to pipeline safety and operational concerns through the project selection process.



PROJECT SELECTION CRITERIA / PROCESS

Risk Ratio

To allow for comparison of relative risk between systems, a normalized total relative risk score is used. This normalized score is referred to as the “risk ratio” and is the DIMP total relative risk score normalized by the total pipe length of a selected system. The risk ratio is calculated using Equation 2.

$$\text{Equation 2.} \quad \text{Risk Ratio} = \frac{\sum(\text{Total Relative Risk Score} \times \text{Pipe Length})}{\sum \text{Pipe Length}}$$

Prioritization of Projects

SSIP projects selection criteria will be based on risk ratio results and SME input. The risk ratio will be the primary selection criteria. Replacement projects with higher risk ratios will be the priority. Projects with similar scores may be reprioritized based on SME discretion. Factors that may lead to reprioritization include:

- Resource availability (staffing, materials, equipment, etc.)
- Contractor availability
- City/State infrastructure improvement projects (forced relocate, cost savings)
- Budget

Timetable

The prioritization methods described in Prioritization of Projects will be used to develop a rolling five-year replacement plan. This plan will be reviewed annually with primary focus being on the current working year. Projects to be completed during the current working year must be fully-developed and include detailed plans, permits, contracts, and any requisitions. Projects included in the remaining 4 years of the plan may not be fully developed and are subject to reprioritization as described in Prioritization of Projects. The hierarchy of the SSIP is illustrated in Figure 1.

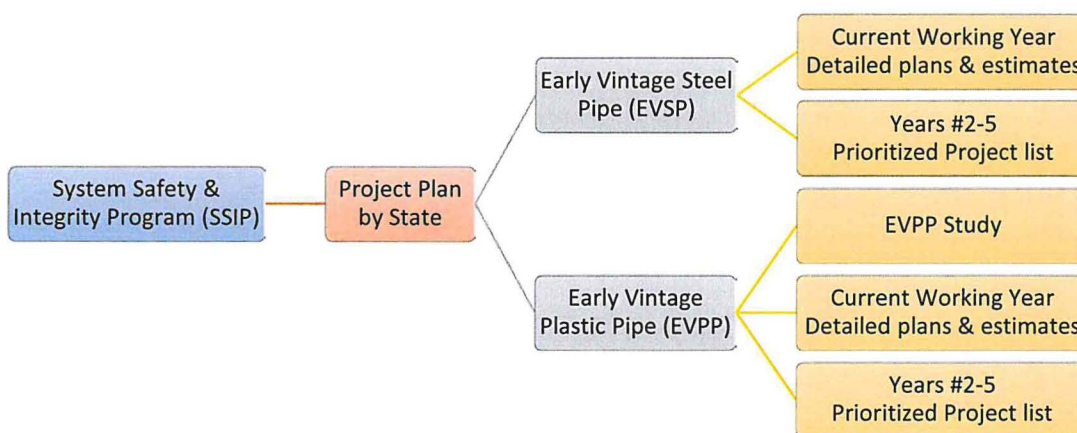


Figure 1. System Safety & Integrity Program (SSIP) Hierarchy Chart

Exhibit A: Statement of Work

GTI SCOPE OF WORK (SOW) FRAMEWORK

Method for Developing an Initial Risk Profile for Aldyl-A Piping Systems

Proposal No.: 74415

Proposal Issued: July 9, 2018

Submitted To:

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Introduction

MDU contacted GTI to determine what assistance GTI could offer in evaluating the remaining useful life expectancy and the corresponding pressure-carrying capacity of various vintages of Aldyl-A pipe material installed in several gas distribution systems operated by MDU. On February 2nd the following RFP was received from MDU:

Montana-Dakota Utilities Co. and its sister company Great Plains Natural Gas Co. (MDU/GP) operate natural gas distribution systems in 197 towns across five states. Based on GIS data, these systems are comprised of approximately 11,676 miles of distribution pipelines. And of these, roughly 28%, or 3260 miles, are identified as Early Vintage Plastic Pipe (EVPP) installed before 1994. These EVPP fall into one of four categories based on installation date: 1970-1972 (elevated LDIW potential), Pre-1983 (excluding 1970-1972), 1983-1994, and unknown installation date.

MDU/GP is seeking a proposal to assist in the development and implementation of a study of its distribution system, especially EVPP. The primary goals of the study are to: 1) estimate the remaining life of MDU/GP's EVPP infrastructure, and 2) improve how relative risks between pipeline segments are quantified and incorporate the improved methods into MDU/GP's Distribution Integrity Management Program (DIMP).

A follow up conference call was held in the afternoon of February 23, 2018 to gather additional information and describe GTI capabilities regarding evaluation of Aldyl-A piping.

Background

GTI has developed comprehensive risk models for plastic piping systems over the past decade through multiple proprietary projects funded by gas distribution companies across North America and several publicly available projects sponsored by DOT PHMSA¹. The methods developed in these projects have been successfully deployed in several risk models that address multiple utility specific threats to their plastic distribution systems. The models can:

1. Provide estimates of the remaining life of EVPP
2. Provide a method for ranking the relative risks between pipeline segments
3. Be integrated into GIS systems to provide segment specific risk estimates based on available data, and provide credible risk ranges as a best estimate in the absence of segment specific data

GTI has executed several information gathering projects to estimate risk drivers over multiple geographic areas. The sampling methods developed in these projects are designed to provide sound probabilistic estimates of region specific risk drivers that can guide mitigation and further

¹ <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=643&s=26A683834C1945B4B56CCA8E413F323D&c=1>
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=554&s=26A683834C1945B4B56CCA8E413F323D&c=1>
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=194>

information gathering efforts. Based on this experience it is GTI's view that the preferred approach to addressing the MDU RFP is to integrate the GTI vintage plastic pipe risk models directly into the MDU GIS system and to conduct an adaptive sampling plan to develop the prior estimates of EVPP risk across the areas of interest. This prior estimate will be superseded by segment specific data that can be input into the GIS database due to directed information gathering efforts, or opportunistic information gathering over time.

Proposed Scope of Work

Task 1: GIS Data Development and Risk Model

GTI will require an updated set of GIS data (Esri format, geodatabase) for the areas of investigation and any relevant system data to carry out the risk model integration. In previous projects, GTI has typically provided clients with access to the database, models and analytics via secure web portal during the development and analysis phases of the project to facilitate collaboration and to train the customer on the use of the models.

The following components will be required to conduct the risk modelling for MDU:

1) Mobile Data Collection

GTI will develop two separate mobile data collection applications using the Esri Survey123 platform to be used for the following purposes:

Field Data/SME Input: This application will be configured to allow subject matter experts (SMEs) the ability to provide specific institutional knowledge about the gas systems in the subject geographic areas. This data will be collected for portions of the gas system that are identified as 'unknown' with the MDU GIS data.

Pipe Samples: This application will act as the documentation tool for pipe samples collected for analysis and updating the risk model. This application will allow users to identify the geographic location where a pipe sample was collected and additional attributes about the sample.

2) Obtain and Setup GIS Data

This task will work with MDU to obtain GIS data and configure it within the GTI geodatabase environment.

3) Integrate Risk Models into the GIS

GTI will develop integration with the appropriate risk model developed for the MDU project and automate GIS data processing to allow MDU to run their own data once the integration is built for the first three geographic areas.

4) Develop and Customize Web Application

GTI will develop a custom web application based on Esri technology. The application is intended to allow MDU to visualize and interact with the resultant data from the risk models developed for the project. In addition, the capability to allow MDU to build scenarios and run iterative models is expected to be developed in this task.

Task 2: Sampling Plan

GTI will work with MDU to develop the most appropriate geographic sampling plan. GTI employs a Bayesian probabilistic approach to field sampling and evaluation. The Bayesian method learns more about system attributes with each successive sampling and provides a robust method for determining the credibility bounds of the analysis results based on the number of data points. GTI suggests an initial sample size of 22 in each region of interest. If the condition we are sampling for is not found in 22 samplings we can state with 80% confidence that no more than 10% of the unsampled system is likely to test positive for the condition. If the condition is found in the 22 samples the actual number of occurrences define the credibility bounds for the result. If the calculated credibility bounds are not acceptable to the customer, further sampling is required until the stipulated acceptable credible bounds are met.

Task 3: Evaluation of Samples

In-Field Tasks and Evaluation

Twenty-two (22) random pipe samples each measuring 2-feet long will be removed from each designated geographical location by MDU.

Laboratory Evaluation

- 1) Photographic documentation of all the exhumed pipe samples
- 2) Dynamic Thermo-Mechanical Analysis (DTMA) testing designed to reveal the creep/relaxation behavior of the material will provide a complete understanding of the visco-elastic characteristics of the material being tested.
 - a. Bi-directional shift factors will allow investigators to properly shift accelerated test results to operational temperatures.
 - b. Knowing the temperature and strain rate dependencies of each pipe sample (size) will allow investigators to calculate stress intensification factors for specific installations more precisely. This is essential in estimating the remaining residual life of the installations.
- 3) Perform microscopic examinations on selected specimens.
 - a. Fourier Transform Infrared (FTIR) spectroscopy will be performed on selected specimens of Aldyl-A pipe before any hydrostatic pressure testing to determine if organic materials not associated with the pipe material formulation and/or oxidation products, resulting from improper processing or aging, are present. Samples will be grouped based on the results of the FTIR.
 - b. Cross polarized light microscopy (CPLM) will be performed on selected specimens of Aldyl-A pipe to examine the distribution of the spherulitic structure of the pipe materials across the wall of the pipe. The characteristics of the spherulites are related to polymer formulation and processing and affect the SCG characteristics of the pipe.

- c. Scanning Electron Microscopy (SEM) will be performed on samples depicting abnormal spherulitic structure (based on CPLM examinations) to examine the structure of the Aldyl-A pipe after it has been exposed by careful use of relief cuts. SEM is very useful for examining the inner wall surface at high magnification to identify sites of Slow Crack Growth (SCG) initiation due to poor spherulitic structure. The resolution and depth of field is far greater with SEM than with light microscopy methods resulting in images that capture key features of micro fractures. Energy Dispersive X-ray analysis (EDX) collects x-rays emitted from the SEM to identify elements.
- 4) Oxidation Induction Time (OIT) profiles across the sampled pipe wall will be developed
- 5) Bend-back testing will be performed on selected specimens of Aldyl-A pipe to qualitatively determine the presence of low inner pipe wall ductility.
- 6) Hydrostatic pressure testing will be performed in general accordance with PPI TN-16:2008 *Rate Process Method for Projecting Performance of Polyethylene Piping Components*. The intent of this testing will be to validate the categorizing of the sampled pipe based on the tests performed in 4 and 5 described above. The test results will be referenced to the prediction bounds developed over the years by GTI (~1,500 reference data points). The 22 samples extracted from each region will
- 7) Analysis and reporting will be completed on each grouping of aged Aldyl A specimens. The development of data sets will allow for the calculation of the probability of system failure due to Slow Crack Growth (SCG). This information will provide risk profiling information that can be used in conjunction with Aldyl A leak and failure data to identify threats and prioritize risk.
- 8) Other tests deemed appropriate for additional information

Budget Estimate

Based on similar evaluations we have performed in the past the estimated cost of this testing will be billed on a **time and materials basis**. We have established a Not to Exceed (NTE) amount (without additional authorization) as follows:

No of Geographical Locations Sampled	No. of Pipe Specimens Tested	Estimated Budget
One area	22	\$196,705

Please note that the formal proposal will be provided by GTI’s Proposal Center.

Additional consulting services such as conference calls, interim reports, etc. are not specifically included, but can be supplied as needed on the same T&M basis at additional cost. Please let the GTI Project Manager know if you require these additional services and we can give you an estimate of the cost.

Schedule Estimate

Based on our current work load we anticipate that we can complete this work within 6-8 months from the receipt of the samples and a fully-executed contract.

Project Deliverables and Communication Method

- Execute the proposed scope of work
- Risk model integrated into a GIS database
- Draft Final Report and conference call to review the report
- Final Report
- Communications via e-mail and telephone

Qualifications

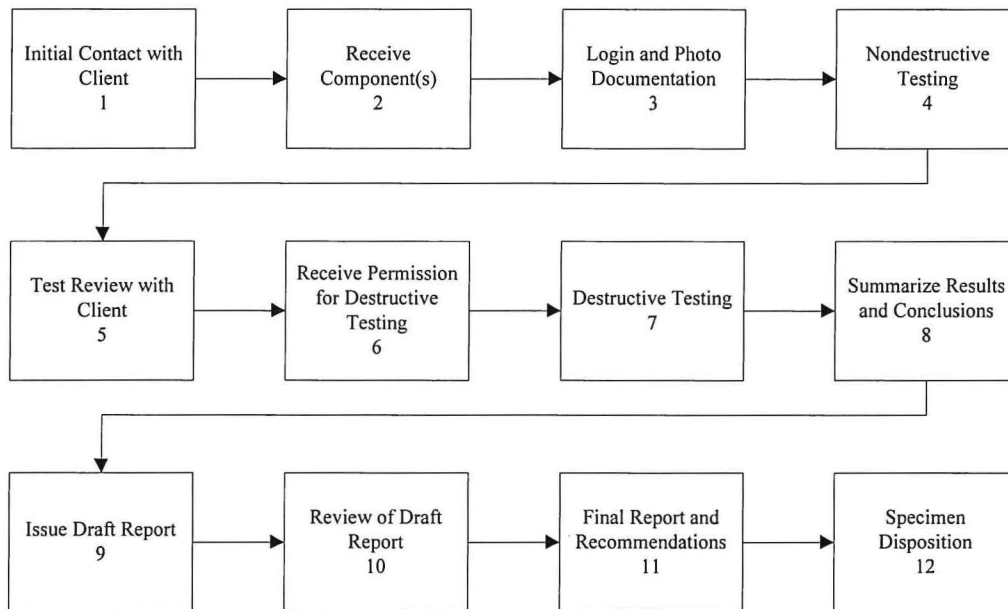
GTI is an independent not-for-profit organization serving research, development, and training needs of the natural gas industry and energy markets. GTI is dedicated to meeting the nation's energy and environmental challenges by developing technology-based solutions for consumers, industry, and government. GTI is located on an 18-acre site in the Chicago suburb of Des Plaines, Illinois. The facility houses nearly 250 of GTI's professional and support staff, and all the equipment necessary to support this program. GTI currently manages approximately \$60 million in government and industrial research and development contracts per year (over 100 projects), and has been managing contracts of this type since the 1940s.

While GTI provides services for a wide variety of industries, its unique expertise has historically focused on the natural gas and energy industries. It is estimated that GTI's research on polyethylene (PE) pipe has saved the gas industry more than \$500 million since 1994. The staff in GTI's plastic materials group has more than 100 years of experience, and has published more than 300 reports, technical papers, and studies on plastic pipe topics. Maintaining the integrity of plastic piping systems is critical in the operation of many industries.

GTI holds an A2LA Accreditation to ISO 17025 for its laboratory procedures, including failure analysis.

GTI General Analysis Flow for Test Specimens

A failure analysis will typically follow the process outlined below.



1. Initial Contact with Client

- Establish scope of testing, formulate protocol
- Agree on test protocol
- Determine specimens to be tested
- Establish schedule

2. Receive Components

- Store specimens and/or components to be used in testing

3. Login and Photo Documentations

- Enter specimen data into Lab Information Management System (LIMS)
- Generate photo record of specimens (as received)

4. Nondestructive testing

- Perform nondestructive testing
- Perform data analysis

5. Test Review with Client

- Review nondestructive testing results. Adjust protocol as required.

6. Receive Permission for Destructive Testing

- Verification with client to proceed with destructive testing

7. Destructive Testing

- Perform destructive testing
- Perform data analysis

8. Summarize Results and Conclusions

9. Issue Draft Report and obtain client feedback.
10. Review of Draft Report
11. Final Report and Recommendations
12. Specimen Disposition
 - Disposition options are:
 - Store samples 60 days, then discard or return
 - Store samples for more than 60 days, requires storage contract
 - Return to client with final report

The enclosed "GTI Sample Submission Form" must be filled and provided before commencement of work.



GTI TESTING LABORATORIES
1700 South Mount Prospect Road | Des Plaines, Illinois | 60018



GTI Sample Submission Form

Please submit this form with the shipped sample(s) to:

Attention of Tony Kosari/Natalya Bates, GTI, 1700 South Mount Prospect Road, Des Plaines, Illinois 60018

Description of Sample(s):

Pipe/Fitting and Design Information:

- Pipe/Fitting Information:
 - a) Print line (exactly as appears on pipe):

 - b) Pipe/Fitting Diameter (nominal O.D. in inches): ____ in.
 - c) SDR: _____
 - d) Resin: _____ (e.g., PE 2406, PE 3408, etc.)

- *Design* or intended operating parameters:
 - a) Design Pressure: _____ psig MAOP
 - b) Design Temperature: _____ °F in below ground applications
 - c) Media Inside Pipe: _____
 - d) Comments:

Service Information:

- Actual *service* conditions (if same as design parameters state "same"):
 - a) Service Pressure: _____ psig
 - b) Maximum Pressure the pipe/fitting was exposed to: _____ psig during pressure test
 - c) Service Temperature (ground temperature): Approximately _____ °F
 - d) Media Inside Pipe/Fitting: _____
 - e) Pipe/Fitting was pressure tested with _____ (air, nitrogen, methane, etc.) at _____ psig for _____ hours and _____ minutes

f) Comments:

• Time or total usage to fracture (when was the pipe/fitting placed into service and when did it fail):

- a) Placed in service on ___ / ___ / ___
- b) Ambient temperature during installation: ___ °F
- c) Installation method: _____ (e.g., directly laid, horizontal drill, etc.)
- d) Exhumed on ___ / ___ / ___
- e) Comments:

• Environmental details:

- a) Soil Type Pipe/Fitting was buried in: _____ (e.g., clay, loam, rocky, sandy)
- b) Comments:

• Evidence of abuse or 3rd party damage:

Leak Report/Service Orders/Field Data:

- Is an "Installation Field Service Order" available? If yes, attach a copy.
- Is a "Failure Report" available? If yes, attach a copy.
- Brief history of the sample prior to delivery to GTI (i.e., chain of custody):

This laboratory maintains A2LA accreditation to ISO/IEC 17025 for specific tests listed in A2LA Certificates 2139-01 and 2139-04, and meets the relevant quality system requirements of ISO 9000:2008.

End of Document

Early Vintage Plastic Pipe (EVPP) Study Overview



Integrity Engineering Department

2/12/2019

OVERVIEW

The EVPP Study is considered a preliminary survey and investigation (PS&I). The work order will capture GTI program requirements and allow the Utility Group the option of placing costs to O&M or Capital based on the study results. The study will identify LDIW characteristics, resin formulations, and remaining life of the EVPP within the utility group. Data collected will allow the Integrity Dept. to more accurately assign risk weighing to EVPP within the DIMP model based on the results of the study.

The Construction Services Dept. will be responsible for collecting and completing all “Map Book Samples” to the requirements and timeline outlined in the EVPP packet. Construction Services responsibilities include -

- Completion Deadline - Friday, April 5, 2019
- Utilize WO #260184 to capture all applicable costs
 - Labor
 - Contract Services
 - Materials
 - Site Restoration
 - Etc.
- Download & train staff on mobile collection app (Survey123)
- Knowledge and understanding of Map Book information
- Train staff to understand and identify soil types via “Soil Texture By Feel Flowchart”
- Physical extraction and collection per requirements stated in the attached document
 - In-House or 3rd party contractor
 - Some areas may require the use of ground thawing technology to facilitate extraction
 - Bypass requirements include a “like for like” approach to be utilized
- Knowledge and understanding of proper protocol if a primary sample cannot be exhumed

Early Vintage Plastic Pipe (EVPP) Study Sample Collection Information



Integrity Engineering Department

2/12/2019



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PURPOSE OF EVPP STUDY

Develop and implement of a study of MDU/GP EVPP distribution systems to –

- 1) Estimate the remaining life of MDU/GP's EVPP infrastructure
- 2) Quantify and incorporate relative risks of EVPP into MDU/GP's Distribution Integrity Management Program (DIMP)

BACKGROUND

MDU has partnered with the Gas Technology Institute (GTI) to complete the EVPP study. A sampling plan has been developed and laboratory testing will be performed on each sample collected. Twenty-two (22) samples from each of the following categories will be tested within the Badlands Region.

- 1) Pre-1983 Aldyl-A (22)
- 2) Post-82 Aldyl-A. (22)

*The year 1983 is significant due to manufacturer changes of Aldyl-A resin

Testing of 22 samples in each category will yield -

- 1) Negative - 80% confidence that no more than 10% of the un-sampled system is likely to test positive for the condition
- 2) Positive - Actual number of occurrences define the credibility bounds
- 3) Remaining Life of pipe categories

SAMPLE COLLECTION REQUIREMENTS

Several Districts have collected samples of Aldyl-A that they wish to have included in the EVPP study. For clarity, samples will be divided into two categories:

- 1) *Map Book Sample* – Sample locations identified by **GTI Map Books**
- 2) *Non-Map Book Sample* – Samples collected before creation of EVPP study – **not in Map Books**

Map Book Sample Requirements

- Responsible Department – Construction Services
- Due Date – samples must be received by **Friday, April 5, 2019**.
- Cost Tracking – Work Order # **260184** – “EVPP PS&I Study MDU” will be used to track the costs
- Physical Sample Requirements - Each pipe sample collected for this project must:
 1. Be 2 feet in length
 2. Include the complete and legible print line, if possible
 3. Have the “Pipe Sample Location ID” written legibly on the pipe in permanent marker
 4. Be photographed according to the requirements of the Survey123 app:
 - a. Soil type the Pipe/Fitting was buried in
 - b. Pipe section prior to removal from line
 - c. Pipe sample after removal from line
 - d. Picture line after pipe sample has been removed & line was repaired
 - e. Pipe sample ID written on pipe
 - f. Print line



5. Samples are to be replaced with piping of the same size as what was removed
- The Survey 123 smartphone app will be used to collect Field Sample Information (page 5)
 - Additional Resources
 1. Construction Services Dept. will be responsible for **Map Book** samples collection
 - a. Extraction process (fittings, bypass requirements, etc.)
 - b. Assignment of work to MDU crews or contractor
 - c. Questions & answers
 - d. Inaccessible sample locations – request backup location through Construction Services to Integrity Engineering
 2. Map Books from GTI detailing sample locations will be provided (page 8)
 3. A “Soil Texture by Feel Flowchart” is included to assist in soil classification (page 11)

Non-Map Book Sample Requirements

- Responsible Department – Integrity Engineering
- Due Date – samples must be received by **Friday, March 22, 2019**.
- Cost Tracking – Work Order # **260184** – “EVPP PS&I Study MDU” will be used to track the costs
- Physical Sample Requirements - Each pipe sample collected for this project must:
 1. Be 2 feet in length
 2. Include the complete and legible print line, if possible
 3. Be labelled in permanent marker with the following information:
 - a. Sample ID- Town name & sequential numbering (e.g., Willison #1, Williston #2, etc.)
 - b. Date sample was removed from the system
 4. Include a complete copy of the “Pipe Sample Data Collection Information” form (page 8)
 5. Include a map showing the exact location (± 50 ft) from where the sample was extracted
 6. Provide a copy of the installation order, if available.
 7. If sample does not meet criteria, do not submit/ship sample
- Additional Resources
 1. Integrity Engineering Dept. will be responsible for **non-Map Book** samples
 - a. Digitizing information from Data Collection Form into Survey123 app
 - b. Questions & answers
 2. A “Soil Texture by Feel Flowchart” is included to assist in soil classification (page 11)

Sample Submittal and Shipping

Pipe samples and associated paperwork are to be sent to:

Montana-Dakota Utilities
Attn: Kris James
718 Steele Ave.
Rapid City, SD 57701



FIELD COLLECTION FORM (SURVEY123) INSTRUCTIONS

Download and Access Survey Form

- 1.) Download the Esri Survey123 Application to your smart/mobile device via:
 - a. Play Store (Google/Android)
 - b. App Store (Apple/iOS)
 - c. Windows Store (Microsoft)
- 2.) Access the Survey123 Application by clicking on the Survey123 icon on the smart/mobile device.
- 3.) Once the Survey123 Application loads, click on the three horizontal lines in the upper right-hand corner to Sign into the Survey123 application:
Username: gti_pp1
Password: GTI_!700
- 4.) After you have Signed In, click on the Download Surveys Tab. Download the Pipe Sample Field Data Collection Form survey by clicking on the cloud button to the right of the survey.
- 5.) Once the survey has been downloaded, navigate to the My Surveys home screen to launch the Pipe Sample Field Data Collection Form survey by tapping on it.



Collect and Submit

- 1.) Click on the Collect button to start inputting data for the current survey.
- 2.) Start answering the survey questions.
- 3.) Navigate through the survey by clicking on the Blue Arrow buttons at the bottom of the page to move forward and back.
- 4.) Submit a completed survey by clicking on the Blue Checkmark on the last page of the survey.
- 1.) To capture a GPS location, either click on the GPS target icon in the upper right-hand corner of the map or tap on the map display screen to type in an address.



GPS Location and Camera Tools

- 2.) To take a picture, tap on the Gray Camera icon to bring up the camera option and then click on Blue Camera icon to capture the picture of the feature.
- 3.) To upload a picture from a file, click on the Gray Folder icon.
- 4.) Left Icon = Flash, Center Icon = Flip Camera, Right Icon = Capture GPS Location of Photo.





SURVEY123 SCREENS

Survey123 for ArcGIS

Pipe Sample Field Data Collection Form

Pipe Sample Data Collection Information:

Date and Time of Collected Pipe Sample: *

; February 8, 2019 10:50 AM

GPS Location of Collected Pipe Sample: *

44°14'N 103°24'W ± 176 m

Drag map to drop pin or use crosshair icon to use current location

Sampling Plan Number: *

1
 2
 3
 4
 5

Plan #1 – Default Map Book
Plan #2 – Backup Map Book

Select Plan #1 unless instructed by engineering to do otherwise

Pipe Sample Location ID: *

Use later as the Pipe Sample ID

(From Map Book)

Name of Individual Collecting the Pipe Sample: *

(Your Name)

Notes:

1 of 4

Survey123 for ArcGIS

Pipe Sample Field Data Collection Form

Pre-Sample Removal Information:

Environmental Details:

Soil Type Pipe/Fitting was Buried in: *

Clay
 Loam
 Rocky
 Sandy
 Unknown
 Other

Take Picture of Soil Type *

Comments:

Are there Roots, Rocks, or Impingement Points Present? *

Comments:

Is there any Evidence of Abuse or Third Party Damage? *

Comments:

2 of 4





Survey123 for ArcGIS

Pipe Sample Field Data Collection Form

Pipe Sample Removal Details:

▼ Removal Details:



Take Picture of Pipe Section Prior to Removal from Line *

Comments:

Take Picture of Pipe Sample after Removal from Line *



(Include Tape Measure in Picture for Pipe Length Reference:)

Comments:

Take Picture of Line after Pipe Section Sample has been Removed *

(Picture of the In-ground Line after Removed Pipe Sample has been Replaced:)

Comments

Was Backfill Completed? *

Yes
 No
 Unknown

Comments

3 of 4



Pipe Sample Field Data Collection Form

Post-Sample Removal Information:

▼ Pipe/Fitting Information:



Pipe Sample ID: *
Select Pipe Sample ID and Write it on the Removed Pipe Sample:

Take Picture of Sample ID on Pipe Sample *
(Include Tape Measure in Picture for Pipe Length Reference:)

Print Line: *
Exactly as it appears on pipe:

Take Picture of Print Line on Pipe Sample *

Pipe/Fitting Diameter: *
Nominal O.D. in inches:

SDR: *

Resin: *

Is there an Apparent Bend in the Pipe? *

Yes
 No
 Unknown

Has the Pipe been Repaired? *

Yes
 No
 Unknown

Has the Pipe been Squeezed-off? *

Yes
 No
 Unknown

Comments

4 of 4

Repair & Squeeze off questions are about pipe history, not the work required to collect samples



Pipe Sample Data Collection Information

Name of Individual who collected sample: _____

Date & Time of Collected Pipe Sample: _____ (Date) _____ (Time)

Pipe Sample ID (e.g., Williston #1): _____

Soil Type Pipe/Fitting was Buried In:

Clay Loam Rocky Sandy Unknown Other

Is there any Evidence of Soil Movement? Yes No Unknown

Are there Roots, Rocks, or Impingement Points Present? Yes No Unknown

Is there any Evidence of Abuse of Third Party Damage? Yes No Unknown

Has Backfill been completed? Yes No Unknown

Print Line: (Exactly as it appears on pipe: _____)

Pipe/Fitting Diameter: (Nominal OD in inches): _____

SDR: 0.154 0.156 10 11 11.5 13.5 Unknown Other

Resin: Aldyl-A MDPE Unknown Other

Is there an Apparent Bend in the Pipe? Yes No Unknown

Has the Pipe been previously repaired? Yes No Unknown

Has the Pipe been previously squeezed-off? Yes No Unknown

Is sample from main or service line? Main Service

In-service/Installation Date: _____

Installation Method: Directly Laid Horizontal Drill Unknown Other

Max Operating Pressure: _____ Min Operating Pressure: _____

Pressure Test Media Air Nitrogen Methane Unknown Other

Pressure Tested at _____ psig for _____ hours and _____ minutes

Comments:

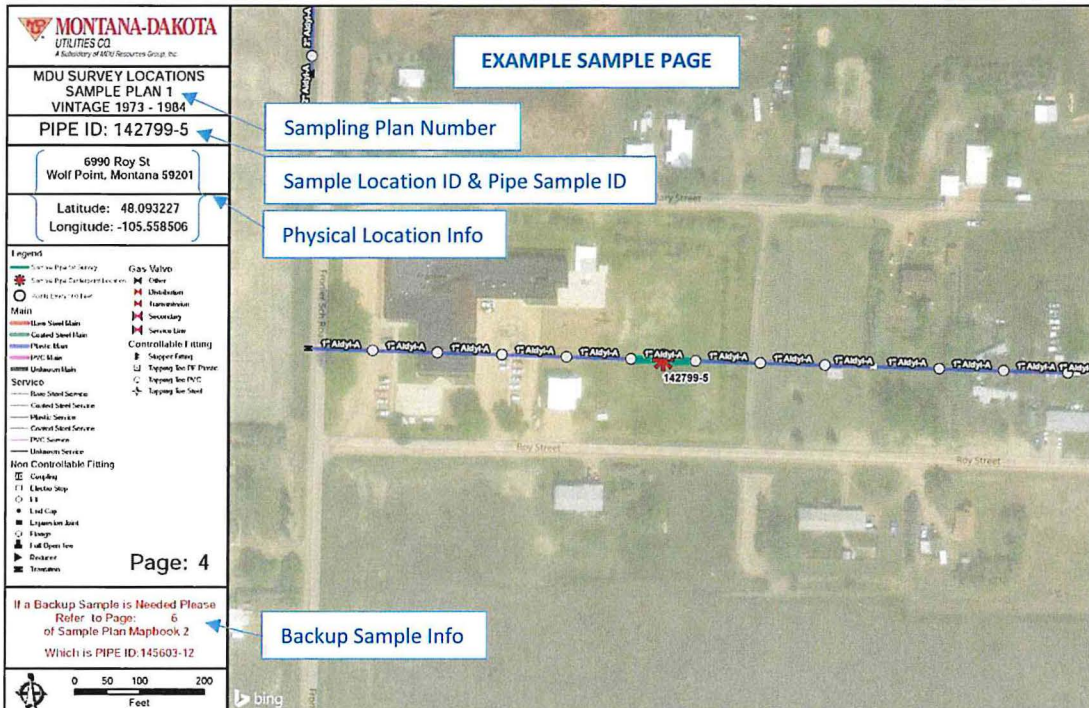
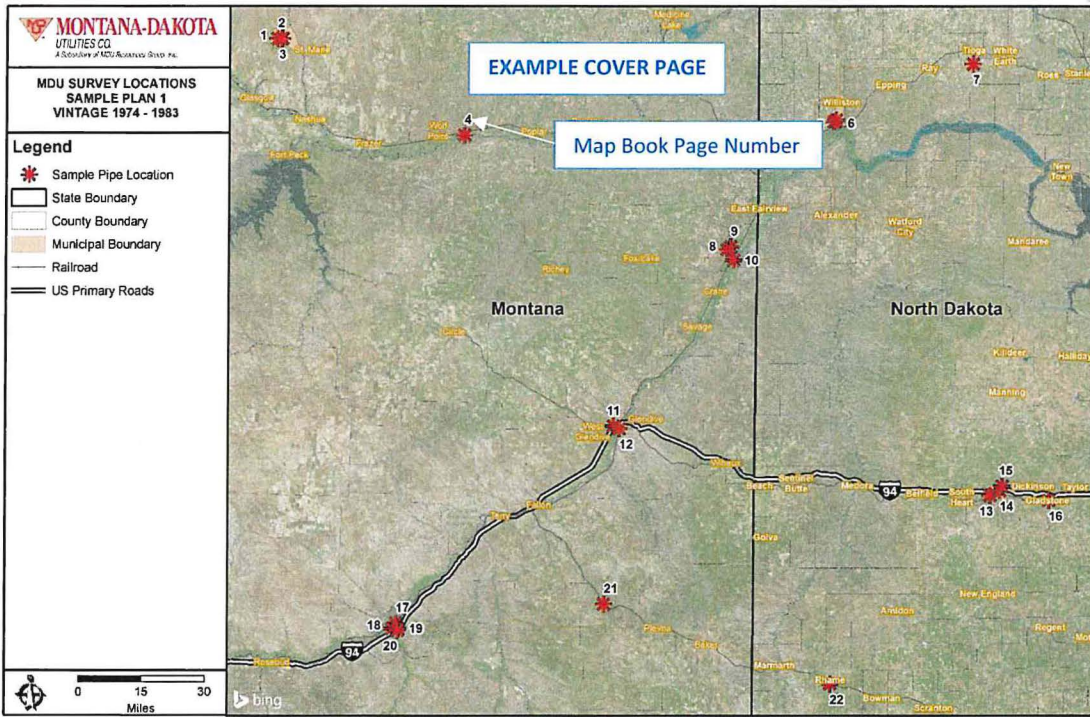
Attach a map showing the exact location of sample removal (± 50 ft). Map Attached? Yes No

Attach original install order, if available. Order attached? Yes No



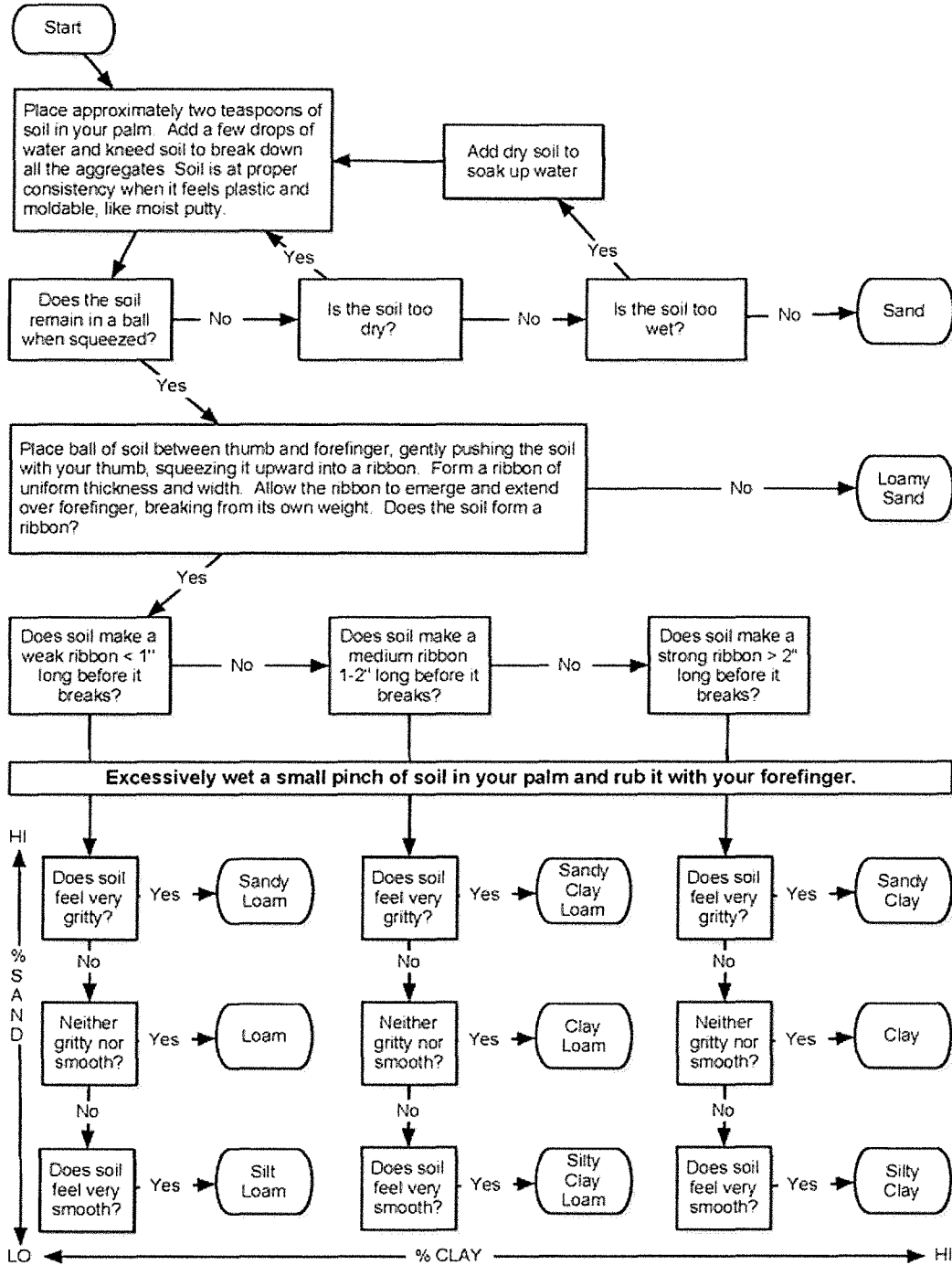
MAP BOOK INFORMATION

Map books are provided by GTI. Each book contains a cover page that shows the approximate location of each sample and one additional page for each sample that shows details about that sample. Due to conflation, the GPS coordinates provided on each map sheet may or may not land exactly on the pipe segment desired. In these instances, it is important that the sample collected be 1) as near as possible (+/- 50ft) to the location, and 2) be the same size, material, and vintage described on the map sheet. If the first sample location is inaccessible, please request a backup location through the Construction Services Dept. An example of each type of map book page follows.





SOIL TEXTURE BY FEEL FLOWCHART



Early Vintage Plastic Pipe - Sample List

9-Apr-19

Count	GTI Location ID	Town	State	District	Pipe Size	Install Date
1	136931-4	Williston	ND	Williston	2	1/1/1988
2	134436-3	Williston	ND	Williston	2	1/1/1989
3	139142-3	Trenton	ND	Williston	2	1/1/1993
4	147197-3	Miles City	MT	Glendive	1.25	1/1/1982
5	139950-13	Tioga	ND	Williston	4	1/1/1993
6	165611-12	Miles City	MT	Glendive	2	7/15/1977
7	138008-1	Williston	ND	Williston	2	1/1/1979
8	148265-1	Miles City	MT	Glendive	2	1/1/1978
9	149693-4	Glendive	MT	Glendive	2	1/1/1987
10	156133-9	Glendive	MT	Glendive	1.25	1/1/1992
11	154495-3	Terry	MT	Glendive	2	1/1/1993
12	154475-1	Terry	MT	Glendive	1.25	1/1/1992
13	150884-4	Glendive	MT	Glendive	2	1/1/1976
14	156075-50	Glendive	MT	Glendive	2	1/1/1993
15	153946-4	Terry	MT	Glendive	2	1/1/1993
16	150672-21	Glendive	MT	Glendive	3	1/1/1980
17	149676-2	Glendive	MT	Glendive	2	1/1/1993
18	156061-1	Sentinel Butte	MT	Glendive	2	10/9/1990
19	142752-12	Saint Marie	MT	Wolf Point	2	1/1/1979
20	156041-1	Beach	ND	Glendive	4	1/1/1988
21	155423-4	Ismay	ND	Glendive	2	7/13/1977
22	142415-5	Saint Marie	MT	Wolf Point	4	1/1/1983
23	164237-3	Belfield	ND	Dickinson	3	1/1/1988
24	145668-13	Saint Marie	MT	Wolf Point	4	1/1/1983
25	142799-5	Wolf Point	MT	Wolf Point	1	1/1/1983
26	144724-1	Wolf Point	MT	Wolf Point	2	1/1/1989
27	157510-1	Belfield	ND	Dickinson	2	1/1/1986
28	164256-4	Belfield	ND	Dickinson	2	9/4/1974
29	168503-1	Gladstone	ND	Dickinson	2	1/1/1980
30	156304-3	Sidney	MT	Glendive	2	1/1/1983
31	156737-7	Sidney	MT	Glendive	2	1/1/1980
32	154158-6	Sidney	MT	Glendive	2	1/1/1984
33	159053-3	Dickinson	ND	Dickinson	2	1/1/1981
34	140780-2	Williston	ND	Williston	4	1/1/1985
35	133902-1	Williston	ND	Williston	2	1/1/1985
36	137730-4	Williston	ND	Williston	4	1/1/1981
37	165316-2	Bowman	ND	Dickinson	2	1/1/1991
38	164590-11	Marmath	ND	Dickinson	2	1/1/1988
39	163542-2	Dickinson	ND	Dickinson	2	1/1/1979
40	163392-6	Dickinson	ND	Dickinson	2	6/22/1976
41	138015-3	Williston	ND	Williston	2	1/1/1980
42	162040-6	Marmath	ND	Dickinson	1.25	1/1/1988
43	162759-1	Rhame	ND	Dickinson	1.25	1/1/1989
44	162804-3	Rhame	ND	Dickinson	1.25	1/1/1982

Total by State

ND	23
MT	21
	<u>44</u>

Total by District

Dickinson	12
Glendive	18
Williston	9
Wolf Point	5
	<u>44</u>

Exhibit 4

ND	Risk Ratio	Length (miles)
Hettinger*	23.4	3.3
New Salem*	22.4	11.4
Taylor	18.8	0.1
Minot Air Force Base (712)*	18.7	33.1
Dickinson	17.5	150.4
Mandan	17.0	137.8
Glen Ullin*	15.6	11.5
Bismarck	15.5	372.8
Lefor	13.9	1.2
Wheellock	13.9	1.2
Epping	13.6	2.3
Killdeer	13.6	0.1
New England	13.6	10.0
Williston	13.6	150.4
Palermo	13.2	1.9
Springbrook	13.0	1.1
Steele	12.8	10.2
Mott	12.7	15.7
White Earth	12.3	1.8
Regent	12.3	5.1
Minot	12.3	310.8
Berthold	12.1	7.2
Des Lacs	11.9	2.8
Riverdale	11.8	5.5
Lincoln	11.6	15.0
Fairview*	11.3	2.9
Max	11.2	6.5
Arnegard	11.2	2.9
Washburn	11.1	20.0
Valley City	11.1	26.9
Wilton	11.0	9.5
Jamestown	11.0	77.9
Ruthville	10.9	2.2
Garrison	10.9	16.3
Watford City	10.2	31.4
Devils Lake	10.1	39.1
Lignite	10.0	2.3
Turtle Lake	10.0	10.1
Eldridge	10.0	0.7
Alexander	9.9	6.7
Underwood	9.9	12.0
Belfield	9.7	14.8
Ray	9.7	8.9
Grafton	9.6	47.5
Walhalla	9.6	18.7
Langdon	9.5	29.5
Portal	9.3	5.4
Sanborn	9.3	5.0
Sheyenne	9.3	6.1

ND	Risk Ratio	Length (miles)
Judson	9.2	0.6
Stanley	9.2	20.5
Tioga	9.2	19.7
Barlow	9.2	0.5
North Almont	9.1	0.1
Dawson	9.1	3.6
Medina	9.0	10.2
Tappen	8.9	4.5
Rawson	8.9	0.1
Cleveland	8.8	4.0
Park River	8.8	25.0
Linton	8.8	0.0
Gladstone	8.7	0.8
Carrington	8.6	11.9
Cavalier	8.6	25.0
Burlington	8.5	16.9
New Rockford	8.5	8.5
South Heart	8.2	4.8
Ross	8.1	0.5
Fargo	8.1	1.5
Apple Valley	8.0	11.1
Surrey	8.0	6.5
Bowman	7.6	24.4
Hebron	7.3	12.9
Richardton	7.3	2.7
Ft. Totten	7.2	8.7
Cartwright	7.0	0.8
Beach	7.0	16.8
Trenton	6.7	8.9
Rhame	6.6	4.8
ADM Velva	6.5	0.3
Golva	6.5	2.6
Marmarth	6.4	3.8
Menoken	6.3	0.7
Prairie View Heights	6.3	1.0
Sentinel Butte	6.2	2.8
ND Total	13.0	1933.4

NOTES:

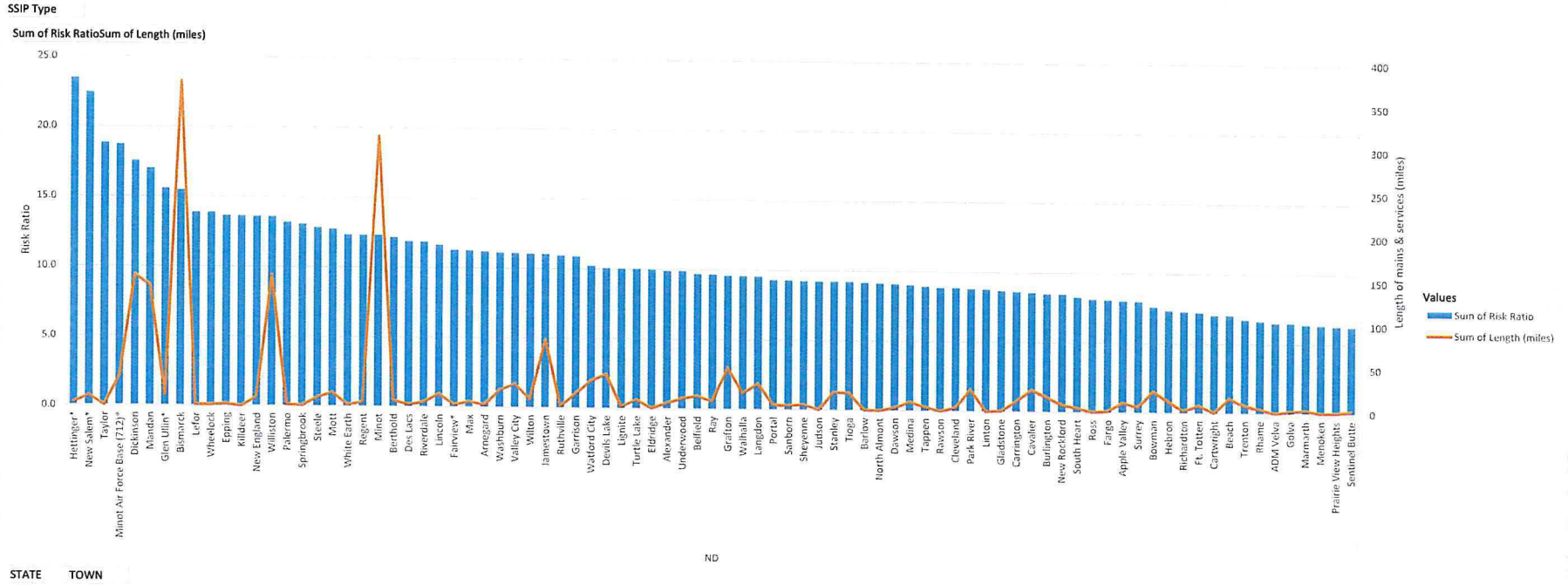
Hettinger - RR score modified to account for propane consequence factor

MAFB - Contracted operation

Fairview - 2018

New Salem - 2018 carry over

Glen Ullin - 2018 carry over



***Hettinger, ND - Propane adjustment**

Hettinger, ND has an isolated system which is run entirely on propane, it has an elevated consequence factor (+0.7). The adjustment to the risk ratio below is necessary because fuel type cannot feasibly be changed as an SSIP project.

Propane Risk Ratio	Non-propane Risk Ratio
23.4	14.8

Row Labels	Length (miles)	Breakdow n (%)
Total ND System	4639	100.00%
ND System (SSIP)	1933.4	41.68%
ND System (NON SSIP)	2705.6	58.32%
Dickinson SSIP (ALL) vs ND SSIP	150.4	7.78%
Dickinson SSIP (2019) vs ND SSIP	17.8	0.9%
2019 ND SSIP vs Dickinson SSIP (ALL)	-	11.80%