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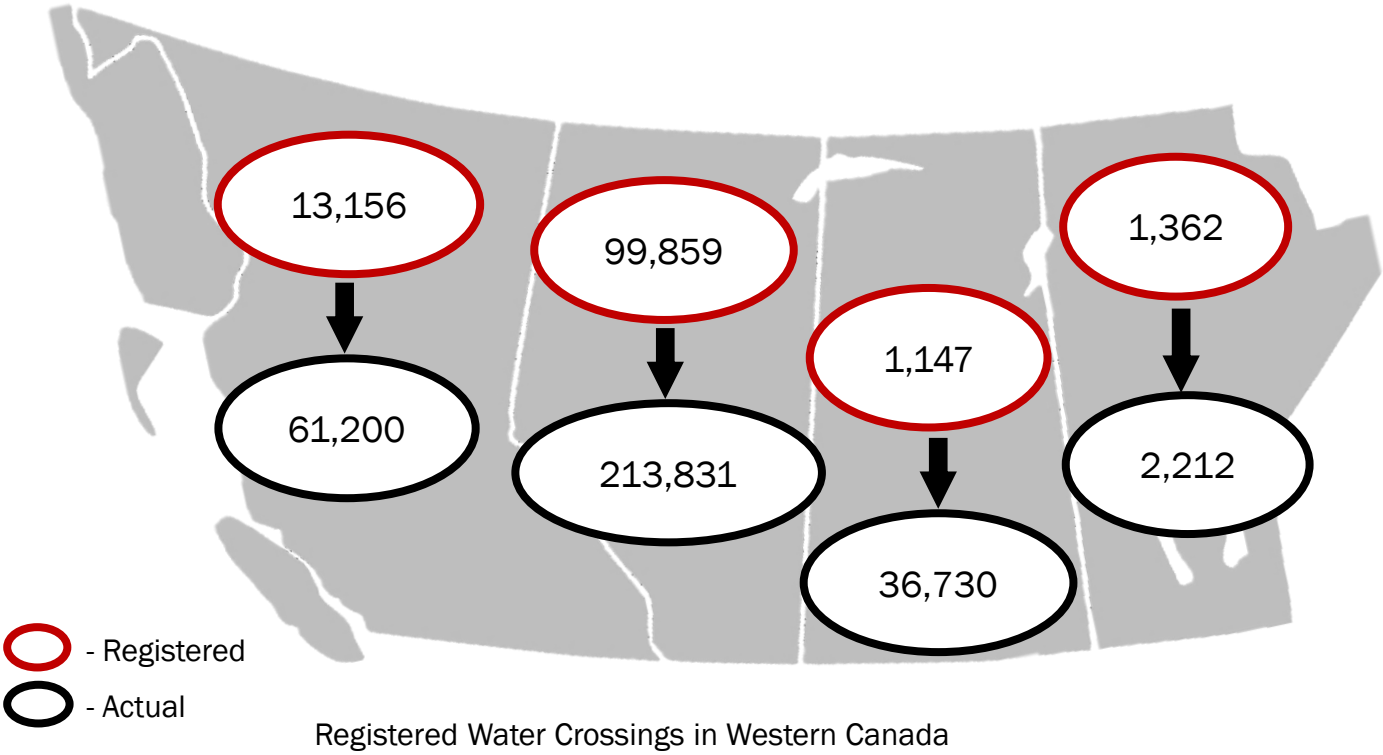
The 4-Step Guide to Effective Pipeline Water Crossing Management

Contents

Why Focus on Water Crossings?

In recent years, there have been several high-profile pipeline releases that impacted water bodies. In addition to the effect on public safety and the environment, these types of events also negatively impact the operating company's public image, and may come with significant financial impact or enforcement action by regulators. And so, it comes as no surprise that pipeline water crossings are an important part of creating an overall pipeline integrity program.

However, there are many challenges when it comes to defining and implementing a successful water crossing program. The first challenge may simply be, "where do I begin?" And, while it seems like this should be easy, in fact, this can be a very difficult question to answer. Defining a water body and identifying the associated pipeline crossings comes with a series of complexities and challenges. It's not enough to rely on the Environmental Classification code on a registered pipeline. Of the close to 314,000 pipeline water crossings in Western Canada, only around 115,000 currently have a water crossing designed as part of their Environmental Code classification.



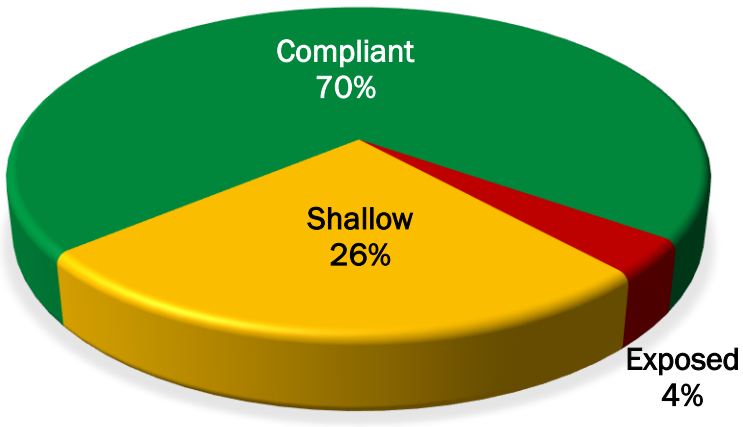
Registered Water Crossings in Western Canada

The number of pipeline water crossings that are registered as having an Environmental Code classification is significantly lower than the number of actual pipeline water crossings that exist in Western Canada.

Source: GDM Pipelines

This is concerning for two reasons. First, there is potential that these un-registered crossings are not known to the operators and are therefore not being accounted for as part of their integrity program.

Second, and possibly more alarming, is that based on close to 8,500 water crossing inspections that were completed by Explore Inc. between 2010 and 2018, roughly 30% were shown to have a shallow depth of cover (less than 1.2 m), or to be completely exposed. If these are the results we are seeing for known crossings, imagine what issues might be lurking with crossings which have not been identified and incorporated into an inspection program.



Water Crossing Compliance

Inspections completed on 8,474 water crossing locations in BC, Alberta and Saskatchewan between 2010 and 2018 showed 30% of known crossings were shallow or exposed.

Source: Explore Inc.

So, how can we go about identifying pipeline water crossings, assessing their associated risk and implementing best practices to ensure we are managing them as effectively as possible?

In this paper, we will offer insight into the proven 4-step process for managing pipeline water crossings. This includes highlighting regulatory requirements across Western Canada, as well as taking a closer look at how water crossings are classified.

Creating a 4-Step Program

As with any integrity process, it is important to apply a set of continuous, repeatable steps that will help you to implement and enforce best practices.

When it comes to pipeline water crossing inspection programs, these steps are **Plan → Do → Check → Apply**. Each of these 4 steps includes a series of actions to implement and follow to ensure your program is as effective as possible.

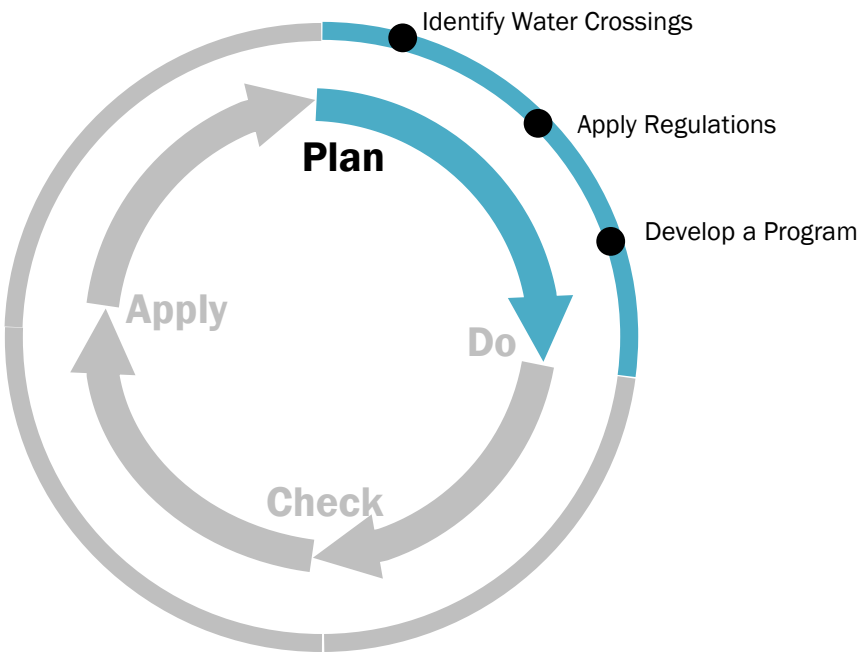
Next, we will examine each of these steps in more detail.

Step 1: Plan

Plan: Identify Water Crossings

Generating an effective plan begins with first identifying your crossing inventory. However, as mentioned above, simply relying on the registered Environmental Crossing indications may not be enough.

A pipeline with an indicated crossing may not actually have one, or a pipeline that does have a water crossing may not be licensed accordingly.



Traditional Water Crossing Scale Classifications

1:1,000,000
typically includes named waterbody crossings that have year-round water

1:250,000
includes anything that shows up on a 1:1,000,000 scale, plus smaller unnamed water crossings with year-round water

1:50,000
includes anything that shows up on a 1:250,000 scale, plus any smaller unnamed crossings with seasonal water as opposed to year-round water

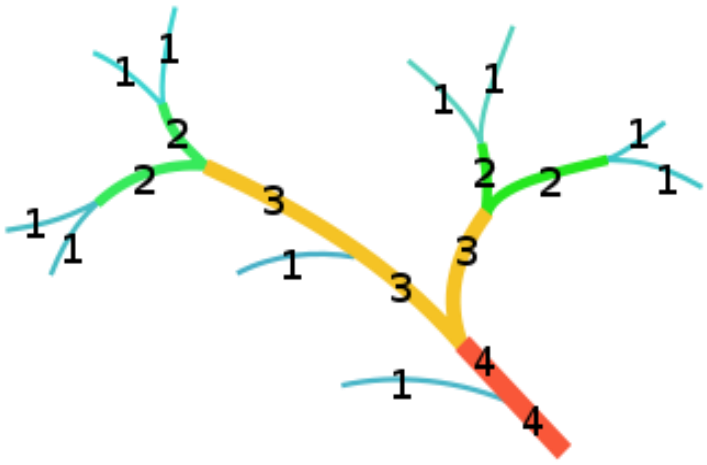
Traditionally, water crossing classifications have been based on the scale of the water body impacted by the pipeline crossing. This scale is based on a subjective interpretation of whether a body of water would appear on a map at a designated scale. The most common scales are 1:1,000,000, 1: 250,000 and 1:50,000.

Historically, the regulatory requirements have been to register an Environmental Crossing for any crossing which would appear at a 1:1,000,000 scale. However, this definition does not have an objective standard, and is left to the interpretation of the viewer of the map. Further, this subjective interpretation may also be based on old or incorrect source data. When using this as a guideline, you may miss crossings altogether, or the significance of the crossing may be understated.

Therefore, it is important to analyze your entire pipeline inventory to identify and validate crossings. This includes working with a more objective approach to classifying the size of a waterbody.

One approach to doing this is to apply the Strahler Stream Order classification. This allows you to identify and classify the size of streams based on their number of tributaries.

Highlight: Strahler Stream Order - A Better Way to Classify Crossings



When we apply Strahler Stream Order to hydrology, each waterbody is assigned a number. This begins by giving the outermost tributaries an order of 1.

If two bodies of the same order merge, the resulting stream is given a number that is one higher. If two bodies with different stream orders merge, the resulting stream is given the higher of the two numbers.

Applying this objective scoring system gives us a more accurate depiction of the relative size of a waterbody to help assess the priority of any associated pipeline water crossings.

Plan: Apply Regulations

With the potential for errors that comes with simply using a 1:1,000,000 scale to identify crossings, regulatory requirements are constantly being updated to provide additional clarity and guidance to ensure safe operations.

While most of the guidelines in Canada are provided as part of CSA Z662, there are also some additional requirements put forth by the Alberta Energy Regulator (AER) and the National Energy Board (NEB).

CSA Z662
According to CSA Z662-15, there are requirements for the design, operations and maintenance of pipeline water crossings.

			Cover for buried pipelines, minimum, m	
Location	**Type of pipeline**	**Class location**	**Normal excavation**	**Rock excavation requiring blasting or removal by comparable means**
General (other than as indicated below)	LVP or gas HVP or CO2 HVP or CO2	Any 1 2, 3, or 4	0.60 0.90 1.20	0.60 0.60 0.60
Right-of-way (road or railway)	Any	Any	0.75	0.75
Below travelled surface (road)	Any	Any	1.20	1.20
Below base of rail (railway) - Cased - Uncased	 Any Any	 Any Any	 1.20 2.00	 1.20 2.00
Water crossing	Any	Any	1.20	0.60
Drainage or irrigation ditch invert	Any	Any	0.75	0.60

CSA Z662-15 Section 4.11 Table 4.9
This section provides guidance for coverage requirements for pipelines, and specifically for water crossings.

Section 4.11 addresses coverage requirements for pipelines, specifically related to pipeline water crossings. Regardless of Class location, a minimum of 1.2 m cover is required for any pipeline water crossing. However, even this requirement must be scrutinized further. Waterbodies have the potential to move or change over time, depending on environmental conditions. In Alberta, there are also additional requirements to design water crossings for scour potential in the event of one in one-hundred-year flood conditions. So, in some cases, even 1.2 m of coverage may not be adequate. That's why it's so important to have a plan in place to manage and mitigate risk in event of changing conditions.

When it comes to the frequency of inspections, Section 10.6.11 of the CSA Z662 standards indicates that operating companies shall *periodically* patrol their pipelines to observe conditions and activities that could affect the safety of pipeline operations.

Further, Section 10.6.4.2 requires that underwater crossings be inspected for adequacy of cover, accumulation of debris and other conditions that could affect the safety or integrity of the crossings.

All provincial regulatory bodies require that pipelines are constructed, operated and maintained in accordance with these CSA Z662 standards. The Alberta Energy Regulator and National Energy Board have some additional requirements:

Alberta Energy Regulator

In Alberta, the AER has also mandated that the licensee of a pipeline that crosses water or unstable ground should inspect the pipeline right of way at least once annually to assess the surface conditions on and adjacent to the right of way.

National Energy Board

For NEB regulated pipelines, Sections 39 and 40 of the Onshore Pipeline Regulations also require that pipelines with water crossings have a surveillance and monitoring program in place, and also that the Licensee must develop, implement and maintain an integrity management program that anticipates, prevents, manages and mitigates conditions that could adversely affect safety or the environment during the design, construction, operational maintenance or abandonment of a pipeline.

In all cases, what causes some confusion are the definitions of what *periodically* means when it comes to inspection frequency. Even in Alberta, with the requirement for an annual inspection, there are no concrete guidelines to define whether this should include a visual inspection or a full depth of cover profile.

The onus, then, is on each operator to determine how best to manage their pipeline water crossing inventory.

Based on the guidelines, at a minimum, you must perform a visual inspection for water crossings as part of your right of way management programs. However, it is also critical that you ensure Depth of Cover is verified at appropriate intervals. It is up to each operator to determine what is appropriate for each pipeline based on the risk of the pipeline and the impacted water crossing.

Plan: Develop a Program

To truly be effective, a water crossing inspection program should take multiple factors into account, including the physical properties such as the diameter, substance, age and material of the pipeline, as well as an assessment of the size of the impacted waterbody using the Strahler Stream Order classification. This allows you to prioritize and categorize the crossings to identify those that present the highest overall risk.

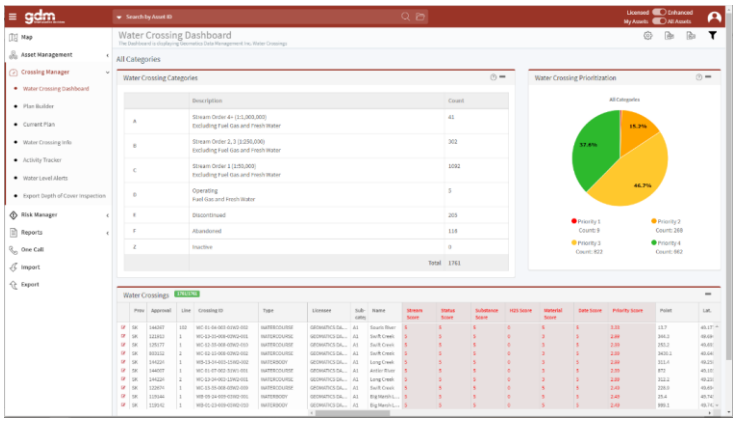
Once you have the prioritized list, you can begin to build the intervals and overall inspection timelines for your program. This may be spread over several years, depending on several factors including budgetary restraints, total number of crossings in your inventory and how many of your crossings may not meet acceptable coverage levels.

Using this list, you can move on to the “Do” phase where you schedule and complete your in-field inspection work.

Highlight: Creating Your Crossing Program

Converge by GDM Pipelines is an online application that provides insight into oil and gas assets, specifically related to risk and integrity processes. The **Crossing Manager** module helps to simplify the process of planning and managing your water crossing program.

Pipeline crossing locations are calculated using GDM’s spatially accurate pipeline data overlaid onto a hydrology network. The crossing inventory is then broken out into categories and subcategories and assigned a priority score based on a weighted average of the pipeline’s Status, Substance, H2S, Material, Age and Strahler Stream Order scores. Each crossing is also assigned a unique identifier which makes it easy to identify and view its specific attributes.

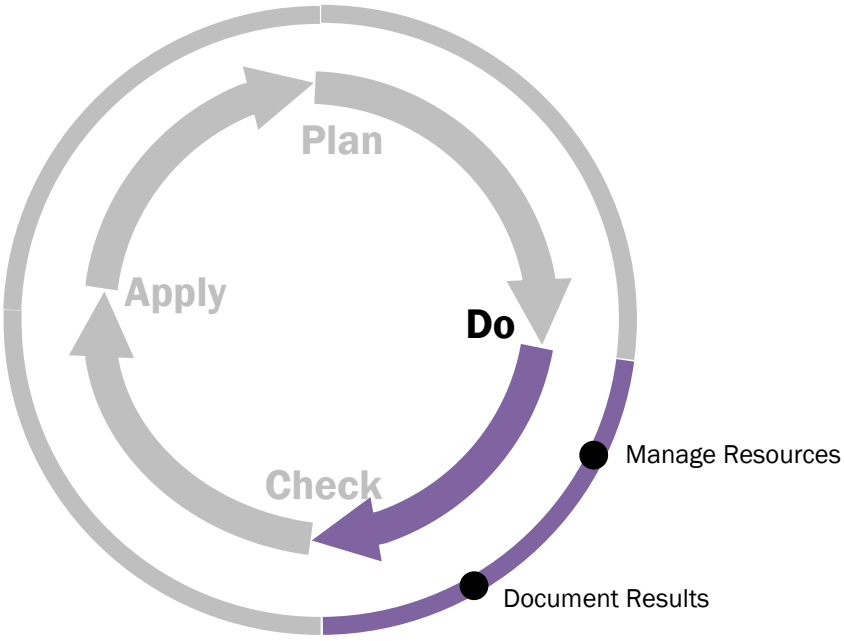


Step 2: Do

Do: Manage Resources

Using the prioritized list as a starting point, the next step is to schedule and complete the required inspections. The most efficient way to do this is using a geographical approach. Identifying crossings that are in the same area allows you to use resources more efficiently.

A key component of executing field inspections includes recording inspection details. This could include inspection forms, videos, photos, or any other documentation that is collected through the inspection process.



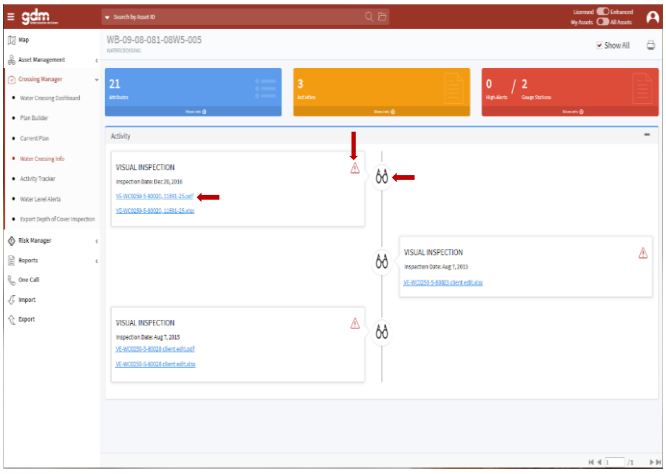
Do: Document Results

Once you have this information, it is also critical that the information is stored in a way that is easily accessible and available to incorporate into future plans.

Highlight: Managing Your Crossing Program

The map in Converge displays the location and classification for all your pipeline water crossings. It is easy to identify your highest priority crossings and isolate any crossings in the same area, which can be used to plan your inspections for maximum resource efficiency.

Once inspections are complete, the resulting inspection documents can be attached to the crossing and stored in Converge. These documents remains persistent so there is always a record of any previous work, and you can easily compare year over year results to see where they have been changes.



Step 3: Check

Check: Review Results

With inspections complete, the next step is to ensure that progress is being made, and that plans are remaining on schedule and within planned budgets.

It's also important to review and determine the effectiveness of the program.

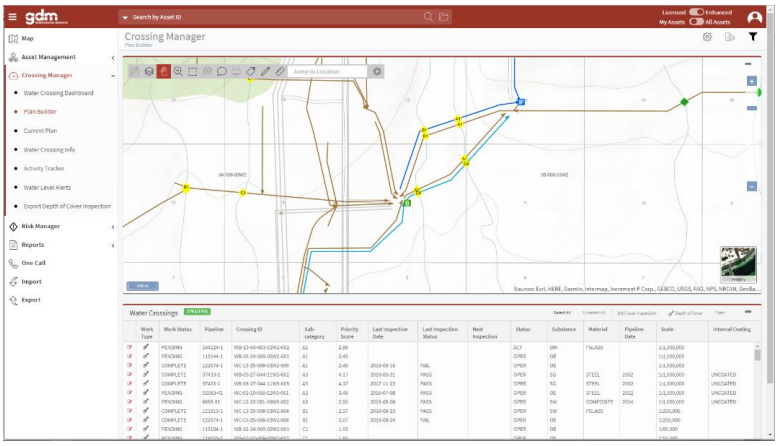
Check: Determine Effectiveness

Based on the results, subsequent re-inspection intervals should be recommended and recorded. This recommendation may be based on the results of the individual inspection, and may also take into account previous inspection results.

Typically, pipelines which meet compliance standards can be designated for reinspection at longer intervals than those that are found to be non-compliant. Should a pipeline be found to be exposed, plans should be put in place in a timely manner to remove and re-bore it.

Highlight: Tracking Results

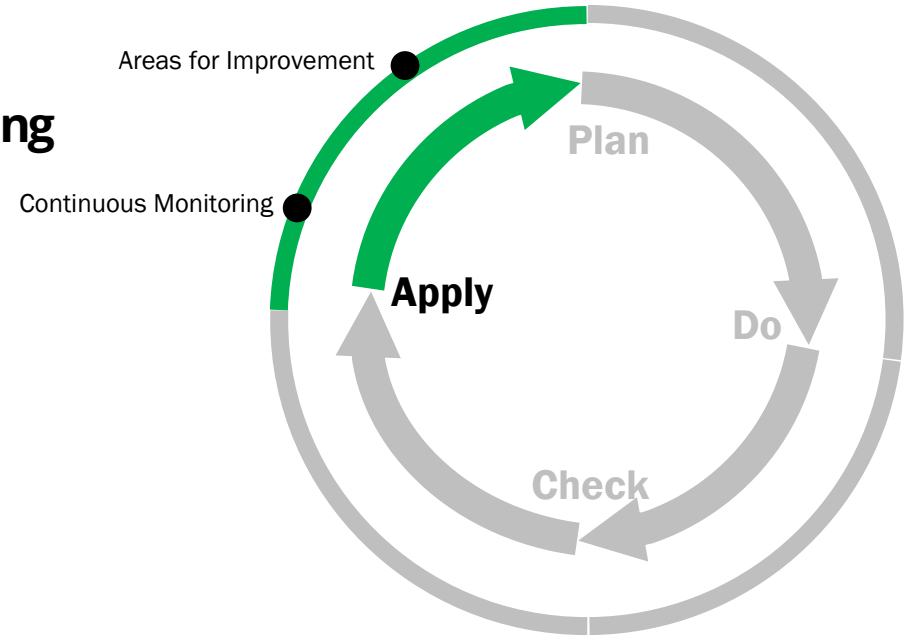
The Crossing Plan view displays the work status, last inspection date and last inspection status based on information collected from the field. This allows you to easily identify any crossings which do not meet the 1.2m depth of cover requirements so they can be instantly flagged for re-inspection or follow up work.



The Activity Tracker also allows you to monitor the progress of your current crossing inspection program. As work is completed and the results imported, you will see how many inspections are complete, and how many are remaining so you can stay on top of your planned schedule.

Step 4: Apply

Apply: Continuous Monitoring

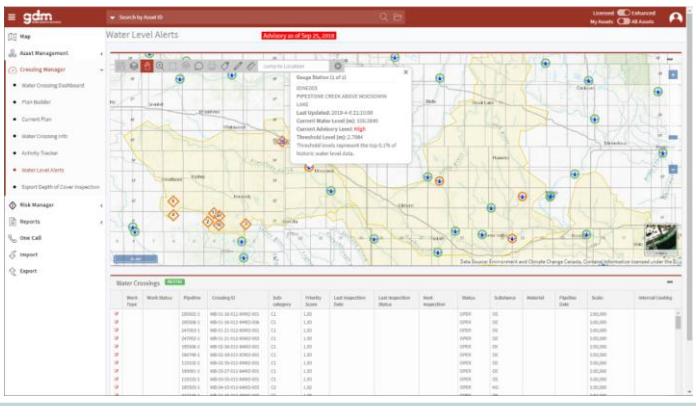


As with any process, one of the keys to success is to constantly review, analyze and update results to contribute to future plans. Ask yourself, “How am I managing information from the field?”, “Am I able to respond and identify when additional work is required?”, and “How am I prioritizing work for future inspections?”. If you are unable to answer these questions, you may be missing a key component in the success of your overall program.

For a program to be continuously effective, information in the field should be reviewed regularly and the results of inspections should be incorporated into future plans and requirements. Any crossings that do not pass the depth of cover criteria can be addressed by performing subsequent work which may include scour analysis, engineering assessments or hazard identification reports,

Highlight: Real-Time Monitoring

Converge contains a real-time Water Level Alert feature which monitors gauge station data and flags any crossings which may be impacted. You can visually see any gauge stations which are reporting higher than normal levels, as well as a list of any of your crossings which are in these areas. This allows you to quickly identify where you may have issues and ensure you are taking the necessary steps to avoid any serious issues.



Apply: Areas for Improvement

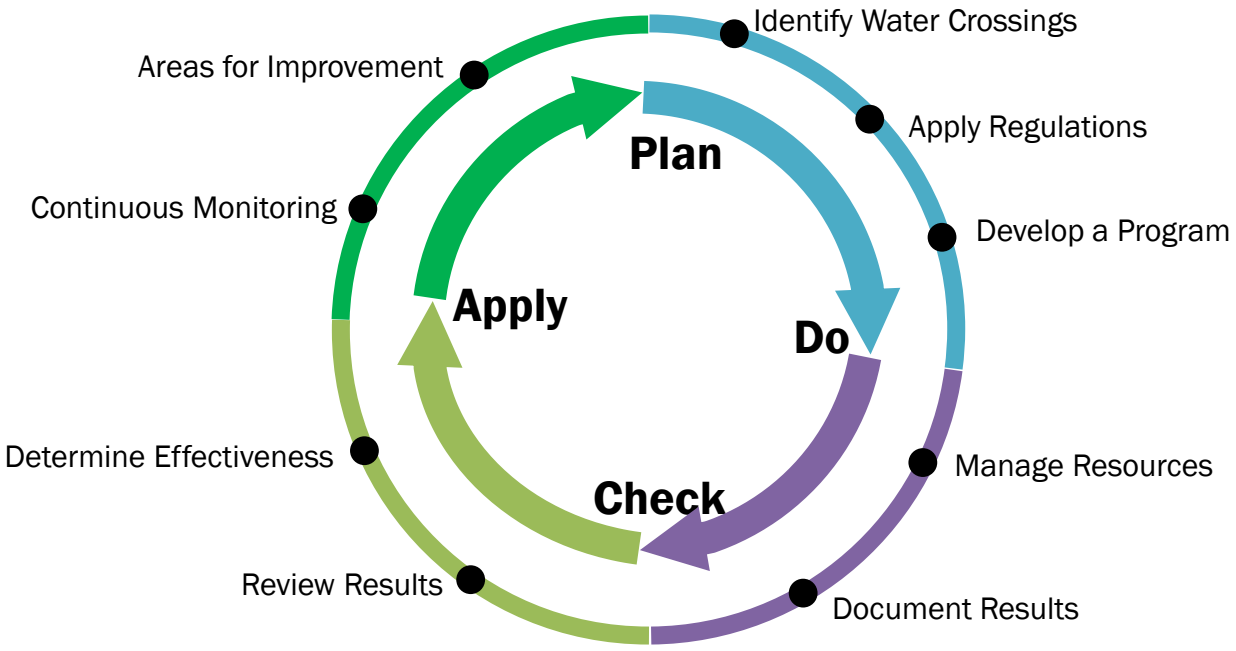
A final component of managing your program involves being proactive and monitoring any changes that could impact your pipeline water crossings. High stream events have the potential to trigger changes in the depth of cover of a crossing, cause erosion of a bed and bank, or even re-position water bodies altogether.

As these events are occurring, it’s important to stay on top of high-risk crossings and deploy resources to mitigate any potential risk before an incident occurs.

Summary

With all the different requirements for managing water crossings, it's important to understand the regulations and then apply a consistent approach to achieve positive results. It's also necessary to base your decisions on good data to ensure you are using your resources to maximum efficiency.

By using the proven 4-Step **Plan → Do → Check → Apply** approach, you can be sure that you are utilizing the best available information and making informed decisions at every step in the process. The result is a water crossing program which is efficient, effective and repeatable.



GDM Pipelines and Explore Inc. have combined expertise to deliver a complete crossing management approach. Using GDM's industry-leading data through Converge, it's possible to develop a categorized and prioritized list of your crossings.

Explore then leverages this information and applies their experience having inspected over 20,000 water crossings to advise on how to create an effective program, or implement and execute a full crossing management program for you.

About GDM Inc.

GDM Inc. is the industry leader in providing comprehensive pipeline, facility, midstream and transportation information to the North American Oil and Gas Industry. Based in Calgary, Alberta and in operation since 1997, GDM offers a broad range of information and services and is the only source for accurate and complete Canadian oil and gas infrastructure data. For more information on GDM, please visit www.gdm-inc.com

About Explore Inc.

Incorporated in April of 2008, Explore is a professional Asset integrity and Land Surveying firm that provides services related to all aspects of the Oil & Gas industry. Explore was started at the onset of the recession and in spite of that fact, we have not only survived, but thrived. Our integrity division builds on the success of our well established, full scale land surveying division. This segment of our company is an industry leader in delivering full scale surveying services including superior depth of cover pipeline inspections to the oil and gas industry. For more information on Explore, please visit www.exploreinc.ca.