APPENDIX C
Environmental Mitigation Plan

Environmental Mitigation Plan

Arrow NB Residue Gas Pipeline
and
Arrow Bakken NGL Pipeline Project
McKenzie County, North Dakota

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PSC Case No. PU-17-__

January 2017

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Appendix

1.0 INTRODUCTION

This Environmental Mitigation Plan (EMP) provides general guidance and requirements for construction of an approximately 2.6-mile-long, 10-inch-diameter welded steel residue gas pipeline that will extend from a natural gas processing plant to a third-party transmission pipeline and an 8-inch-diameter welded steel natural gas liquids (NGLs) pipeline that will extend from the same natural gas processing plant to a different third-party NGL facility. Both pipelines will be co-located in the same right-of-way. The proposed pipelines and associated surface facilities owned by Arrow are referred to as the Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project (Project). The Project is located approximately 7.5 miles southeast of Watford City, McKenzie County, North Dakota (Figure 1).

This EMP outlines general construction-related mitigation measures that will be implemented by Arrow and its construction contractor (Contractor) during construction of the Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project. Specific conditions associated with agency permits are not specifically addressed herein.

This EMP has been developed to meet or exceed applicable industry standards and regulatory requirements. Guidance documents used in the preparation of this EMP include *A Guide to Temporary Erosion-Control Measures for Contractors, Designers, and Inspectors* (North Dakota Department of Health 2001), the Construction and Environmental Disturbance Requirements (North Dakota Department of Health Letter dated November 23, 2016), *Erosion and Sediment Control Handbook* (North Dakota Department of Transportation 2004), and several U.S. Army Corps of Engineers (USACE) regional conditions for projects operating under Nationwide Permits (NWPs) in North Dakota.

The Project will not cross identified waterbodies (i.e., perennial streams, lakes, ponds, etc.), but will cross three delineated wetlands, as described in the *Natural Resources and Wetland Delineation Report for the Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project, McKenzie County, North Dakota* (SWCA Environmental Consultants [SWCA] 2016[1]). Each of the three wetland crossings is a single and complete project as defined by the USACE and can be constructed under NWP 12. NWP 12 authorizes the construction of utility line projects in non-tidal waters of the U.S., provided the activity does not result in the permanent loss of greater than 0.5 acre of waters of the U.S., including wetlands. None of these single crossings equals or exceeds 0.5 acre.

Site-specific details for the horizontal directional drilling (HDD) borings and the trenching crossings are not included in this EMP.

[1] SWCA Environmental Consultants (SWCA). 2016. *Natural Resources and Wetland Delineation Report for the Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project, McKenzie County, North Dakota*.

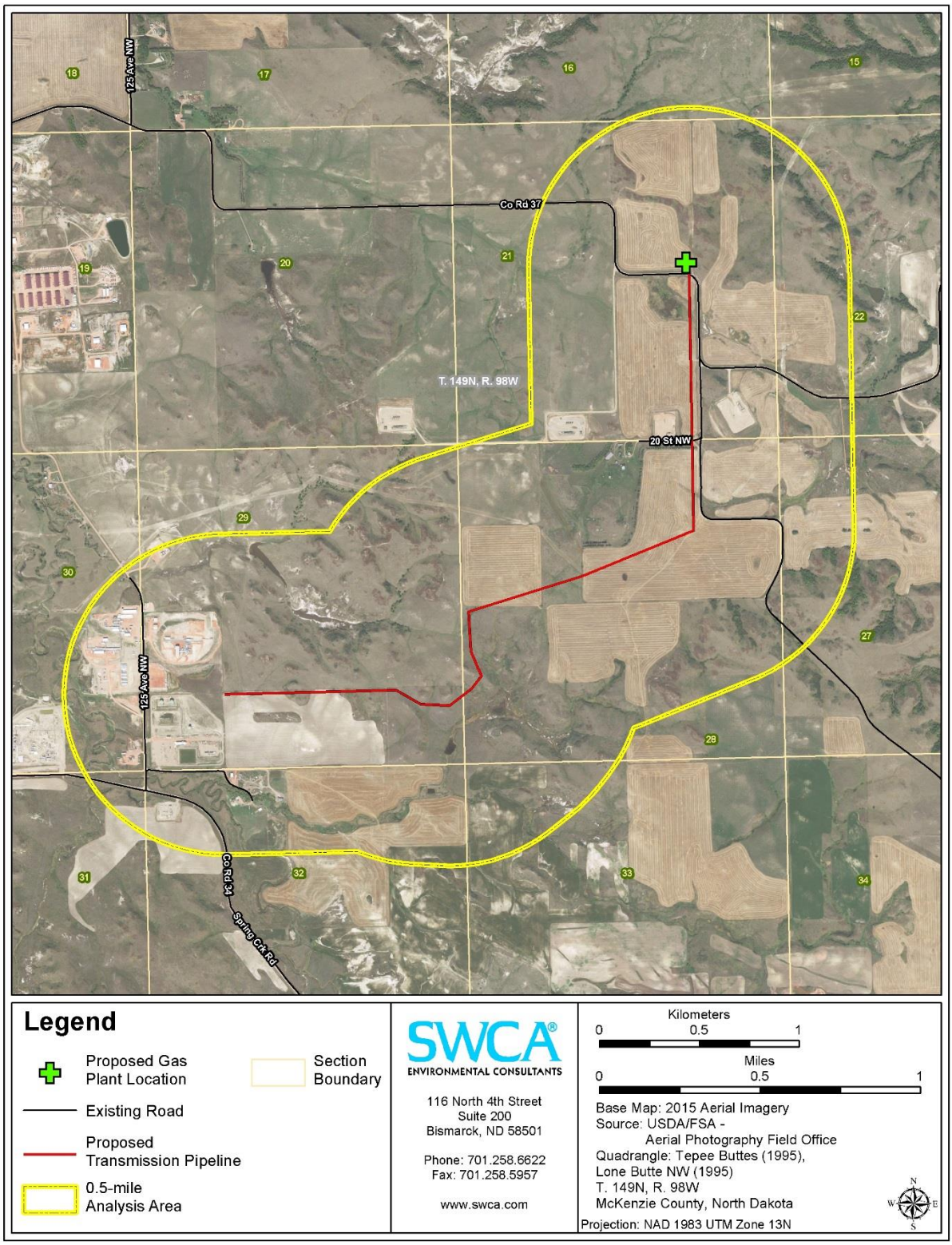


Figure 1. Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline location.

2.0 GENERAL MITIGATION MEASURES

2.1 CONTRACTOR

Arrow will make responsibility for compliance with this EMP a contractual obligation of the Contractor. The Contractor will ensure that persons engaged in construction of the Project are informed of these construction requirements.

2.2 LINE LIST AND PERMITS

Arrow will provide the Contractor with a construction list that describes special requirements, as agreed upon with private landowners and as required through agency permitting processes (e.g., stream crossing, section line, and road crossing permits).

2.3 THIRD-PARTY INSPECTOR

Arrow will provide construction oversight to confirm Contractor compliance with the measures of this EMP and any landowner agreements as well as applicable federal, state, and local environmental permits. For each construction segment, Arrow will assign third-party environmental inspectors (EIs) who are knowledgeable of the environmental mitigation requirements for this Project. The third-party EIs will have the authority to stop construction activities and order corrective mitigation for actions that are not in compliance with this EMP, any landowner agreements, or environmental permit requirements. The third-party EIs will maintain appropriate records to document compliance with these and other applicable environmental permit conditions. At the end of each week, the third-party EIs will summarize daily reports into a weekly report that will be submitted to Arrow. Monthly reports will be submitted to the North Dakota Public Service Commission (PSC).

2.4 RIGHTS-OF-WAY

Access to the pipeline construction right-of-way will be from public roadways and private landowner-approved access roads. The Contractor will mark access routes with signs to clearly identify approved access roads.

All construction equipment and vehicles will be confined to the approved access roads, the permitted pipeline construction right-of-way, any additional temporary workspaces, and to the proposed natural gas processing plant location.

2.5 DUST CONTROL

Dust control related to construction activities will be accomplished through administrative and physical means.

All construction-related vehicles will adhere to posted speed limits on public roadways and as designated in landowner agreements on private lands. Work hours near residential areas may be limited.

The Contractor may use multiple methods to wet the right-of-way to control airborne dust, including water trucks and sprinklers, or additional appropriate measures, such as chemical application and/or reduced speed limits, based on site-specific conditions.

2.6 UNDESIRABLE SPECIES CONTROL

Arrow will require that all construction-related equipment be thoroughly cleaned prior to moving the equipment to the job site to limit the potential for the spread of noxious weeds, insects, and soil-borne pests. All equipment will be cleaned with high-pressure washing equipment.

Noxious weed surveys were completed for the alignment during November 2016 surveys. SWCA did not identify any occurrences of state-listed or county-listed noxious weeds within the survey corridor. Surveys were conducted outside of the growing season, however residual plant matter likely would have been observed if noxious weed communities were present (SWCA 2016). Arrow will monitor and control noxious weeds within their right-of-way prior to and subsequent to construction. If a noxious weed species is present within the construction right-of-way, the extent of infestation areas will be clearly demarcated in the field with flagging or staking prior to clearing and grubbing operations so that the infestation area can be segregated and the vegetative materials destroyed or removed prior to reclamation of the right-of-way.

During construction, the Contractor will clean the surface area of all vehicles and construction machinery, including the undercarriage, to remove excess soil and vegetative debris, if that equipment is known to have passed through a weed-infested or soil-borne pest-infested area.

Only certified weed-free vegetative components (e.g., mulch, straw/hay bales, seed mixtures) will be used on the Project.

2.7 NON-HAZARDOUS WASTES

The Contractor will handle and dispose of human wastes by use of portable, self-contained chemical toilets. Wastes from these units will be collected by a licensed contractor for disposal only at licensed and approved facilities.

The Contractor will remove all trash from the construction right-of-way on a daily basis unless otherwise approved or directed by Arrow.

The Contractor will dispose of HDD cuttings and drilling mud at an approved landfill or disposal area located off of the right-of-way.

2.8 HAZARDOUS WASTES

The Contractor will ensure that all hazardous and potentially hazardous materials are transported, stored, and handled in accordance with all applicable regulations. Workers exposed to or required to handle hazardous materials will have received proper training in use of those materials, in accordance with the applicable regulations and the manufacturer's recommendations.

The Contractor will dispose of all hazardous materials at licensed waste disposal facilities.

If toxic or hazardous waste materials or containers are encountered during construction, the Contractor will stop work immediately and notify Arrow. The Contractor will not restart work until clearance is granted by Arrow.

2.9 BURNING AND FIRE PREVENTION

The Contractor will comply with all federal, state, and county fire regulations regarding prevention of uncontrolled fires.

The Contractor will maintain a contact list and information of jurisdictional fire authorities. Fire control equipment, including water and chemical fire extinguishers, will be available at construction sites and construction personnel will be properly trained in the use of such equipment.

Flammable materials kept on a construction site will be stored in approved containers away from ignition sources. All flammable wastes will be removed from construction sites on a regular basis.

Smoking will be prohibited at construction sites, except in designated areas away from flammable materials.

2.10 WET WEATHER

The Contractor may restrict certain construction activities during excessively wet soil conditions to minimize rutting and soil compaction. Activities may be suspended based on the following conditions:

- type of equipment and nature of construction activity planned for that day;
- potential that rutting may cause mixing of topsoil with subsoil layers;
- extent of surface ponding; and,
- the potential for excessive soil compaction.

If these conditions cannot be appropriately mitigated through equipment rerouting or the use of construction mats, then construction work will be suspended until adequate protection measures, approved by the PSC, are taken to avoid irreparable damage to roads or land.

3.0 SPILL PREVENTION

3.1 GENERAL

The Contractor will ensure that all equipment is free of leaks prior to use on the construction right-of-way and access roads. Throughout the period of construction, the Contractor will conduct regular maintenance and inspections of the equipment to reduce the potential for spills or leaks.

All equipment parked overnight will be at least 100 feet from any topographical surface drainage or wetland, unless otherwise approved by the EI.

Stationary equipment will be placed within a secondary containment berm if it will be operated or require refueling within 100 feet of a wetland boundary or drainageway.

3.2 STORAGE

Fuels and lubricants will be stored only at designated staging areas. Storage of fuel and lubricants will be at least 100 feet from the edge of any wetland, topographical surface drainage, or identified environmentally sensitive area.

No bulk fuel or storage tanks will be placed in the construction right-of-way. Bulk fuel storage at temporary work or construction staging areas will be located in a secondary containment structure with sufficient capacity to capture spills or leaks during filling and/or dispensing activities.

3.3 REFUELING

Refueling and lubrication of equipment will be restricted to upland areas at least 100 feet from any wetland, topographical surface drainage, or any environmentally sensitive area, except where equipment is required to be within 100 feet of those areas for construction-related activities (e.g., trench dewatering pump).

Rubber-tired vehicles (e.g., pickup trucks) normally will refuel at the construction staging areas or commercial gas stations. Tracked machinery (e.g., backhoes, bulldozers) will be refueled and lubricated on the construction right-of-way. Equipment maintenance will be conducted in staging areas when practical. When necessary and with EI approval, equipment repairs may be made on the construction right-of-way.

Each fuel truck that transports and dispenses fuel to construction equipment or project vehicles along the construction right-of-way or within equipment staging areas will carry oil spill response equipment and materials onboard at all times. Truck drivers and construction crew personnel will be trained on proper use of this equipment and materials.

3.4 CLEANUP AND EMERGENCY NOTIFICATION

Construction activities will be conducted to allow for prompt and effective cleanup of spills of fuel and other hazardous materials. Each construction crew will have sufficient tools and material to stop leaks and supplies of absorbent and barrier materials to allow rapid containment and recovery of spilled materials. Crew members must know and follow the procedure for reporting spills.

Emergency notification procedures between the Contractor and Arrow will be established in the planning stages of construction. In the event of a spill meeting agency reporting criteria, the Contractor will immediately notify Arrow who will then promptly notify the appropriate regulatory agency.

4.0 TEMPORARY EROSION AND SEDIMENT CONTROL

4.1 GENERAL

Temporary erosion and sediment control measures will be installed as detailed in the Stormwater Pollution Prevention Plan (SWPPP) for this Project prior to initial disturbance of the soil, maintained throughout construction, and reinstalled as necessary until replaced by permanent erosion control structures or restoration of the construction right-of-way is complete.

The Contractor will inspect all temporary erosion control measures within 24 hours of each significant rainfall event of 0.25 inch or greater. The Contractor will repair or replace all ineffective temporary erosion control measures as expediently as practicable, but prior to the next rainfall event.

4.2 SEDIMENT BARRIERS

Sediment barriers will be constructed of silt fence, staked hay or straw bales, fiber rolls, compacted earth (e.g., drivable berms across travel lanes), sand bags, or other appropriate materials.

Sediment barriers will be installed below disturbed areas where there is the potential for offsite sedimentation. Areas where temporary sediment barriers will be placed include the base of sloped approaches to roadways, flowing streams, and wetlands; along the edge of the construction right-of-way, as needed to prevent downslope siltation of adjacent drainageways and wetlands; and along trench or test water discharge locations, as required.

Sections of temporary sediment barriers may be designed to allow passage of construction equipment. Sediment barriers will be reinstalled to their original specifications when equipment passage is no longer required, heavy precipitation is imminent, or at the end of the work day, whichever is sooner.

The Contractor will maintain hay or straw bale/wattle and silt fence sediment barriers by removing collected sediment when it reaches one-half the height of the barrier and replacing

the damaged control. If bale filters cannot be replaced due to access problems, the Contractor will place a new row of sediment barriers upslope.

The Contractor will use hay or straw bales that are free of noxious weeds.

The Contractor will remove sediment barriers, except those needed for permanent erosion and sediment control, during cleanup of the construction right-of-way.

4.3 TEMPORARY SLOPE BREAKERS

Temporary slope breakers will be installed to minimize concentrated or sheet flow runoff in disturbed areas at the following recommended spacing.

Slope (%)	Spacing (feet)
<5	125
5–10	100
10–20	75
20–30	50
>30	25

Temporary slope breakers will be constructed of earthen material, silt fence, staked hay or straw bales, fiber rolls, sand bags, or similar materials.

When earthen berms are constructed, they will be constructed of subsoil material, when practical, and have a 2% to 8% slope with a 4.0-foot base and 1.5-foot height, or as site conditions require.

Temporary slope breakers will direct outfall to a stable, well-vegetated area or an appropriate energy-dissipating device (e.g., silt fence, hay or straw bales/wattles) at the end of the slope breaker and off the construction right-of-way. The outfall of each temporary slope breaker will be installed to prevent sediment discharge into wetlands or other sensitive resources.

A hard plug will be left in place where a slope breaker crosses an open trench.

Temporary slope breakers will not be installed on cultivated land except by landowner request.

4.4 TEMPORARY MULCHING

If a disturbed construction work area is inactive for 1 month or is expected to be inactive for 1 month or more, the Contractor will apply temporary seed and/or mulch to reduce risk of erosion. The Contractor will not apply temporary mulch in cultivated areas unless specifically requested by the landowner. The Contractor will not apply mulch within wetland boundaries.

Temporary mulch of straw or equivalent applied on slopes will be spread uniformly to cover at least 75% of the ground surface at an approximate rate of 2 tons per acre of straw or its equivalent. Mulch application on slopes within 100 feet of wetlands will be increased to an approximate rate of 3 tons per acre.

5.0 HIGHWAY AND ROAD CROSSINGS

Construction across paved and graveled roads will be in accordance with the requirements of the crossing permits and approvals obtained by Arrow. All graded roads will be bored. The Contractor will take measures, such as posting informational signs, along the routes being bored to ensure traffic safety. Specific details of the conventional or HDD borings are not included in this EMP.

6.0 UPLANDS

6.1 CLEARING

The initial stage of construction will involve clearing the construction right-of-way to allow for a safe operating environment. Clearing of trees, brush, and other vegetation from the right-of-way may be accomplished with hand-held chainsaws, brush hogs, hydraulic tree-cutting equipment, bull dozers, or other equipment designed for that purpose. Woody material will be chipped or mulched onsite or hauled off to an appropriate disposal location, or as otherwise directed by the landowner. No burning will be conducted as part of this Project.

6.2 GRADING

After clearing, the construction right-of-way will be graded to develop a right-of-way that allows for a safe working surface for equipment and pipeline fabrication and bending requirements. All work will be conducted in accordance with applicable permits, regulations, or guidelines. All grading will be undertaken with the understanding that original contours and drainage patterns will be re-established to the extent practicable.

6.3 TOPSOIL REMOVAL AND STORAGE

Measures will be taken to preserve the physical and chemical property integrity of topsoil so it may be used during final reclamation of the construction right-of-way. Generally, these measures will segregate the topsoil from underlying subsoil layers to prevent mixing during construction and to allow for easy retrieval during reclamation. Topsoil will not be used for construction of earthen berms, as trench breakers, to fill low areas, or to backfill the trench.

Topsoil, to a maximum depth of 12 inches or topsoil to the depth of cultivation, whichever is greater, will be stripped. Stripped topsoil will be stockpiled in a windrow along the edge of the right-of-way. After backfilling is completed, excess subsoil must be placed over the excavation area and the area graded to blend with the existing topography. Topsoil is replaced to the area of excavation after the subsoil is replaced.

6.4 TREE AND SHRUB MITIGATION

Arrow will address mitigation, reclamation, and remediation measures with individual landowners and comply with any applicable state requirements, including the PSC's Tree and Shrub Mitigation Specifications.

During SWCA's field survey, two tree and shrubland areas were geographically referenced within the project area. SWCA counted 24 tree, sapling, and shrub individuals that may be impacted by construction activities (SWCA 2016). Two 2-year-old saplings will be planted for every one tree removed. Two shrubs (stem cuttings) will be planted for every one shrub removed.

Except in the case of invasive or noxious species, trees and shrubs will be replaced by the same species or similar species, suitable for North Dakota growing conditions, as recommended by the North Dakota Forest Service. Invasive or noxious species will be replaced by similar non-invasive or non-noxious species suitable for North Dakota growing conditions as recommended by the North Dakota Forest Service.

Tree and shrub replacement will not be conducted within a 20- to 30-foot-wide path over the pipeline to facilitate visual inspections of the right-of-way in accordance with U.S. Department of Transportation safety regulations.

Landowners will be given the option of having replacement trees and shrubs planted on the landowner's property, either on or off the right-of-way, but not directly over the top of the pipeline itself. The landowner will also be given the opportunity to waive those options, in writing, to have replacement trees and shrubs planted off the landowner's property.

6.5 TRENCHING

Trenching in uplands is typically accomplished with a backhoe excavator or a rotary wheel ditching machine to provide a ditch of sufficient depth and width, with a bottom to continuously support the pipeline. The trench will be excavated to a depth that will enable the pipeline to be installed in accordance with the PSC requirements (i.e., 48 inches in rangeland, 48 inches in cultivated land, 48 inches at the bottom of the ditch for road crossings, and 72 inches across undeveloped section lines), applicable U.S. Department of Transportation regulations, and McKenzie County standards. If an increased pipeline depth is requested by a county- or state-level agency, modifications to additional temporary workspace may be necessary to accommodate the increased amount of trench spoil.

Excavated material will be side cast within the construction right-of-way with consideration for topsoil segregation, as noted in Section 6.3. Excavated material will be stored in a manner to minimize erosion and sedimentation.

Gaps will be left in the right-of-way lateral spoil piles that coincide with breaks in the strung pipe to facilitate natural drainage patterns and to allow the passage of livestock or wildlife.

Trenching operations will be followed as closely as practicable by lower-in and backfill operations to minimize the length of time the ditch is open.

When pumping captured stormwater from the trench, the Contractor will ensure that adequate pumping capacity and sufficient hose is available. The discharge of pumped water will be through filter bags or other method detailed in the SWPPP and in accordance with the environmental mitigation measures outlined throughout this EMP. If shallow groundwater is

encountered during trenching that requires more extensive dewatering, a separate dewatering discharge permit will be obtained.

If drain tile is encountered during construction, the Contractor will repair and/or replace the drain tile. Additionally, if any culverts are disturbed during construction the Contractor will repair and/or replace the culverts.

6.6 PIPE PREPARATION AND INSTALLATION

Prior to lowering into the trench, pipe section ends are beveled to prepare them for welding. This process produces shavings which will be removed, to the extent practicable, immediately following beveling. Sections are then welded together to form a continuous pipe.

The pipe may be wrapped with a protective shielding (e.g., epoxy, urethane epoxy) to protect the pipe coating during backfilling. This process is typically completed prior to pipeline delivery to the right-of-way, except for a 3- to 6-inch section at each end to prevent the coating from interfering with the welding process. This bare section of pipe will be coated with a two-part epoxy liquid coating that will be brush applied. Any residual material from this coating process will be disposed of in accordance with measures outlined in Section 2.8.

Prior to lowering into the trench, the coated and welded pipeline will be inspected to ensure it is free of defects.

6.7 BACKFILLING

The subsoil excavated during the trenching process is initially used to backfill the trench. Prior to backfilling, the trench will be dewatered and trench breakers (soft plugs) installed on slopes where necessary to minimize the potential for water movement and erosion of the trench after the trench is backfilled. Trench breakers will be constructed of materials such as sand/cement bags, bentonite bags, or other suitable materials. Topsoil will not be used to construct trench breakers.

Stormwater accumulated in the trench will be removed and discharged in accordance with the SWPPP and the environmental mitigation measures outlined throughout this EMP.

Backfill will be comprised of soil material excavated from the trench. If rocky conditions, as determined by the Arrow EI, are encountered so that the backfill will contain rocks that could cause damage to the pipeline or the pipeline coatings, the pipe will be shielded or padded with an approved material for at least 6 inches above the pipeline before any rock is introduced back into the ditch.

The lesser of 4 feet or the actual depth of topsoil cover will not be backfilled with soil containing rocks of any greater concentration or size than existed prior to pipeline construction in the pipeline trench, bore pits, or other excavations.

To reduce the potential for ditch line subsidence, spoil will be replaced and compacted by backhoe bucket or roller or by the wheels or tracks of equipment traversing down the trench.

6.8 CLEANUP

Cleanup activities to restore the right-of-way and other disturbed areas to the approximate pre-construction conditions will be conducted immediately following backfilling operations, as weather conditions permit.

All non-hazardous and hazardous materials will be disposed of in accordance with measures outlined in Section 2.7 and Section 2.8.

The right-of-way will be re-contoured with spoil material to approximate pre-construction contours and surface drainage patterns. Loading of slopes with unconsolidated spoil material will be avoided during slope re-contouring. Topsoil will be replaced after re-contouring of the grade with subsoil. The topsoil will be replaced on the subsoil storage area and over the trench so that after settling occurs, the approximate original depth and contour (with an allowance for settling) of the topsoil will be achieved. Subsoil will not be placed on top of topsoil.

Temporary sediment barriers will be removed and accumulated sediment will be re-contoured with the rest of the right-of-way. As needed, permanent erosion controls will be installed.

6.9 PERMANENT EROSION AND SEDIMENT CONTROL

After final grading and contouring of upland areas, sloped areas will be stabilized using standard Best Management Practices.

6.9.1 Permanent Slope Breakers

Where necessary, permanent slope breakers (e.g., diversion berms/ditches and level spreaders) will be installed to minimize concentrated or sheet flow runoff in disturbed areas. Permanent slope breakers will be constructed of earthen material. Slope breakers will divert surface runoff to adjacent stable vegetated areas or to energy-dissipating devices. In general, permanent slope breakers should be installed immediately downslope of all trench breakers.

Permanent slope breakers will be installed as specified on the construction drawings or generally with the following minimum spacing.

Slope (%)	Spacing (feet)
<5	125
5–10	100
10–20	75
20–30	50
>30	25

The gradient (fall) for each slope breaker will be 2% to 8% unless otherwise modified as required by site-specific conditions.

6.10 RECLAMATION AND REVEGETATION

Reclamation and revegetation activities are designed to return disturbed areas to approximately pre-construction use and capability. The following mitigation measures will be used, unless otherwise modified to address site-specific conditions or circumstances.

6.10.1 Soil Compaction

Compacted cultivated land and any other severely compacted or rutted areas within the construction right-of-way will be tilled or chiseled to loosen compacted soils. The subsoil surface will be graded smooth and any subsoil clumps broken up (disc and harrow) in an effort to avoid topsoil mixing. Arrow will pay the landowner for any such activities in agricultural areas.

Plowing under of organic matter, including wood chips and manure, or planting of a green crop such as alfalfa, to decrease soil bulk density and improve soil structure or any other measures will be considered, in consultation with the Natural Resources Conservation Service, if mechanical relief of compaction is unsuccessful.

6.10.2 Rock Removal

On agricultural land, rocks greater than 4 inches in diameter that are exposed on the surface due to construction activity will be removed from the right-of-way prior to and after topsoil replacement.

Clearing of rocks may be conducted with a mechanical rock picker or by manual means, provided that preservation of topsoil is assured. Rock removed from the right-of-way will be hauled off the landowner's premises or disposed of on the landowner's premises at a location that is mutually acceptable to the landowner and to Arrow.

6.10.3 Seeding and Mulching

The final seed mixture will be based on recommendations from the local Natural Resources Conservation Service office or otherwise specified by the landowner with PSC approval.

Certificates of seed analysis are required for all seed mixtures to restrict the introduction of noxious weeds.

Seed will be used within 12 months of testing. Seeding will follow cleanup, re-grading, and topsoil replacement as closely as possible. Seed will be applied to all disturbed surfaces, except cultivated fields unless requested by the landowner.

If mulch was applied for temporary erosion control during construction activities, the Contractor will remove and dispose of the excess mulch prior to seedbed preparation to ensure that seedbed preparation equipment and seed drills do not become plugged with mulch. After seeding, the Contractor may evenly re-apply and anchor (straw crimp) the removed temporary mulch on the construction right-of-way.

Seeding will be completed at a rate appropriate for the region and stability of the reclaimed surface. Seeding rates will be based on pure live seed specifications for the seed mixture.

The Contractor will use a drill seeder equipped with a cultipacker designed and equipped to apply grass and grass-legume seed mixtures. Equipment will include mechanisms (e.g., seed box agitator) to allow even distribution of all species in each seed mixture, an adjustable metering mechanism to accurately deliver the specified seeding rate, and a mechanism (e.g., depth bands) to accurately place the seed at the specified depth.

The Contractor will plant seed at depths consistent with the local or regional agricultural practices.

Broadcast or hydro seeding, used in lieu of drilling, will require double the recommended seeding rates. Where seed is broadcast, a cultipacker or other equipment will be used immediately following broadcasting to incorporate the seed to the specified depth and to firm the seedbed.

Areas that are too steep or otherwise cannot be safely harrowed or cultipacked will be hand-raked to incorporate the broadcast seed to the specified depth.

Arrow will work with landowners to discourage intense livestock grazing of the construction right-of-way during the first growing season by use of temporary fencing or a decreased grazing regimen.

Immediately after seeding, the Contractor will apply certified weed-free mulch on all areas with high erosion potential and on slopes greater than 5%. The Contractor will spread mulch uniformly over the area to cover at least 75% of the ground surface at an approximate rate of 2 tons per acre of hay or straw or their equivalent. The Contractor will not apply mulch in cultivated areas unless requested by the landowner.

If a mulch blower is used, the majority of strands of the mulching material will not be shredded to less than 8 inches in length to allow anchoring. The Contractor will anchor mulch immediately after application to minimize loss by wind and water. Depending on the length of straw mulch, a soil tackifier may be applied to the soil before the mulch is blown on to help anchor the mulch.

When anchoring (straw crimping) by mechanical means, the Contractor will ensure that the straw stalks are a minimum of 12 inches in length and will use a tool specifically designed for mulch anchoring with flat, notched disks to properly crimp the mulch to a depth of 2 to 3 inches.

6.10.4 **Fences**

Upon completion of all backfilling, cleanup, and restoration, including mulching and seeding of the construction right-of-way, permanent repairs will be made to all fences using either the original material or good quality new material similar to existing fences.

Historic fences will be carefully reassembled by hand from the original material. Where the original material has deteriorated to a state that makes it unsalvageable, replacement material similar to the original will be used if possible.

6.10.5 Right-of-Way and Pipeline Markers

Upon completion of all cleanup and restoration activities and during the time when the Contractor is making permanent repairs to fences, the Contractor will install pipeline markers on each side of all roads, section line crossings, fence lines, and other areas where the pipeline markers do not conflict with intended land use or as required by Title 49 Code of Federal Regulations Part 195.

7.0 WETLAND CROSSINGS

7.1 GENERAL

Arrow and its Contractor will comply with requirements of all permits issued for the wetland crossings by federal, state or local agencies.

Wetland boundaries will be clearly marked in the field with signs and/or highly visible flagging during construction.

7.2 EASEMENT AND WORKSPACE

The Contractor will maintain wetland boundary markers during construction in all areas and until permanent seeding is complete in non-cultivated areas.

The Contractor will locate extra work areas (such as staging areas and additional spoil storage areas) at least 100 feet from wetland boundaries, where topographic conditions allow.

The Contractor will limit clearing of vegetation between extra work areas and the edge of the wetland to the construction right-of-way and limit the size of extra work areas to the minimum needed to construct the wetland crossing.

7.2.1 Conventional Bores and Horizontal Directional Drill Crossings

Arrow will develop specific plans for road crossings, or other identified features that cannot be trenched through. The Contractor shall construct each bored crossing in accordance with a site-specific plan as shown in the construction drawings.

Any drilling fluids and additives used during implementation of a directional drill shall be non-toxic to the aquatic environment.

The Contractor will follow the Frac-out Contingency Plan included as Appendix B or will develop its own, equivalent contingency plan to address a frac-out during a directional drill. The plan shall include instructions for monitoring during the directional drill and mitigation in the event that there is a release of drilling fluids. Additionally, the waterbody shall be monitored downstream by the Contractor for any signs of drilling fluid.

The Contractor shall dispose of all drill cuttings and drilling mud in an approved manner. Disposal options may include land-spreading over the construction right-of-way in an upland location approved by Arrow or hauling to an approved licensed landfill or other site approved by existing regulations.

7.2.2 Boring Crossing Method

The Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project will use either conventional or the HDD slick-bore process for boring under roadways. With this method, an entry bore pit and exit bore pit will be excavated on both sides of the crossing. The boring machine shall be placed in the entry pit where it will drill a pilot hole through to the exit pit. This hole will then be widened to accept the carrier pipe by back reaming. A section of pipeline that is already welded together, inspected, and pressure tested is then pulled back through the drilled hole. The minimum depth of cover for these road crossings shall be 5 feet or greater depending on the minimum depth as specified by the crossing permit and the PSC. The bored crossing pipe will extend at least 10 feet beyond either side of the road right-of-way and 25 feet beyond the wetland boundary. A pipeline marker shall be placed at either end of the bored crossing when completed.

8.0 RESTORATION AND RECLAMATION

All timber riprap, timber mats, and prefabricated equipment mats and other construction debris shall be removed upon completion of construction. As much as is feasible, the Contractor shall replace topsoil and restore original contours with no crown over the trench. Any excess spoil shall be removed from the wetland. The Contractor shall stabilize wetland edges and adjacent upland areas by establishing permanent erosion control measures and revegetation, as applicable, during final clean up.

In the absence of detailed revegetation plans or until the appropriate seeding season for permanent wetland vegetation in standard wetlands, the Contractor shall apply a temporary cover crop on the construction right-of-way at a rate adequate for germination and ground cover unless standing water is present. The Contractor shall apply the temporary cover crop during final cleanup. For farmed wetlands, the Contractor shall apply seeding requirements for agricultural lands or as required by the landowner.

The Contractor shall not use fertilizer, lime, or mulch in wetlands unless required in writing by the appropriate land management agency.

9.0 HYDROSTATIC TESTING

9.1 GENERAL

The Contractor will provide for the safety of all pipeline construction personnel and the general public during hydrostatic test operations by placing warning signs in populated areas.

Staging and work areas for filling the pipeline with water will be located a minimum of 100 feet from a wetland boundary, if topographic conditions permit.

The Contractor will locate hydrostatic test manifolds 100 feet outside wetlands to the extent practicable.

9.2 TEST WATER SOURCE

Arrow will provide the Contractor with a copy of the appropriate withdrawal/discharge permits for the sourcing of state-regulated water for use in hydrostatic testing. The Contractor will keep water withdrawal/discharge permits on site at all times during testing operations.

To ensure that source water meets National Pollutant Discharge Elimination System permit discharge limitations, the Contractor will be responsible for obtaining pre-test water analyses from each state-regulated source to be used in sufficient time to have a laboratory analysis performed prior to any filling operations. The analysis will determine the pH value and total suspended solids and other parameters that may be required by the North Dakota Department of Health.

No chemicals will be used in the test water.

9.3 PERMITTED DISCHARGES OF HYDROSTATIC TEST WATER

In the event that Arrow seeks to discharge hydrostatic test water within the confines of the Project area, it will do so under a state-issued National Pollutant Discharge Elimination System permit and landowner approval. Arrow and its Contractor will comply with state-issued National Pollutant Discharge Elimination System permit requirements.

The Contractor will not discharge any water that exceeds water quality limitations specified in the permit.

The discharge operation will be monitored and water samples will be collected and analyzed prior to the beginning of the discharge to ensure that it complies with the project and permit requirements. If required by state permits, additional water quality testing will be conducted during discharge, in accordance with permit conditions.

The Contractor will regulate the velocity discharge rate (3,000 gallons per minute maximum), use energy dissipation devices, and install sediment barriers, as necessary, to prevent erosion, sedimentation, or drainageway scour. Water must be disposed of using good engineering judgment so that all federal, state, and local environmental standards are met. Dewatering lines will be of sufficient strength and be securely supported and tied down at the discharge end to prevent whipping during this operation.

Road crossing pipe sections will be pressure tested accordingly to all federal, North Dakota PSC, state or, in absence thereof, generally accepted industry practice. Where water hauling licenses or permits apply, water for pre-testing of any road crossings will be hauled by a tanker truck from an approved water source.

10.0 **REFERENCES**

- North Dakota Department of Health, Division of Water Quality. 2001. *A Guide to Temporary Erosion-Control Measures for Contractors, Designers and Inspectors*, Bismarck, North Dakota.

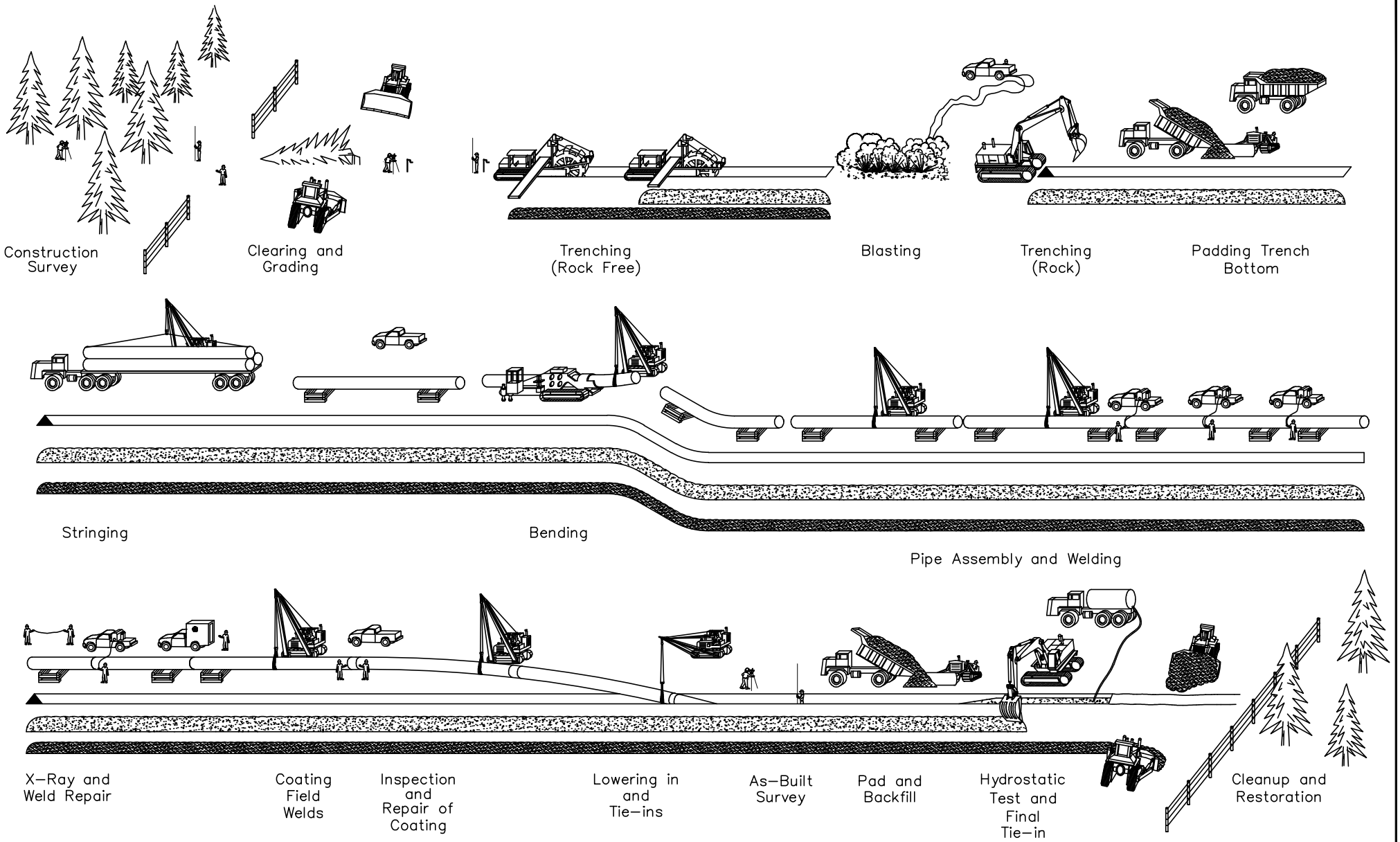
- North Dakota Department of Transportation. 2004. *Erosion and Sediment Control Handbook*, Bismarck, North Dakota.

APPENDIX A

Pipeline Construction Sequence

ROW Construction Schemataic

Typical ROW Plan and Profile Details



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Sound Science. Creative Solutions.®

REV LEVEL	DATE	BY	DESCRIPTION	CK.	APP.

REVISIONS

Arrow Midstream Holdings, LLC
Arrow Field Services, LLC

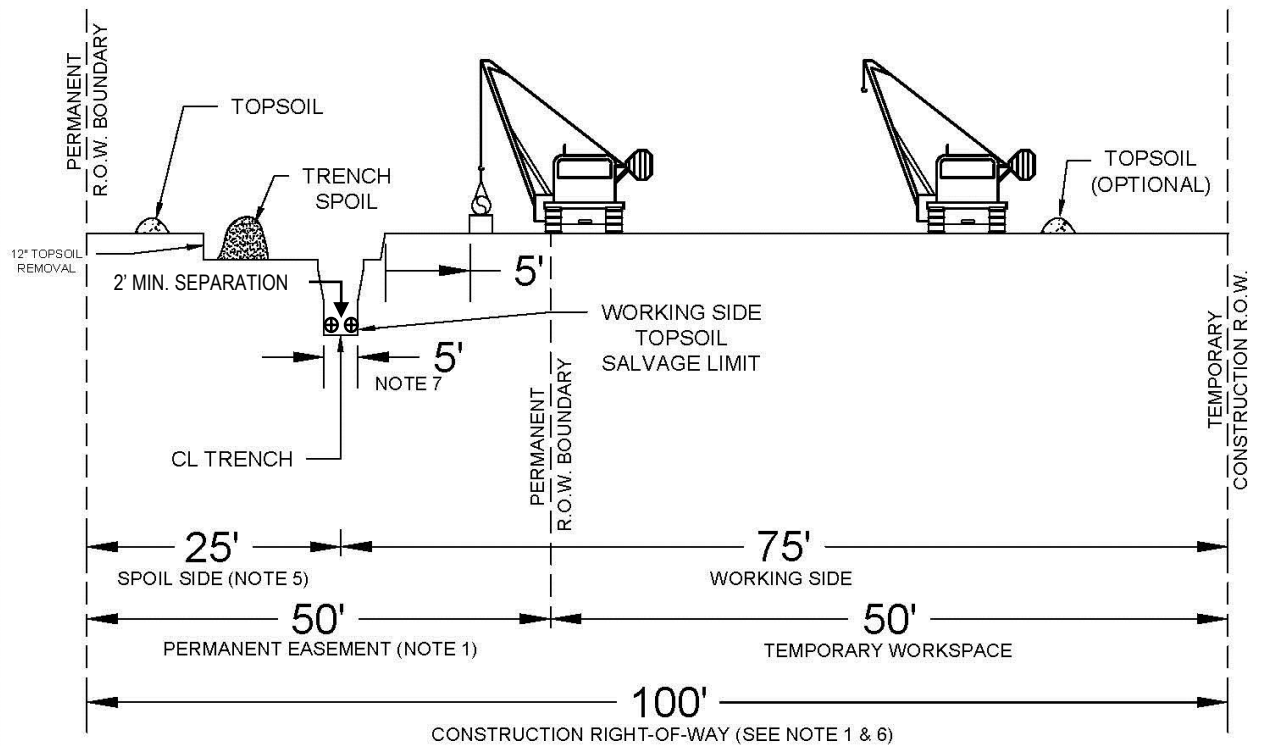
Arrow NB Gas Pipeline and Arrow NGL Pipeline

PIPELINE CONSTRUCTION SEQUENCE

MCKENZIE COUNTY NORTH DAKOTA

DATE:	PLOT DATE:	DRAWN BY:	LOC. NO:	DRAWING NUMBER:	SHEET NO:	REV:
	--		-		-	

CONSTRUCTION RIGHT-OF-WAY TYPICAL



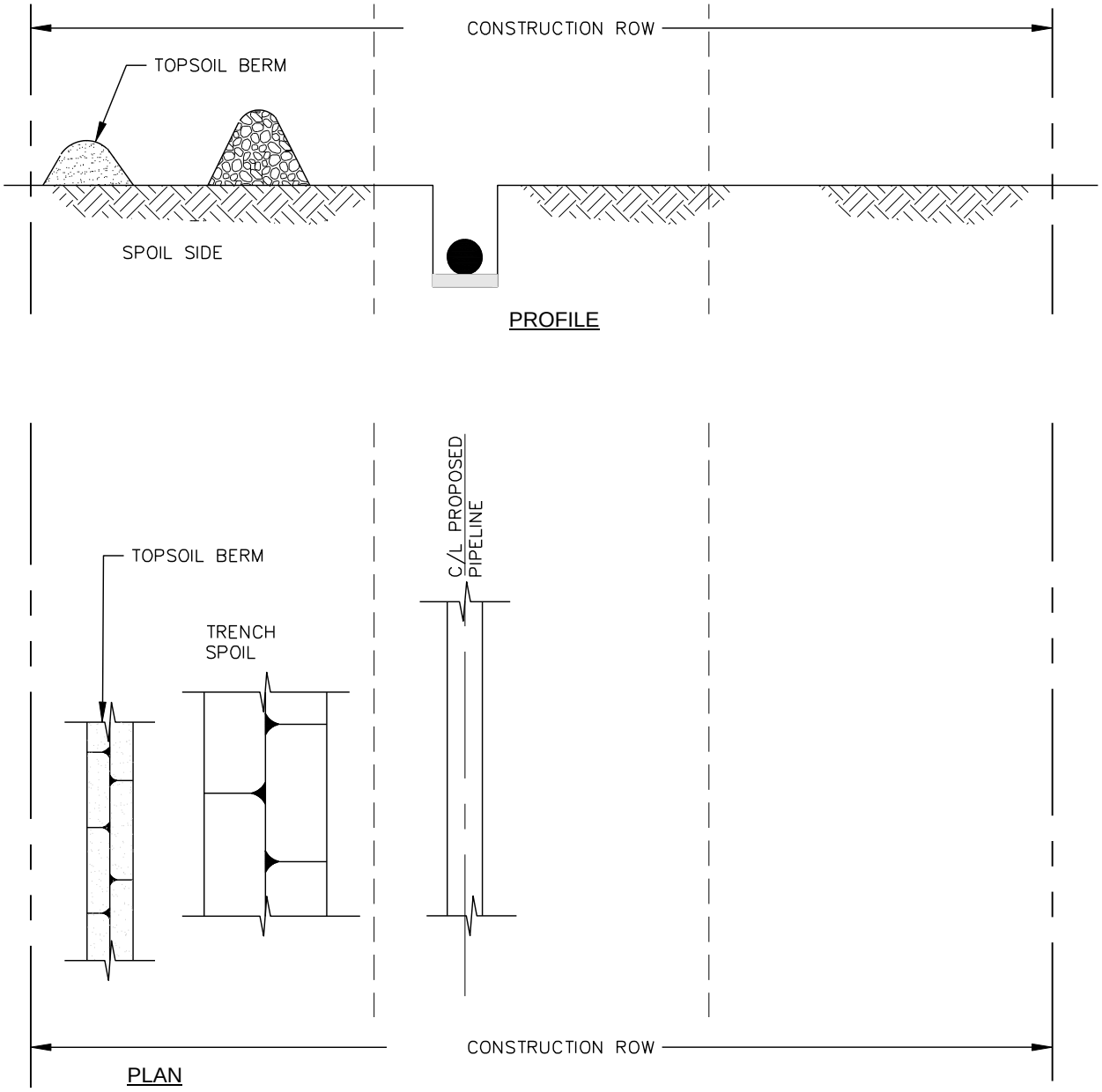
PROFILE
NOT TO SCALE

NOTES:

1. CONSTRUCTION RIGHT-OF-WAY WILL TYPICALLY BE 70' WIDE CONSISTING OF 30' OF PERMANENT EASEMENT AND 40' OF TEMPORARY WORKSPACE. EXTRA TEMPORARY WORKSPACE WILL BE NECESSARY AT MAJOR ROAD, RAIL, RIVER CROSSINGS AND OTHER SPECIAL CIRCUMSTANCES, AS REQUIRED. CERTAIN SITUATIONS MAY REQUIRE A NARROWER WIDTH.
2. THIS DRAWING REFLECTS "TRENCH AND SPOIL SIDE" TOPSOIL STRIPPING PROCEDURE. SALVAGE TOPSOIL OVER TRENCH AND UNDER THE SPOIL PILE AT LOCATION IDENTIFIED ON THE CONSTRUCTION ALIGNMENT SHEETS, OR AS DIRECTED BY THE COMPANY INSPECTOR. DEPTH OF TOPSOIL STRIPPING IS NOT TO EXCEED 12".
3. STOCKPILE TOPSOIL AS SHOW OR IN ANY CONFIGURATION APPROVED BY THE COMPANY INSPECTOR. KEEP TOPSOIL AND SPOIL PILES CLEAN OF ALL CONSTRUCTION DEBRIS. MAINTAIN A MINIMUM OF 12" OF SEPARATION BETWEEN TOPSOIL AND TRENCH SPOIL PILES. ENSURE THAT TOPSOIL AND TRENCH SPOIL DO NOT MIX.
4. LEAVE GAPS IN TOPSOIL AND SPOIL PILES AT OBVIOUS DRAINAGES. DO NOT PUSH UPLAND SOILS INTO CREEKS OR WETLANDS. DO NOT USE TOPSOIL FOR PADDING. AVOID SCALPING VEGETATED GROUND SURFACE WHEN BACKFILLING TOPSOIL AND SPOILS PILES.
5. THE OFFSET FROM EXISTING PIPELINE, WHERE APPLICABLE, WILL BE 25', BUT MAY BE INCREASED OR DECREASED DEPENDING ON THE SITE SPECIFIC CONSTRUCTION REQUIREMENTS.
6. TEMPORARILY SUSPEND TOPSOIL HANDLING OPERATION DURING EXCESSIVELY WINDY CONDITIONS UNTIL MITIGATIVE MEASURES TO MINIMIZE WIND EROSION CAN BE IMPLEMENTED.
7. BOTTOM OF TRENCH WIDTH WILL BE AN AVERAGE OF 5' (TYPICAL) AND UP TO A MAXIMUM OF 10' UNDER CERTAIN CIRCUMSTANCES. PIPELINES SHALL HAVE A MINIMUM SEPARATION OF 2'.
8. TOPSOIL AND TRENCH SPOIL RELATIVE POSITIONS CAN, AS DIRECTED BY THE COMPANY INSPECTOR, BE REVERSED.

SWCA ENVIRONMENTAL CONSULTANTS

TYPICAL ROW PLAN & PROFILE DETAILS



TYPICAL ROW–PLAN & PROFILE NOTES

APPLICATION:
THESE STANDARD PRACTICES ARE USED FOR THE TYPICAL CONSTRUCTION ACTIVITIES PERFORMED WHILE INSTALLING NEW PIPELINE THROUGH TRENCHING AND BORING AND CONSTRUCTION ACTIVITIES.

GENERAL PRACTICES:
1. BMPS SHOULD BE PLACED PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.

2. STOCKPILES SHOULD BE PLACED UP–GRADIENT OF THE TRENCH UTILIZING THE TRENCH ITSELF AS A BMP.

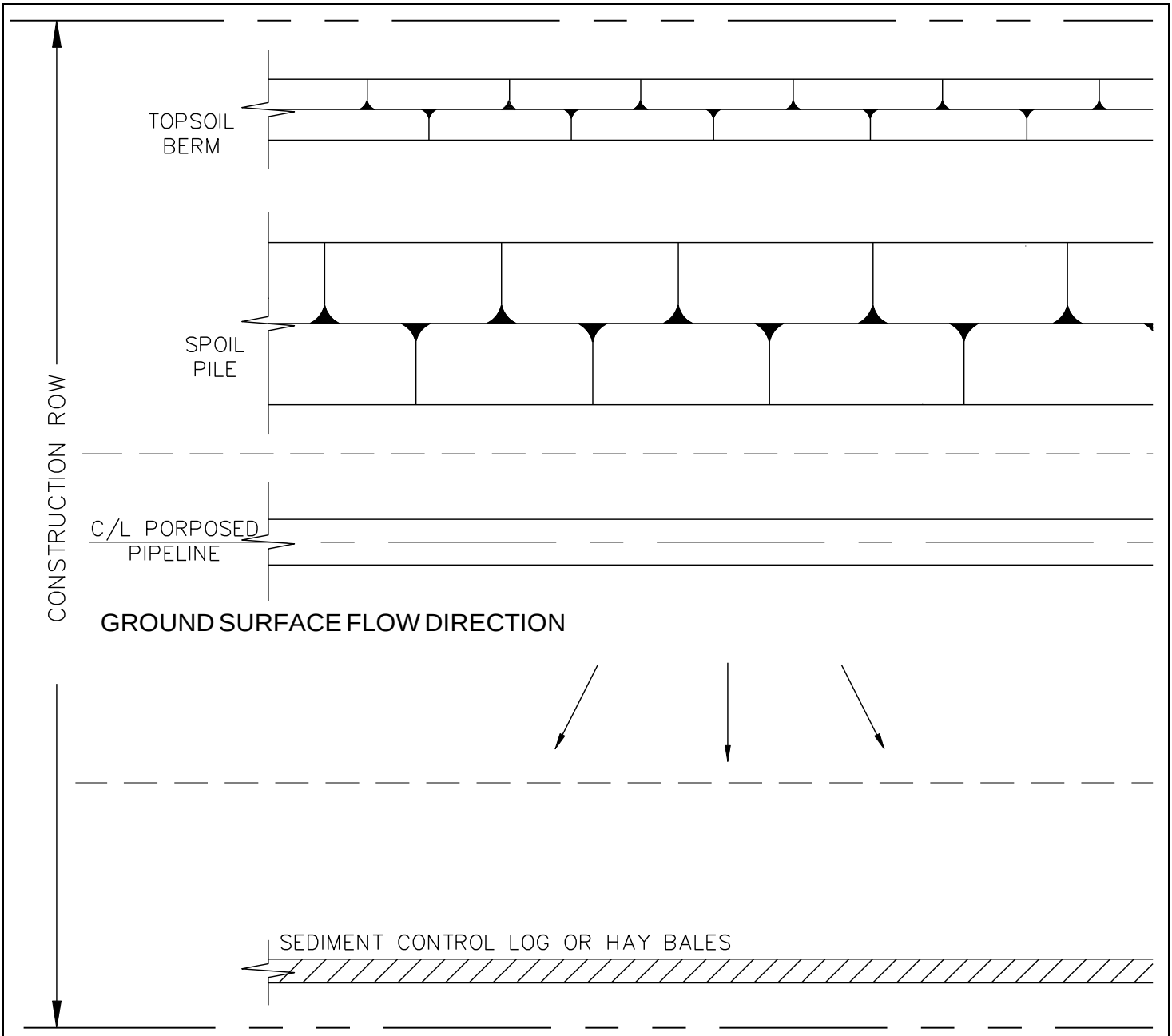
3. VEGETATIVE BUFFERS SHOULD BE PRESERVED AND UTILIZED AS A BMP WHENEVER POSSIBLE.

4. PAVED SURFACES IMPACTED BY THE SITE WILL BE SWEPT OF SOIL/ SCRAPED AS NEEDED.

5. PIPELINE ROW AND WORKING SPACE IS 60 FOOT ROW AND AN ADDITIONAL WORK SPACE OF 20 FEET ON EACH SIDE.
PIPELINE ROW AND WORKING SPACE IS A 60 FOOT ROW AND AN ADDITIONAL WORK SPACE OF 40 FEET.

NOT TO SCALE

PROJECT NO:	TYPICAL ROW-PLAN & PROFILE VIEW	SWCA ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	DETAIL
DRAWN BY:				1 OF 6
DATE:				



TYPICAL ROW–PLAN & PROFILE NOTES

APPLICATION:
THESE STANDARD PRACTICES ARE USED FOR THE TYPICAL CONSTRUCTION ACTIVITIES PERFORMED WHILE INSTALLING NEW PIPELINE THROUGH TRENCHING AND BORING AND CONSTRUCTION ACTIVITIES.

GENERAL PRACTICES:
1. BMPS SHOULD BE PLACED PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.

2. STOCKPILES SHOULD BE PLACED UP–GRADIENT OF THE TRENCH UTILIZING THE TRENCH ITSELF AS A BMP.

3. VEGETATIVE BUFFERS SHOULD BE PRESERVED AND UTILIZED AS A BMP WHENEVER POSSIBLE.

4. PAVED SURFACES IMPACTED BY THE SITE WILL BE SWEPT OF SOIL/ SCRAPED AS NEEDED.

NOTE:
TYPICAL BMP DETAIL FOR USE WHEN GROUND SURFACE FLOW DIRECTION IS DOWN–GRADIENT FROM PIPELINE TRENCH AND SOIL STOCKPILES

NOT TO SCALE

PROJECT NO:	TYPICAL BMP DURING CONSTRUCTION	SWCA® ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	DETAIL
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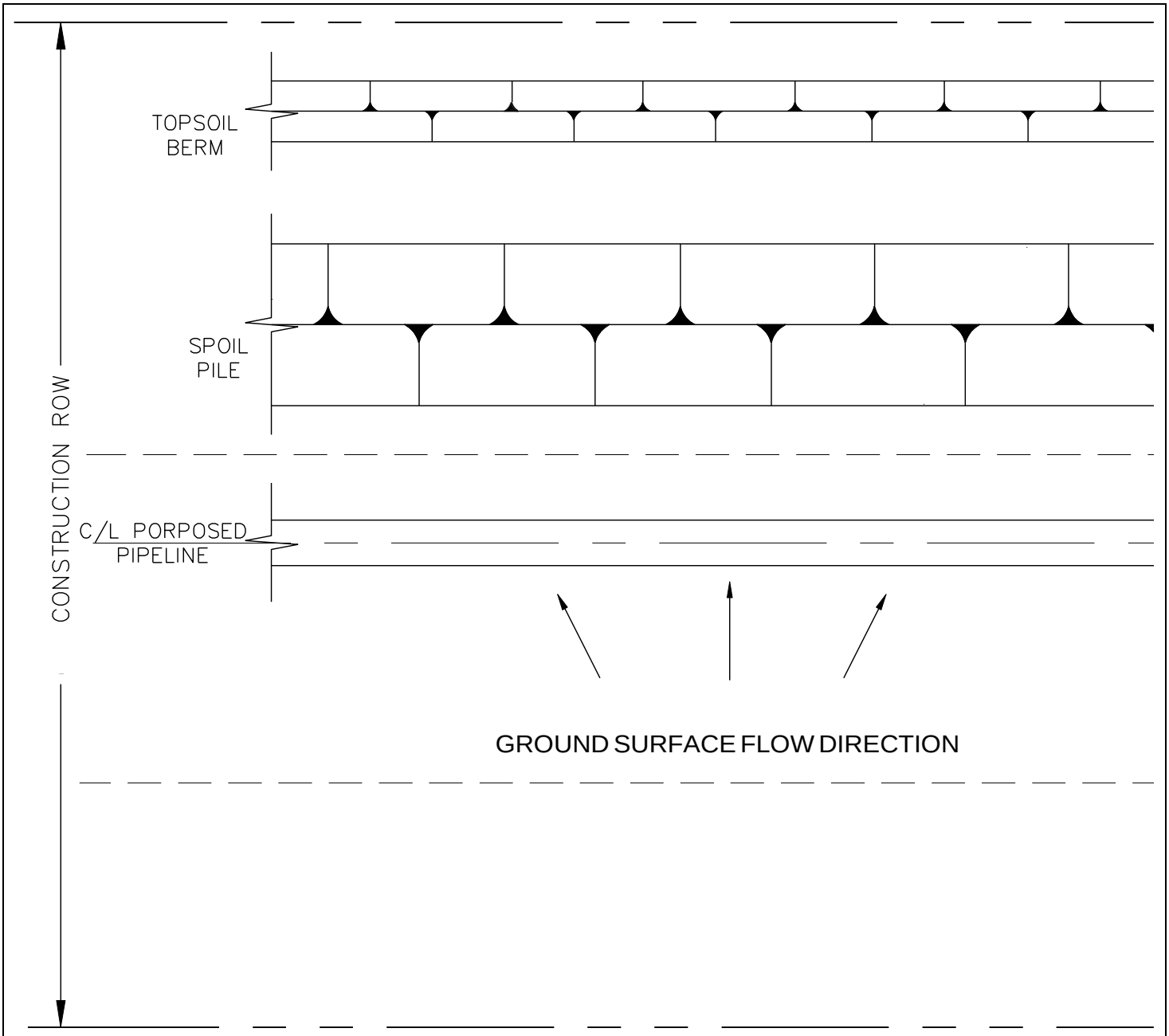
DATE:				



TYPICAL ROW–PLAN & PROFILE NOTES

APPLICATION:
THESE STANDARD PRACTICES ARE USED FOR THE TYPICAL CONSTRUCTION ACTIVITIES PERFORMED WHILE INSTALLING NEW PIPELINE THROUGH TRENCHING AND BORING AND CONSTRUCTION AC TIVITIES.

GENERAL PRACTICES:
1. BMPS SHOULD BE PLACED PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.

2. STOCKPILES SHOULD BE PLACED UP–GRADIENT OF THE TRENCH UTILIZING THE TRENCH ITSELF AS A BMP.

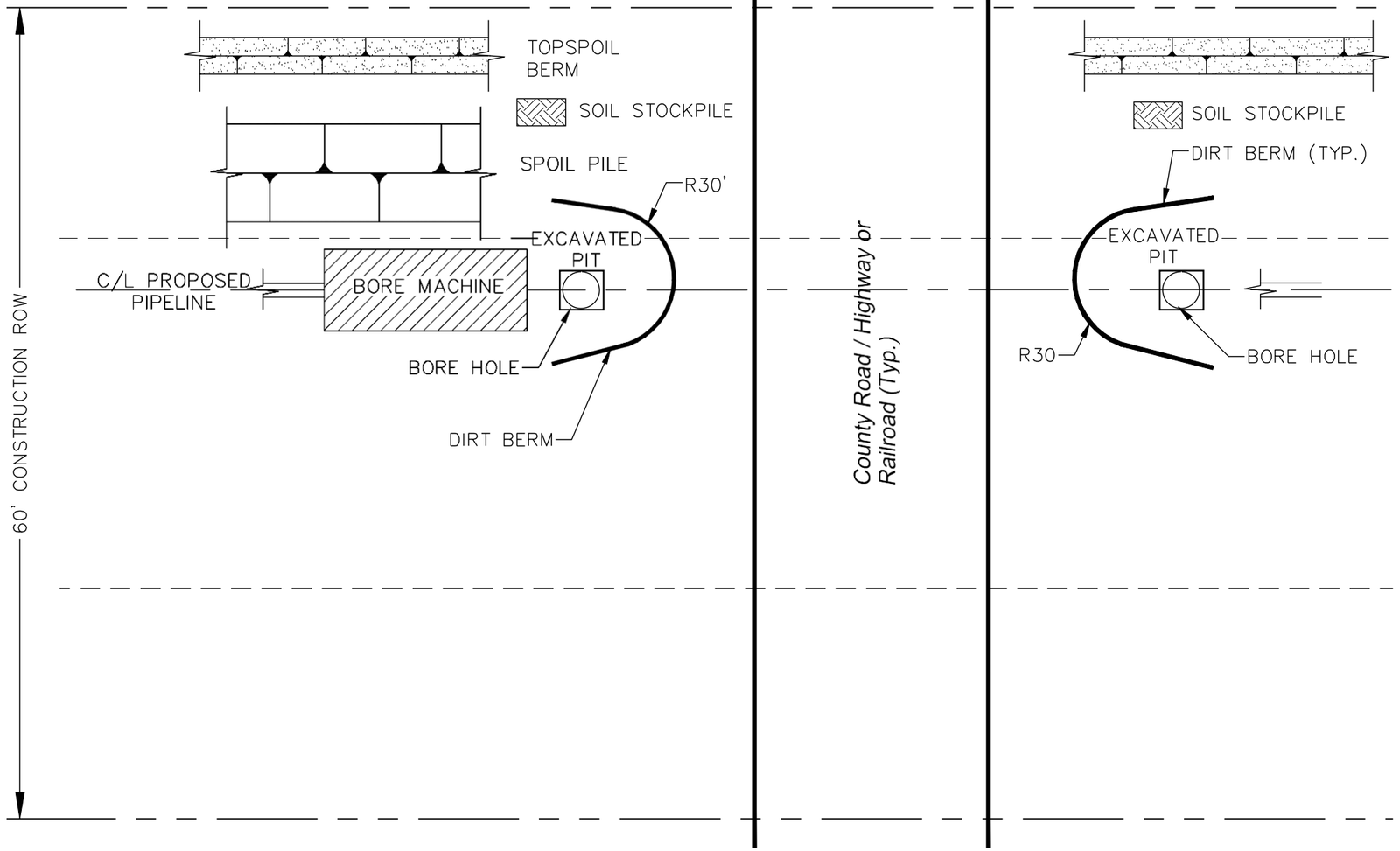
3. VEGETATIVE BUFFERS SHOULD BE PRESERVED AND UTILIZED AS A BMP WHENEVER POSSIBLE.

4. PAVED SURFACES IMPACTED BY THE SITE WILL BE SWEPT OF SOIL / SCRAPED AS NEEDED.

NOTE:
TYPICAL BMP DETAIL FOR USE WHEN GROUND SURFACE FLOW DIRECTION IS TOWARDS THE PIPELINE TRENCH.

NOT TO SCALE

PROJECT NO:	TYPICAL BMP DURING CONSTRUCTION	SWCA® ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	DETAIL
DRAWN BY:				3 OF 6
DATE:				



TYPICAL BMP FOR BORED ROAD CROSSING NOTES

APPLICATION:
THESE STANDARD PRACTICES ARE USED FOR THE TYPICAL CONSTRUCTION ACTIVITIES PERFORMED WHILE INSTALLING NEW PIPELINE USING HORIZONTAL DIRECT DRILLING TECHNIQUES.

GENERAL PRACTICES:
1. BMPS SHOULD BE PLACED PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.

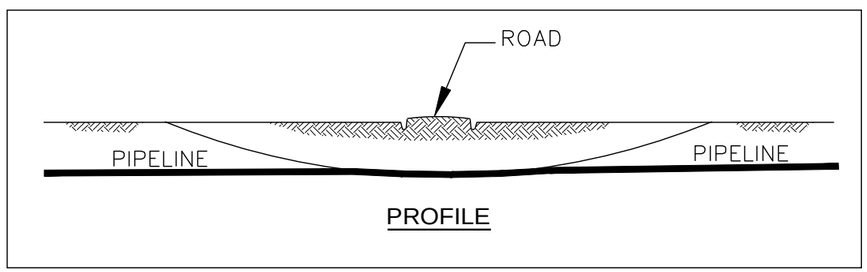
2. EXCAVATION PITS WILL REMAIN OPEN WITH PERIMETER ORANGE FENCING FOR THE DURATION OF THE BORING ACTIVITY.

3. STOCKPILES SHOULD BE PLACED UP-GRADIENT OF THE TRENCH UTILIZING THE TRENCH ITSELF AS A BMP.

4. VEGETATIVE BUFFERS SHOULD BE PRESERVED AND UTILIZED AS A BMP WHENEVER POSSIBLE.

5. PAVED SURFACES IMPACTED BY THE SITE WILL BE SWEPT OF SOIL/ SCRAPED AS NEEDED.

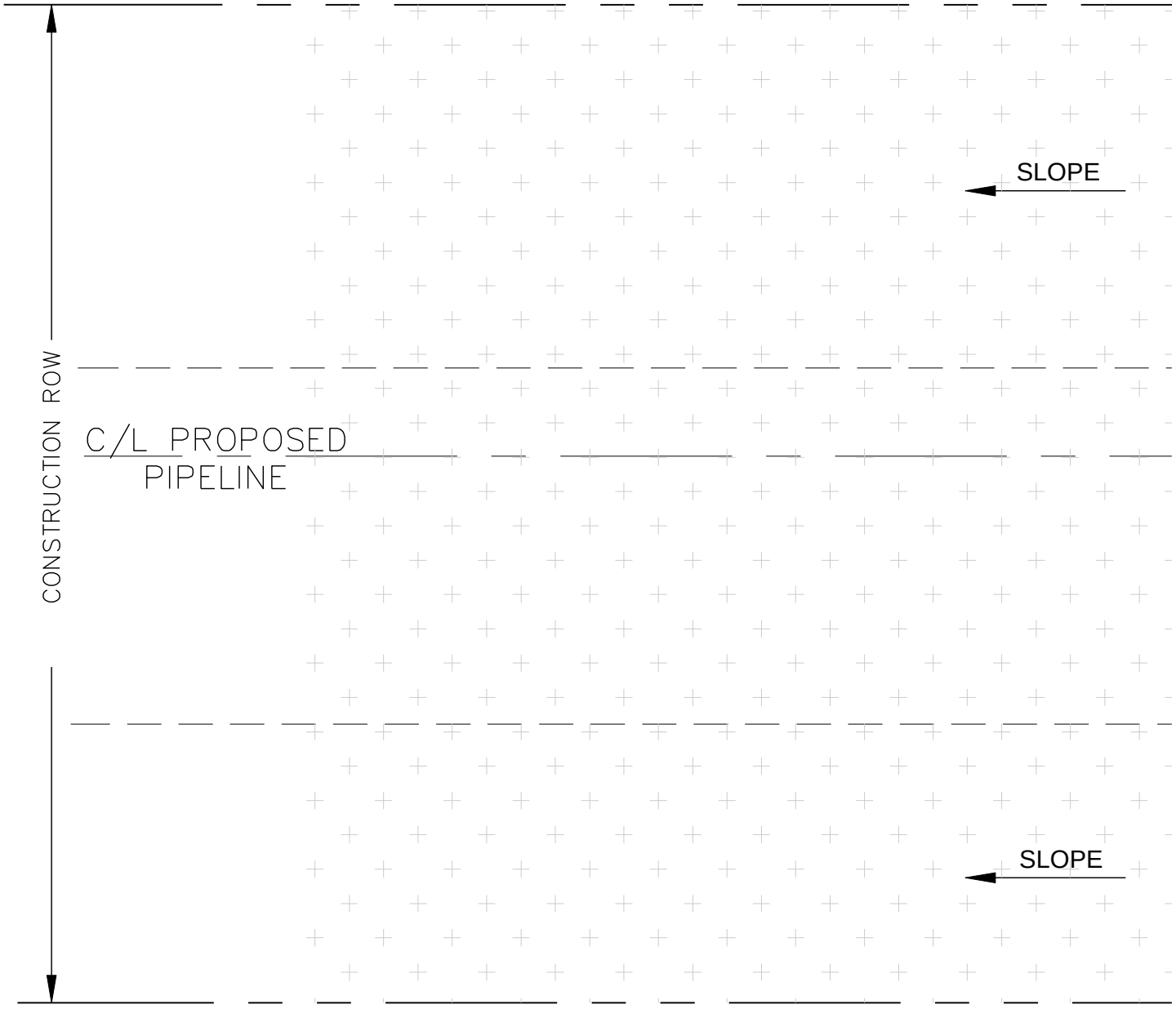
NOTE:
IF ROAD CROSSING IS PAVED, INSTALL VEHICLE STABILIZED CONSTRUCTION ENTRANCE BMP AT ACCESS POINTS TO PREVENT TRACKING OF DIRT/MUD ONTO PAVEMENT.



PROFILE

NOT TO SCALE

PROJECT NO:	TYPICAL BMP FOR BORED ROAD AND RAILROAD CROSSINGS	SWCA ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	DETAIL
DRAWN BY:		116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	4 OF 6
DATE:			



TYPICAL BMP FOR POST CONSTRUCTION STABILIZATION NOTES

APPLICATION:
THESE STANDARD PRACTICES ARE USED FOR THE TYPICAL CONSTRUCTION ACTIVITIES PERFORMED WHILE INSTALLING NEW PIPELINE THROUGH TRENCHING AND BORING CONSTRUCTION ACTIVITIES.

GENERAL PRACTICES:
1. BMPS SHOULD BE PLACED PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.

2. STOCKPILES SHOULD BE PLACED UP-GRADIENT OF THE TRENCH UTILIZING THE TRENCH ITSELF AS A BMP.

3. VEGETATIVE BUFFERS SHOULD BE PRESERVED AND UTILIZED AS A BMP WHENEVER POSSIBLE.

4. PAVED SURFACES IMPACTED BY THE SITE WILL BE SWEPT OF SOIL/ SCRAPED AS NEEDED.

LEGEND

SEED AND MULCH WITH CRIMP STRAW

NOT TO SCALE

PROJECT NO:	TYPICAL BMP FOR POST-CONSTRUCTION STABILIZATION ON SLOPES OF 3:1 OR GREATER	SWCA® ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	DETAIL
DRAWN BY:		116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	5 OF 6
DATE:			

SURFACE ROUGHENING INSTALLATION NOTES

1. SURFACE ROUGHENING SHOULD BE PROVIDED ON ALL FINISHED GRADES.

2. DISTURBED SURFACES SHALL BE ROUGHENED USING TILLING EQUIPMENT.

SURFACE ROUGHENING MAINTENANCE NOTES

1. VEHICLES AND EQUIPMENT SHOULD BE CONFINED TO ACCESS DRIVES NEAR THE EDGE OF THE RIGHT-OF-WAY AND NOT DRIVE OVER AREAS THAT HAVE BEEN SURFACE ROUGHENED.

SURFACE ROUGHENING

NOT TO SCALE

PROJECT NO:	SURFACE ROUGHENING	SWCA® ENVIRONMENTAL CONSULTANTS Sound Science. Creative Solutions.®	116 NORTH 4TH STREET SUITE 200 BISMARCK, ND 58501 TEL 701.258.6622 FAX 701.258.5957	DETAIL
DRAWN BY:				6 OF 6
DATE:				

APPENDIX B
Frac-Out Contingency Plan

Arrow Midstream Holdings, LLC
Arrow Field Services, LLC

Frac-Out Contingency Plan

Arrow NB Residue Gas Pipeline
and
Arrow Bakken NGL Pipeline Project
McKenzie County, North Dakota

Prepared for:

Arrow Field Services, LLC
10702 Highway 73
Keene, North Dakota 58847

Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

SWCA Environmental Consultants
116 North 4th Street, Suite 200
Bismarck, North Dakota 58801

January 2017

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LIST OF FIGURES

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1.0 INTRODUCTION

This Frac-Out Contingency Plan (Plan) provides specific procedures and steps to contain the inadvertent releases of drilling mud (frac-outs) for highways, roads, and other areas or structures that are crossed underneath using horizontal directional drilling (HDD) techniques.

This Plan is intended to:

- provide for the timely detection of frac-outs;
- ensure an organized, timely, and "minimum-impact" response in the event of a frac-out; and
- ensure that the HDD Contractor takes all immediate actions necessary to stop the flow of HDD mud, contain the release, and notify Arrow Field Services, LLC.

This Plan is applicable for the Arrow NB Residue Gas Pipeline and Arrow Bakken NGL Pipeline Project (Project) to be constructed in McKenzie County, North Dakota, by Arrow Field Services, LLC (Arrow). As illustrated in Figure 1, the proposed Project will be approximately 2.6 miles long, comprised of one 10-inch-diameter welded steel pipeline that will transport residue gas from a natural gas processing plant to a third-party natural gas transmission pipeline and an 8-inch diameter, welded steel pipeline that will transport natural gas liquids (NGLs) from the same natural gas processing plant to a third-party NGL facility. Along the proposed route, the pipelines will cross two county roads, and two section lines.

2.0 DRILLING PROCESS AND DRILLING FLUID SYSTEMS

The drilling process begins when the HDD machine pushes a bore head connected to hollow pipe into the ground at an angle. As each joint of drill pipe is pushed into the ground, a new one is added behind it.

This process is continued until the bore head comes out of the ground at the end of the bore.

The most commonly used equipment for determining the location of the bore head is called a 'Walk Over' Locating system that uses a transmitter behind the drill bit that registers angle, rotation, magnetic direction, and temperature data. The information is then encoded into an electro-magnetic signal, which is transmitted through the ground to the surface. At the surface, a receiver is manually positioned over the transmitting signal where the signal is decoded and steering directions are relayed to the operator of the drill machine.

The HDD process involves the use of drilling fluids (referred to as drilling mud) that consist primarily of water. Bentonite clay is added to the water to enhance lubrication, soil cuttings transport, and caking properties of the drilling fluid. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI 60 NSF Drinking Water Additives Standards and is frequently used as a component in drilling mud for drilling potable water wells.

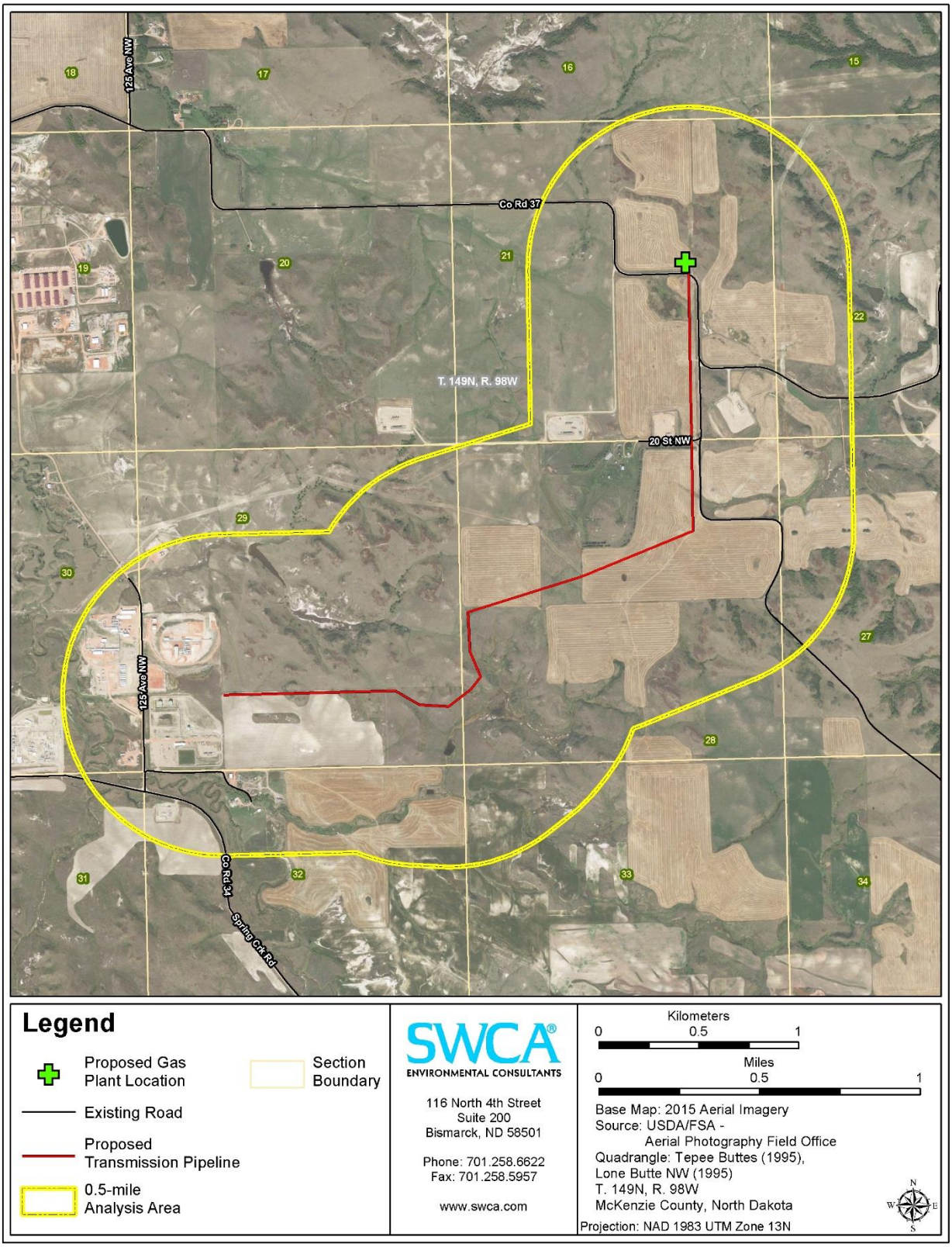

Figure 1. Arrow NB Residue Pipeline and Arrow NGL Pipeline Project location map.

The drilling fluid is prepared in a mixing tank containing both new and clean recycled drilling fluid. The drilling fluids to be used in this Project may vary but could include a typical mixture of extra high-yield bentonite, Pipeclad 2000 Slow Gel, and FlowPac™. The Safety Data Sheets for these materials are provided in Appendix A, as an example. Safety Data Sheets for actual materials used will be kept onsite when materials are received, stored, used, and transported for disposal. The fluid is generally pumped at a rate of 100 to 1,000 gallons per minute through the center of the drill pipe to the drill head bit.

Return flow is through the annulus created between the wall of the boring and the drill pipe. The cuttings are then carried back to either the entry or the exit pit, depending on a combination of elevation difference and drilling/hole opening direction. Once in the entry pit, the fluid moves to the pickup pit to be pumped to the fluid processing equipment. Typically, shaker screens, de-sanders, and de-silters remove increasingly finer cuttings from the drilling fluid. The cleaned and recycled fluid is returned to the mixing tank and pumps for reuse in the borehole.

Upon reaching the exit point, the drill bit is detached and a reamer tool is attached. The reamer is pulled back while rotating the drill pipe, with as many passes as required to widen the borehole to the desired diameter. Once the borehole is the correct size for the pipe to be installed, it is attached to the end of the reamer and pulled through the hole. Throughout this process, bore fluid is continually pumped into the hole to ensure that the hole is sealed, with no void being left between the pipe and the native soil.

The HDD method has the potential for loss or seepage of drilling fluid into subsurface unconsolidated soil through which the drill passes. In some cases, the drilling fluid may be forced to the surface resulting in what is commonly referred to as an inadvertent release or a frac-out. Drilling fluid release is typically caused by pressurization of the drill hole beyond the containment capability of the overburden soil material or due to an inherent weakness within the overlying soils, such as a fissure, fracture or other pathway.

The HDD operation is a closed system to minimize the discharge of drilling mud and cuttings outside the work area. To minimize the possibility of fluid escape, berms will be constructed around reserve pits used to contain the drilling fluid. Any drilling mud that inadvertently exits at points other than the entry and exit points will be contained and collected to the extent practical. Additional frac-out response actions are described in the following sections.

3.0 HDD CONTRACTOR RESPONSIBILITIES AND REQUIREMENTS

The HDD contractor is responsible for detecting and controlling the inadvertent release of drilling fluid. An Arrow inspector will closely observe the progress and actions of the HDD contractor.

The HDD contractor will be equipped with a trackhoe excavator, straw bales, stakes to secure bales, silt fence, sand bags, shovels, pumps, and any other materials or equipment necessary to contain and clean up inadvertent releases. A vacuum truck will be on call and available to respond to frac-out events during drilling operations.

4.0 FRACTURE DETECTION

Drilling crew personnel, the mud system operator, and the Arrow inspector will be responsible for the detection and monitoring of frac-outs. The most obvious signs of a frac-out are the visible pooling of drilling mud on the surface, a sudden decrease in mud volume returns during drilling operations, or loss in drilling mud pump pressure. The mud system operator will observe the volume of drilling fluid return and immediately report reductions to the drilling supervisor and Arrow inspector.

The mud system operator will monitor actual drilling fluid volumes from the pumps and the return flow from the borehole and will alert the on-site personnel if there is a significant variance. In the event of partial circulation loss, pumping of drilling fluid may be decreased to reduce borehole mud pressures applied to subsurface soil materials. Figure 2 illustrates a typical frac-out surface expression.

Figure 2. Typical surface expression of a frac-out.

5.0 CORRECTIVE ACTIONS FOR AN INADVERTANT RELEASE

In the event of an inadvertent release to the surface, the following actions will be taken.

If the release is large, mud circulation will cease immediately as practical. If the spill is small to moderate, the contractor will continue circulation in order to maintain pressure in the borehole. Maintaining circulation may be necessary to maintain borehole stability.

In all cases, the HDD contractor will proceed as follows.

- Contain any drilling fluid that has surfaced.
- Notify the Arrow inspector.
- Reduce circulation pressure and evaluate the circumstances leading to the circulation loss to determine if the fracture can be sealed.
- Thicken the drilling fluid in an attempt to seal off the location of the release, if practical.

6.0 CONTAINMENT OF DRILLING FLUID RELEASE

Immediately following the detection of the inadvertent drilling fluid release, containment and clean-up operations will begin. For releases on land, the HDD contractor will use straw bales, silt fences, sand bags, hand tools, and earthen berms to prevent fluid from migrating or flowing from the immediate area of the discharge. If the volume released is too small for containment measures or if the release occurs in an environmentally sensitive area where cleanup actions would cause environmental surface damage, the receiving area will be allowed to dry naturally. If there is a threat to a sensitive resource, or a threat to public safety, HDD activities will cease immediately until a plan to proceed is discussed and approved by Arrow.

Other containment measures include the following.

- Additional berms and sediment control devices may be constructed around the release area as directed by the Arrow inspector to prevent the release of drilling mud into an adjacent waterbody.
- If hand tools cannot contain a small on-land release, small collection sumps may be constructed to pump the released material into the mud processing systems.
- Sump pumps or vacuum trucks will be used to remove and dispose of any drilling fluids as needed.

While not anticipated, in cases of inadvertent releases to open water or flooded wetlands, it may be impractical or impossible to contain the release. For releases in shallow water, the HDD contractor will shut down drilling fluid circulation to minimize the volume of the release.

The decision to proceed with the HDD drilling operation will be at the sole discretion of Arrow after all practical methods to seal off the release location of the discharge have been attempted.

7.0 CLEAN-UP OF RELEASES

Cleanup activities will start immediately after the release has been contained and will entail removal of as much bentonite drilling mud that can be collected. Removal methods will vary based on the volume of the release and site-specific conditions. Removal equipment may include vacuum trucks, loader and trackhoe buckets, small pumps, and hand tools (e.g., shovels and buckets). In some instances, the bentonite drilling mud may remain in place because cleanup operations would cause more harm to the wetland or waterbody. Special tools, such as open-ended wooden boxes, open-ended steel drums, or other similar equipment, may be used to isolate the drilling fluid in water so it can be removed using a vacuum truck. After removal of the released drilling fluid, the release area will be returned as close to the original condition as possible.

8.0 AGENCY NOTIFICATION PROCEDURES

If an inadvertent release is discovered, steps will be taken to contain the release as described in Section 6.0. Notification procedures for Arrow construction management personnel and regulatory agencies are as follows.

- When monitoring indicates that a wetland or surface waterbody release has occurred, the Arrow inspector will notify the Arrow Project Manager as soon as possible. The nature of the release will be described and corrective actions will be detailed. The Project Manager will determine if additional measures are required and if drilling operations should continue.
- The Project Manager will make all necessary internal notifications. Arrow will make all necessary and appropriate notifications to jurisdictional government agencies as required (Table 1).

Table 1. Notification of Government Agencies

NOTIFICATION OF OUTSIDE PARTIES,
PUBLIC SAFETY OFFICIALS, AND GOVERNMENT AGENCIES

Arrow Field Services, LLC
Arrow Transmission Pipelines Project

PUBLIC SAFETY NOTIFICATION

Fire 911
Police 911

GOVERNMENT AGENCY NOTIFICATIONS

National Response Center **1-800-424-8802**
(24 hours/day, 7 days/week)

North Dakota Department of Health (toll free) ..... ….**1-800-472-2121**
Environmental Health Section 701-328-5150
Division of Water Quality 701-328-5210
Division of Waste Management 701-328-5166

North Dakota Industrial Commission
Department of Mineral Resources, Oil and Gas Division 701-328-8020
North Dakota Department of Emergency Services 701-328-8100

McKenzie County

Highway Department (Suhail Kanwar, County Engineer) 701-444-7426
Emergency Management (Karolin Jappe) 701-444-3616
Sheriff's Department (Matthew Johansen, Sheriff) 701-444-3654

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APPENDIX A
Safety Data Sheets

ECCA
HOLDINGS (PTY) LTD

MATERIAL SAFETY DATA SHEET

SECTION 1: IDENTITY:

Product Name:	BENTONITE
Common Name:	BENTONITE / SWELLING CLAY/ MONTMORILLONITE / SMECTITE.
Chemical Name:	MAGNESIUM AND ALUMINIUM SILICATE / PHYLLOSILICATE
Manufacturer's Name:	ECCA HOLDINGS (PTY) LTD.
Manufacturer's Address:	PO BOX 8118 CENTURION 0046 SOUTH AFRICA
Emergency Telephone Number:	(+27) 12 643 5880

SECTION 2: HAZARDOUS INGREDIENTS:

Cape Bentonite is a natural material that consists of variable proportions of various minerals, including Montmorillonite, quartz and mica. Cape Bentonite products consist primarily of montmorillonite and other minor natural minerals.

Hazardous Ingredient:	Approximate Weight %:	CAS no:
Montmorillonite	>90%	1318-93-0
Quartz	<10%	14808-60-7
Mica	<10%	12001-26-2

SECTION 3: HAZARDS IDENTIFICATION AND CAUTIONS:

Bentonite is of low acute toxicity. Long-term exposure to any respiritible mineral dust could cause slight effects on the respiratory system.
Wet bentonite spillage constitutes a major slipping hazard.

Primary hazards:	This product does not present any primary hazards.
Specific hazards:	Respiratory effect: possible slight irritation from dust. May aggravate pre-existing difficult respiratory conditions. Wet material is very slippery.
Cautions:	Inhalation of dust may cause slight irritation Material is very slippery when wet.
	OES (Occupational Exposure Standard) for respiritable Bentonite dust: 5mg/m³ in an 8 hours time weighted average reference period
HMIS Hazard Classification:	Health: 1 (possible chronic health effects)
(See Section 11)	Flammable: 0
	Reactivity: 0

SECTION 4: FIRST AID MEASURES:

Eye Contact: Flush with copious amount of fresh water. Eyelids may become sticky. Avoid rubbing eyes. If irritation develops, seek medical attention.
Skin Contact: Wash with soap and water. Bentonite is a desiccant and may cause dry skin. Repeated contact may also cause slight irritation. If irritation develops, seek medical attention.
Inhalation: Move to dust free fresh air. If respiratory distress develops, seek medical attention.
Ingestion: No adverse effect expected. Rinse mouth out with water. Seek medical attention if significant quantities have been ingested

SECTION 5: FIRE FIGHTING MEASURES:

Explosion Data:	Not explosive.
Extinguishing Media:	Product will not burn.
Flammability:	Not flammable or combustible.
Flash Point:	Not applicable.
Auto Ignition:	Not applicable.

SECTION 6: ACCIDENTAL RELEASE MEASURES:

Collect spillage by vacuum cleaning or other means whereby dust creation is minimised. If dust levels should exceed the occupational exposure standard, then personal protective equipment is required.

Personal precautions: Wear dust mask, safety gloves and goggles.

Environmental precautions: Do not allow the entering into drains, rivers, or lakes.

Method of cleaning: Use a vacuum or any other means minimising dust creation (flushing with water must be avoided by all means).

SECTION: 7: HANDELING AND STORAGE:

Handling: Bentonite is safe to handle. Material is very slippery when wet. Use appropriate controls and ventilation to avoid creating accumulation dust. Avoid inhalation and repeated contacts with eyes or skin.

Storage: Store in a dry covered area

SECTION 8: EXPOSURE CONTROL / PERSONAL PROTECTION:

Ventilation: Use exhaust ventilation to keep airborne dust concentration below exposure limits. Additionally, local exhaust ventilation is recommended where dusts may be released.

Respiratory Protection: Use appropriate engineering controls to avoid dust oration or accumulation. Ensure all occupational exposure limits are maintained (5 mg/m³ on TWA 8 hours for alveolar dust, and 10mg/m³ on TWA 8 hours for total inhalator dust). Wear approved respirator or dust mask in the event of dust creation.

Skin Protection: Use gloves to avoid skin irritation.

Eye Protection: Eyewash should be available, but eye protection is not required unless physical working conditions demand it.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES:

Physical State:	Solid
Odour and Appearance:	Light colour (grey, pink, yellow, green brown) granules or Powder. Odourless
pH:	8.1 to 10.5
Specific gravity	2.5 g/cc
Bulk density	1.18 g/cc
% Soluble in water:	Nil
Melting Point	1200°C
Boiling Point:	Not applicable
Freezing Point:	Not applicable
Vapour pressure:	Not applicable
Vapour density:	Not applicable
Flash Point:	Not applicable / non-flammable product.

SECTION 10: STABILITY AND REACTIVITY:

Chemically stability:	Stable.
Compatibility with other substances:	Compatible with all substances.
Hazardous decomposition / By product:	No hazardous decomposition or by products expected.
Conditions to avoid:	None

SECTION 11: TOXICOLOGICAL INFORMATION:

Bentonite has no determined acute toxic affects. Long-term exposure to moderate or high concentrations of Bentonite dust may affect nose and respiratory tract and chest health. No toxicological effects are expected if respiratible dust concentrations are maintained below the occupational exposure standards.
Repeated contact with skin may cause dry skin and irritations. Repeated eye contact may generate irritations. No toxicological effects are expected if personal protective equipment is worn.
No adverse effects are expected when ingested.

Acute Health Hazards:

Eye contact may cause mechanical irritations if exposed to excessive amount of Bentonite.
Skin contact may aggravate existing dermatitis.
Inhalation from prolonged and continuous exposure may aggravate existing asthmatic or respiratory conditions.

Chronic Health Hazards:

Prolonged inhalation of excessive levels of Bentonite dust may cause a simple pneumoconiosis condition, not normally associated with a decrement in lung function. In cases of long-term exposure to externally high levels of dust, complicated pneumoconiosis with lung function impairment may occur.

Carcinogenicity: none known
Mutagenicity: none known
Ieratogenicity: none known
Reproductive effect: none known

Cape Bentonite contains less than 10% crystalline silica according to testing, with a typical value around 5%. The International Agency for Research on Cancer (IARC) has classified crystalline silica as a possible carcinogen, which means there is limited evidence for human carcinogenicity of crystalline silica.

Cape Bentonite does not contain dioxin and can be used in animal feed.

SECTION 12: ECOLOGICAL INFORMATION

Environmental Statement: Bentonite has a low impact on environment. Bentonite is persistent and non-biodegradable but it is unlikely to have any long-term adverse effect on the environment.

Mobility:	Solid, non volitile, insoluble in water
Degradability:	Non-biodegradable. Persistent.
Accumulation:	No bioaccumulation or bio-magnification identified.
Ecotaxicity:	Non-toxic to aquatic living organisms and animals. Non-toxic to aquatic plants Non-toxic to soil organism. Non-toxic to aerobic and anaerobic plants Non-toxic to aerobic and anaerobic living organisms and animals.

SECTION 13: DISPOSAL CONSIDERATIONS:

Bentonite and waste from residue can be disposed as non-toxic and inactive materials in approved landfill sites in accordance with local regulations.
Contaminated packaging can be disposed in approved landfill sites in accordance with local regulations.

SECTION 14: TRANSPORT INFORMATION:

Bentonite is not classified as dangerous for transportation. Bentonite may be transported in accordance with the standard local authority regulations.

SECTION 15: REGULATORY INFORMATION:

Bentonite is not classified as dangerous for supply under EEC regulations. Bentonite does not require labelling for safety information or risk information.

Bentonite is 5mg/m³ respiritable dust in a TWA 8 hour's reference period.

Refer to all applicable local, national and international regulations and provisions to ensure that all the above are the relevant applicable measures.

SECTION 16: OTHER INFORMATION:

The information contained in the Material Safety Data Sheet does not constitute and assurement of workplace risks.

Workers should be trained to handle powder products without generating airborne dust.

The information and recommendation contained above are based on data and measures believed to be correct. However, they do not carry any guarantee or warranty of any kind.

Date: 14 January 2005

Signature: _____
Hamdi SETATI

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