NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD

WASTE TRANSFER (NUMBER)

CODE 634

DEFINITION

A system using structures, pipes or conduits installed to convey wastes or waste byproducts from the agricultural production site to storage/treatment or application.

PURPOSE

To transfer agricultural waste material associated with production, processing, and harvesting to:

- a storage facility,
- a treatment facility,
- a handling or loading area,
- agricultural land for agronomic application.

CONDITIONS WHERE PRACTICE APPLIES

The waste transfer system is included as an element of the agricultural production area, storage/treatment facility and/or land application areas of the agricultural operation.

The practice applies where it is necessary to transfer waste material generated by livestock production or agricultural product processing from:

- the generation site to the application area,
- the generation site to a storage/treatment facility,
- the storage/treatment facility to land for agronomic application.

This practice does not apply to hauling waste material with equipment or vehicles.

CRITERIA

General Criteria Applicable to All Purposes

Safety. Engineering plans shall follow the industry standard for addressing safety issues associated with agricultural waste storage and handling. This standard is maintained by the American Society of Agricultural and Biological Engineers as ASAE EP 470, Manure Storage Safety, October 2011 (as revised).

Include a water-sealed trap and vent or similar devices where necessary to **prevent** gases **within a** pipeline **from** entering an enclosed building or reception pit. Include ventilation provisions for an enclosed structure.

Provide warning signs as necessary to warn of the danger of entry and to reduce the risk of explosion, poisoning, or asphyxiation possible with the waste transfer system. **In Montana, at least one warning sign shall be placed at the entrance of confined spaces such as covered tanks, pump stations, sumps, and manholes, with the notation "Confined Space," "Hazardous Gas," or similar. If the preservation of a warning sign is not possible or practical, the cover shall be bolted or locked, or otherwise secured by weight (greater than 100 pounds) into a notched groove.**

Reducing a reception pit design volume by flood routing the design storm runoff storage may be used only when there is dependable back-up power supply for pumps and where no impact to surface water can occur, should the reception pit pump fail.

Prevent tractors and other equipment from slipping into waste collection, storage, or treatment facilities by placing barriers on push-off ramps.

NRCS, MT
November 2015

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard contact the Natural Resources Conservation Service.

NOTE: This type of font **(AaBbCcDdEe 123..)** indicates NRCS National Standards.
This type of font (AaBbCcDdEe 123..) indicates Montana Supplement.

Provide covers or barriers, such as gates, fences, grates, etc., across openings to a manure storage structure. **Traffic barriers should be considered around the perimeter of buried tanks to prevent un-necessary or un-planned vehicle loads.**

Identify pipe at risk to being damaged by equipment or livestock by placing**, as appropriate,** fence**,** markers**, or barriers** along the pipeline.

Provide a secure cover or otherwise restrict access to **the gate operator of** any in-line valve **controlling** discharge from a waste storage structure to prevent unauthorized release of effluent.

Permits. Notify landowner and/or contractor of responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures.

The landowner is required to obtain all necessary permits for project installation prior to construction.

Structures. Structures including concrete pits, tanks, hoppers, manholes, and channels used for waste transfer, prefabricated or cast-in-place, must meet the criteria in NRCS Conservation Practice Standard (CPS) Waste Storage Facility (Code 313) for liquid tightness and structural strength, regardless of materials used for construction.

Design all structures, including those that provide a work area around pumps to withstand the design static and dynamic loading. Design structures to withstand earth and hydrostatic loading as specified for comparable structural criteria in NRCS CPS Waste Storage Facility (Code 313).

In locating structures, utilize existing topography to the greatest extent possible to generate head on effluent flow and reduce pumping requirements.

Investigate the subsurface conditions (i.e., depth to bedrock, soil classification, water table, etc.) when locating and designing structures. **The minimum number of soil borings for reception tanks shall be one per 40 feet structure length. Soil borings shall be located within 50 feet of the actual installation.**

Reception tanks, hoppers, sumps, manholes, channels, and other transfer structures, which store waste only during the transfer process are not required to meet well, groundwater, or bedrock separation distances discussed in Montana Department of Environmental Quality (DEQ) General Permit (dated November 1, 2013) for Concentrated Animal Feeding Operations (CAFO).

Size reception pits **or tanks** (areas established to temporarily accumulate effluent flow) to contain a minimum volume of one full day's waste production. Provide additional storage for reception pits receiving stormwater runoff to contain the volume of precipitation and runoff from the 25-year, 24-hour storm plus any required freeboard and emergency storage.

Where an intermediate station along a pipeline is needed for transition of direction or lift in elevation, and no additional flow will be added to the pipe at that station, size the direction transition station or lift station to accommodate the peak flow, taking into account the designed outflow.

Design floor openings with structures that receive manure from alley scrape collection, with a minimum of 9 square feet, having one dimension of that opening 4 feet or larger. Equip floor grate with openings wide enough to pass the waste and engineered to support the anticipated live loads. Provide safety features to prevent accidental entry to the waste reception pit.

Construct curbs in conjunction with structures that meet the purpose of this standard and design criteria in NRCS CPS Waste Storage Facility (Code 313). Design curbs to be anchored to withstand working loads. Construct curbs of sufficient height to ensure all waste flows into the transfer structure.

Use the NRCS CPS Roofs and Covers (Code 367) to design covers where needed for structures.

Pipelines/Conduits-General. Design transfer pipeline/conduits in accordance with sound engineering principles, taking into account the waste material properties, management operations, pipe exposure, static and dynamic loads on the pipe, working pressure, transfer system pressure rating, required capacity and all applicable design factors. Pipe pressure rating required may need adjustment based on effluent temperatures and consistency.

Use watertight or sewer grade pipelines and connection devices for waste transfer pipelines.

The type of liquid waste material and total solids content will determine the transfer pipe designs to convey the required flow without plugging.

Table 1 establishes minimum pressure ratings recommended for effluent with greater than 4 percent total solids content. Higher pressure ratings such as these allow for high-pressure cleanout techniques.

Table 1. Minimum allowable pressure rating for pipelines conveying waste with 4 percent greater total solids (wet basis).

	PVC		PE	
	ASTM	Pressure Rating (psi)	ASTM	Pressure Rating (psi)
Piston Pump	D2241 D1785	160	None	-
	AWWA C900	100		
Chopper Pump	D2241 D1785	160	F714	160
	AWWA C900	100		
Centrifugal Pump	D2241 D1785 AWWA C900	100	F714	100
Gravity Flow	D2241 D1785	160	F714	100

AWWA C900 pipe utilizes a higher safety factor than D2241 and D1785 pipe thus warranting the lower pressure rating as acceptable.

Sewer and drain pipe can be utilized under gravity flow conditions where less than 25 feet of static head develop. This limitation reflects the pressure for which sewer and drain pipe joints must be water tight according to ASTMs noted in Table 2.

Gravity flow effluent with greater than 4 percent total solids can utilize sewer and drain pipe only when cleanout maintenance methods other than high-pressure flow are planned. Minimum pipe diameter for these circumstances is 12 inch.

Table 2. ASTMs and AASHTO specifications for PVC sewer and drain and Corrugated PE pipe.

PVC	Corrugated PE
D3034 F679 F794	F667 AASHTO M252 AASHTO M294

Pressure Pipe

AWWA C900 **Poly Vinyl Chloride (PVC) pressure pipe and fabricated fittings 4-12 inch for water distribution.**

D1785-15 **Standard specification for PVC plastic pipe, Schedule 40, 80, and 120.**

F714-13 **Standard specification for Polyethylene (PE) plastic pipe (DR-PR) based on outside diameter.**

D2241-15 **Standard specification for PVC pressure-rated pipe (SDR Series).**

Non-Pressure Pipe

F667/F667M-15 **Standard specification for 3-24 inch Corrugated Polyethylene (PE) pipe and fittings (smooth wall).**

AASHTO M252 **Standard specification for Corrugated PE drainage pipe.**

AASHTO M294 **Standard specification for Corrugated PE pipe, 300-1500 mm (12-60 inch) diameter.**

D3034-14a **Standard specification for Type PSM PVC sewer pipe and fittings.**

F679-15 **Standard specification for PVC Large-Diameter plastic gravity sewer pipe and fittings.**

F794-03 **Standard specification for PVC Profile gravity sewer pipe and fittings based on controlled inside diameter.**

The minimum pipeline/conduit design capacity from collection facilities to a storage/treatment facility is the maximum anticipated peak flow.

Design the pipeline capacity from the storage/treatment facility to the land application area, to empty the facility within the time as outlined in NRCS CPS Nutrient Management (Code 590) or Comprehensive Nutrient Management Plan (CNMP).

Protect pipes exposed to sunlight from ultraviolet radiation by selecting UV resistant pipe materials or by painting the pipe exterior to withstand UV damage throughout the intended life of the pipe. **Provide anchor points, expansion/contraction joints, or other as needed to control pipe movement resulting from expansion and contraction. The change in length of un-restrained pipe can be computed by:**

$$\text{Delta L} = \text{L} \times \text{C} \times \text{Delta T}$$

Where:

Delta L = change in length (in)
L = original length (in)
C = coefficient of Thermal Expansion (in/in/deg F)

Delta T = maximum temperature change (deg F)

Coefficients of Thermal Expansion for Common Materials are:

- **HDPE** 1.1×10^{-4} **inch per inch per deg F**
- **PE** 1.1×10^{-4} **inch per inch per deg F**

- **PVC 2.8 x 10^{-5} inch per inch per deg F**
- **Alum 1.2 x 10^{-5} inch per inch per deg F**
- **Steel 6.7 x 10^{-6} inch per inch per deg F**

Install pipe properly at all locations to accommodate any traffic crossing, farming operations, frost depth, subsurface saturation, or bedrock elevations. Protect pipe from uplift if subjected to hydrostatic forces. Separate pipe installed near bedrock with at least 6 inches of bedding. Excavation of bedrock is acceptable to provide bedding depth. **The minimum depth of cover shall be 30 inches unless additional protective measures are included in the design.**

Provide thrust control designed in accordance with National Engineering Handbook (NEH), Part 636, Chapter 52, **Section 636.5207**, for all buried pressure pipe 4 inches and larger in diameter and all angled fittings and valves. **Thrust block design can be computed as outlined in Irrigation Pipeline (Code 430) and re-iterated here:**

$$A = \frac{98\,HD^2}{B}\sin\frac{a}{2}$$

Where:

- ***A*** **= Area of thrust block required in ft²**
- ***H*** **= Maximum working pressure in ft**
- ***D*** **= Inside diameter of pipe in ft**
- ***B*** **= Allowable passive pressure of the soil in lb/ft²**
- ***a*** **= Deflection angle of pipe bend.**

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90 degree deflection angle of pipe bend.

If adequate soil tests are not available, the passive pressure may be estimated from Table 3.

Table 3. Passive pressure estimates for varying soils at varying depths of burial.

Natural Soil Material	Depth of cover to center of thrust block			
	2 feet	3 feet	4 feet	5 feet
	----------lb/ft²----------			
Sound Bedrock	8,000	10,000	10,000	10,000
Dense Sand and Gravel	1,200	1,800	2,400	3,000
Dense fine to coarse sand	800	1,200	1,650	2,100
Silt and Clay Mixture	500	700	950	1,200
Soft Clay and Organic Soils	200	300	400	500

If the possibility exists for nearly instantaneous shutoff, then conservatively add surge to the static head for thrust block design:

$$P = \frac{aV}{2.31g}$$

Where:

- **P = Pressure surge, lb/in²**
- **a = wave velocity, ft/sec (See equation below)**
- **V = maximum velocity change, ft/sec**
- **g = acceleration of gravity, 32.2 ft/sec²**

And:

$$a = \frac{4660}{\sqrt{1 + \frac{kd}{Et}}}$$

Where:

- **a = wave velocity, ft/sec**
- **k = fluid bulk modulus, (300,000 psi for water)**
- **d = pipe ID, in.**
- **E = modulus of elasticity of the pipe, (400,000 psi for PVC pipe), (29x10^6 psi for steel pipe), (113,000 psi for HDPE)**
- **t = wall thickness, in.**

Maintain the integrity of a wall or liner at pipe penetrations of waste storage structures, reception tanks, and channels. The section of pipe that penetrates the liner of a waste storage facility wall will have a minimum length of 10 feet and will be supported with a cast-in-place concrete restraint. Provide a mechanical joint restraint, concrete thrust block or concrete restraint for all joints within 25 feet of the waste storage facility wall (measured along the length of the pipe). Protect storage structure liners from hydrostatic pressures that may be caused by preferential flow paths along installed pipe.

If cold weather pipeline operation is planned, design transfer pipe to be: insulated, heated, buried below anticipated frost depth **(minimum 48 inches)**, constructed of freeze resistant material, or installed such that it can be drained after each use by gravity or compressed air.

Provide clean-out access for all pipelines transferring waste material to allow for removal of settled solids or obstructions. For transferring waste to storage/treatment facilities, space clean-outs for pipelines at a maximum interval of 150 feet along the pipe length, or a maximum interval of 300 feet along the pipe length if bi-directional clean-outs are used. For pipes that are transferring low solid content **(less than 4 percent**

solids) wastewater to cropland for application, incorporate a method to clean plugged pipes into the design.

Install pipelines with appropriate backflow prevention devices to prevent return siphoning of waste**, when necessary**.

Install air vents and vacuum relief valves where necessary to eliminate air locks, as well as to protect the pipe against negative pressures. **Install a standpipe style air vent within 4 feet of the inlet with gravity pipelines.**

Pipelines-Pressure: Select pipe and appurtenance material that meet the design working pressure criteria of the system. **Include** air and water pressures used to clear the pipe **(commonly 150 psi) when establishing design working pressure.**

The pipeline working pressure **(excluding cleaning pressures)** must not exceed 72 percent of the pipe rating.

For a pumped system use design velocities between 3 to 6 feet per second. Limit the waste stream velocity to 5 feet per second or less if transfer pipe is not buried or tightly secured. Fluid velocities in a buried or secured pipelines may exceed 5 feet per second only if the pipeline is installed without gates or valves, and discharges freely to a tank or pond. **A surge analysis may also justify velocities exceeding 5 feet per second.**

The 3 feet per second lower limit does not apply to a system that is powered by a pump such as a ram plunger or piston type pump that operates by pushing semi-solid waste material in a periodic stroke cycle.

Install a check valve near the outlet of each pump except where backflow is incorporated into the design **is not going to occur**.

Provide a pressure relief valve near the pump(s) to protect the pipe against any pump shut-off head due to a blockage. This valve is not required if the pump shut-off head is less than the working pressure of the transfer system.

Provide a pressure relief valve or properly sized water hammer arrestor on the pressure side of shut-off valves to protect against water hammer due to the sudden closing of a valve.

Size pressure relief valves to be no smaller than ¼-inch for each inch of the pipe diameter. Set pressure relief valves to open at a pressure no greater than 5 psi above the transfer system working pressure.

Pipeline-Gravity. In a gravity flow pipe system, a minimum head is required, depending upon the consistency of the material. **The following criteria shall be followed:**

Minimum feet of hydraulic head - consistency

4 feet - heavily bedded undiluted manure
2 feet - slurry or semi-liquid manure
<1 foot - liquids and 1:1 dilute liquid manure

For a dilute manure**,** gravity pipeline over 100 feet in length**,** increase minimum feet of head by an additional 1 percent of the transfer pipe length exceeding 100 feet. Ensure that the design flow velocity is at least 3 feet per second.

Minimum diameter of gravity pipe is 24 inches for heavily bedded high solids content manure.

Convey waste into and through the pipeline to minimize ponding in the production area. Design the gravity pipe to follow as direct a route as possible. Horizontal curves or bends in the pipe joints of a gravity pipeline require special design considerations. **The maximum allowable deflection per joint is 2 degrees. Where joint deflection exceeding 2 degrees cannot be avoided, incorporate standard or special order fabricated elbows. Elbows and tees should be specified as "long radius" in order to facilitate conveyance.**

In a gravity flow design that transfers diluted sand laden manure, account for the process of sand settling out of the waste stream. See: **CONSIDERATIONS Transfer Operations** section below. The minimum gravity pipe flow velocity for dilute manure with sand is 5 feet per second.

For a pipeline designed to gravity discharge liquid waste from a waste storage or treatment facility, install a manually operated in-line valve as close to the storage facility as practical. **In cases where an accidental discharge can occur, a second valve, shall be installed to serve as a backup. Automated valves must be accompanied by a manually operated version.**

Waste transfer pipelines shall not be connected to private or public water distribution systems without

review and approval by the State Conservation Engineer.

Other Conduits. The minimum design velocity for waste transfer in open ditches and channels is 1.5 feet per second **unless the design includes a means or agreed-to management for periodic cleaning of these conveyance structures.**

A reinforced cast-in-place concrete lined ditch or channel for waste transfer will have a minimum concrete thickness of 5 inches. Concrete must be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place. A dense durable product is required.

Contraction joints in a concrete **lined ditch**, if required, must be formed transversely to a depth of about one-third the thickness of the lining at a uniform spacing in the range of 8 to 15 feet. Provide steel reinforcement or other uniform support to the joint to prevent unequal settlement.

Flex and hard hoses used in drag-line injection systems shall be designed based on the manufacturer's specifications.

Pumps. Use the NRCS CPS Pumping Plant (Code 533) for a waste transfer pump where needed.

Select the pump to transfer the waste material at the system pressure head and volume (rate) required. The type of pump will be determined by the consistency of the material and the type of solids. Use pump manufacturer's recommendations for the installation requirements.

Pump selection guidelines include:

- **Consider positive displacement pumps for waste with total solids exceeding 8 percent.**
- **Waste with less than 3 percent total solids can be handled with conventional irrigation pumps.**
- **Consider a chopper-style pump when handling manure slurry with straw, twine, hair, or sludge. Chopper pumps condition the manure with a series of cutting actions and incorporate rugged mechanical seals and semi open impellers. These features reduce the chance of plugging within the pump and pipeline.**
- **Consider pump selection with a low RPM for manure slurries which contain abrasives such as sand.**

Correct the total dynamic head for viscosity and specific gravity of the liquid waste used in pump selection. Reference AWMFH, Chapter 11, Waste Utilization, for increased friction losses caused by higher fluid viscosity and Chapter 12, Waste Management Equipment, for pump selection guidance.

Pump power ratings should be increased by 10 percent as a rule of thumb for cases where the friction loss ratio, as used in Agricultural Waste Management Field Handbook (AWMFH), Table 11-1, exceeds 1.0.

Solid/liquid waste separation. Use NRCS CPS Waste Separation Facility (Code 632) to design a filtration or screening device, settling tank, settling basin, or settling channel to separate a portion of the solids from the manure or liquid waste stream, as needed.

CONSIDERATIONS

General. Consider economics (including design life), overall nutrient management system plans, and health and safety factors.

Consider the timing and location of agitation and transfer activities to minimize odor formation and the breeding of insects within the material.

Consider covering and/or minimizing the amount or number of times the material is disturbed to reduce the likelihood of air emissions formation and release of particulate matter, volatile organic compounds, methane, and ammonia.

Consider abandonment, relocation, or additional floodproofing for *existing reception structures* located in flood prone areas. For additional information on floodproofing structures, see "Floodproofing Non-Residential Structures," FEMA 102, May 1986, Federal Emergency Management Agency.

Transfer Operations. Consider potential loss of pipe integrity due to internal erosion by the materials being transported for a flow velocity exceeding 6 feet per second.

Consider designing the maximum flow area of a gravity pipe, **for a flume system,** with dilute

manure, at 50 percent of the pipe depth to maintain the scouring effect of the flow.

Consider increasing the total dynamic head up to 30 percent for pumping manure slurries with 3-8 percent total solids (wet basis). **Also consult Table 11-1 in the AWMFH.**

Consider the use of a wet sump and agitation pump to reduce solids separation within the gravity reception structure.

Consider using pre-manufactured manholes as risers at stations to change direction for needed transitions.

Consider the operating space requirements of loading and unloading of equipment in the vicinity of the transfer components.

When applicable and compatible, consider the dual use of waste transfer pipelines for irrigation water delivery.

Consider installing a locator wire in the trench with transfer pipelines.

Chemistry of waste material may need consideration for corrosion resistance and water tightness in the selection of pipe material**,** joints**, valves, and other appurtenances.**

Consider the potential for struvite phosphate (magnesium ammonium phosphate), mineral deposition in smaller diameter pipes. Preventative measures may be needed, such as acid washing the pipe to prevent deposits.

Consider the need for additional check valves, clean-outs, vent risers, knife valves, anti-siphon protection, vacuum relief valves and open air breaks, as appropriate, on all transfer pipe systems.

Consider the use of leak detection methods and equipment for monitoring and periodic pressure testing of waste transfer systems installed in sensitive areas, having large daily flow volumes, long flow lengths or high flow pressures.

Consider installing a manually-operated shutoff valve for isolation purposes for gravity discharge pipe used for transferring waste from one structure to another.

Consider posting a warning sign on all risers indicating the transfer system pressure rating.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for constructing a waste transfer system that describe the requirements for applying this practice to achieve its intended use.

Construction plans and specifications must include a location map, plan view, profiles, cross sections, details and specifications of all structures, etc., to ensure that the project can be properly constructed.

Pipeline construction and installation specifications may be taken from the National Engineering Handbook sections listed in the References.

NRCS acceptance requires pressure testing of a pressure pipe system prior to waste transfer service. Include the test protocol and results in the as-built documentation.

OPERATION AND MAINTENANCE

Prepare an Operation and Maintenance (O&M) Plan for review with the landowner or operator responsible for the application of this practice. Provide specific instructions in the O&M Plan for proper operation and maintenance of each component of this practice and any detail needed for the level of repairs to maintain the effectiveness over the useful life of the practice.

Evaluate the overall functionality of the waste transfer system for possible malfunctions that could lead to a spill or release of waste material. Address the identified potential failures in the inspection procedures of the operation and maintenance plan. Prepare an emergency response plan to be implemented in the event of such a failure.

Include, as appropriate, the following items in the O&M plan:

- **Operate all in-line valves through their full range at least twice per year in addition to when used for emptying the pond.**
- For the purpose of land application, adequately agitate liquid or slurry waste material prior to transfer.
- Flush pipelines**, pumps, and metal appurtenances** used for transferring **or applying** waste material with clean water after

use, to reduce the risk of gas build up and pipeline explosion **as well as corrosion and struvite buildup.**

- Make provisions for removing solids from conveyance conduits such as concrete lined ditches, grates, etc., during management operations.

- **When applying waste through sprinkler systems, select nozzles and spray heads which can operate well considering the total solids content and chemical makeup of the waste stream.**

- **Maintain paint coverage of exposed PVC materials throughout the life of the project.**

Biosecurity.

Include, as appropriate, the following items regarding biosecurity in the O&M plan:

- Handle waste products according to the state veterinarian guidance on biosecurity for animal waste material.

- Sanitize equipment leaving the farm as appropriate to prevent the spread of disease.

REFERENCES

USDA-NRCS, National Engineering Handbook, Title 210, Part 651, Agricultural Waste Management Field Handbook, Chapter 10, Agricultural Waste Management System Component Design.

USDA-NRCS, National Engineering Handbook, Title 210, Part 651, Agricultural Waste Management Field Handbook, Chapter 11, Waste Utilization.

USDA-NRCS, National Engineering Handbook, Title 210, Part 651, Agricultural Waste Management Field Handbook, Chapter 12, Waste Management Equipment.

USDA-NRCS, National Engineering Manual, Title 210, Part 536.20, Design Criteria for Reinforced Concrete.

USDA-NRCS, National Engineering Handbook, Title 210, Part 642, Chapter 2, National Standard Construction Specifications.

USDA-NRCS, National Engineering Handbook Title 210, Part 642, Chapter 3, National Standard Material Specifications.

Montana Engineering Specifications.

American Society of Agricultural and Biological Engineers, ASAE EP 470, Manure Storage Safety, October 2011.

Montana Department of Environmental Quality (DEQ) General Permit for Concentrated Animal Feeding Operations, November 2013.