Chapter 2 Planning Considerations

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651.0200 Introduction

Planning an agricultural waste management system (AWMS) involves the same process used for any type of natural resource management system, such as an erosion control system. Each system includes a group or series of practices planned, designed, and installed to meet a need. However, different resource concerns, management requirements, practices, environmental effects, and economic effects must be considered.

Planning an AWMS requires the collaboration and combined efforts of a team of people. The decisionmaker for the property involved, NRCS specialists and conservationists, county agricultural extension agents, and other professionals often make up the team. Specialists include engineers, geologists, soil scientists, and agronomists. The planner must establish a good working relationship with all members of the team in order to present the best plan.

Because of the number of alternatives to be considered, the planning process is multifaceted; however, a simple and easily managed AWMS is often the best option.

Consideration of soil, water, air, plant, animal, and energy resources and the interrelationships in the planning process has increased the complexity for decisionmakers. To successfully plan an AWMS, it is critical for planners to understand and be able to articulate the connections to the client. Although individual practices are important, each is only a part of an answer. Implemented as a system, practices and appropriate interactions of practices must be in place to fully address the resource concern. By combining conservation practices and management strategies, the resulting resource management system is applied to adequately treat a resource problem or address a resource concern (fig. 2–1).

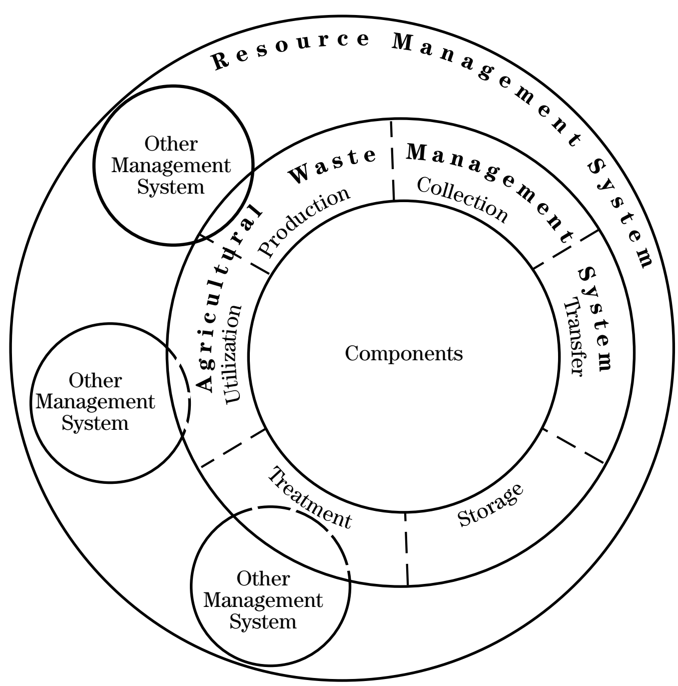
An AWMS includes the following functions:

- production
- collection
- transfer
- storage
- treatment
- utilization

Viewing the AWMS by function simplifies interpreting, analyzing, and evaluating the inventory data as well as the planning of alternatives.

The functions are accomplished by implementing components. Components may be an interrelated group of conservation practices, such as a waste storage structure, roof runoff water management, diversion, and nutrient management. Push-off ramps, manure pumps, transport equipment, grade control structures, and vegetative treatments are examples of component elements that support the functions.

Figure 2–1 Relationship of an AWMS, other management systems, and Resource Management System

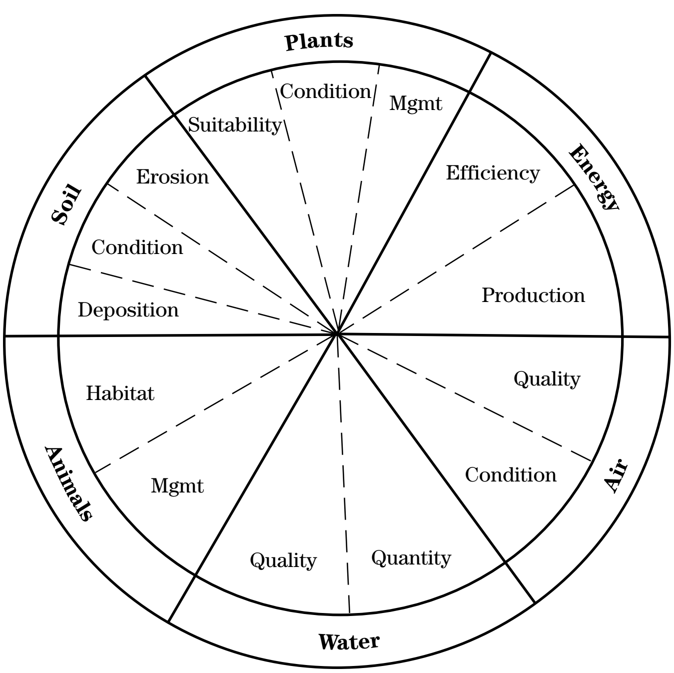


651.0201 Planning for protection of natural resources

The major objective of the NRCS in planning an AWMS is to collaborate with the producer to achieve wise use of natural resources. The key to doing this is to involve the decisionmaker in the planning process. The NRCS must assure that the decisionmaker recognizes the nature, extent, and importance of natural resource conservation (fig. 2–2). In addition to the resources, social, cultural, and economic effects of alternatives on the human environment must be considered. A brief description of each of the planning aspects as they relate to an AWMS follows.

A natural resource is any naturally occurring resource needed by an organism, population, or ecological system. The NRCS applies this term to soil, water, air, plants, animals, and energy.

Figure 2–2 Resource considerations



(a) Soil

Soils are important both in the utilization component of the plan and in the siting and construction of storage facilities and other structural components. The soil resource is most often the medium used in the final assimilation of many of the agricultural waste products.

Waste must be applied to the soil so that the constituents in the waste do not exceed the soil's capacity to adsorb and store them. The rate at which liquid wastes are applied must not exceed the soil's infiltration rate. Application of wastes at a rate that exceeds the soil's infiltration rate can result in runoff, which can cause erosion and convey contaminants. Plant nutrients in solution or those attached to the soil particles along with bacteria, organic matter, and other agricultural material may be transported to the receiving water.

The application of organic agricultural wastes can have a beneficial influence on soil condition by improving tilth, decreasing crusting, increasing organic matter, and increasing infiltration.

(b) Water

Maintaining or improving the quality of surface and groundwater generally is critical in the planning of an AWMS. Potential groundwater contaminants from agricultural operations include nutrients such as nitrates; salts; waste pesticides; pathogens, generally bacteria; and pharmaceuticals. Potential surface water contaminants from agricultural operations are nutrients, usually nitrates or other agriculture chemicals in solution; phosphorus and other agricultural chemicals attached to soil particles; organic matter; and bacteria.

Water, both clean and contaminated, must be considered in an AWMS. The usual objective in planning an AWMS is to exclude unneeded clean water and capture polluted water for storage or treatment for subsequent use when conditions are appropriate.

(c) Air

Air quality can be of concern in an AWMS and should be considered in the system plan.

An AWMS may have an adverse impact on the air resource, so planning must consider ways to minimize degradation of air quality. An AWMS may be a source of emissions of volatile organic compounds (VOCs), ammonia, odorous sulfur compounds, particulate matter, oxides of nitrogen (NO_x), methane, and N_2O.

Objectionable odors are considered in planning an AWMS. Emissions of odorous compounds (VOCs, ammonia and odorous sulfur compounds) from confined livestock, waste storage areas, lagoons, and field application of wastes can cause nuisance conditions.

Direct emissions of particulate matter (dust), as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions (ammonia, NO_x, and VOCs), can also cause environmental impacts such as the unintended movement of:

- particulate matter (typically dust or smoke), which results in safety or nuisance visibility restriction
- particulate matter and/or chemical droplets, which results in unwanted deposits on surfaces; increased atmospheric concentrations of particulate matter can impact human and animal health and degrade regional visibility
- particulate matter (typically dust) that can easily settle out of the air or be "washed" out of the air through contact with rain, which can cause water quality problems that may be regulated under State or Federal law

Emissions from an AWMS can also increase atmospheric concentrations of greenhouse gases such as methane and N_2O. Agricultural contributions to global atmospheric concentrations of methane and N_2O are significant, and efforts to reduce emissions of these compounds are often focused on agricultural sources.

Proper siting, selection, design, and operation of an AWMS can reduce the formation and release of air emissions. Meteorological and topographical features of the area around the AWMS must be considered. Technologies that help mitigate the formation, release, and/or transport of air emissions can be used to address air-related resource concerns.

(d) Plants

Plants are an important aspect of planning an AWMS. Utilized to recycle the nutrients available in agricultural waste (often producing an economic return), plants screen undesirable views, channel or funnel wind, reduce noise, modify temperature, or prevent erosion. To develop a utilization component where the wastes will be used to help meet the nutrient needs of crops, several details regarding the crops that are grown need to be known. Plants selected for an AWMS must be adapted to the site conditions. If wastes are applied to agricultural fields, the application must be planned so that the available nutrients do not exceed the plant's need or contain other constituents in amounts that would be toxic to plant growth.

(e) Animals

An AWMS for a livestock enterprise must be planned to be compatible with the type of animals involved. A healthy and safe environment is essential to maintain health or production goals for the specified kinds and classes of livestock. Instructions to both protect the AWMS structure from the animals and the animals from the structure are included in the plan. Planning should also consider feed management, biosecurity and catastrophic animal mortality (CAM), and wildlife.

Managing the quantity of available nutrients fed to livestock and poultry for their intended purpose can have a beneficial impact on the AWMS. Feed management has the potential to reduce the quantity of nutrients, especially nitrogen and phosphorus, excreted in manure by minimizing the over-feeding of these and other nutrients. Feeding nutrients in a more efficient manner could result in improved net farm income.

Planning for CAM, whether the result of a natural disaster or the spread of contagious disease may help to mitigate those losses by having a response plan in place before an event occurs. While the occurrences of natural disasters are beyond our control, biosecurity measures can be implemented to help prevent the spread of contagious disease.

Biosecurity measures can minimize on-farm exposure of animals to the transport of diseases from an extraneous source and should be considered part of an AWMS. By maintaining as much isolation as practicable, the spread of contagious diseases can be minimized if farms, and those persons interacting with the farms, observe a series of rudimentary practices to include but not be limited to the following items:

- boot washing
- equipment washing
- vehicle washing
- disinfectants

A CAM event can have a devastating impact to the farm income through the loss of animals and the costs associated with disposal of animal carcasses.

A farm-level CAM response plan that would include, but not be limited to, the following items should be considered part of an AWMS:

- facility location and directions to the facility
- list of emergency contacts (i.e., local veterinarian, local emergency number, contractor with heavy equipment for handling carcasses, and/or excavating burial sites)
- list of agencies to notify within 24 hours
- response procedures—the CAM plan should identify site-specific conditions that require action, specify the actions to be taken, and designate responsibility for the specified actions
- site-specific disposal options
- map of emergency staging, composting, and burial areas, as allowed

Wildlife is an important consideration of the AWMS plan. Pollution of receiving water can have a significant effect on fish and wildlife habitat. Organic matter can drastically reduce dissolved oxygen levels in a stream, and high ammonia concentrations can kill fish. In addition, water over-enriched by nutrients, contaminated by agricultural chemicals, or polluted by bacteria can result in an environment that has a very negative effect on animals.

(f) Energy

Inefficient use of energy in farm and field operations increases dependence on nonrenewable energy sources that can be addressed through improved energy efficiency and the use of on-farm renewable energy sources.

In some settings, manure management systems result in the production of energy through anaerobic digesters or thermochemical processes of gasification, pyrolysis, and combustion.

Within the NRCS, the goal is to help producers and private landowners reduce the use of fossil fuel-based energy by:

- improving the efficiency of energy use
- conserving energy
- producing renewable energy
- producing biomass energy feedstocks in a sustainable manner

(g) Human

Individual owner preference, equipment, farm layout, and any current system may affect the AWMS design. It is especially important to know future building or expansion plans because that could either significantly expand or limit options for various components of an AWMS.

Community or social factors must also be taken into consideration. The wide differences in perspective and perception in a community can affect how an AWMS is received. For example, an AWMS system by an adjacent landowner who has a similar enterprise could be viewed completely differently as compared to an urban, suburban, or exurban neighbor. For this reason, planning must deal not only with complex technological considerations, but also human or social considerations.

An AWMS must be planned so that the negative social effect on a community is minimized. Measures to minimize odors and maximize landscape compatibility must be included. A public relations effort by the decisionmaker can also be helpful in assisting a community in understanding and accepting an AWMS.

Federal, State, and local laws and regulations must be considered in the development of an AWMS. Compliance with the laws and regulations may be the main objective of some decisionmakers.

Human safety must be considered in planning an AWMS. Potential hazards are numerous. Safety measures need to be incorporated into structures and must be stressed in operation and maintenance plans.

(h) Cultural

Any cultural resources discovered onsite during the planning process must be evaluated according to current Federal, State, and local laws. These may include pioneer homes, buildings or old roads; structures with unique architecture; prehistoric village sites; historic or prehistoric artifacts or objects; rock inscription; human burial sites; and earthworks, such as battlefield entrenchments, prehistoric canals, or mounds.

(i) Economic

To assist decisionmakers, economics should also be considered in planning and evaluating an AWMS. Average annual costs and associated benefits should be developed for the evaluation. Average annual costs are the initial costs amortized plus necessary operation, maintenance, and replacement costs.

The value of agricultural wastes may also be considered. The term "waste" has the connotation of being something left over that has little or no value. However, many agricultural wastes are valuable as soil building amendments. If the land user would account for animal waste applications, then purchased inputs (nutrients) could be reduced. If treated, the waste can be used for bedding or energy production.

The financial costs related to implementing an AWMS can be significant, such as required manure storage facility and purchase of equipment to handle the manure. These costs should be incorporated into a farm's business plan. Financial assistance to assist in implementing an AWMS may be available through the NRCS or other Federal or State programs. Commercial banks may provide part of the financing for an AWMS, as bankers have seen that these systems can contribute to the long-term viability of a farm. The financial benefit of a system is in the form of reductions in other costs, such as fertilizer, feed, and health/veterinary expenses. It is challenging to accurately account for these cost reductions before the system is in place and may only be evident after the system has been in operation for some time.

651.0202 Conservation planning process

The NRCS nine steps of planning include:

Step 1 Identify the problem.

Step 2 Determine the objectives.

Step 3 Inventory the resources.

Step 4 Analyze the resource data.

Step 5 Formulate alternative solutions.

Step 6 Evaluate alternative solutions.

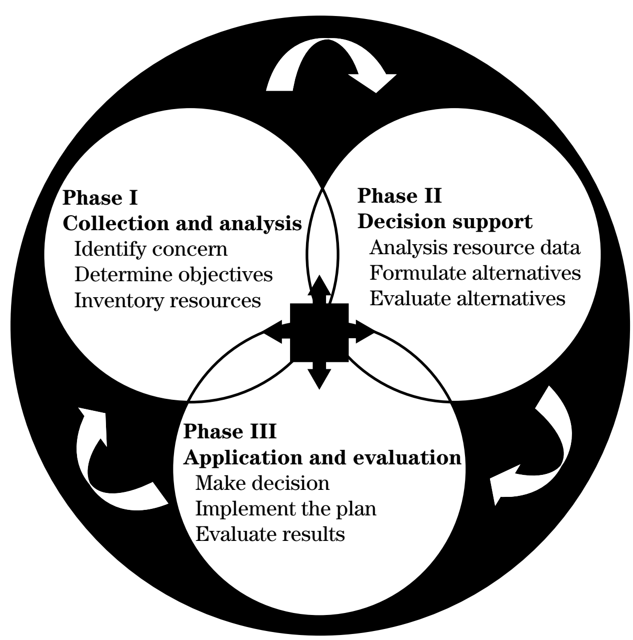
Step 7 Client determines a course of action.

Step 8 Client implements the plan.

Step 9 Evaluation of the results of the plan.

Although the steps are listed in order, the process is often nonlinear (fig. 2–3).

Figure 2–3 Planning process



To thoroughly and efficiently plan an AWMS, each planning step must be considered.

An AWMS plan can and should be part of the overall conservation plan for a farm. The overall plan identifies the concerns and opportunities related to all the soil, water, air, plant, animal, energy, and human resources. Often, it will briefly address the issues related to animal waste (such as type and number of livestock, and location, type and construction dates for any manure storage facilities), and leave many of the specific details to be covered by the AWMS plan. It is especially important the conservation plan assesses the potential for nutrients to be transported offsite through runoff (where nutrients attached to soil particles that erode), by leaching through the soil profile to groundwater and by volatization into air. If a potential problem is identified, the plan should include appropriate conservation practices and management activities. Also, the nutrients that are in the manure and wastewater applied on crop fields are considered and counted in the nutrient management plan for the farm.

Decisionmakers request assistance in developing an AWMS for many reasons. Regulations and complaints from the public motivate some decisionmakers. Others have an interest in reducing costs or labor associated with the current system. Some may desire to make use of nutrients available in agricultural wastes for crop production. All may be motivated by a genuine interest in protecting the environment. A decisionmaker's reason for requesting assistance does not change the planning process, but may influence the attitude and responsiveness to the plan presented.

Following is a description of the planner's activities and responsibilities in each planning step as it relates to an AWMS.

(a) Identify the problem

Decisionmakers need to know what problems, potential problems, and Federal, State, and local laws and regulations affect their operation. This information can help them recognize the need to develop an AWMS that will protect the resource base.

(b) Determine the objectives

Determining objectives requires developing an understanding with the client of the desired future conditions for the planning area as compared to the existing conditions. To plan an AWMS that is acceptable and will be implemented, the planner must determine the decisionmaker's objectives early in the planning process.

The objectives greatly influence the type of AWMS planned. For example, the type of AWMS planned would be significantly affected if the decisionmaker's primary objective is to use the waste for power generation rather than for land application. A decisionmaker's objective to bring the operation into compliance with laws and regulations may result in an AWMS that is not as extensive as one where the objective is to minimize the effect on the environment and enhance public acceptance of the system. A decisionmaker's objective to minimize management efforts may result in an AWMS significantly different from one that would emphasize the role of management.

(c) Inventory the resources

Inventory or collecting appropriate natural resource, economic, and social information about the planning area and related area is planning step 3. Some inventory data may have been developed during the process of determining objectives. However, at this point the planner must assure that the resource inventory data are complete to the extent that they can be used to develop AWMS alternatives.

Planning an AWMS requires an inventory based on compilation of data from many different sources. Some of the required data can be digitally measured. For example, the number of acres available for land application of waste can be determined from aerial imagery. Other data needed, such as the level of management, are less tangible and must be determined based on observation, discussions with the decisionmaker, and judgment of the planner.

Planning an AWMS requires gathering a great deal of information. A partial list of items that must be inventoried or evaluated follows. These items are described in more detail in their specific chapter.

(1) Type of enterprise

The type of enterprise is an important factor to be evaluated during the inventory. A dairy enterprise is significantly different from a beef cattle feedlot. Agricultural operations that grow feed present an aspect different from that of operations that purchase all the feed. Handling of cannery wastes is significantly different from the handling of municipal wastes. Each type of enterprise has a different overall objective that must be established by evaluating the type of enterprise.

(2) Size of enterprise

The size and characteristics of the enterprise must be carefully evaluated to determine the amount and type of wastes generated. For livestock enterprises, the number, type, size of animals, management, expected mortality level and at what size mortality is expected, and ration fed are important inventory factors. The type, source, and consistency of all wastes that must be managed are also inventoried.

(3) Site location

A careful evaluation of the site should be made to determine the best location for components and practices of an AWMS. Aerial imagery for site evaluation and nutrient application can expedite evaluation. If possible, components that are not visually pleasing should not be located, when possible, where they are routinely visible to neighbors or passersby. An AWMS that is managed correctly and shields its components has few problems. Sites that are highly visible or conspicuous on well-traveled roads should include visual barriers, special design, and good management practices.

The location of lakes, streams, wells, and other receiving water should be noted and actions designed to minimize the negative effect of an AWMS on the water.

AWMS components should not be placed on floodplains; however, if alternative locations are not available, proper planning and care should be taken to floodproof facilities according to requirements of Federal and State laws. In addition, land application of agricultural wastes should not be made during periods when flooding normally occurs unless the waste is injected or tilled to mix and combine with soil immediately.

(4) Present facilities

A careful inventory of existing livestock housing facilities and waste handling facilities allows consideration for use of existing components in the planned system.

(5) Land availability

The amount of land available for an AWMS needs to be carefully determined for both facilities and land application. Adequate amounts of agricultural land are needed for application of nutrients and other constituents in agricultural wastes to assure crop utilization and protection. Space for expansion of the enterprise for additional components or the enlargement of components should also be evaluated. It may be appropriate to flag the approximate boundaries of the proposed AWMS components to aid the planner and decisionmaker in visualizing how components will integrate with the current facilities.

(6) Soil

Soils must be evaluated to determine if they are appropriate for AWMS components and activities, such as land application, construction, mortality disposal, and associated traffic, soil physical and chemical characteristics, nutrient levels, water table level, depth to bedrock, and other soils features are included in the evaluation. Engineering characteristics may need to be evaluated for structural components. Soil reports, test holes, and soil tests are all useful in evaluating soil.

(7) Topography

Certain topography favors certain waste handling systems. A gravity flow system may be a good choice where elevation differences exist, while dramatic elevation changes might create more complex problems for waste transport and land application. Topography often dictates the location of AWMS components and the method of land application of wastes. Physiogeographic information and site visits can be used to evaluate topography.

(8) Climate

Climate information should be evaluated in the inventory phase of planning an AWMS. Weather often dictates how long it must be stored and when waste can be land applied. Extremely low temperatures cause problems with equipment and freezing of wastes in storage and treatment facilities.

Long-term weather characteristics should be evaluated relative to climatic extremes in temperature or precipitation. The amount of precipitation for a location can dictate consistency of the waste and subsequent handling techniques and equipment needs. For instance, an unroofed waste storage structure in a humid climate can be expected to receive a certain amount of precipitation for a given season of the year. Knowledge of local weather records is essential for proper planning.

(9) Geology

The geology of a site plays an important part in selecting an appropriate AWMS. For this reason, the geology of the area in which the AWMS will be located must be evaluated. The groundwater table, variations in depth to bedrock or in soil depth, potential for sinkholes, and fractured or cavernous rock often eliminate use of some types of AWMS components. Geologic information, including depth to the water table and geologic reports, should be reviewed for any given site. Onsite geologic investigations with the assistance of a qualified geologist should be given a high priority, especially where storage or treatment components are involved.

(10) Crops

When developing an AWMS that uses the waste material on cropland, grassland, or hayland, the cropping schedule for all land that might be involved must be evaluated. To achieve appropriate use and avoid offsite pollution, the planner and decisionmaker must determine the best time for land application. A tentative schedule for land application of waste should be prepared during planning to determine if the system that has been selected will work. Once all the variables have been firmed up, detailed plans can be prepared.

(11) Labor availability

Some waste handling activities, such as frequent spreading of wastes, are labor intensive. Systems considered should be carefully evaluated to determine labor requirements throughout the year. An adequate labor supply should be available for waste handling without adversely affecting the other activities of the enterprise. The planner should consider all labor requirements of the enterprise. Scheduling conflicts between such operations as waste application and crop planting and harvesting should be avoided.

(12) Equipment

Existing waste handling equipment is inventoried and evaluated for its suitability for the alternative systems being planned. A list of necessary equipment, including critical replacement parts, and how the existing equipment fits into the overall equipment requirements should be developed during planning of an AWMS. In planning equipment needs, such factors as the complexity of the machinery, availability of service and parts, and relative importance of the machine to the operation should be considered. As a rule, the amount and complexity of equipment should be minimized.

(13) Level of management

An AWMS must be manageable by the decisionmaker. During the inventory phase, the level of management that will be provided by the decisionmaker must be assessed. Some require intensive levels of management and good recordkeeping ability. Composting and anaerobic digesters are in this category; many of these systems have failed not because of the shortcomings of the system itself, but because of the shortcomings (level of management and lack of interest) of the producer. When a change in the waste handling system is being considered, it is necessary to evaluate any management changes that the desired system might present. For example, if a dairy farmer wants to switch from a solid to a slurry or liquid waste handling system, a modification in the amount and type of bedding used and equipment needed will most likely be necessary.

If possible, the planner and decisionmaker should visit several operational sites that have waste handling systems similar to those being considered.

(14) Adjacent land use

Adjacent land use is also evaluated, especially in relationship to prevailing winds and views. Consideration should be given to the sensitivities of anyone living, traveling, or working near the site of the AWMS. For example, attitudes of the public regarding spillage, odors, flies, and unsightly conditions can have a negative effect on the given operation.

(15) Travel routes

Existing and potential haul routes should be inventoried. Many AWMS's require that wastes be transferred to fields for land application using equipment that can haul and spread the material. Although haul routes should be the shortest distance possible, roads should be located to avoid extreme cutting, filling, and potential erosion.

Where it is necessary to use public roads as haul routes, applicable State and local laws that govern their use must be followed. Use of public roads as haul routes requires that safety precautions be taken and hauling equipment that minimizes spillage and tracking of waste material, mud, and dirt be used. Aerial imagery and soil maps can also be used to inventory haul routes.

(16) Laws and regulations

The planner must determine what Federal, State, and local laws apply to an AWMS. However, the decisionmaker must know how the laws affect planning and operation of the AWMS and must obtain the necessary permits and licenses.

The laws and regulations may require the decisionmaker to obtain permits to construct and operate an AWMS. They may also dictate the type of AWMS or that certain features be incorporated into the AWMS components. Undoubtedly, the decisionmaker will need to contact officials of various Federal, State, and local agencies to determine the requirements for compliance with laws and regulations. Officials to contact may include milk inspectors, local zoning authorities, and environmental regulatory personnel. Permits must be applied for well in advance of the actual date of beginning the installation of an AWMS.

Handling and transport of animal mortalities (particularly those associated with an emergency or disaster situation) may be under an even higher degree of examination than other wastes, and the decisionmaker may want to take these laws into consideration.

(17) Water quality

NRCS requires that an AWMS be planned to preclude offsite discharge for precipitation events that are equal to or less than the 25-year, 24-hour storm, unless authorized by Federal, State, or local regulations.

The sensitivity of lakes, streams, or groundwater aquifers to contaminants in the agricultural waste should be evaluated and made part of the decision process of whether to allow discharge. Receiving water sensitivity must also be considered when establishing the intensity of management and level of efficiency needed to avoid or minimize accidental spills and to assure that the designated water use is protected.

(18) Utilities

All utilities that may be needed or affected by an AWMS must be determined. They include buried or overhead electrical wires; size of service and voltage needed; and types of motors to be serviced (single or three-phase); other buried wires, such as telephone cables; gas lines; sewer lines; wells; and water lines. See part 503 of the National Engineering Manual (NEM) for NRCS policy on developing a plan to prevent damage to public or private utilities during engineering and construction activities.

(19) Landscape resources

Landscape features need to be evaluated during the inventory to make the AWMS compatible with the surrounding landscape. Earth mounds, fencing, vegetation, and position on the landscape are alternatives to enhance the landscape. In addition, structures can be painted to complement other farm buildings. Similarity in construction materials and texture should be promoted.

When planning AWMS components that will be visible, the planner should consider planting fast-growing trees or shrubs that screen the facility as soon as possible. An earthen barrier can also be constructed with or without trees or shrubs.

Areas not easily accessible for mowing should be protected with vegetation that requires minimal maintenance. Ground cover adds to the attractiveness of the site and reduces the potential for erosion.

An archaeological site that is identified during planning or during construction of structural components of an AWMS must be reported to the State Historic Preservation Officer.

(20) Expansion of the enterprise

Possible expansion of the enterprise should be explored with the decisionmaker during the inventory. Installation of facilities to meet expansion needs may be best accomplished to begin with rather than enlarging the facilities later. Such factors as increasing family size and the economy can dictate the need for expansion of an enterprise.

(21) Flexibility

The need for flexibility should be explored with the decisionmaker during the inventory. For example, providing for 180 days storage of wastes as compared to 90 days would give more flexibility in waste application to the land. Roofs over waste storage facilities with gutters and directional downspouts would provide flexibility in the amount and consistency of wastes to be handled. Another example of flexibility would be where the decisionmaker may prefer the labor saving advantages of a flush system for collection of wastes combined with scraping. During freezing weather, however, a flush system might seem inappropriate; although, it can be successfully operated if it is properly installed and managed. Having both a waste stacking facility and a waste storage pond would give the decisionmaker the flexibility to vary the collection method used.

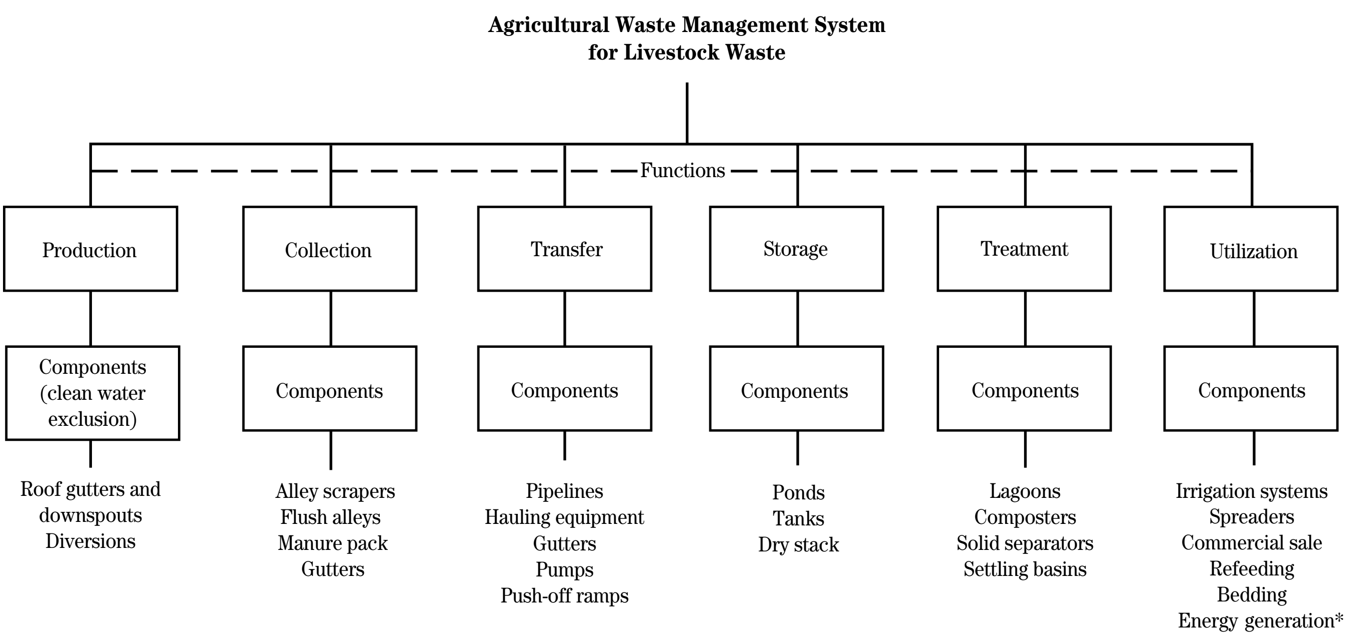
(d) Analyze the resource data

In step 4 of the planning process, the resource data collected in the previous planning step is analyzed. This step can be best accomplished by viewing an AWMS as having six functions (figs. 2–1 and 2–4): production, collection, transfer, storage, treatment, and utilization. The inventory data are cataloged into one of the six functions and then interpreted, analyzed, and evaluated in preparation for developing alternatives. This may result in data in all of the functions or in only a few. Following is a brief explanation of each function of an AWMS.

(1) Production

The data cataloged in this function are the type, origin, amount, consistency, and constituents of the waste. For example, a dairy enterprise waste amount depends

Figure 2–4 Analyzing resource data and formulating solutions using the six functions of an AWMS



* Energy generation is included under the utilization function because utilization of the waste material is the basic purpose of such operations. This is distinct from the treatment function in which the basic purpose is to change characteristics of the waste material. Consequently, waste material discharged after energy generation must be managed similarly to that which has not been used for energy generation. In the case of livestock manure, the management process could include transfer to storage and, from there, transfer to a second waste utilization function of application on the land.

on the number of each type of stock in the herd and the amount of wash water used. The consistency of the waste is either a solid, semisolid, slurry, or liquid. Wastes from a dairy could be generated in one or more of these consistencies. Components that exclude or introduce clean water also affect the consistency and amount of waste.

(2) Collection

Inventory data that apply to the collection and initial short-term holding of the waste are cataloged in this function. Using a dairy as an example, the manure may be collected by scraping, flushing, or some other method to a storage tank or other short-term storage facility for eventual transfer to longer term storage or treatment.

(3) Transfer

Cataloged in this function of the AWMS is inventory data that apply to moving the waste from the point of collection to storage or treatment and the transfer of waste from storage or treatment to the point of land application or final use. For a dairy, liquids could be transferred through a pipeline from the point of collection to either a waste storage pond or waste treatment lagoon or to cropland for land application.

(4) Storage

Inventory data that apply to storage are cataloged in this function. For a dairy that has ample land for application of wastes, the waste can be stored in a waste storage pond or structure for application to cropland when soil and weather conditions are appropriate.

(5) Treatment

Inventory data that apply to treatment are cataloged in this function. For a dairy operation where enough land for application of wastes is not available, a waste treatment lagoon could be used to reduce concentration of nutrients in the part that is water.

(6) Utilization

Data cataloged under this function are those that apply to utilization, such as land application, sacking dried manure for sale, bedding with treated manure, or generating energy. Inventory data that apply to this part would be the type of soil, existing land application equipment, amount of area for land application, crops, crop rotations, market for dried manure, and potential for use of energy on the farm and sale of excess energy.

(e) Formulate alternative solutions

Step 5 of the planning process, formulate alternative solutions, is used to develop alternative AWMSs based on the analysis of the inventory data as cataloged into one of the six functions of an AWMS.

(f) Evaluate alternative solutions

Alternative solutions need to be evaluated to determine if they meet the objectives, solve the problem, and are socially, culturally, and economically acceptable.

(g) Client determines a course of action

The seventh step in the planning process is making decisions. The decisionmaker must select one system from among the alternatives developed by the planner; however, the planner needs to guide the decisionmaker by presenting cost effective, environmentally sound, and socially acceptable alternatives. If the preceding planning elements are properly carried out, the decisionmaker will have all of the information available, including the private and public objectives, on which to make the needed decision.

Numerous worksheets and guides are presented in various sections of this handbook to aid in documenting information used in planning. Resource information and data that need to be documented provide a basis for the decisions that are made. All engineering and design information must be in design folders as required in part 511 of the NEM. Operation and maintenance plans must be developed so the decisionmaker fully understands how the AWMS is to be operated safely and what facilities need to be inspected and maintained. Nutrient management plans and specifications including water budgets and plant nutrient budgets should be developed in accordance with the guidelines in chapter 11 of this handbook and the requirements of the Field Office Technical Guide.

(h) Client implements the plan

In step 8, the client implements the plan. Well-planned, economically sound, and acceptable plans have a much greater likelihood of being implemented. Decisionmakers ultimately have almost total control over implementation. The planner, however, can help decisionmakers by providing approved detailed construction drawings and specifications for facilities, specific operation and maintenance plan for each component, and information on cost sharing programs, low interest loans, and other opportunities or conditions, such as pending laws that may affect the decision to implement the AWMS installation.

(i) Evaluation of the results of the plan

Changing demands, growth, and technological advances create a need to evaluate an AWMS to update objectives and modify plans. Plans developed but not implemented within a few years should be reevaluated. This requires repeating some or all of the planning elements to maintain a viable plan. The implemented AWMS may need to be fine-tuned not only because of technical advances, but because of what the decisionmaker has learned about the system. This planning element gives the planner an excellent opportunity to gain experience and knowledge that will be useful when providing planning assistance to other decisionmakers.

651.0203 AWMS plan

An AWMS plan is prepared as an integral part of and in concert with conservation plans. It is prepared in consultation with the producer and is formulated to expressly guide the producer in the installation, operation, and maintenance of the AWMS. The AWMS plan must account for all management systems operating on the farm that relate to the AWMS operation. For example, manure nutrient management must be a part of the overall nutrient management. The plan must interface with other systems, such as the tillage, irrigation, and cropping systems.

(a) Purpose of the plan

The purpose of the AWMS plan is to provide the producer with all the information necessary to manage agricultural wastes in a manner to protect the air, soil, water, plant, animal, and energy resources. The plan may be necessary to comply with State regulation or law. It must take into account such factors as the financial status and management capabilities of the producer.

(b) Contents of the plan

The AWMS plan should include:

- a description of all system components or practices planned
- the sequence and schedule of component installation
- the operation and maintenance requirements including a time schedule
- engineering design and layout information on location, size, and amounts
- nutrient management plans, including an accounting of the nutrients available, crops and fields where applied, and amount and timing of application
- biosecurity measures and CAM response plan
- information showing the relationship between the AWMS and the other management systems

The plan is to guide the actions of the producer in a way that provides for protection of all natural resources. It must have adequate information to accomplish this purpose.

651.0204 Waste impoundment planning considerations

Waste impoundments include earthen waste storage ponds and waste treatment lagoons. See chapter 10 of this handbook for the design detail of these AWMS components. The planning of waste impoundments must consider the potential consequences if they fail. Safeguards or measures to reduce the potential for failure or the consequences of failure should be considered as warranted.

Not all waste impoundments are planned to have an embankment. Those that do must consider the risk to life and property should the embankment fail. The information that follows is limited to embankment impoundment sites where the potential risk is limited to physical damage of farm buildings, agricultural land, or township and county roads. This hazard criterion is the low hazard classification for dams that will impound clean water. Waste impoundments, however, present additional risk beyond that of clean water impoundments because of the nature of material they contain. This material can be high in organic matter, nutrients, and microorganisms. In addition, the wastewater may produce offensive odors. As such, even though a waste impoundment is sited so the risk is limited to physical damage of property, there may still be a significant potential in failure to degrade soil, water, air, plant, and animal resources as well as negatively impact the human environment.

The purpose of this section is to describe the potential consequences of failure and excessive odors. Also described are the planning considerations for minimizing the potential of failure and the consequences should failure occur. The two major categories considered are:

- embankment breach or accidental release
- liner failure

(a) Potential risk from sudden breach of embankment or accidental releases of waste impoundments

Because of site conditions, waste impoundments are often planned and designed to have an embankment.

These types of impoundments may have significant consequences if the embankment fails. Waste impoundments may also be designed to have a gravity outlet to facilitate emptying as a part of the transfer function of an AWMS. This type of outlet potentially can allow an accidental or unplanned release.

Significant consequences in the event of sudden embankment breach or accidental release may occur, particularly if there is impact to a surface waterbody. The primary consequence to a surface waterbody is contamination with microorganisms, organic matter, and nutrients. This contamination may kill aquatic life and make the water unsuitable for its intended use. As a minimum, the waterbody would most likely be discolored. Chapter 3 of this handbook describes more completely the effects of animal waste on surface water.

The magnitude of the environmental impact from breach or accidental release to a surface waterbody is related to the amount and concentration of the released waste and to the quality and quantity of water and the biota in the receiving waterbody. The magnitude of the impact may also vary according to the time of year and such factors as the dilution capacity, reaeration coefficients, antecedent dissolved oxygen conditions, sensitivity to phosphorus and nitrogen loads, and proximity of drinking water intakes and recreation areas. Exactly what the effect of released waste would be is difficult, if not impossible, to predict with any precision. Regardless of the impact, it must be recognized that releasing wastewater in any amount or concentration into a surface waterbody is seldom socially acceptable. For this reason, precautionary measures should be considered in planning and design to minimize the risk or consequences of embankment breach or accidental release if a hydraulic analysis indicates that a surface waterbody may be impacted. This would be even more important from a social acceptability aspect if the affected waterbody is off-farm.

Embankment breach or the accidental release of effluent from a waste impoundment may also cause severe erosion and destruction of cropland and critical habitat. Because animal waste potentially contains disease causing microorganisms that are transmittable to humans (see ch. 3, table 3–5 of this handbook for a listing), a release that would contaminate areas where people live can potentially lead to human health problems.

Features, safeguards, or management measures to minimize the risk of embankment failure or accidental release or to minimize or mitigate impact of this type of failure should be considered if one or more of the categories listed in table 2–1 may be significantly impacted.

A substantive evaluation of the impact of sudden breach or accidental release from waste impoundments should be made on all waste impoundments. Waste impoundments planned with embankments where significant direct property damage may occur should be evaluated with an appropriate breach routing procedure, such as that in NRCS Technical Release No. 66, Simplified Dam Breach Routing Procedure. The following should be considered, either singly or in combination, to minimize the potential or the consequences of sudden breach of embankments if one or more of the potential impact categories (table 2–1) may be significantly impacted.

- an auxiliary (emergency) spillway
- additional freeboard
- accommodating the wet year rather than normal year precipitation
- reinforced embankment, such as additional top width, flattened or armored downstream side slopes
- secondary containment
- permanent markers at critical wastewater elevations to indicate need for operational action

Table 2–1 Potential impact categories from breach of embankment or accidental release

Surface waterbodies—perennial streams, lakes, wetlands, and estuaries
Critical habitat
Farmstead or other areas of habitation
Off-farm property

The potential for accidental release exists whenever a gravity outlet is used to facilitate emptying the waste impoundment as part of the utilization function of an AWMS. Any one of many possibilities, including vandalism, may result in an accidental or unplanned release. Evaluation of the impact of this type release should be made by routing the outlet's maximum discharge. The following should be considered to minimize the potential for accidental release of gravity outlets from the required volume when one or more of the categories described in table 2–1 may be significantly impacted.

- Use outlet gate locks or locked gate housing.
- Have a secondary containment.
- Use an alarm system.
- Do not use a gravity outlet. Use another means of emptying the required volume.

Development of an emergency action plan should be considered for waste impoundments where there is potential for significant impact from breach or accidental release. In addition, consideration should be given to actions to minimize damage from breach. Actions would include wellhead protection, dikes, and diversion channels. These actions should be taken to augment, not replace the measures to reduce the risk of breach.

(b) Potential hazard of liner failure for waste impoundments

Waste impoundments present a risk of contaminating underlying groundwater aquifers and surface water that may be fed by these aquifers because of the nutrients and microorganisms contained in the wastewater. To minimize this risk, NRCS practice standards require that waste impoundments be located in soils of acceptable permeability or be lined. Despite this, risk remains because of the possibility of poor performance of these measures in preventing the movement of contaminants to the groundwater. Any of a number of causes could lead to nonperformance of liners. These causes would include such things as not being homogenous with lenses of more permeable material, being constructed with inadequate compaction, having desiccation cracks develop following impoundment emptying, and being damaged during agitation. Flexible membrane liners may fail by such things as cracks, tears, seam separation, or loosened connections. Concrete liners may leak if they crack or joint seals fail. The acceptability of the risk depends on the importance of the underlying aquifer, location and type of aquifer, and geologic site conditions that may be unforgiving to poor performance.

The seepage protection planned for a waste impoundment should correspond to the risk involved. A thorough geologic investigation is essential as a prerequisite to planning seepage control for a waste impoundment. Special consideration should be given to seepage control in any one of the following conditions:

- any underlying aquifer is at a shallow depth and not confined
- the vadose zone is rock
- the aquifer is a domestic water supply or ecologically vital water supply
- the site is located in an area of carbonate rock (limestone or dolomite)

Should any of these conditions exist, consideration should be given to the following:

- a clay liner designed and installed in accordance with procedures of appendix 10D of this handbook with a thickness and coefficient of permeability so that specific discharge is less than 1×10^{-7} centimeters per second.
- a flexible membrane liner over a clay liner
- a geosynthetic clay liner or flexible membrane liner
- a concrete liner designed in accordance with the criteria for watertight slabs on grade

The subsurface investigation for a waste impoundment site must be conducted so as to locate any subsurface drainage lines. If found, the lines must either be removed, rerouted, or replaced with nonperforated pipe with watertight joints.

Some waste impoundments require foundation drains to lower the seasonal water table to an acceptable depth. These drains must be designed and installed to have an appropriate separation distance from the impoundment liner and outlet in nonsensitive areas. Functional failure of these drains may impact impoundment liner performance. As such, outlets should be guarded from damage and located so they can be inspected for proper operation. Dual outlets should be considered so a backup outlet is available if one fails.

Pumping and agitation, if used, can be destructive to liners, especially soil blanket liners. Plan for pumping and agitation at locations that will not result in damage to liners or for measures that will eliminate the possibility of damage.

(c) Potential impact from odors and gaseous emissions from waste impoundments

Potential odors from a livestock operation are not limited to waste impoundments. Other sources include buildings (e.g., housing units and milking parlors), open lots, the animals themselves, and operational activities, such as agitation and land application. When developing recommendations for minimizing odor, all sources must be dealt with effectively. This section describes AWMS odors and their impact assessment in general terms. However, the planning considerations given are limited to waste impoundments.

Assessment of the potential for offensive odor impact from an AWMS is complex. Several factors account for this complexity. Odors from an AWMS vary in intensity, frequency, and duration depending on time of year, time of day, weather conditions, and management activities underway. Physiographic characteristics of the site, including such items as topography, vegetation, and cultural features, can also affect the potential for impact. These characteristics interact to vary the distance to which odors may have an impact. Social factors, described in detail later in this section, also add significantly to the potential for odors to have an impact. All of these factors must be assessed in planning an AWMS and associated waste impoundments. Consider as many of the interacting factors as each individual situation necessitates.

The first planning consideration for minimizing the impact of odors from waste impoundments is choosing the best site possible. This siting will maximize separation distance and use prevailing wind direction, topography, buildings, and vegetative screens to direct and dissipate odors. See chapter 8 of this handbook, Siting Agricultural Waste Management Systems, for more details on siting to minimize odors.

Assessment of the social factors related to odors is difficult because of the varied human response to odors. Odor sensation is a personal response. Odor is not observed by individuals with equal sensitivity nor is there always agreement among individuals as to whether an odor is objectionable when detected. Individuals respond differently to odors primarily because of variations of background. For example, someone raised in an urban setting would observe an odor from an AWMS differently than someone raised in a rural setting.

The social factors to consider in determining the extent that measures must be taken to minimize odors are related to who the owner or operator is, who the neighbors are, and the nature of the community in which the AWMS is located. Odors from an enterprise owned and operated by a person who has a long-standing presence in the community are more likely to be tolerated than a similar enterprise owned and operated by a newcomer, if local experience to the farm has been positive. Less likely to be tolerated would be a newly established, large enterprise owned and managed by someone who does not live on the farm. Odors that affect neighbors with similar enterprises are more likely to be tolerated. For example, odors from a dairy that is located in a rural area surrounded by other similar sized dairy farms would probably be tolerated. However, odors from a livestock operation that is much larger than the majority of neighboring farms and not considered to be part of the farming community may not be tolerated. An example would be a large corporate farm in the midst of smaller family farms.

Less tolerant of odors would be neighbors who have dissimilar enterprises, especially nonodor producing enterprises. An example is a hog operation located in a predominately corn-growing area. A type of rural neighbor that would be even less tolerant of odors would be those who have migrated to the country from urban areas. Often people with this background have moved to the country for the fresh air and not necessarily to make a living. This neighbor, in all likelihood, would be less tolerant of odors, especially if they are intense and drawn-out. Those living in adjacent urban communities will generally not tolerate odors that they perceive to be objectionable regardless of intensity or duration.

An evaluation that would include, but not be limited to, the following factors in determining the recommendations for minimizing AWMS odors.

Owner/operator assessment

- tenure
- type of enterprise
- size of enterprise
- future plans for expansion
- perception of odors

Neighboring farms assessment

- tenure
- type of enterprise
- size of enterprise
- perception of odors

Nonfarm neighbors' assessment

- tenure
- perception of odors

Community assessment

- composition—percent rural vs. percent urban
- migration to community in the last 5 years
- economic sectors
- history of odor complaints to community leaders

Sources of helpful information in evaluating these social factors and other related factors include but are not limited to the following:

- U.S. Census of Agriculture
- U.S. Census of Population and Housing
- local land use planning reports
- interviews with local health agencies
- interviews with State health agencies
- interviews with State environmental agencies
- published information, such as reports and newspaper items

For sites where measures beyond siting are necessary to minimize odors, anaerobic lagoons should be considered instead of waste storage ponds. Lagoons with loading rates reduced to at least half the values shown in chapter 10, figure 10–27 of this handbook should be used. The following measures should be considered for sites where the need to minimize odors is significant:

- covering anaerobic waste treatment lagoons and storage ponds
- using naturally aerated or mechanically aerated lagoons
- using composting in conjunction with a solid waste system rather than a liquid or slurry system
- using a methane recovery system

651.0205 References

U.S. Department of Agriculture, Natural Resources Conservation Service. 2000. Animal Waste Management Systems Planning Handbook. East Lansing, MI.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006. National Planning Procedures Handbook. Washington, DC.