SOUTHERN WILLAMETTE VALLEY GROUNDWATER MANAGEMENT AREA ACTION PLAN

UPDATES TO AG SECTIONS ONLY: PLEASE REVIEW THIS DOCUMENT AND COME TO THE MAY 10, 2012 GWMA COMMITTEE MEETING PREPARED TO DISCUSS.

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Overview of Nitrate Sources

Nitrate is an inorganic compound that naturally occurs at low levels in soil, air, and water. Low levels of nitrate (3-4 mg/L) are generally considered to be naturally occurring background concentrations (Lamond et al., 1999). Human activities can increase nitrate levels and cause contamination of water supplies. Nitrate is essential to life because it is used and converted by plants to meet some of their nutrient requirements for nitrogen. Nitrate is highly soluble in water and mobile in the soil. This makes it relatively easy for nitrate from a variety of point and non-point sources to leach through the soil and into the groundwater.

The Clean Water Act defines the term 'point source' very broadly. A point source is any discernible, confined, and discrete conveyance of pollution, such as a pipe, ditch, channel, tunnel, or conduit from which pollutants are or may be discharged.

Non-point sources of pollution are caused by rainfall, snowmelt, or irrigation water moving over and through the ground. As the water moves, it can pick up and carry away natural and human-made pollutants, ultimately depositing them into ground and surface waters. Non-point sources of pollution can originate from relatively large areas, can be associated with particular land uses, and may consist of several pollutants. These features make it extremely difficult to trace all individual sources and identify which pollutant came from which specific source. In general, these pollutants can arise from activities that the everyday person has control over.

Potential point and non-point sources of nitrate pollution in the Southern Willamette Valley study are found across land use sectors in the region and include:

- Fertilizers
- Animal waste
- Septic systems
- Wastewater
- Unused or poorly constructed wells

Fertilizers: The three fertilizer manufacturing and sales facilities in the GWMA are potential point sources for fertilizer contamination. A bulk fertilizer facility generally offers commercial quantities of various custom-blended fertilizers, herbicides, and pesticides for the agricultural community and other large fertilizer applications. There are no known releases of fertilizers from existing businesses in the GWMA. Previous manufacturing facilities at these same locations, however, may have had periodic releases to the ground that could still have residual contributions.

Non-point sources of nitrate can come from fertilizers used by homeowners, commercial and industrial businesses, farmers, and city and county parks. The actual use of a fertilizer is not necessarily a practice that will contribute nitrate to the groundwater. Rather, it is the amount, timing, frequency and type of fertilizer, as well as the timing of irrigation relative to the application of fertilizers that can cause nitrate to be flushed beyond the root zone.

Fertilizers come in many different forms such as granular, water soluble, foliar applied, quick release, and slow release. Slow-release fertilizers, as their classification implies, release nutrients at a slower rate throughout the season and are less likely to leach to the groundwater. Although they are initially more expensive, they may deliver a higher percentage of the applied fertilizer to the target crop.

Regardless of the form of nitrogen applied, it is eventually converted in the soil to nitrate. Nitrate in soil water solution is readily taken up by actively growing plants. However, if plants are not actively growing or are unable to take up all available nitrate, nitrate dissolved in water percolates through the soil below the root zone into groundwater. Over-watering practices combined with over-fertilizing can exacerbate the problem and be a cause for groundwater impacts.

Animal Waste: Animal waste has the potential to contribute nitrate to groundwater if not managed properly. All animal waste contains nitrogen/nitrate although the amount is largely dependent on animal species and diet. Nitrate contributions from animal waste can come from either point or non-point sources. By law, confined animal feeding operations (CAFOs) are considered point sources. These facilities are often permitted and hold relatively large numbers of animals including chickens, swine, and cattle. Small acreage, rural residential lots with fewer animals are considered non-point sources and can also contribute to nitrate loading in the groundwater. Even the family dog can contribute a small amount of nitrate. Like fertilizer, animal waste does not have to be a source of nitrate to groundwater. Larger permitted facilities address nitrate leaching by implementing Animal Waste Management Plans. Animal waste on small acreage lots can often be managed by covering manure during the rainy season and then using the waste as a soil amendment at agronomic rates during the growing season.

Septic Systems: Septic systems can be a non-point source of nitrate contamination. Standard septic systems used at individual households release water containing nitrate from the drainfield even if they are functioning properly. While values can vary depending on the system and household load, nitrate in effluent percolating through the soil one to three feet below the drainfield trench can be as high as 40 mg/L (Anderson and Gustafson, 2004). A large number of septic systems in close proximity may introduce more nitrate than can be diluted by the underlying groundwater, and thus contribute to increased groundwater nitrate levels. Sand-filter septic systems provide some additional treatment of the water leaving the septic tank before it reaches the drainfield. While results vary, sand-filters generally do not reduce the nitrate concentration by more than half. There are also alternative treatment technology wastewater systems that can substantially reduce nitrate levels, some of which can nearly eliminate nitrate contributions to the groundwater. While more effective than standard systems in treating nitrate, they are also more expensive.

Wastewater: Potential point sources of nitrogen/nitrate include permitted public wastewater treatment facilities. Most of the cities within the GWMA, and many of the commercial and industrial facilities located outside of cities have their own permitted wastewater treatment system. These systems include relatively large on-site treatment that uses a drainfield (similar to an individual septic system only at a larger scale), or treatment lagoons followed by land applications. The water usage in these

facilities is different than a typical household, because water is primarily used for kitchen and restroom purposes and rarely includes shower and laundry facilities. Total nitrogen levels in the effluent are typically higher in these larger systems than for household septic systems because the waste is more concentrated. Treatment lagoons have the potential for nitrate contributions if the lagoon is not sealed properly. Certain organic waste materials such as processed municipal sewage sludge, reclaimed water, food processing wastes, and other similar materials may be recycled and land applied under DEQ regulations and permit. Some of these wastes may be high in nitrogen or nitrate, and must be properly managed through land application.

Unused or Poorly Constructed Wells: Wells properly installed to meet Oregon Water Resources Department (OWRD) Minimum Well Construction Standards help prevent surface water from reaching groundwater by way of the well opening. However, wells that may have been improperly constructed, damaged or altered, or are no longer in use may provide a pathway for nitrate and other surface contaminants to enter groundwater. Driven wells, sometimes referred to as sand-point wells, typically consist of a pipe, two inches or less in diameter, pounded into the earth until groundwater is encountered. Driven wells provide an easy access to water; but, in many cases, these wells were not installed by an Oregon licensed well contractor.

Agricultural

Overview

There are 111,350 acres under agricultural use encompassing over 93 percent of the GWMA. These lands are mostly in crop production but also include a few CAFOs. Rural residential properties with a small number of large animals (such as horses, llamas, cows, etc.) are also under the umbrella of agricultural land uses.

The Willamette Valley is one of the most highly productive agricultural areas in the world. Today, hundreds of commodities are grown in the Southern Willamette Valley. Grains, hay and forage, seed crops (grass and legume), field crops (primarily peppermint), vegetables, fruits, and various specialty crops make up the bulk of the crop production. Map 6 displays the predominant crops in the GWMA.

Crop producers use fertilizers to boost production and maintain economic viability in a competitive world marketplace. Beginning in the 1990s, there have been a number of changes in fertilization and irrigation practices in Southern Willamette Valley agriculture. These changes resulted in the reduction of nitrogen loss below the root zone as well as lower overall fertilizer and irrigation water applications. During this period, Oregon State University Extension Service (OSU Extension) embarked on an intense outreach and education effort to area growers. Some experts believe that many producers responded with appropriate management changes to reduce nitrogen loss to both ground and surface waters.

At about the same time, the primary vegetable processing facility in the Southern Willamette Valley closed, the price of peppermint (a plant with high fertilizer and water needs) declined, and nitrogen fertilizer prices began to rise, a trend that continues today. Vegetables and peppermint represent the primary high value crops in the region. They are also grown extensively on the highly productive and permeable soils located mainly on the west side of the Willamette River. The loss of the primary vegetable processing facility and the lower price of peppermint resulted in a decline in acreage planted to these high value crops and conversion primarily to grass seed production. While this conversion may result in a small decrease in total nitrogen applications (because of generally lower required rates), the primary benefit may be the ability of grass seed crops to scavenge and store soil nitrogen. In addition, the soaring fuel costs and very high nitrogen costs of the mid-2000s provided another incentive for members of the farming community to only apply fertilizer when absolutely necessary and/or to apply slow release fertilizers to reduce the number of applications necessary. OSU Extension has updated fertilizer guides for many crops grown in the Willamette Valley. Over the last several years, with the loss of field burning as a management tool and a decline in market demand, there has been a shift from grass seed to cereal grains, legumes and small seeded crops (clovers). It is important to note that both legumes and clovers are nitrogen-fixing crops.

Today the area's most productive producers continually work to capture input efficiencies, and this

ongoing effort includes evaluating their operations to reduce nitrogen applications, increase irrigation efficiencies, and take advantage of research to reduce nitrogen losses. Successful growers know this is vital to protect the area's natural resources as well as to operate a profitable business in an extremely competitive marketplace.

Map 6: Crop Types

In addition to crop producers, livestock operations constitute another important agricultural activity in the GWMA that supports local markets and the economy. These operations are considered to be Confined Animal Feeding Operations, or CAFOs, when they meet at least one of the following criteria:

- Animals confined in a building, or pen, or lot with an improved surface (e.g., concrete, rock, or fibrous material),
- The facility has a waste treatment works (manure pile, lagoon, tank, etc.), or
- The facility has potential to discharge or is discharging waste.

Initially, the program regulating CAFOs was complaint driven. In 1999, ODA introduced the Performance Based Inspection requiring all permitted CAFOs receive at least one routine inspection per year. The switch to performance based inspections also included more rigorous groundwater protection requirements (Youse, 2005).

In response to new federal CAFO standards adopted by the U.S. EPA in 2008, Oregon again revised the CAFO program and issued a new CAFO general permit in 2009. The new CAFO permit incorporates both state and federal CAFO definitions and regulations. For permit requirements see appendix ??

As the population continues to expand in the Southern Willamette Valley, residents recognize that the area provides an ideal rural landscape for an increasingly popular country life. Many people include livestock such as horses, llamas, cows, or sheep as part of their country lifestyle. While these operations do not require a permit, they are regulated by ODA's Agricultural Water Quality Program, and are prohibited from discharging pollution to surface or groundwater. The Agricultural Water Quality Program regulates all potential agricultural sources of nitrate other than permitted CAFO's. ODA's Water Quality Program responds to water quality concerns or works to prevent and control water pollution with assistance from the Linn, Benton, and Upper Willamette SWCDs at the local level. Regulatory oversight is based on a complaint-driven system. Many of the complaints received by ODA relate to waste from a few animals on small acreages. The complaints are often related to uncovered manure piles.

Three of ODA's Agricultural Water Quality Areas overlap or fall partially within the geographic boundary of the GWMA including the Middle Willamette, the Upper Willamette/Upper Siuslaw, and the South Santiam. Area Plans for the Management Areas were developed in partnership with ODA,

the Local SWCD, and Local Advisory Committees consisting of stakeholders residing in the area. The Area Plans outline voluntary and regulatory mechanisms to help landowners to achieve compliance and for surface and groundwater to meet water quality standards. For more information on the Area Plans and Rules see: http://oregon.gov/ODA/NRD/water_agplans.shtml.

Southern Willamette Valley agriculture must continue to make changes as it works with neighboring land uses to lower groundwater nitrate levels. Following is the identification of the potential sources of nitrate from agricultural land uses and the goals and strategies to achieve success.

Inventory of Potential Agricultural Sources of Nitrate

Potential agricultural sources of nitrate in the groundwater include:

- Fertilizer and irrigation
- Confined animal feeding operations
- Small acreage landowners with livestock

Fertilizer and Irrigation

A number of groundwater studies in the 1990s indicated that nitrate has been leaching from both irrigated and non-irrigated cropland soils. These sources may contribute to nitrate groundwater contamination in the Southern Willamette Valley. These studies emphasize the need for greater awareness of potential nitrate issues and the incorporation of this awareness into fertilizer and irrigation practices.

Many studies show that where intensive agricultural production occurs with high nitrogen inputs and irrigation practices, groundwater nitrate levels can be expected to approach and exceed the 10 mg/L drinking water standard. Studies measuring nitrate loss to groundwater from vegetable fields, mint crops, and even organic growing operations found nitrate levels exceeding 10 mg/L below the root zone (Feaga and Selker, 2004). Both timing and amount of fertilizer are often a factor in nitrogen loss. OSU Extension Service found that applying nitrogen late in the season or applying amounts above the recommended 225 lbs/acre (mint crop rate) resulted in excess soil nitrogen remaining after harvest. In one study of grass seed production, Mark Mellbye (2002) found increased residual soil nitrate levels at rates of 180 lbs/acre on annual ryegrass. He also found that maximum profit per acre was reached at lower nitrogen application rates, showing that careful fertilizer applications can protect water quality and maximize income. Attendees of the 2011 agriculture workgroup supported a repetition of this research to better understand what is happening below the root zone for different cropping and fertilizer application scenarios.

Nutrient and Irrigation Efficiency Management Practice Recommendations

Practice	Resource Concerns Addressed	Benefits to Producer	Costs to Producer
Apply fertilizer at the correct rate and time applications for crop uptake.	Reduces the risk of excess nitrogen in the soil at the end of the growth season.	Precise application saves the producer money in fertilizer costs.	Time related to precision application.
Sample soil prior to fertilizer application to know existing nutrients.	Prevents the application of excess nutrients.	Precise application saves the producer money in fertilizer costs.	Cost of soil sampling and analysis.
Plant winter cover crops to take up excess nitrogen left over after crops are harvested.	Takes up extra nitrogen and limits potential for leaching into ground water.	Stores extra nitrogen in plant matter for later release when cover crop is incorporated into the soil.	Cost of seed and fuel to plant cover crop.
Properly maintain irrigation systems to prevent over-irrigation.	Prevents leaching of excess nitrogen past the root zone.	Uniform irrigation application and save producer money on nitrogen costs.	Replacement nozzles at least every four years is recommended.
Monitor soil water content and adjust irrigation schedules to maintain soil water content in an appropriate range in the root zone.	Prevents over-irrigation and leaching of excess nitrogen past the root zone.	Allows accurate irrigation application and keeps nutrients available to crops.	Soil monitoring equipment and time to evaluate soil water content.
Schedule irrigation applications based on expected evapotranspiration rates.	Prevents over-irrigation and leaching of excess nitrogen past the root zone.	Allows accurate irrigation application and keeps nutrients available to crops.	Time to evaluate expected evapotranspiration rates.

Selker et al, 2004

Confined Animal Feeding Operations (CAFOs)
There are currently eight CAFOs in the GWMA permitted by the CAFO Program of the ODA (see Map 7). These include dairy, beef, hog, and chicken facilities. As mentioned previously, these facilities hold annual operating permits, must meet state requirements, and are inspected once a year to ensure compliance. The potential for nitrate from these facilities is predominantly associated with manure waste leaching into groundwater.

Small Acreage Landowners with Livestock
There are an unknown number of smaller animal operations, such as horse farms that do not require a permit for operation due to limited size, lack of confinement, and other factors. In addition, many of the rural homeowners outside of city limits in the GWMA, have a small number of large animals such as horses, llamas, goats, sheep, and or cows.

Map 7: Confined Animal Feeding Operations

Agricultural Goals, Objectives, Strategies, and Actions

The goals and associated strategies focus on integrating GWMA efforts with the three existing Agricultural Water Quality Management Area Plans in the Southern Willamette Valley. Education and outreach is the primary mode for helping producers understand the best and most economical means for making any necessary changes to reduce nitrate loading to groundwater. Regulatory mechanisms are in place through ODA's Agricultural Water Quality Program. Agricultural Water Quality Rules state that agricultural practices cannot pollute waters of the state, including groundwater. The most important objective that is likely to impact groundwater nitrate levels is implementation of BMPs by landowners. Monitoring and research goals are vital to accurately measure how well the Action Plan and Area Plans are performing and to continually improve management options for producers. Finally, financial resources are necessary to undertake actions for the protection and improvement of the groundwater resource. The funding strategies suggest ways for producers, agribusiness, and government partners to collaborate in the development of successful initiatives.

The following section identifies the objectives, strategies and actions associated with two goals for achieving continued reduction of nitrate inputs from agricultural lands. The GWMA Committee has identified the following as high priority goals, objectives, strategies, and actions with the intent of improving groundwater quality in the GWMA. The GWMA Committee recommends that ODA, DEQ, the Linn, Upper Willamette, and Benton SWCD, watershed councils, and other partners implement these strategies and actions to address groundwater quality. The Committee recognizes that this list is not all-inclusive, that other strategies may also be effective in improving water quality, and that resources may not permit these objectives, strategies, and actions to be completed in the specified timeframes.

Goal 1: Prevent and control pollution of groundwater from agricultural activities and achieve

applicable water quality standards that protect beneficial uses through voluntary management actions.

Goal 2: Reduce existing concentrations of nitrate and prevent further contamination from agricultural sources of groundwater in the GWMA. Identify: practices contributing to contamination, best management practices to prevent nitrogen inputs to groundwater, and a schedule for implementation of actions.

Objective 1: Education and Outreach—Organize education and outreach efforts to increase the agricultural community's awareness of groundwater vulnerability and best management practices.

Strategy 1.1 Within the GWMA, coordinate agricultural surface and groundwater pollution control efforts. Coordinate groundwater pollution control efforts among the various agriculture-related organizations and plans in the GWMA.

Actions

- Annually evaluate the Benton, Upper Willamette, and Linn SWCD Scopes of Work to include groundwater quality tasks. These tasks should focus on nitrogen use efficiency, irrigation use efficiency, and manure management.
- During biennial reviews of the South Santiam, Middle Willamette, and Upper Willamette Agricultural Water Quality Management Area Plans, update groundwater quality items in the Goals and Objectives. The Area Plans Goals and Objectives sections should include a focus on nitrogen use efficiency, irrigation efficiency, and manure management.
- Communicate to NRCS local work groups the priority of spending funds on nutrient use efficiency, irrigation efficiency, and manure management within the GWMA.

Strategy 1.2 Organize and deliver workshops and demonstration projects aimed at producers to show BMP implementation and increase BMP adoption. At the workshops, educate producers about groundwater conditions, populations at risk from high nitrate levels, federal assistance programs, and sustainable agriculture opportunities.

Actions

- Each SWCD develop two demonstration projects showcasing successful BMPs and systems.
- Organize one tour (field or virtual) of each demonstration project for agricultural managers and producers. Partner with agribusiness for tours of demo projects.
- Each year partners sponsor two small acreage resource management workshops that provide presentations (either as a stand-alone presentation or part of a broader presentation) on surface and groundwater quality issues.
- Include information on sustainable practices, incentive programs, and third-party certification at the workshops. The goal is to attract 100 producers annually to the demonstrations and workshops.

Strategy 1.3 Write and publish articles to promote/improve the agricultural community's awareness of water quality issues in the GWMA.

Actions

- Once per year, provide an update on the status of the GWMA and associated water quality data in the Benton SWCD newsletter. The Linn and Upper Willamette SWCDs do not have a newsletter, and therefore, should provide an update to be included in a partner newsletter. This may include OSU Extension for the Linn SWCD and the Farm Service Agency for the Upper Willamette SWCD.
- Publish two media articles or public service announcements per year in the GWMA about successful agricultural resource management practices.

Strategy 1.4 Share information and coordinate with agribusiness, producers, and producer groups to promote practices and conditions that protect and improve water quality.

Actions

- Follow-up meeting with agribusiness field representatives active in the GWMA to review the groundwater nitrate issue and share appropriate outreach materials. This should occur in 2012 and once every three years thereafter. Possible ways to meet with field representatives include:
    - Grower meetings
    - Individual company meetings
    - Oregon Agriculture Chemical and Fertilizer safety training workshops
- Each SWCD will deliver one groundwater quality presentation (either as a stand-alone presentation or part of a broader presentation) at one agribusiness or producer group meeting per year.
- Make at least 100 contacts (total) with landowners about groundwater quality per year within the areas served by the Benton, Upper Willamette, and Linn SWCDs.
- Provide or develop outreach materials for producers that summarizes practical resource management for groundwater quality.

Objective 2: Resource Management—Implement BMPs in the GWMA to improve groundwater quality.

Strategy 2.1 Work with agricultural producers in the GWMA to implement practices to improve groundwater quality.

Actions

- Provide technical assistance to producers in the GWMA. Each SWCD will have a minimum of 25 contacts with producers within the GWMA annually promoting irrigation efficiency, and nutrient and manure management.
- Promote proper nutrient management, irrigation efficiencies, and manure management to reduce nitrogen loss to groundwater. Each SWCD will work with four producers within the GWMA annually to design and implement best management practices.

Strategy 2.2 Obtain sufficient financial assistance to support technical assistance to producers and implementation of resource management practices.

Actions

- Include tasks in the SWCDs Scopes of Work for technical assistance to producers and to seek funds for implementation of practices related to groundwater quality.
- Communicate to NRCS local work groups the priority of spending funds on nutrient use efficiency, irrigation efficiency, and manure management within the GWMA.
- Include the promotion and support of USDA programs such as the Environmental Quality Incentives Program and the Conservation Reserve Enhancement Program into SWCD work plans and Scopes of Work.
- Seek funds from USDA incentive based cost-share programs to assist producers to implement groundwater protection practices.
- Seed DEQ 319 funds to assist with agricultural on-the-ground projects and management practices that minimize groundwater nitrate pollution.

Strategy 2.3 Develop and target a priority area within the GWMA to evaluate progress related to implementation of the Agricultural Water Quality Plans and GWMA Action Plan. (The purpose of the priority area is to evaluate the area before and after targeting and demonstrate progress. Progress is a measurement of improvement of water quality parameters or surrogates.) As resources and time allows, multiple priority areas will be identified for targeting.

Actions

- Identify a priority area to target education, outreach, and other resources. This area should be identified by July 2012.
- Identify BMPs that will be promoted for improvement of groundwater quality.
- Identify management practices or conditions that assure agricultural contributions of nitrate to groundwater are at acceptable levels.
- Measure soil nitrate levels at enough sites in the priority area to assess potential of nitrate leaching.
- Contact all landowners within the priority area with information on the GWMA and best management practices to reduce nitrate inputs.
- Develop targets and milestones specific to the priority area.
- Implement management practices with all willing landowners in the priority area.

Strategy 2.4 Obtain adequate funding for implementation of desired practices within the priority area.

Actions

- Develop implementation and funding plan for the identified priority area.
- Work with producers in the priority area to determine interest in implementation of specific practices.
- Work with partners to submit funds proposals to cost-share implementation of practices.

Objective 3: Monitoring and Research—Monitor groundwater quality in agricultural areas to evaluate the impacts of agricultural management practices. Research best management practice effectiveness, adoption of best management practices, and priority research needs.

Strategy 3.1 Evaluate current domestic and monitoring wells to determine monitoring needs in agricultural areas.

Actions

- Coordinate with local, state, and federal partners to evaluate current surface and groundwater monitoring network and identify additional monitoring needs, by January 2013.
- Evaluate aquifer characteristics to determine whether the existing monitoring wells provide comprehensive data on nitrate concentrations or if additional wells are necessary to monitor nitrate levels in the GWMA.
- Evaluate LiDAR (light detection and ranging) data to understand connections between wells.

Strategy 3.2 Measure the success of BMPs implementation efforts.

Actions

- Measure producer (within the priority area from Strategy 2.3):
    - Awareness of groundwater quality issues,
    - Level of BMPs implementation,
    - Ease of implementing BMPs, and
    - Barriers to BMPs implementation.
- This measurement should be completed in the spring of 2013 and repeated two years later to determine any changes. Target: 50% of the producers surveyed in 2013 using groundwater protection BMPs as identified by groundwater staff and agricultural partners.

Strategy 3.3 Document groundwater related investigations and violations of Agricultural Water Quality Management Area Rules and CAFO permit conditions within the GWMA.

Actions

- Document the number, issue, validity, and outcome investigations regarding potential violations of Agricultural Water Quality Management Area Rules where the violations could impact groundwater.
- Document CAFO violations and outcomes.

Strategy 3.4 Research, document and coordinate BMP effectiveness. Implement priority research identified at February 2010 researchers meeting.

Actions

- Follow-up to the February 2010 researchers meeting to track progress related to identified priority research and funding needs. Research needs identified include:
    - Nitrogen budgets and BMPs for other and nontraditional crops (such as specialty seed crops)
    - Nitrogen mineralization under different crop scenarios
    - Bioreactors on tile lines
    - Time of groundwater travel (data needs improved)
    - No till vs. conventional (difference in cost and potential leaching)
    - Study nitrate sources and how nitrate moves
    - Impact of tile lines on nitrate concentration and movement
- Maintain a prioritized research plan and identified sources of funding.
- Work with OSU or other partners to design a nitrate leaching study to further characterize potential nitrate leaching from various agricultural sources in the GWMA.

- Implement research to measure BMP and systems effectiveness and identify factors affecting groundwater nitrate levels from agricultural practices.
- Research and document effectiveness and impacts of specific BMPs on nitrate leaching.

Strategy 3.5 Obtain sufficient funding to support priority research needs.

Actions

- Submit research grant applications to support high priority research needs. Potential grant sources include the DEQ 319 program, ODA's fertilizer research funds, EPA, the USDA, and other agencies and private organizations.

Table 7 – Agriculture Measures of Implementation and Potential Implementing Entities

Strategy	Measures of Implementation	Potential Lead Implementing Entities
1.1 Coordinate agricultural surface water and groundwater pollution control efforts	1) Include groundwater quality tasks in the SWCD Scopes of Work. 2) Include groundwater quality items during Water Quality Management Area Plans review	ODA, SWCDs
1.2 Organize and deliver workshops and demonstration projects	3) Demonstration projects designed 4) Demonstration projects implemented 5) Tours completed 6) Workshops completed 7) Attendance at tours and workshops	SWCDs, NRCS, ODA, OSU Extension
1.3 Write and publish articles	8) Articles written and published in newsletters and other local media	SWCDs, OSU Extension, LCOG
1.4 Share information and coordinate with agribusiness, producers, and producer groups	9) Follow-up meeting with agribusiness field representatives 10) Establish systems for tracking groundwater quality contacts 11) Track groundwater quality contacts	SWCDs, ODA, NRCS
2.1 Work with producers to implement practices to improve groundwater quality	12) Landowners provided with technical assistance 13) Best management practices implemented by landowners	SWCDs, NRCS, OSU extension, ODA
2.2 Obtain financial support for technical assistance and practice implementation	14) Track changes in funding amounts and allocations 15) Landowners signed up for USDA cost-share programs 16) Grant applications submitted and approved for implementation of practices	SWCDs, NRCS, ODA, OSU extension.
2.3 Develop and target priority area to evaluate progress	17) BMPs identified in relation to improvement of groundwater quality 18) Soil nitrate levels in the priority area measured 19) Landowners contacted in the priority area	

Table 7 – Agriculture Measures of Implementation and Potential Implementing Entities

Strategy	Measures of Implementation	Potential Lead Implementing Entities
	20) Practices implemented in the priority area	
2.4 Obtain adequate funding for implementation in the priority area	21) Landowners interested in implementation of specific practices 22) Funds proposals submitted	
3.1 Evaluate current monitoring to determine needs in agricultural areas	23) Additional monitoring needs identified 24) Aquifer characteristics evaluated	DEQ, ODA, OSU, NRCS, WSCs
3.2 Measure success of BMP implementation efforts	25) Measure baseline of BMP awareness, implementation, ease of implementation, and barriers to implementation 26) Repeat measurement after two years	ODA, SWCDs
3.3 Document groundwater-related violations	27) Track the number of groundwater violations and investigations	ODA
3.5 Research and document BMP effectiveness; implement priority research identified in February 2010	28) Meet to update the priority list of ideas to research 24) Maintain research plan and identified sources of funding 29) Summary of research findings produced	OSU, ODA, NRCS
5.1 Obtain sufficient funding to support priority research needs	30) Meet to update the priority list of ideas to research 31) Grant applications prepared and submitted	OSU, ODA, NRCS