

# North Dakota Adjuvant Compendium

For other adjuvants: [www.herbicide-adjuvants.com/](http://www.herbicide-adjuvants.com/)

## Nonionic Surfactant (NIS)

Activator 90	Loveland	\$32.00 gal	0.25 to 0.5% v/v
APSA-80	Amway	\$32.00 gal	0.25 to 0.5% v/v
ChemSurf 90	United Suppl.	\$32.00 gal	0.25 to 0.5% v/v
Wetcit	Oro Agri	\$75.00 gal	0.25 to 0.5% v/v
Haf-Pynt	Drexel	\$31.00 gal	0.25 to 0.8% v/v
Hypertonic	CHS	\$35.00 gal	0.25 to 0.5% v/v
Induce	Helena	\$31.00 gal	0.25 to 0.5% v/v
Insist 90	Willbur-Ellis	\$24.00 gal	0.25 to 0.5% v/v
Liberate LeciTech	Loveland	\$44.00 gal	0.25 to 0.5% v/v
Pen-A-trate II	Precision Labs	\$32.00 gal	0.25 to 0.5% v/v
Prefer 90	West Central	\$32.00 gal	0.25 to 0.5% v/v
Preference	Winfield	\$35.00 gal	0.25 to 0.5% v/v
Protyx	Precision Labs	\$100.00 g	0.125% v/v
R-11	Wilbur-Ellis	\$32.00 gal	0.25 to 0.5% v/v
Rainier EA	Wilbur-Ellis	\$37.00 gal	0.25 to 0.5% v/v
Surf-AC 910	Drexel	\$25.00 gal	0.25 to 0.5% v/v
Tradition 93	Rosens	\$ - gal	0.25 to 0.5% v/v
Translate	United Suppl.	\$38.00 gal	0.25 to 0.5% v/v
Wet-Sol 99	Schaeffers	\$28.00 gal	0.25 to 0.5% v/v

## NIS Approved for use in Water

Surfactants approved for use in bodies of water are:

Activate Plus	AgriDex	Class Act NG	Induce
Level 7	Liberate L-Tech	Preference	R-11
Top Surf	X-77		

## Surfactant & Silicone

Freeway	Loveland	\$110.00 g	0.75 to 2 pt/100 gal
Kinetic	Helena	\$115.00 g	0.75 to 2 pt/100 gal
Sil-Fact	Drexel	\$45.00 gal	0.75 to 2 pt/100 gal
Silkin	Winfield	\$100.00 g	0.75 to 2 pt/100 gal
Speed	Precision Labs	\$135.00 g	0.25 to 2 pt/100 gal
Sur-Plus	United Suppl.	\$87.00 gal	0.5 to 2 pt/100 gal
Sylcoat	Wilbur-Ellis	\$122.00 gal	0.75 to 2 pt/100 gal

## Surfactant & Deposition/Retention (Drift Retardant)

Cerium Elite	West Central	\$ -	1 qt/100 gal
Fixate Pro	West Central	\$ -	1 qt/100 gal
MasterLock	Winfield	\$55.00 gal	5 to 8 fl oz/A

## Surfactant & Drift Retardant & Antifoam

Powerlock	Winfield	\$55.00 gal	5 to 8 oz/A
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## Surfactant & Nano-technology (carbon tubes)

Chem Xcel Gen 2	C&R Enterprise	\$59.00 gal	12.8 fl oz/gal herb.
Chem Xcel Gen 3	C&R Enterprise	\$62.50 gal	22-25 fl oz/gal herb.
Nano Excel	Enviro Science	-	2 to 8 fl oz/A
Nano-Revolution 3.0	Max Systems	\$145.00 g	2 to 8 fl oz/A

## Petroleum Oil Concentrate (POC/COC)

Agri-Dex	Helena	\$21.00 gal	1 to 2 pt/A
Herbimax	Loveland	\$22.00 gal	1 to 2 pt/A
Rendur Crop Oil	West Central	\$14.00 gal	1 to 2 pt/A
Peptoil	Drexel	\$12.00 gal	1 to 2 pt/A
Prime Oil	Winfield	\$15.00 gal	1 to 2 pt/A
Protyx Aerial	Precision Labs	\$21.00 gal	0.5 pt/A
R-Way	Rosens	\$ - gal	1 to 2 pt/A
ROC Crop Oil	Wilbur-Ellis	\$15.00 gal	1 to 2 pt/A

## Crop (Soybean) Oil Concentrate

BeanOil	Drexel	\$15.00 gal	1 to 2 pt/A
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## High Surfactant Petroleum Oil Concentrate (HSPOC)

Between	United Suppl.	\$20.00 gal	1 to 2 pt/A
Diplomat	Rosens	\$21.00 gal	1 to 2 pt/A
Exchange	Precision Labs	\$26.00 gal	1 to 2 pt/A
Hi-Load	Simplot	\$26.00 gal	1 to 2 pt/A
High Load	Wilbur-Ellis	\$26.00 gal	1 to 2 pt/A
High Mark	Loveland	\$26.00 gal	1 to 2 pt/A
Sitka	CHS	\$23.00 gal	1 to 2 pt/A
Stake	West Central	\$23.00 gal	1 to 2 pt/A
Superb HC	Winfield	\$25.00 gal	1 to 2 pt/A

## Methylated Seed Oil (MSO)

Emulate	CHS	\$22.00 gal	1 to 2 pt/A
Fire-Zone	Helena	\$27.00 gal	1 to 2 pt/A
Hasten	Wilbur-Ellis	\$34.00 gal	1 to 2 pt/A
MES-100	Drexel	\$15.00 gal	1 to 2 pt/A
MSO Leci-Tech	Loveland	\$27.00 gal	1 to 2 pt/A
MSO Ultra	Precision Labs	\$26.00 gal	1 to 2 pt/A
Noble	Winfield	\$23.00 gal	1 to 2 pt/A
Persist Ultra	J.R. Simplot	\$20.00 gal	1 to 2 pt/A
Premium MSO	Helena	\$20.00 gal	1 to 2 pt/A
Succeed	United Suppl.	\$19.00 gal	1 to 2 pt/A
Sundance II	Rosens	\$21.00 gal	1 to 2 pt/A
Superspread MSO	Wilbur-Ellis	\$27.00 gal	1 to 2 pt/A
Upland MSO	West Central	\$22.00 gal	1 to 2 pt/A

## MSO & Organosilicone Surfactant

Air Force	United Suppl.	\$47.00 gal	4 to 6 fl oz/A
Dyne-Amic	Helena	\$57.00 gal	4 to 6 fl oz/A
Inergy	Winfield	\$55.00 gal	4 to 6 fl oz/A
Sil-MES 100	Drexel	\$40.00 gal	4 to 6 fl oz/A
Syl-Tac	Wilbur-Ellis	\$63.00 gal	4 to 6 fl oz/A

## MSO & Basic pH Blend

Entro	Various	\$28.00 gal	1 to 2 pt/A
Renegade EA	Wilbur-Ellis	\$30.00 gal	1 to 2 pt/A

## MSO & Deposition/Retention (Drift Retardant)

StrikeLock	Winfield	\$ - gal	0.5 to 1 pt/A
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## MSO & Surfactant & Deposition/Retention (Drift Retardant)

Plexus	Rosens	\$ - gal	10 to 12 fl oz/A
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## High Surfactant Methylated Oil Concentrate (HSMOC)

Cide Winder	Helena	\$42.00 gal	1 to 1.5 pt/A
Destiny HC	Winfield	\$40.00 gal	1 to 1.5 pt/A
Duce	Helena	\$36.00 gal	1 to 1.5 pt/A
Glacier EA	Wilbur-Ellis	\$50.00 gal	1 to 1.5 pt/A
Hot MES	Drexel	\$20.00 gal	1 to 1.5 pt/A
Kixyt	Precision Labs	\$44.00 gal	1 to 1.5 pt/A
Savvy	West Central	\$32.00 gal	1 to 1.5 pt/A
Top Shelf	Loveland	\$32.00 gal	1 to 1.5 pt/A
Woodside	CHS	\$36.00 gal	1 to 1.5 pt/A

**ADJUVANTS CONTAINING AMMONIUM**  
**Ammonium sulfate (AMS) / Urea ammonium nitrate (UAN)**

**Fertilizer**

AMS (Dry)	Various	\$0.35 lb	4 to 8.5 lb/100 gal
AMS (liquid)	Various	\$6-9 gal	2 to 4 qt/A
28% UAN/Bulk	Various	\$3-10 gal	2 to 4 qt/A

**AMS & Surfactant (NIS)**

Cayuse Plus	Wilbur-Ellis	\$27.00 gal	2 to 6 qt/100 gal
Class Act NG	Winfield	\$13.00 gal	2.5% v/v
Class Act Flex	Winfield	\$15.00 gal	1 to 4 % v/v
Deliver	Precision Labs	\$14.00 gal	2.5% v/v
Impressive DB	Rosens	\$1.25 lb	2.25 lb/A
Powerhouse	Rosens	\$12.00 gal	5 to 10 qt/100 gal
Precinct	West Central	\$ -	2.5% v/v
Re-Duce	Helena	\$12.00 gal	1% v/v
Surfate	Loveland	\$23.00 gal	1% v/v
Ultra Surf AMS	United Suppl.	\$10.00 gal	2.5% v/v
Wheelhouse	CHS	\$12.00 gal	2.5% v/v

**AMS & Drift Retardant (Deposition)**

AMS 20/10	United Suppl.	\$1.60 lb	10 lb/100 gal
Array	Rosens	\$2.50 lb	9 lbs/100 gal
Lox Plus	Drexel	\$15.00 gal	1 to 2 gal/100 gal
StrikeZone MXD	Helena	\$5.00 gal	2 lb/100 gal
Vector	Rosens	\$7.50 gal	2 lb/100 gal

**AMS & Defoamer**

AMS-Xtra	Drexel	\$4.00 gal	2.5 to 5% v/v
Omnix LDF	Precision Labs	\$9.00 gal	2.5 to 5% v/v

**AMS & Deposition & Defoamer**

AMS-Supreme	Drexel	\$15.00 gal	2.5 to 5% v/v
Border Xtra DF	Precision Labs	\$2.00 lb	18 lb/100 gal
Border Xtra 8L	Precision Labs	\$13.00 gal	2.5% v/v
Drift-Gard	Rosens	\$ - gal	9 lb/100 gal

**AMS & Surfactant & Deposition & Defoamer**

AMS-All	Drexel	\$11.00 gal	1 to 5 gal/100 gal
Blue Diamond	NWC,Emerado	\$15.00 gal	1 to 2 qt/100 gal
Bronc Triple	Wilbur-Ellis	\$43.00 gal	10 lb/100 gal
Pay Off Plus	United Suppl.	\$2.00 lb	10 lb/100 gal
Zenith	Rosens	\$1.80 lb	1.5 to 2.25 lb/A

**AMS & Surfactant & Paraffinic oil**

Flame	Loveland	\$42.00 gal	0.5% v/v
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**AMS & WCA\* (AMS Replacement)**

Alliance	Winfield	\$18.00 gal	1.25% v/v
Bronc Max	Wilbur-Ellis	\$25.00 gal	0.5 to 1% v/v
Choice W-Master	Loveland	\$30.00 gal	0.5% v/v
Enact	Rosens	\$25.00 gal	0.5% v/v
SeQuel	Helena	\$17.00 gal	1 to 5 pt/100 gal
Transport LpH	Precision Lab	\$20.00 gal	0.5% v/v

**AMS & WCA\* & Deposition**

AMS 2000	United Suppl.	\$1.25 lb	10 to 17 lb/100 gal
AmSol Plus	United Suppl.	\$6.00 gal	2.5 gal/100 gal
Double Down	United Suppl.	\$8.00 gal	2.5 gal/100 gal
Rush	Winfield	\$25.00 gal	2 to 4 qt/100 gal

**AMS & WCA\* & Deposition & Defoamer**

Holzit	Drexel	\$1.60 lb	9 lb/100 gal
Stay Down	Rosens	\$ - gal	5 lb/100 gal

**AMS & WCA\* & Surfactant & Deposition & Defoamer**

Veracity	West Central	\$26.00 gal	3 qt/100 gal
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**Basic pH Blend**

Axon	CHS	\$24.00 gal	1% v/v
Linkage	West Central	\$24.00 gal	1% v/v
Newtone	Winfield	\$30.00 gal	1% v/v
Quad 7	Loveland	\$22.00 gal	1% v/v
Sequestra	Drexel	\$24.00 gal	1% v/v

**Acidic AMS Replacement (contains AMADS)**

AMADS - Monocarbamide dihydrogen sulfate = urea + sulfuric acid

Aduro	Winfield	\$32.00 gal	4 pt/100 gal
Brimstone	Wilbur-Ellis	\$42.00 gal	4 pt/100 gal
ET-4000	MK Ag Service	\$31.00 gal	4 pt/100 gal
Fixate	CHS	\$32.00 gal	4 pt/100 gal
Gun Smoke	Loveland	\$40.00 gal	4 pt/100 gal
Hel-Fire	Helena	\$36.00 gal	4 pt/100 gal
Import	Precision Labs	\$37.00 gal	4 pt/100 gal
Jackhammer	West Central	\$32.00 gal	4 pt/100 gal

**Acidic WCA\***

ET-4000	MK Ag Service	\$31.00 gal	4 pt/100 gal
Regulator 2.0	Max Systems	\$22.00 gal	2 to 4 qt/100 gal

**Acidic WCA\* & Surfactant & Base Oil**

Simplyx	Precision Labs	\$40.00 gal	0.5 pt/A
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\*Non ammonium / non-AMS water conditioning agent

**ADJUVANTS CONTAINING NO AMMONIUM**

**WCA\* / AMS Replacement**

Choice Trio	Loveland	\$29.00 gal	0.5% v/v
Citron	Farm Direct	\$3.50 lb	2.2 lb/100 gal
Cut-Rate	Wilbur-Ellis	\$2.75 lb	3 to 4 lb/100 gal
Quest/Request	Helena	\$22.00 gal	0.5% v/v
Speedway	United Suppl.	\$38.00 gal	0.5% v/v

**WCA\* & Surfactant**

Fastrack	United Suppl.	\$28.00 gal	0.75% v/v
Flame	Loveland	\$42.00 gal	0.5% v/v
Jackhammer Elite	West Central	\$ -	2 qt/100 gal
Transport Ultra	Precision Labs	\$39.00 gal	0.25 to 0.75% v/v
Wheelhouse Pro	CHS	\$ -	2 qt/100 gal

**WCA\* & HSMOC**

Zaar	Helena	\$37.00 gal	1% v/v
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**WCA\* & Surfactant & Deposition/Retention & Defoamer**

Strike Force	Loveland	\$65.00 gal	2 qt/100 gal
Trapline Pro	CHS	\$ -	2 qt/100 gal
Veracity Elite	West Central	\$ -	2 qt/100 gal
Weather-Gard	Loveland	\$65.00 gal	2 qt/100 gal
Complete Leci-Tec			

**WCA\* & Deposition/Retention & Defoamer**

AccuQuest WM	Helena	\$36.00 gal	1 to 3 qt/100 gal
Formula 1	United Suppl.	\$30.00 gal	1 to 3 qt/100 gal

\*Non ammonium / non-AMS water conditioning agent

**UTILITY ADJUVANTS**

**Deposition/Retention - Drift Retardants**

Affect GC	United Suppl.	\$40.00 qt	1 to 2 fl oz/100 gal
Border EG 250	Precision Labs	\$1.20 oz	10 oz/100 gal
Buckhorn Total	CHS	\$56.00 gal	2 to 6 fl oz/A
Corral Poly	Winfield	\$25.00 qt	4 to 12 fl oz/100 gal
Crosshair	Wilbur-Ellis	\$51.00 gal	4 fl oz/A
Direct	Precision Labs	\$34.00 qt	1 to 4 oz/100 gal
In-Place	Wilbur-Ellis	\$51.00 gal	4 fl oz/pt-lb
InterLock	Winfield	\$60.00 gal	herbicide
Lox	Drexel	\$25.00 gal	4 to 6 fl oz/A
Placement	Winfield	\$45.00 gal	4 to 8 fl oz/A
Parachute	West Central	\$45.00 gal	3 to 4 fl oz/A
Point Blank	Helena	\$42.00 qt	2 to 6 fl oz/100 gal
Sedate Max	West Central	\$58.00 gal	2 to 6 fl oz/A

**Deposition/Retention & Defoamer**

Compadre Leci-Tc	Loveland	\$58.00 gal	1 pt/100 gal
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**Acidifying Agents**

BS-500	Drexel	\$17.00 gal	2 to 4 pt/100 gal
Complete	Winfield	\$44.00 gal	1 to 3 pt/100 gal
Denali EA	Wilbur-Ellis	\$35.00 gal	0.4 to 4 pt/100 gal
Indicate 5	United Suppl.	\$48.00 gal	2 to 4 pt/100 gal
Induce pH	Helena	\$37.00 gal	2 to 4 pt/100 gal
LI-700 Leci-Tech	Loveland	\$39.00 gal	2 to 4 pt/100 gal
New Balance	Precision Lab	\$44.00 gal	2 to 4 pt/100 gal
SuperSpread 7000	Wilbur-Ellis	\$31.00 gal	0.5 to 2 pt/100 gal
Sequestra	Drexel	\$24.00 gal	1 to 5 gal/100 gal
Tri-Fol	Wilbur-Ellis	\$36.00 gal	0.5 to 4 pt/100 gal

**Compatibility Agents**

Blendex	Helena	\$55.00 gal	1 to 5 pt/100 gal
CompatibilityAgent	West Central	\$35.00 gal	1 to 3 pt/100 gal
Complete	Winfield	\$44.00 gal	1 to 3 pt/100 gal
Convert	Precision Labs	\$50.00 gal	1 to 6 pt/100 gal
EZ-Mix	Loveland	\$38.00 gal	1 to 4 pt/100 gal
Mix	Drexel	\$20.00 gal	1 to 4 pt/100 gal
Mix-All	Rosens	\$45.00 gal	1 to 4 pt/100 gal
Compatibility Plus	United Suppl.	\$41.50 gal	1 to 2 pt/100 gal

**Spray Tank Cleaners**

Tank Cleaner	Various	\$12-25 qt	1 to 2 qt/100 gal
Tank Cleaner	Various	\$5-7.00 lb	1 to 2 lb/100 gal

# Understanding a Water Quality Analysis Report

## 1. Water pH

Generally, the normal pH range of water used for application has little effect on herbicide efficacy. Carbamate and organophosphate insecticides quickly degrade through alkaline hydrolysis at water pH above 7. Water pH above 7 significantly increases degradation of Cobra, Resource, and Valor, however these herbicides have very low water solubility and alkaline degradation would affect only the soluble fraction of the herbicide. Increasing water pH to 9 can reduce precipitation and nozzle plugging with the sugarbeet micro-rate treatment. Most sulfonylurea herbicides, POST HPPD herbicides, Select, Status, and Sharpen are more soluble at high pH and efficacy can be greater when applied in water with pH above 7. Some adjuvants marketed for glyphosate reduce water pH. Low pH forces some salt formulated herbicides into the acid state that may not be soluble in the amount of water being sprayed and thus plug nozzles and reduce efficacy. Herbicides need to be in solution for absorption into plant foliage. See #23 on page 73 for additional information.

## 2. Total Dissolved Solids and Electrical Conductivity

The major mineral constituents in northern plains water and their ionic charges are:

Cations (+ charge) = calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and iron (Fe).

Anions (- charge) = sulfate (SO<sub>4</sub>), chloride (Cl), bicarbonate (HCO<sub>3</sub>), and nitrate (NO<sub>3</sub>).

The sum of all the minerals dissolved in a sample of water is normally referred to as the total dissolved solids (TDS). The higher the TDS, the more electric current water can conduct. Because of this characteristic, a measure of the electrical conductivity (EC) is often used to provide a quick, economical estimate of the TDS in water. If the EC is less than 500 umho/cm, water quality problems for herbicides are unlikely. Water EC values in ND and western U.S. run between 1000 and 2,500. Usually hardness and cation concentration, not TDS, are used to evaluate water quality on herbicide performance.

## 3. Hardness

Water hardness is caused by potassium, calcium, magnesium, and iron. These minerals can react and antagonize most all POST herbicides registered. Almost all POST herbicides are weak acid herbicides and can ionize (separate into neutral, + and - molecules) in acidic pH. Negative charged molecules can bind with cationic minerals resulting in antagonism. The ester formulations of growth regulator herbicides are oil soluble and do not react directly with the salts in the water. However, these oil type liquid herbicide formulations include an emulsifier to mix with water. Sometimes these emulsifiers when mixed in water with salts cause an oil-like scum or precipitate in the spray water reducing efficacy and plugging nozzles. Refer to pages 118 to 125 for a list amine or ester herbicide formulations.

Sodium contributes to water hardness but functions to soften water similar to home water softener systems. Hardness levels are reported in mg/L (ppm) of calcium carbonate (CaCO<sub>3</sub>). Hardness values are calculated by adding meq/L of Ca and Mg then multiplying by 50. Hardness of individual cations can be confusing because they can be reported as milliequivalents/L (meq/L), milligrams per liter (mg/L), parts per million (ppm), or grains per U.S. gallon (gpg). The mg/L and ppm are considered equal, and 1 grain per gallon is equal to 17.1 mg/L or ppm.

To convert meq/L to ppm, multiply meq/L x atomic number of the atom: K meq/L x 39.102, Na x 22.991, Mg x 12.156, Ca x 20.04. Water hardness values in MT, ND, and MN run between 0 and 2,500 ppm. There are variations in water hardness classifications but the following scale can be used:

Soft = <75 ppm

Mod. hard = 75 – 150 ppm  
Hard = 150 – 300 ppm  
Very hard = > 300 ppm

The amount of AMS needed to overcome antagonistic ions can be calculated as follows:

$Lbs\ AMS/100\ gal = (0.002 \times ppm\ K) + (0.005 \times ppm\ Na) + (0.009 \times ppm\ Ca) + (0.014 \times ppm\ Mg) + (0.042 \times ppm\ Fe)$ .

This does not account for antagonistic minerals on the leaf surface on some species like lambsquarters, sunflower, and velvetleaf which may require additional AMS. Apply AMS at 8.5 lbs/100 gallons of water unless water hardness requires more.

## 4. Sodium Absorption Ratio

Water high in sodium, when added to clay soils, may have a detrimental effect. Excess sodium will attach to clay particles and displace other ions, namely chloride and sulfide. A high SAR may indicate a limited ability for plants to extract water from the soil. The adjusted SAR has reference to bicarbonates. Some water in the northern plains is very high in bicarbonates, which increases the SAR problem. Water quality standards for SAR are as follows:

Excellent = <3  
Good = 3 – 5  
Permissible = 5 – 10  
Doubtful = 10 – 15  
Unsuitable = >15

## 5. Residual Sodium Carbonate

Values greater than 0 increase the sodium hazard.

## 6. Bicarbonates

Since bicarbonate is anionic (-) it is always associated with a cation (+) like sodium or calcium to make sodium or calcium bicarbonate in ground water. The corresponding cation (Ca, Na) may have a greater role in herbicide antagonism than the bicarbonate. High sodium and sodium bicarbonate antagonism of herbicides is usually overcome by ammonia type adjuvants. Small amounts of antagonistic salts do not appear to reduce herbicide efficacy with full use rates. This is because the use rate was established for efficacy using various waters. However in principle to optimize herbicide efficacy, any amount of antagonistic salts will have some negative effect and to optimize efficacy for all conditions always apply AMS to overcome even low amounts of antagonistic salt.

Water with high bicarbonate levels may have low levels of other anions like chloride and sulfate. Calcium chloride is also antagonistic and spray water pH should be below 7. Bicarbonate levels greater than 500 ppm may reduce herbicide efficacy of Achieve, Poast, Select, MCPA amine, and 2,4-D amine. When using water with more than 500 ppm bicarbonates the high rate of these herbicides should be used and applied at the most susceptible weed stage for efficacy. Bicarbonate also increases water pH and high bicarbonate levels may also be associated with high water pH (See #1 above). Water bicarbonate levels in MT, ND, and MN range from 200 to 1,000 ppm.

Analysis of spray water sources can determine water quality effects on herbicide efficacy.

Water samples can be tested at:

USPS: NDSU Dept 7680, Fargo, ND 58108-6050,  
UPS and Physical Address: NDSU Soil and Water Laboratory,  
Waldron Hall 202, 1360 Bolley Dr. NDSU, Fargo, ND 58102.  
701 231-7864.