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PAM CONFORMATION EFFECTS ON FURROW EROSION MITIGATION EFFICACY

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Water soluble polyacrylamides (PAM) have been used in laboratory studies to maintain the structure and permeability of soils subjected to artificial rainfall *(Levy et al., 1991; Shainberg et al., 1990)*. In a field study, Mitchell (1986) increased furrow infiltration into a clayey soil by 30-57% during the first 4 hr of an irrigation by applying 150 g m^{-3} (150 ppm) PAM to the irrigation water during inflow. An initial small application of anionic polyacrylamide to irrigation water nearly eliminated furrow sediment loss on Portneuf silt loam *(Lentz et al.,1992; Sojka and Lentz,1993)*. Application of 10 g m^{-3} (10 ppm) PAM (per unit of water) during furrow advance reduced total sediment loss from treated furrows by 94% and increased net infiltration 15% *(Lentz and Sojka, 1994a)*.

PAM's furrow erosion mitigation and infiltration maintenance effects result largely from its soil aggregate stabilizing *(Terry and Nelson, 1986)* and sediment flocculating *(Aly and Letey, 1988)* characteristics. PAM binds to soil particles in a thin layer at the soil aggregate surface and increases the cohesive forces that prevent aggregate breakdown. This helps surface soil resist the shear forces exerted by flowing water, and decreases the rate of soil removal along the wetted furrow perimeter. The large PAM molecules also bind to, and bridge clay and silt particles suspended in the furrow stream. The resulting flocculating and coagulating action produces larger soil masses, and increases the average aggregate size of particles transported in the flow. This reduces the transport capacity of the furrow stream and further decreases the erosion rate in the furrows.

PAM's influence on furrow infiltration probably results from its impact on sediment aggregation and, hence surface-seal formation *(Lentz, 1995)*. Overland flow applies shear forces to the soil surface which causes particle detachment and movement. As the water infiltrates the soil, dispersed flow-suspended sediments enter and clog soil pores at the furrow surface *(Shainberg and Singer, 1985)*. This produces a thin depositional layer, or seal *(Segeren and Trout, 1991)*. The seal conductivity values of the Portneuf silt loam reached values 0.1 to 8% of the conductivity of the underlying soil *(Segeren and Trout, 1991)*. In PAM-treated furrows, dispersed sediments flocculate and form more massive aggregates. These aggregates settle or are carried toward the furrow bottom by infiltrating water. These deposited aggregates are less able to plug soil pores than the dispersed silts and clays typically present in untreated furrow streams. Hence, the PAM-treated depositional layer is more permeable and supports a higher infiltration rate. Ross et al.(1996) have shown that PAM stabilizes surface soil pore geometry and increases unsaturated infiltration, compared to untreated furrows.

This suggests that it is PAM's soil-binding or particle-linking properties that allows the polymer to affect irrigated furrows so remarkably. It follows that those factors influencing PAM adsorption on soil particles may also affect PAM's potency in irrigated furrows.

Polymer adsorption on soils is a function of soil, polymer, and solvent (water) characteristics *(Wallace et al., 1986; Aly and Letey, 1988)*. An important PAM characteristic that partially determines how dissolved PAM interacts with soil is its conformation, ie. its shape and physical volume. For example, adsorption of PAM molecules having compact forms in aqueous solution is greater than for larger, less dense molecules. Increasing its charge density or molecular weight increases the size of the dissolved molecule, which decreases its adsorption *(Lakatos et al., 1981)*. PAM charge type can affect its conformation upon adsorption: e.g. cationic PAMs adopt a flat configuration on the predominantly negatively-charged soil particles, while adsorbed anionic PAMs are less tightly bonded to the soil surface and their unattached polymer loops project into the solvent *(Lyklema and Gleer, 1987)*. The presence of projecting polymer loops and tails would increase bridging opportunities between treated soil particles *(Gregory, 1989)*.

These conformational influences can be further modified by specific soil-particle/polymer or polymer/solvent interactions. For example, increasing the salt concentration in the solvent (water) causes charged-PAM molecules to contract, while neutral PAM's are unaffected *(Tam and Tiu, 1993)*.

Adsorption of PAM on clay minerals varies with mineral, polymer charge type and density. For montmorillonite, Aly and Letey (1988) reported the general order of adsorption to be: cationic > neutral > anionic. As charge density of cationic polymers increased, adsorption increased; but, as charge density of anionic PAM increased, adsorption on montmorillonite decreased *(Aly and Letey, 1988)*. Adsorption of PAM on whole soils vary because they are comprised of several mineral constituents. For a soil with a clay mineral suite dominated by mica, vermiculite, and kaolinite, the order of anionic polymer adsorption was: medium > high > low charge density *(Malik and Letey, 1991; Nadler and Letey, 1989)*. Nadler and Letey (1989) also found that organic matter decreased anionic polymer adsorption on soils, apparently by blocking potential adsorption sites.

The relationship between a polymer's adsorption characteristics and its soil flocculating abilities is not entirely clear. Aly and Letey (1988) found that the flocculating capacity of polymers was positively correlated to polymer adsorption. In contrast, Helalia and Letey (1988) reported the opposite finding. Adsorption of very-low-charge-density anionic PAM on Arlington soil was less than that of medium-charge-density anionic PAM, yet the very-low-charge anionic polymer proved to be more effective as a soil flocculating and aggregate stabilizing agent *(Nadler and Letey, 1989)*.

Polymer molecular weight influences adsorption and flocculation processes. In general, as the molecular weight increases, polymer adsorption increases *(Lee and Somasundaran, 1989)*. The relation between molecular weight and flocculation is less generalizable because the polymer molecular weight at which maximum flocculation occurs differs depending on the polymer and adsorbent *(LaMer and Healy, 1963)*; however, polymer activity often increases with increasing molecular weight.

The preceding discussion reveals the complex nature of polymer-soil interactions. We tested the hypothesis that polymer conformation influences PAM's ability to reduce furrow sediment-loss and maintain infiltration during surface irrigation. The experiments focused on factors that strongly influence polymer conformation. PAM charge type and density, and molecular weight.

Table 1. Treatment and product codes, and properties of polyacrylamides employed in the initial study.

Treatment Code	SUPERFLOC Designation	Charge Type	Charge Density (mole %)	Molecular Weight (Mg mol^{-1})
A35	835A	Anionic	35	15
A18	836a	Anionic	18	15
A7	837A	Anionic	7	15
Neutral	905N	Neutral	0	15
C10	492C	Cationic	10	6
C20	494C	Cationic	20	6

Table 2. Time, Furrow Conditions, and Treatment Rates for Each Irrigation in the initial study.

Irrigation Number	Month/day (1992)	Furrow Condition[†]	PAM application rate[‡] (conc., initial and supplemental)
1	6/4	New	10 g m^{-3}, 30 min. initial + interm.
2	6/18	Repeat	0
3	7/15[§]	New	10 g m^{-3}, 30 min. initial + interm.
4	7/29	Repeat	0
5	8/12	Repeat	10 g m^{-3}, 30 min. initial + interm.
6	8/19	Repeat	10 g m^{-3}, 30 min. initial + interm.
7	8/26	Repeat	10 g m^{-3}, full advance (~60 min.)

[†] Furrows were formed on June 1, and cultivated and reformed on July 10. Repeat furrows were undisturbed since the last irrigation.

[‡] Initial application began when flow commenced. Supplemental, intermittent applications (5 g m-3 PAM for 10 min) were made at 4 and 8 hrs. into irrigation.

[§] Acrolein (moss herbicide) present in irrigation water.

Methods and Materials

The study area was a 0.6 ha (1.5 ac) field located near Kimberly, Idaho; the soil was the highly erodible Portneuf silt loam (coarse-silty, mixed, mesic, Durixerollic Calciorthid); and slope was 1.5%. An initial study was conducted in 1992 on a conventionally prepared and planted field of silage corn (*Zea mays L.*). The field was disked after the previous season's corn harvest. In spring, the seedbed was prepared with disk and roller-harrow; corn was planted on 76 cm (30 in.) rows. A second study in 1995 was done on the same field, similarly prepared, but planted to beans (*Phaseolus vulgaris*) on 0.56 m (22 in.) rows. Snake River water was used for irrigation; average electrical conductivity is 0.5 dS m^{-1}, and SAR is 0.6 *(Carter et al., 1973)*.

Only trafficked furrows were monitored to avoid infiltration differences between wheel-tracked and non-wheel-tracked furrows. Irrigation water was applied from individually regulated valves on gated pipe. Furrows were 175 meters (574 ft) long. Irrigations were 12 h in duration. Inflow rate was 23 L min^{-1} (6 gpm) during the initial advance of water (typically about 1 hr) and 15 L min^{-1} (4 gpm) for the remainder of the irrigation. Details of the irrigation inflow and runoff monitoring procedure were described by Lentz et al. (1992). The sediment content in 1-L runoff samples was measured using the Imhoff cone technique *(Sojka et al., 1992)*. Soil loss and infiltration were computed from field data with FUROFIGR, an analytical computer program *(Lentz and Sojka, 1994b)*.

Each study employed a randomized block design with three replications. In the first study, seven PAM treatments of different charge type and density were tested. An eighth treatment was the control (Table 1).The polymers employed were commercially available polyacrylamide (PAM) formulations, manufactured by CYTEC Industries (Wayne, NJ). The A18 PAM was identical to Superfloc A836, the moderately anionic PAM commonly used as a furrow-irrigation-erosion deterrent *(Lentz and Sojka, 1996)*. All had high molecular weights, but we were unable to obtain a set of polymers that were completely identical in this regard. Polymer characteristics and treatment codes are listed Table 1.

In the first study, PAM was applied at 10 g m^{-3} (10 ppm) during the initial 0.5 hr of each irrigation, ie. about 50% of the advance, then two additional 0.63 L applications of stock solution were applied over a 10 min period (~5 g m^{-3} or 5 ppm in furrow water) at 4 and 8 hrs into the irrigation ($IE_{10, 50\%}$). We expected that the reduced application rate would emphasize any potential differences in polymer performance. In the seventh irrigation, on repeat irrigated furrows, PAM was applied during the entire advance, with no episodic additions, ie. an $I_{10, 100\%}$ treatment. PAM treatment concentrations were achieved by metering an appropriate quantity of 1200 g m^{-3}, (1200 ppm) stock solution into irrigation water at each furrow head. Total PAM application was 0.26 kg ha^{-1} (0.23 lb ac^{-1}).

In the first study, both newly formed and previously irrigated and undisturbed (repeat) furrows were irrigated (Table 2). Irrigations 2 and 4 were not treated in order to observe potential residual impacts of a previous PAM application. Acrolein, a moss herbicide, was added to irrigation water by the canal district during much of the third irrigation. Data from this irrigation were excluded from the analysis because the furrow stream acrolein may have been high enough to differentially degrade injected PAMs *(Castor et al., 1981)*. The Duncan multiple comparison procedure examined sediment-loss mean separations ($P < 0.05$) for treatments in each irrigation.

PAM molecular-weight effects were tested in a second field study. These results also helped determine how unequal molecular-weight treatments of the first study may have affected experimental results. The treatments included a control and three moderately anionic (18% hydrolysis) polyacrylamide treatments with molecular weights of: Low MW = 4-7 Mg mol^{-1}; Med MW = 12-15 Mg mol^{-1}, and High MW = 14-17 Mg mol^{-1}. The Med MW PAM was identical to the Superfloc 836a. PAM was applied as $I_{10, 100\%}$ treatments in all five irrigations in the second study. The total PAM application was about 1.1 kg ha^{-1} (1 lb ac^{-1}). Both new and repeat furrows were irrigated. Sediment-loss and net infiltration treatment means for new and repeat furrows were evaluated with Duncan's multiple comparison procedure ($P < 0.05$).

Table 3. Soil Loss and net infiltration of molecular weight treatments on newly formed furrows.

	Control	Low MW 4-7 Mg/mol	Med MW 12-15 Mg/mol	High MW 14-17 Mg/mol
Soil Loss (Mg/ha)	2.31_c*	0.75_b	0.33_a	0.39_{ab}
Infiltration (mm)	29_a	34_b	31_{ab}	30_{ab}

Table 4. Soil Loss and net infiltration of molecular weight treatments on repeat furrows.

	Control	Low MW 4-7 Mg/mol	Med MW 12-15 Mg/mol	High MW 14-17 Mg/mol
Soil Loss (Mg/ha)	1.32_b*	0.26_a	0.10_a	0.11_a
Infiltration (mm)	32_a	36_b	33_{ab}	32_a

Results and Discussion

Molecular Weight Effects. Because the molecular-weight study sheds light on the other experimental results, the PAM molecular-weight study will be discussed first. Compared to newly formed control furrows, the PAM-induced soil-loss-reduction for Med MW (Superfloc 836a) and High MW was about 87%, while that of the Low MW was 67% (Table 3). Low MW soil-losses were 1.3x those of Med MW. Soil losses among PAM treatments of repeat irrigated furrows were not significantly different (Table 4).

Standard deviations for soil-losses among replicated furrows tended to decrease as PAM molecular weight increased (data not shown). Thus, while High MW and Med MW treatments produced similar soil-loss reductions, the High MW performance was more consistent. This suggests that the dominant mechanisms providing furrow soil-loss control are sensitive to size and density of the dissolved PAM, and/or to a correlated property such as adsorption.

PAM molecular-weight had the opposite effect on furrow infiltration than it did on runoff sediment. The Low MW PAM was the only treatment that produced a greater net infiltration than the control (Tables 3 & 4). Net infiltration of the Low MW treatment exceeded that of the High MW for repeat irrigations, and trends in both irrigation types indicated an increase in net infiltration with decreasing PAM molecular weight (Tables 3 & 4). This implies that PAM affects furrow processes in at least two ways. One mechanism may exert a dominant influence on erosion processes, and the other may have a more pronounced impact on furrow infiltration. Obviously the two mechanisms respond differently to changes in PAM molecular weight and size.

One possible explanation for PAM's MW-effects on furrow infiltration is that it is a viscosity phenomenon. It is known that PAM-solution viscosity decreases with MW. A less viscous PAM solution would better penetrate and treat the furrow soil, better preserve soil pore structure, and produce a stronger soil interface, compared to more viscous, higher-MW PAMs. But this explanation also implies that the best soil-loss control would result from the use of Low MW, which was not the case. Because furrow infiltration is sensitive to depositional-seal permeability, we hypothesize that MW affects infiltration via its influence on the size, compactness, and strength of flocs or aggregates formed in the furrow stream. Herrington et al. (1993) reported that kaolinite flocs produced with PAM became more dense and compact as PAM MW increased. Larger, less dense flocs produced in the Low MW system would form a more porous depositional layer and be more easily transported downstream than those of higher-MW treatments. In contrast, the higher-MW PAMs produced smaller, denser aggregates that resisted transport, and formed a tighter depositional seal, with smaller pores and lower permeability than that of Low MW PAM treatments.

The Low-MW PAM probably had a more negative influence on furrow soil-loss processes than our data show. That is because the Low-MW PAM treatment simultaneously increased furrow infiltration. This reduced runoff and sediment transport capacity of the furrow-stream. Thus, while sediment concentration in runoff from Low MW furrows was about twice that in Med and High MW furrows, total soil loss of the Low MW was only 1.3x greater than the others.

The efficacy of the standard PAM formulation (Med-MW), was less than typical in this study during the first few irrigations (Table 3). We believe this occurred because early irrigations were conducted on somewhat wet soil profiles. Under such circumstances, infiltration, and hence the strength of the resulting soil-reinforcing PAM film, were partially inhibited. In later irrigations, dryer soil conditions produced 92% soil-loss reductions (Table 4).

Influence of Charge Type and Density. In the initial study, no significant treatment differences were observed for treated repeat-furrows in irrigations 5 & 6 (data not shown). Because of the large variability among furrow replications, we surmised that the $\mathrm{IE}_{10,50\%}$ treatment was not sufficient in these consolidated furrows to control sediment loss. An $I_{10,100\%}$ treatment was applied in the 7th irrigation in order to test this hypothesis. The $I_{10,100\%}$ treatments were more effective in the 7th irrigation, details are discussed later in the paper.

Table 5. Soil Loss and net infiltration of PAM $\mathrm{IE}_{10,50\%}$ charge-type treatments on newly formed furrows in the first treated irrigation.

	Control	Anionic	Neutral	Cationic
Soil Loss (Mg/ha)	2.14_c*	0.77_a	0.75_a	1.43_b
Infiltration (mm)	41_a	42_a	43_a	42_a

*within a given row, means followed by similar letters are not different ($P < 0.05$).

Table 6. Soil Loss and net infiltration of PAM $\mathrm{IE}_{10,100\%}$ charge-type treatments on repeat furrows in the seventh treated irrigation.

	Control	Anionic	Neutral	Cationic
Soil Loss (kg/ha)	500_{ab}*	240_a	460_{ab}	700_b
Infiltration (mm)	57_a	54_a	59_a	55_a

*within a given row, means followed by similar letters are not different ($P < 0.05$).

Charge Type. Polymer charge type had a significant influence on sediment losses from fresh and repeat furrows. In the first irrigation on fresh furrows, neutral or anionic PAMs were about twice as effective as cationic forms for reducing sediment loss (Table 5). The $\mathrm{IE}_{10,50\%}$ application used in the first irrigation was not sufficient to produce a residual soil protection in these furrows, i.e. carry-over effects from a treated irrigation to the following non-treated irrigation could not be differentiated (see Lentz et al. (1993) for data on untreated irrigation). Sediment loss from control furrows did not differ from PAM treated furrows in the seventh irrigation ($I_{10,100\%}$, repeat furrows); however, the soil-loss reduction produced by the anionic PAM was significantly greater than that of the cationic PAM (Table 6).

The inferior performance of cationic PAMs may have resulted, in part, from their lower molecular weights. Results from the second field study suggest, however, that reducing the molecular weight from 12-15 Mg mol^{-1} (Med MW) to 4-7 Mg mol^{-1}(Low MW) would only moderately reduce PAM's soil-stabilizing effects, and not cause a reversal in PAM's mode of action, as was seen for the cationic PAM in the seventh irrigation (Table 6). Thus, results suggest that anionic and neutral PAMs are inherently more effective for furrow irrigation management than cationic forms. The difference may be the result of conformational effects. The flat configuration of adsorbed cationic PAMs may permit formation of fewer interparticle linkages compared to the loose-tail and uncoiled configuration of adsorbed anionic and neutral PAMs. The interparticle linkages form the basis for PAM's soil-stregthening and flocculating capabilities. Anionic PAMs are especially favored for treatment of irrigation water because of their superior performance, but also because they are more environmentally friendly than neutral or cationic PAMs *(Barvenik, 1994)*.

Charge Density. Statistical differences between PAM charge-density treatments were not always demonstrated, but those that were observed, combined with apparent data trends suggest that irrigation-management efficacy of anionic-and cationic-PAMs increased with increasing charge density. Seven statistically validated differences were observed among soil-loss and net infiltation means. All but one supported the concept that increasing PAM charge density produced smaller furrow soil losses and/or greater net infiltration (Tables 7, 8 and 9). The one not supporting the notion was probably not representative (Table 8). The A35 soil-loss quantity in the second nontreated irrigation was inflated by a single furrow replicate value that was anomolously high. When this value was excluded, the average soil loss was only 0.23 Mg ha^{-1}, compared to 1.9 when the quantity was included in the mean. Furthermore, furrow soil-loss consistently trended lower, while net infiltration increased, in response to increased charge density.

The neutral PAM actually has a very small negative charge (<2%) associated with the molecule. Thus, it is not surprising that it produced soil-loss results more similar to the A7 PAM, than to the cationic PAMs (Tables 7, 8 and 9).

The neutral-PAM's influence on infiltration followed a different pattern than that for soil-loss. In the 2nd and 7th irrigations, neutral-PAM produced net infiltration values like those produced by the high-charge-density anionic PAMs, ie, it produced some of the higher net infiltration values in each irrigation. (Tables 8 & 9). This provided additional evidence that PAM influences furrow processes via at least two mechanisms. One mechanism primarily influences soil-loss, and the other dominatantly affects infiltration. A change in PAM's molecular properties influences these two mecanisms differently. The neutral PAM produces moderate soil-loss control, but trends in the data suggest that it does a better job maintaining furrow infiltration compared to anoinic or neutral PAMs. As indicated in the previous molecular weight discussion, the neutral PAM may produce flocs with different properties than anionic PAMs, and influence infiltration in that manner.

Conclusion

These investigations demonstrated that PAM molecular weight, charge type, and charge density, all affect the capacity of PAM to mitigate furrow-irrigation erosion and infiltration on Portneuf soils. These conformational parameters, however, influenced furrow erosion processes somewhat differently than they affected infiltration.

The order of effectiveness for soil-loss control was: anionic > neutral > cationic PAM, and for a given charge type, efficacy increased with increasing size of the dissolved PAM mol-

Table 7. Soil Loss and net infiltration of PAM $IE_{10,50*}$, charge density treatments on newly formed furrows in the first treated irrigation.

	Control	A35	A18	A7	Neutral	C10	C20	C30
Soil Loss (Mg/ha)	2.1$_c$*	0.67$_a$	0.87$_a$	0.77$_a$	0.75$_a$	1.9$_{bc}$	1.2$_a$	1.3$_{ab}$
Infiltration (mm)	41$_{ab}$	49$_c$	41$_{ab}$	43$_{abc}$	43$_{abc}$	39$_a$	42$_{abc}$	46$_{bc}$

*similar letters across rows indicate nonsignificant diferences ($P < 0.05$)

Table 8. Soil Loss and net infiltration of PAM $IE_{10,50\%}$ charge density treatments on repeat furrows in the second non-treated irrigation.

	Control	A35	A18	A7	Neutral	C10	C20	C30
Soil Loss (Mg/ha)	1.5ab$_c$*	1.9$_{bc}$‡ (0.23)	0.87$_a$	1.1$_{ac}$	1.3$_{ab}$	1.9$_{bc}$	2.5$_c$	1.2$_{ab}$
Infiltration (mm)	33$_a$	38$_a$	36$_a$	34$_a$	42$_a$	31$_a$	31$_a$	38$_a$

*similar letters across rows indicate nonsignificant diferences ($P < 0.05$)
‡This value is probably not representative. Soil loss from a single anomolously erosive furrow replicate contributed 88% of this soil loss mean. If the anomolous value was omitted, the mean soil loss from this treatment would be 0.23 Mg ha^{-1}.

Table 9. Soil Loss and net infiltration of PAM $IE_{10,50\%}$ charge density treatments on newly formed furrows in the seventh treated irrigation.

	Control	A35	A18	A7	Neutral	C10	C20	C30
Soil Loss (kg/ha)	98$_{bc}$*	24$_a$	26$_a$	92$_b$	90$_b$	150$_{cd}$	156$_{ad}$	108$_{bcd}$
Infiltration (mm)	57$_{bc}$	55$_{abc}$	60$_c$	48$_a$	59$_c$	55$_{bc}$	51$_{ab}$	57$_{bc}$

*similar letters across rows indicate nonsignificant diferences ($P < 0.05$)

ecule, ie. increasing charge density and/or molecular mass. The order of effectiveness for infiltration maintenance was Neutral > high-charge anionic/cationic > low-charge anionic/cationic-PAMs. For a given charge type, infiltration maintenance increased with decreasing PAM molecular weight. The response to changing molecular weight was the reverse of that observed for soil-loss control. Parameter effects were also interactive, ie. a change in molecular weight reduced aggregate stability and increased stream sediment content, but the impact on total soil loss was diminished by a simultaneous reduction in runoff.

Results imply that at least two types of PAM-soil interactions are involved, each having a primary impact on either erosion or infiltration processes. It is likely that these interactions determine the character of PAM's soil flocculation and aggregate stabililization activity in these furrow-irrigated soils. More study is needed to identify and understand the nature of these PAM-soil interactions. This knowledge will help scientists and industry develop and select the PAM treatments that optimize soil and water conservation for the wide range of irrigated agriculture scenarios.

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SCREENING OF POLYMERS TO DETERMINE THEIR POTENTIAL USE IN EROSION CONTROL ON CONSTRUCTION SITES

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The purpose of this research as a part of the urban component of the Lake Mendota watershed is to produce a practical and reliable erosion control alternative to the sediment delivery from new urban areas to be developed in the watershed. The use of soil erosion inhibitors are an innovative solution to the sediment entering the receiving water in watershed due to changes in the hydrology of the watershed due to changes in land use.

The major sources of sediment include: eroding agricultural lands; eroding streambank; erosion from developing urban areas: and sediment from established urban areas. The sediment moves to the receiving waters by rainfall runoff and snow melt. The result of urbanization in the Lake Mendota Priority Watershed will cause an excess of stormwater runoff delivered to the waterways due to the increase in efficiency in the delivery systems through pipes and channelized flow causing excessive stormwater flow.

Runoff from urbanizing areas is a major source of sediment when large areas of soil are exposed to the erosive powers of rainfall and concentrated flow. The consequences of inadequate construction site erosion control is catastrophic due to the large amounts of eroded soil deposited on streets, suspended solids in rivers and flowing waters and deposited in marshes and lakes.

The urbanization process of a watershed increases the percentage of impervious area. The increase in impervious areas impacts the stream hydrology due to the increase in runoff volume over a short period of time. The reduction in concentration time creates large increases in stream peak flow and flow volumes when compared to natural streams. These sudden increases above normal and decreases below normal during and after a rainstorm produce streams with high sediment load and streambank erosion which limit aquatic life and recreational uses.

Water soluble polymers, generally described as polyacrylamides (PAMs), appear to have a variety of beneficial soil amendment properties including minimization of water runoff, erosion and crusting, and stabilization of soil structure.

The objective of this evaluation was to determine the effects of anionic, cationic and nonionic polyacrylamides (water soluble polymers) on soil aggregation stability and rate of settling in free movement of soil particles. This report presents the evaluation of 22 polyacrylamides (polymers). Polymers were evaluated according to aggregate and settling times' criteria. The methods used for screening the polymers were: the wet Sieving Technique and the Sedimentation rate.

Literature Review

Soil physical characteristics like structure, texture, porosity, and water retention have been recognized as important in determining soil readability, infiltratability and runoff potential. Since the pioneering work of Duley (1939) many studies have demonstrated the significant influence of these factors on surface sealing which causes decreased infiltration, delayed or reduced plant emergence and increased erosion (*Rubin 1966, Segimer and Morin 1970, Callebaut et al. 1986, Ronkens et al. 1990. LeBissonnais 1970*). The structural sensitivity of soils and the iden-