7031-011 Brushy Creek

2009-2011, Final Report

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For

Watershed Improvement Review Board

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WIRB 7031-011 Upper Brushy Creek, 2009-2011

Final Report

Introduction: Brushy Creek (Water Body Number IA 04 RAC 0251_0) is a general use stream in the steeply rolling prairies ecoregion of Iowa (fig 1, 47e). The headwaters begin near the Missouri-Mississippi divide just west of Carroll and flows southeastward parallel to Des Moines lobe landform and the Middle Raccoon River. It discharges into the South Raccoon two miles southeast of Guthrie Center. High *E. coli* counts in Raccoon River at the Des Moines Water Works (DMWW) prompted an investigation of sources of *E. coli* in the Raccoon River. Counts progressively increased upstream through

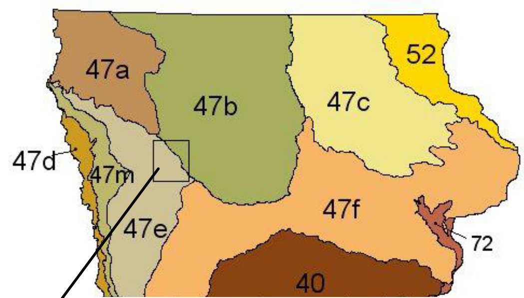
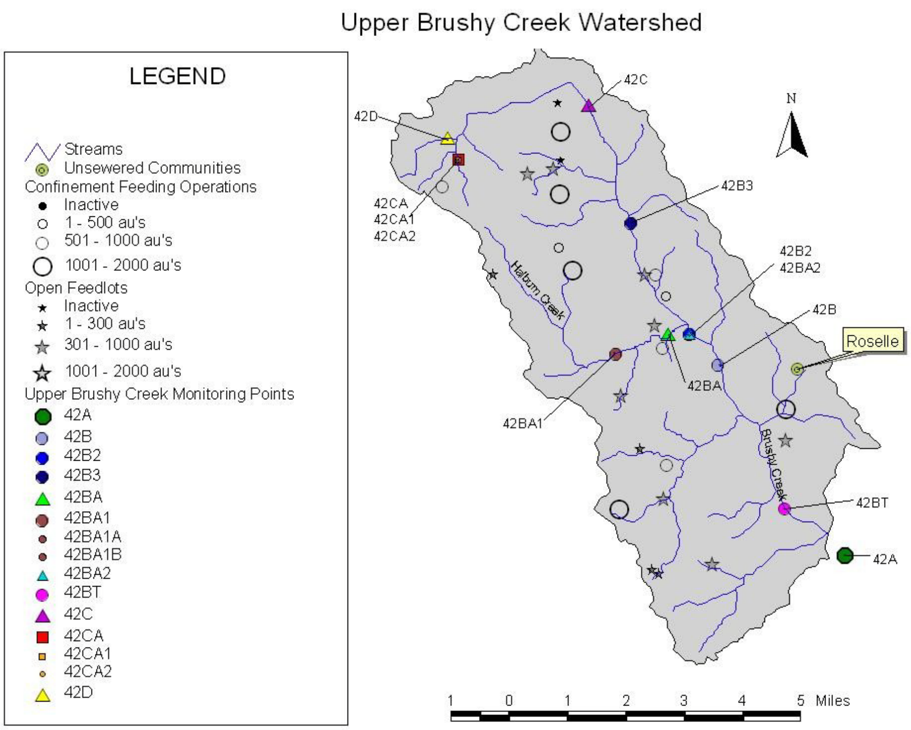


fig 1. Brushy Creek Watershed



the South Raccoon to Brushy Creek. Highest counts were found in upper Brushy Creek where a DNR investigation of a fish kill in 2005 led to legal action to install manure containment structures. Elevated nutrients in the same area demonstrated the need for a comprehensive management approach to this impairment. WIRB approved funding for a three year multi-partner project in upper Brushy above Dedham beginning 2009.

Project Goals: The overall goal of the project was to improve water quality in Brushy Creek in a manner beneficial to both producers and users of the stream. Specific elements of the goal were:

1. Work with producers to identify and implement sound nutrient and manure management practices
2. Evaluate effectiveness of management practices and make changes as needed
3. Demonstrate improvement in water quality through monitoring
4. Assess impact of untreated human waste
5. Develop community interest in protecting the watershed

The strategy to achieve these goals was multi-agency collaboration with local leadership and producers to develop a Watershed Improvement Association (WIA) to self govern watershed activities. Once formed the partnership role would shift toward technical support and facilitate activities as needed. However, no one within the watershed stepped forward to take leadership in the development of a WIA. Therefore implementation of WIRB objectives and leadership remained a collaborative effort of the partners with each providing roles consistent with their organization's mission. The natural resource conservation service (NRCS) used Environmental Quality Incentives Program (EQIP) and payment in kind (PIK) dollars toward manure containment structures and related activities. The Iowa Soybean Association (ISA) focused on sample collection and nutrient management through soil testing and fall stalk nitrogen testing. The co-ops developed communication materials and the Carroll County Soil and Water Conservation District helped distribute the information. DMWW coordinated and administrated the project, performed sample analyses and provided project reports. The Carroll and Crawford County Environmental Health department (CCEH) and IDNR also contributed substantial support to the project. The CCEH facilitated the installation of approved septic systems for all residents of Roselle. The IDNR provided technical support, facilitation, and coordination support to the total project.

WIRB provided synergy by integrating functions of the partners and coordinating activities. This became critical to the success of the project as a self governing WIA did not materialize. Though failure to develop a WIA was disappointing to the partners, it was not due to lack of producer interest in the WIRB project. Producers contributed most of the dollars toward project goals. Meanwhile partners saw WIRB as an opportunity to be more effective in their own respective missions and responsibilities so contributed additional in-kind resources to the project and related goals. This resulted in several amendments to the original WIRB budget (table 1) to better integrate WIRB resources with other projects in the watershed.

Financial Accounting:

Table 1 WIRB Budget

Grant Agreement Budget Line Item	Total Funds Approved—Original	Total Funds Approved—Amended	Total Funds Expended	Available Funds
Automated Samplers	9000	9000	9000	
Data analysis and report writing	9000	9000	9673	(673)
CNMP technical Assistance	54000			
Project coordination	15000	15000	16500	(1500)
Soil Sampling	10020	3850	3850	
Stalk Nitrate Test	19200	27370	28000	(630)
Water Quality Monitoring	90280	90280	88133	129
Manure control structures		34330	34330	
Bioreactors		17670	17014	656

The NRCS committed $54000 in-kind resources toward CNMP technical assistance. WIRB then transferred those budgeted funds to bioreactors. Two bioreactors were installed but producers showed little interest in additional bioreactors. WIRB approved a request to transfer $34330 from bioreactors to manure control structures. The third amendment transferred $4420 from soil testing to the stalk nitrate test. The final amendment transferred remaining dollars in the soil testing budget ($1750) and bioreactors ($2000) to stalk nitrate testing. Producers who developed comprehensive nutrient management plans (CNMPs) through the NRCS self-funded the soil testing leaving money available for stalk testing. The two bioreactors cost less than budgeted so remaining dollars were also applied to stalk testing. Total WIRB expenditures matched available funds.

The total Brushy Creek budget was considerable greater. Partners committed $226600 In-Kind dollars giving a total budget of $433100 (Table 2)

Table 2 Brushy Creek Project Budget

Expense Categories	Cost	WIRB Revenue	Partner Revenue
Automated Samplers	12000	9000	3000
Sampling and Monitoring	107280	90280	17000
Watershed Meetings	12000		12000
Agronomic Support	3000		3000
Manure Control Structures	87600		87600
Comprehensive Nutrient Management plans	66000		66000
Communication materials	6000		6000
Web page creation and support	20000		20000
Data Analysis and Report Writing	18000	9000	9000
NRCS technical assistance	54000	54000	
Project coordination	15000	15000	
Soil nutrient sampling and monitoring	13020	10020	3000
Stalk Nitrogen Testing	19200	19200	
Total	**433100**	**206500**	**226600**

Actual contributions dedicated to the WIRB project was a little less than budgeted (Table 3). This accounting however is subject to interpretation. There were several projects and funding sources in the watershed with overlapping activities and objectives with WIRB. For examples, CNMPs are included in table 3 even though it was funded by EQIP because the approved project budget specifically included it. Expenses and EQIP funding for the additional manure control structures not approved by WIRB are not included. The NRCS provided technical assistance to the producers for a wide variety of WIRB activities such as stalk testing, soil sampling, CNMPs, manure containment structures, but also soil erosion control structures (terraces, waterways, and filter strips) which advanced WIRB objectives. Assigning these activities to specific projects or funding sources proved difficult at best. Therefore all NRCS meetings with the producers were aggregated as technical assistance to the WIRB project. Also not included are producer expenses for additional manure settling basins designed and constructed by the producers. The cost (and benefit) of these is unknown as producers did not report on the design or expenses. Table 3 shows activities charged to the WIRB project for accounting purposes. It must be understood that this is but a subset of total activities and costs within the Brushy Creek Watershed which improved water quality in Brushy Creek.

Table 3. WIRB Project Budget Actual

WIRB Expense categories	cost	WIRB revenue	WIRB cost share agr	Partner revenue	Producer contribution
Equipment Rental	15000	9000	75%	6000	
Salary/Benefits (reports)	18/673	9673	50%	9000	
CNMPs	31730			31730	
Salary/Benefits (coordination)	23500	16500	176 hrs	7000	
Soil Sampling	7850	3850	77%		4000
Stalk Nitrate Testing	28000	28000	59 fields		
Water Quality Monitoring	102133	88133	85%	14000	
Watershed Meetings	14895			14895	
Communication Materials	20643			20643	
Web Page Creation/Support	4509			4509	
Manure Control Structures	67036	34330			32706
Agronomic Support	11977			11977	
Bioreactor	17014	17014			
Technical Assistance	40453			40453	
WIRB budget actual	403413	206500		160207	36706

Activities and costs from related projects that contributed to improved water quality in Brushy Creek are present in table 4.

Table 4 Watershed Improvement Structures Funded by other Sources

Watershed Improvement Activity	No.	Revenue Source			
		EQIP	CRP	State	Producer
Manure Containment Structures	3	24904			33874
Waste Storage Bldgs (confinement)	3	150000			550000
Waterways	58	98146	109548	8135	114935
Filter Strips	3		855	1900	900
Terraces	6	10563		9222	20832
CNMP *	7	31730		2300	2300
Total WIRB related expenses	$1170144	315343	110403	21557	722841

*CNMP was included in the original WIRB Project Budget. Grand total: $1573557

Watershed funding facilitated the development of best management practices (BMPs) for both manure runoff control and nutrient management. Bacteria reduction goals depended primarily on structural BMPs while nutrient reduction goals depended more on implementing precision agriculture practices, the exception being the construction of two bioreactors for nitrate removal. Structural measures have the advantage of providing a known benefit once installed while management practices are voluntary and inherently less certain. The potential reduction in nitrogen application in the watershed through precision agricultural practices cannot be known before soil and stalk testing is performed. Nitrate goals are based on the assumption that producers are applying more nitrogen than necessary so that reducing application on those fields will result in less leakage to the stream. However, where fields test low in nitrogen, producers will increase nitrogen application to increase yields. The extent to which producers follow recommended nitrogen application rates is uncertain. There is no obligation or project requirement to do so. Nonetheless, it provides the greatest potential for reduction in nitrogen application and loss to the stream. Much depends on technical support and education as to how to use this information to reduce cost of operations. The observation of high bacteria counts and elevated phosphorus also indicated the need to integrate manure management with nutrient assessment.

Environmental accounting:

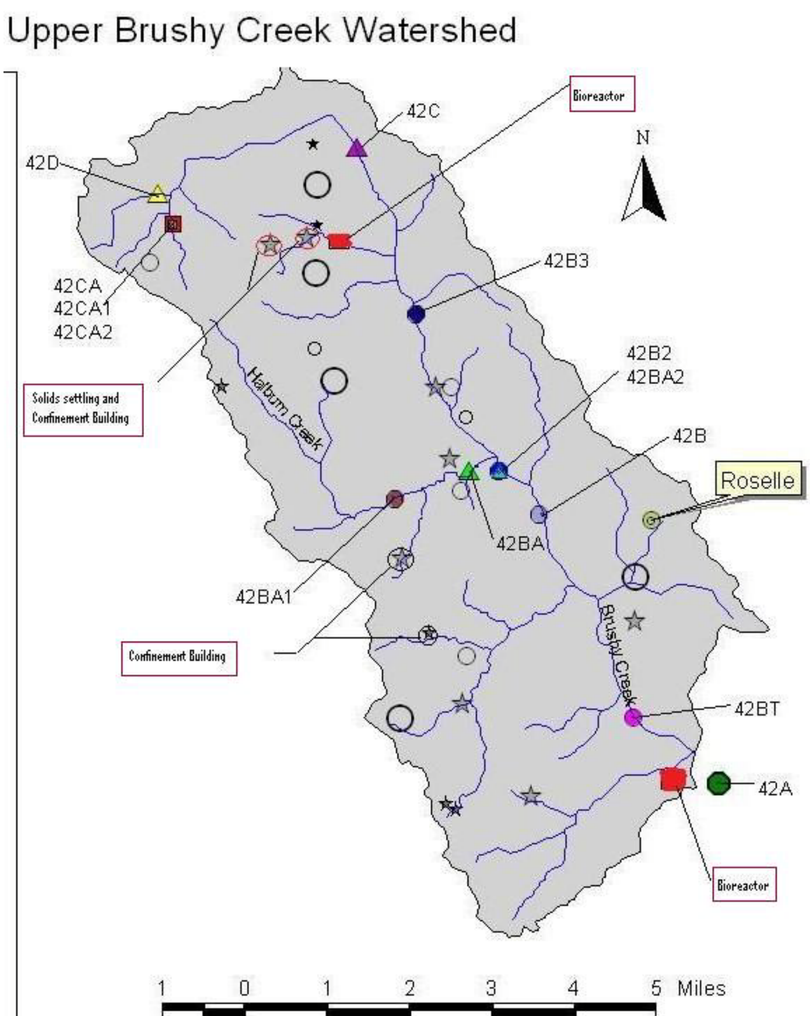


fig 2. Location of bioreactors & manure containment structures

All WIRB approved environmental practices were accomplished and met BMP criteria. The two WIRB financed manure control structures and bioreactors used NRCS design criteria and were certified upon completion. Three manure control structures were funded through EQIP. The location of these structures is linked to the red boxes in fig 2.

Seven CNMPs were developed using EQIP dollars. Septic systems were installed for all residents of Roselle and certified by Carroll and Crawford County Environmental Health. Since this was a collaborative effort, all structures and practices which promoted WIRB objectives and met performance design criteria are included as accomplishments in table 5. Structures not certified by an appropriate agency are not included in this listing.

Table 5: Watershed Practices and Activities Summary

Practices or Activity	Approved Application goal	Accomplishments	% Completion
Manure control structures [1]	2	5	100
Waste storage buildings		5	100
Waterways		58	100
Filter strips		3	100
Terraces		6	100
CNMPs		7	100
Septic system Installation		Systems installed	100
Bioreactors	2	2	100
Soil Sampling	Up to 14 fields	14	100
Stalk Nitrate Test	59 fields, 5900 ac	72 fields, 5013 ac	100
Water samples [2]	1326	1261	100
No. of Analyses [2]	3114	4791	100

1. All producers installed at least manure settling basins
2. Number of samples budgeted, additional analyses performed on each sample. Accomplishment criteria based on 85% cost share

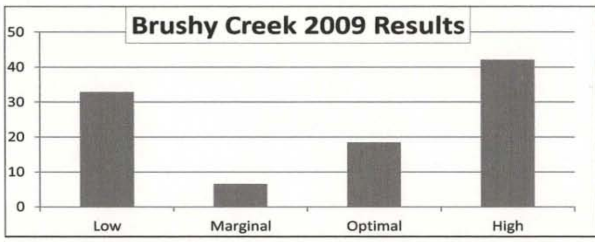
The extent to which each of these BMPs improved water quality in Brushy Creek is difficult to demonstrate at best since this is not a controlled experiment. Transport of contaminants to the stream is greatly influenced by timing of management activities and dynamics of weather and hydrologic conditions. What the water quality would have been without these BMPs is inherently uncertain. Therefore environmental benefits relies more on adherence to design and demonstrated benefits tested under controlled conditions than water monitoring. Nevertheless, an improvement in water quality to state and federal standards should be expected. WIRB water quality goals conform to Iowa requirements for a class A2, BWW-secondary contact fishable warm-water stream. The stated water quality goals of the project are:

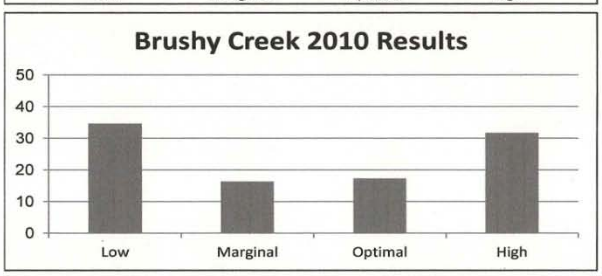
1. *E. coli* geomean counts of less than 630 organisms/100ml from March 15 to November 15 OR a sample maximum of 2880 counts/100ml.
2. An annual average nitrate-N concentrations to less than the drinking water standard of 10 mg/l and a spring time (April 1 through June 30) average less than 12 mg/l
3. Assess the presence and sources of emerging contaminants.

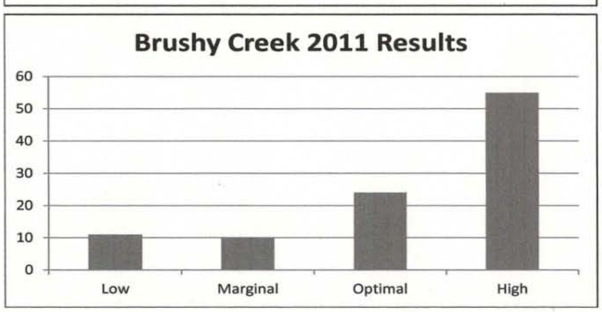
The emerging contaminant goal was to help assess the occurrence and impact of untreated human waste in Brushy Creek. The observation of cyanobacteria mats in upper Brushy Creek and its potential impact on the DMWW source water prompted additional analyses to better characterize runoff and groundwater contributions to the stream.

Nitrogen Management:

The primary strategy for reducing stream nitrate concentration was promotion and implementation of precision agriculture. Producers which developed CNMPs included soil testing to help manage nutrient applications. Producers which did not develop CNMPs generally preferred stalk testing for their nitrogen management tool. The number of fields that were stalk tested exceeded WIRB goals though acreage represented was slightly less. These fields account for approximately 5% of the watershed acres. The test results over the three year period were quite mixed and benefits difficult assess.







2009, 2010, 2011 Results

2009	No. of Fields	3 pt. Ave.	Ave. N Rate
NH3	6	4670	161
NH3 w/Manure	4	5487	325
UAN	2	852	138
UAN w/Manure	4	514	239
Manure-Swine	3	3673	245

2010	No. of Fields	3 pt. Ave.	Ave. N Rate
NH3	6	2015	185
NH3 w/Swine	4	3568	294
UAN	4	1063	152
Swine/NH3	6	2699	237
Swine	6	2244	246

2011	No. of Fields	3 pt. Ave.	Ave. N Rate
NH3	9	3850	197
NH3/beef	3	2559	276
UAN	4	2299	139
UAN/beef	1	4380	205
Swine/NH3	2	2647	188
Swine	6	4381	222

The final year showed a reduction in the number of low nitrogen fields and an upswing in the number of fields in the optimum to high categories. These results suggest that producers may have responded more to the low results by increasing nitrogen application than reducing nitrogen application in fields with elevated stalk nitrate. Furthermore 2010 was quite wet so producers applied additional fertilizer in 2011 anticipating nitrogen loss due to wet soil conditions. Perhaps the primary benefit of the this testing is that it got producers thinking more about nutrient management.

The two bioreactors probably contributed little to any nitrate reduction during this period. The first reactor installed in 2009 had little water movement through the reactor so load reduction was minimal. Work continues on determining the cause of the flow restriction. The second bioreactor was installed during the dry fall of 2011 when there was no tile flow and therefore no flow through the reactor.

Water Monitoring

Fig 3 outlines the WIRB area and the locations of the eight (8) sample sites. Samples were collected on a weekly basis except when ice was too thick. All sites are on Brushy Creek except for 42BA on the Halbur Creek tributary. Water flows downstream from site 42C to site 43. An automated ISCO event sampler was stationed near 42B2 and another just upstream of 42A. They were programmed to trigger when water reached a set stage height. Each sampler contained 24 bottles. Rainfall amounts, time of collection and stage height for each sample was recorded on a data logger and downloaded onto an excel spreadsheet.

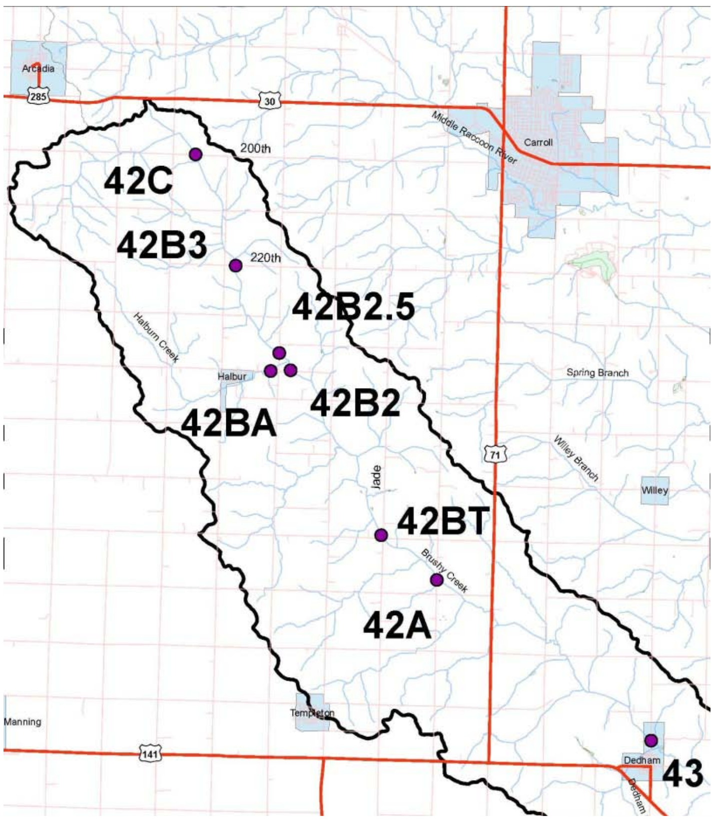
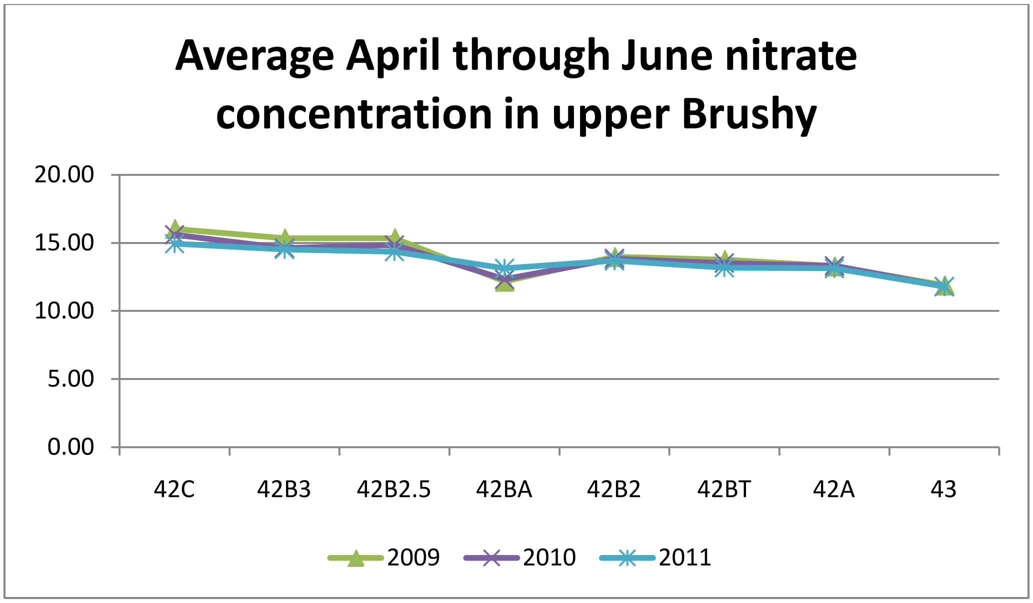


fig 3. WIRB watershed boundary and sample sites.

Results:

There was essentially no change in average nitrate concentrations at any site during the three years of the WIRB project. Nitrate concentrations were highest near the headwaters and decreased downstream. The spring season average goal of 12 mg/l was only met at Site 43 (11.8 mg/l). Nitrate concentrations remained remarkably through the entire monitoring period so that the annual averages was very little different from the spring time averages. The annual average goal of 10 mg/l was not met for any year at any site during the WIRB project (fig 4). There was a slight improvement during the three years of the project.



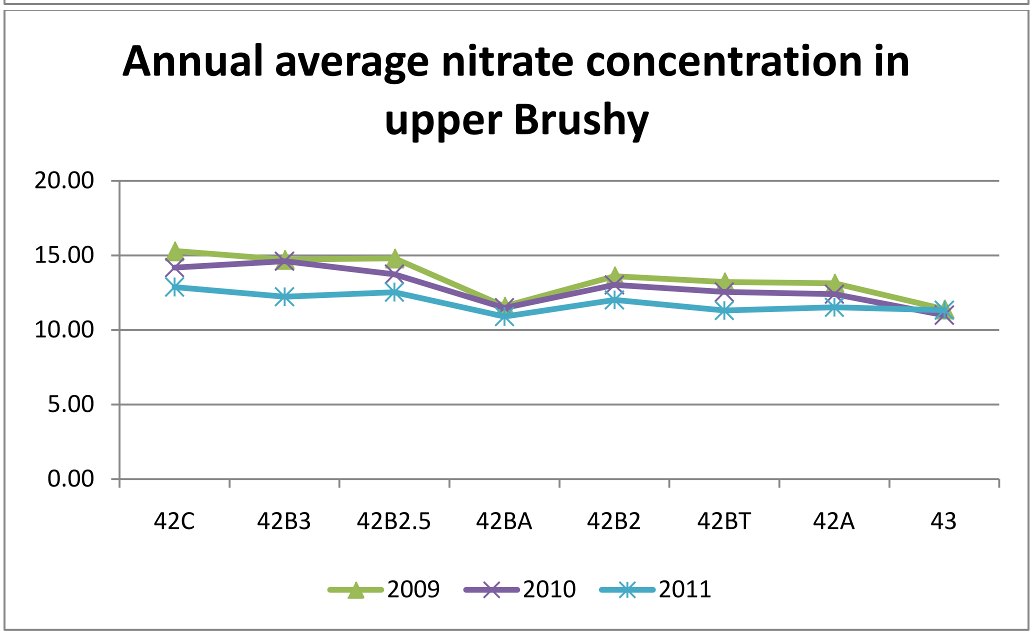


fig 4. Average nitrate concentrations in upper Brushy Creek

The decrease in annual average appears to be more a function of weather and conditions during sampling (springtime snowmelt and a dry fall) than nitrogen management (fig 5). This is consistent with the observation there was no reduction in the number of fields testing high in stalk nitrate.

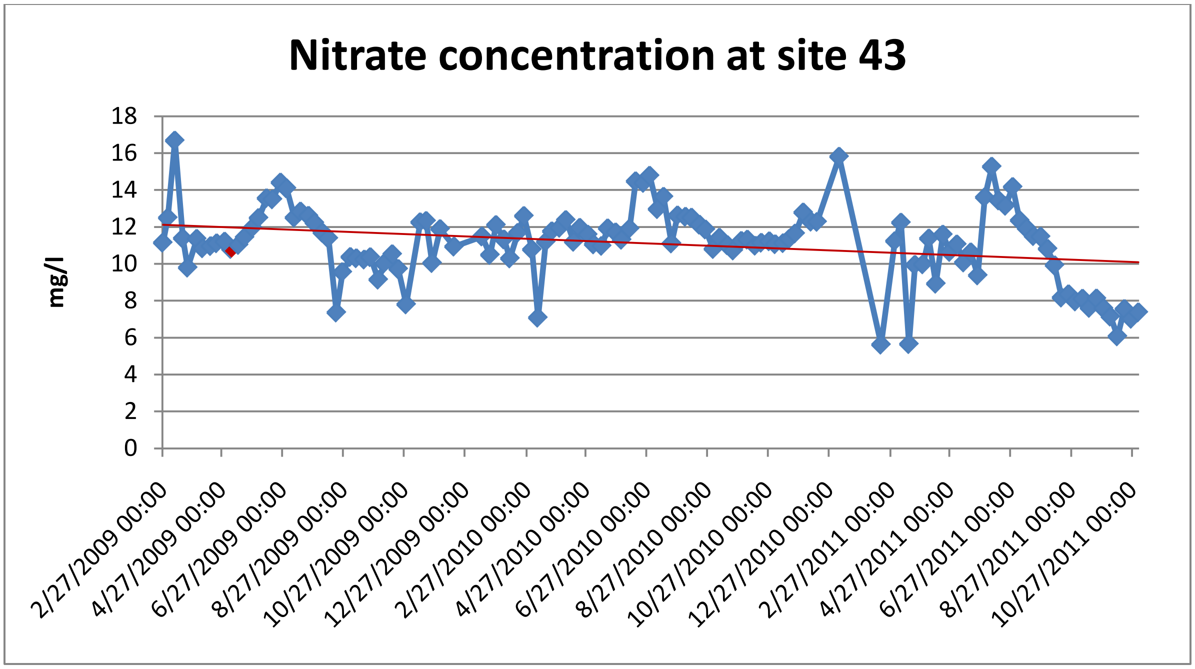


fig 5. Nitrate-N concentration at site 43 through duration of project

E. coli goals however were much more positive. Counts dropped substantially for all sites (fig 6) during each year of the project. The goal of 630 organisms/100ml between March 15 and November 15 was achieved in five (5) of the eight sites during the last year of WIRB. This is not simply the result of more samples with low counts, the whole count distribution shifted downward.

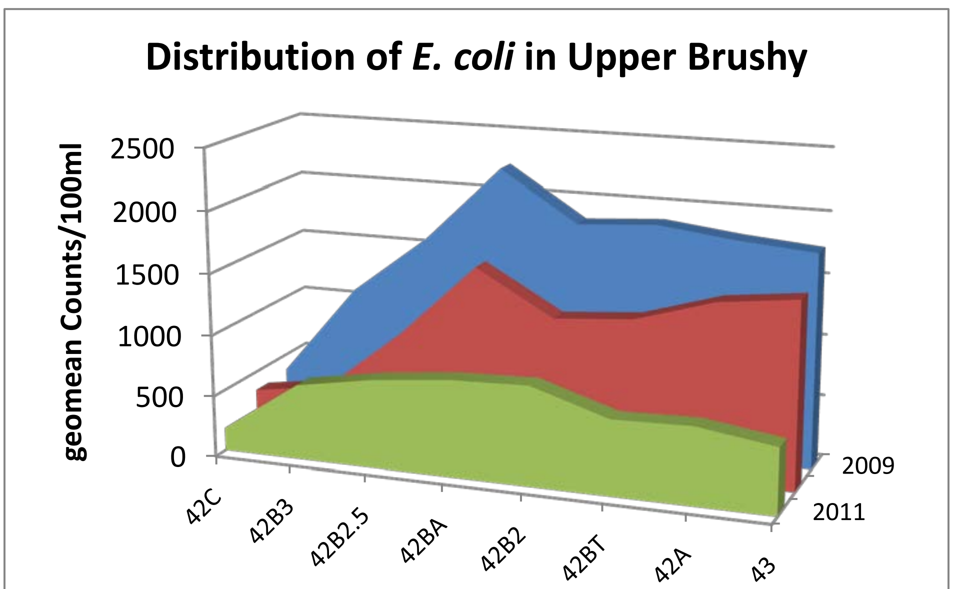
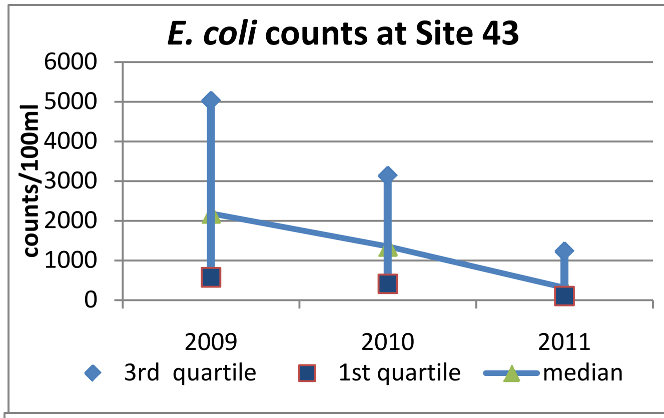
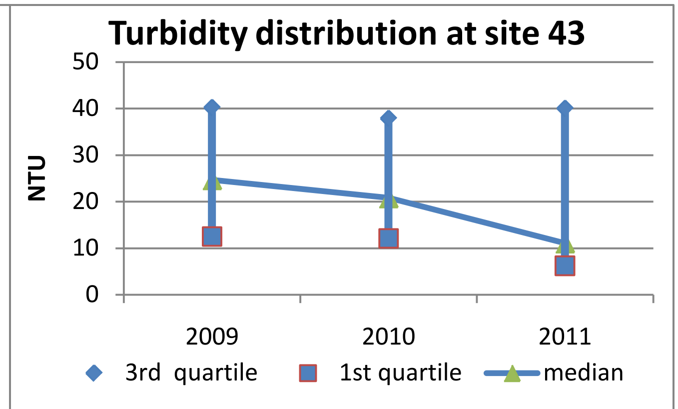
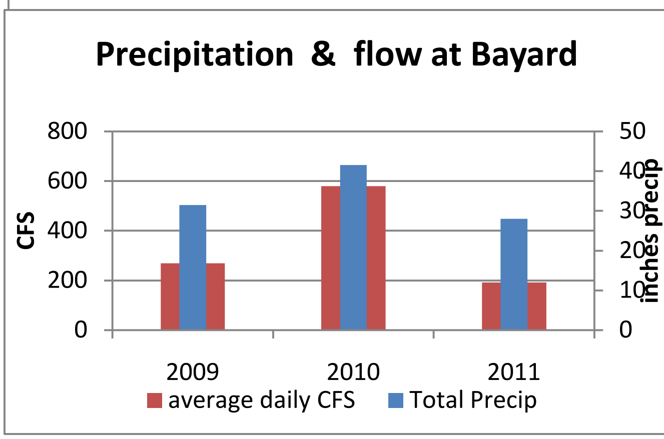


fig 6. Change in annual counts within upper Brushy Creek

This downward shift is particularly noteworthy for 2010 where rainfall amounts and flow were well above average. This suggests a decrease in fecal runoff during rain events (third quartile) with less contamination of the sediments to slough *E. coli* during low flow (first quartile). The counts distribution was similar for all sites. The decrease in turbidity (especially for 2010) also gives evidence that the erosion control practices were reducing sediment and fecal runoff. Particularly noteworthy, however, is the decrease in counts relative to turbidity.







Assuming turbidity to be an indicator of sediment runoff and transport, a decrease in counts relative to turbidity indicates a decrease in fecal runoff with the sediment. Its decrease is especially noteworthy for higher turbidity conditions (3^{rd} quartile) when the potential transport (loading) is much greater. The reduction in third quartile counts suggests less fecal runoff with sediment transport to and within the stream while lower first quartile counts (base flow) suggests less available fecal matter in stream sediments to slough into the stream during low flow.

Event sampling helps characterize contaminant runoff characteristics such relationship of the various contaminants to each other and how they move from the landscape to the stream. Its use in demonstrating a reduction in contaminant runoff is very limited. Rainfall characteristics such as amount and intensity are much more variable than conditions during routine sampling. Counts during runoff events routinely exceeded anticipated counts and therefore exceeded the maximum count capacity of the method (240000 /100ml) during all three years of monitoring. Nitrate data indicated timing and magnitude of runoff water to better characterize overland transport capacity.

The use of two event samplers also helped identify approximate source locations of contaminants by comparing location of the contaminant of the two hydrographs. These samplers showed so inherent limitations of manure control structures that have not been fully developed. These structures have two important components, manure containment structure and a grass filter strip. The manure containment structure limits runoff of solids unto a grass filter to preventing matting so that the filter strips can capture fine particulates including bacteria. Very few (if any) filter strips were established during WIRB which greatly limited their effectiveness in controlling *E. coli* runoff. Neither will soluble substances, such as ammonia, be removed. The samplers did show a lag time for ammonia where it does not move until the manure is hydrated (fig 6). It is unlikely that filter strips would limit ammonia transport. Frequent removal of manure for the lots and application onto fields may be needed to limit ammonia runoff.

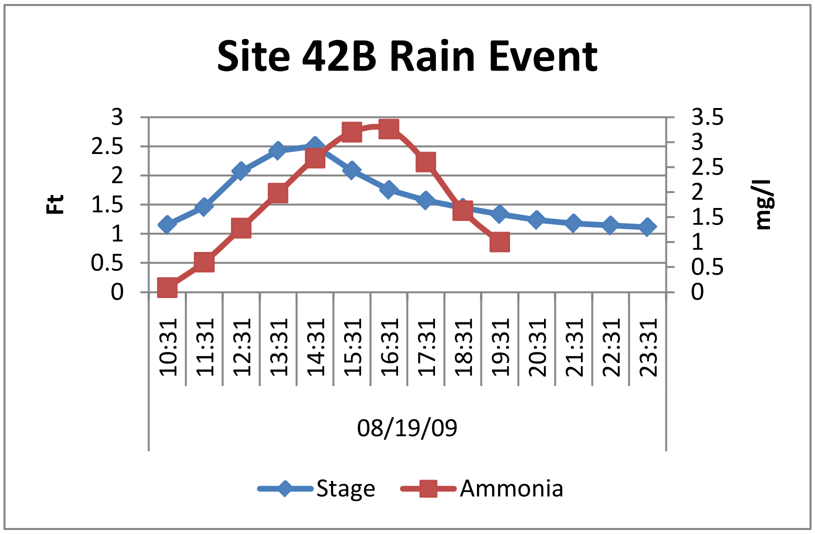


Fig 7. Delayed transport of ammonia

The impact of human waste on water quality in Brushy Creek by all measures appears minimal. Cotinine, a contaminant associated with human waste, was not detected before or after the installation of septic system for all residents of Roselle. Neither were sulfa drugs sulfamethoxazole and sulfathiazole detected. Estradiol was detected at all sites indicating livestock as the source.

Program Assessment:

There was considerable interest and support for the project by all the partners. The partners reported that producer interest and involvement grew as they became more familiar with WIRB goals and the benefits of participation. All WIRB activity goals were completed except the development of a Watershed Improvement Association. The development of a self governing association was seen as a means to foster ownership and pride in their watershed community so that producers would promote and enhance the use of BMPS in their watershed. However, as the project progressed, it became more apparent that no one in the watershed was ready to take on the leadership role. This was not due to a lack of interest, producers responded well to one on one interaction with partners. Interest and participation in WIRB incentives increased throughout the duration of the project as they gained confidence and trust in the partners and saw the benefits in participating in the WIRB program.

Assessing the effectiveness of the program in restoring or improving water quality is problematic due to the overwhelming influence of weather on runoff and groundwater transport. Therefore WIRB relied mostly on implementation of BMPs to produce expected improvements. Nonetheless, state water quality standards for the stream still need to be met. Water quality during WIRB monitoring showed a reduction in fecal runoff and transport but little (if any) improvement in nitrate. Part of this may be due to the relatively small (5%) percentage of acres tested. Water quality from these acres cannot be isolated from other sources through stream monitoring. Furthermore, whether producers used this information to reduce the amount of nitrogen applied is unknown. It is probable that producers increased nitrogen application for fields which tested low in nitrogen and decreased application in fields which tested high. Whether there was a net reduction in nitrogen applied in the entire watershed is unknown. It may take several years before these practices are adopted across the entire watershed and water quality benefits observed in Brushy Creek.

Manure management and related practices provided the greatest observed benefit. The full extent of this benefit will not be known for several years as several manure control structures were installed until late in 2011. The design includes filter strips which are not yet established. Producers are also becoming more aware of the impact of operational BMPs such as lot scrapping frequency and appropriate field application on water quality. Partners in the watershed have expressed interest in continued monitoring to demonstrate the full benefit of their support and the effectiveness of the dollars spent. The WIRB partners request that the state also support this goal and verify that its dollars has indeed accomplished its purpose through an additional two years of stream monitoring.