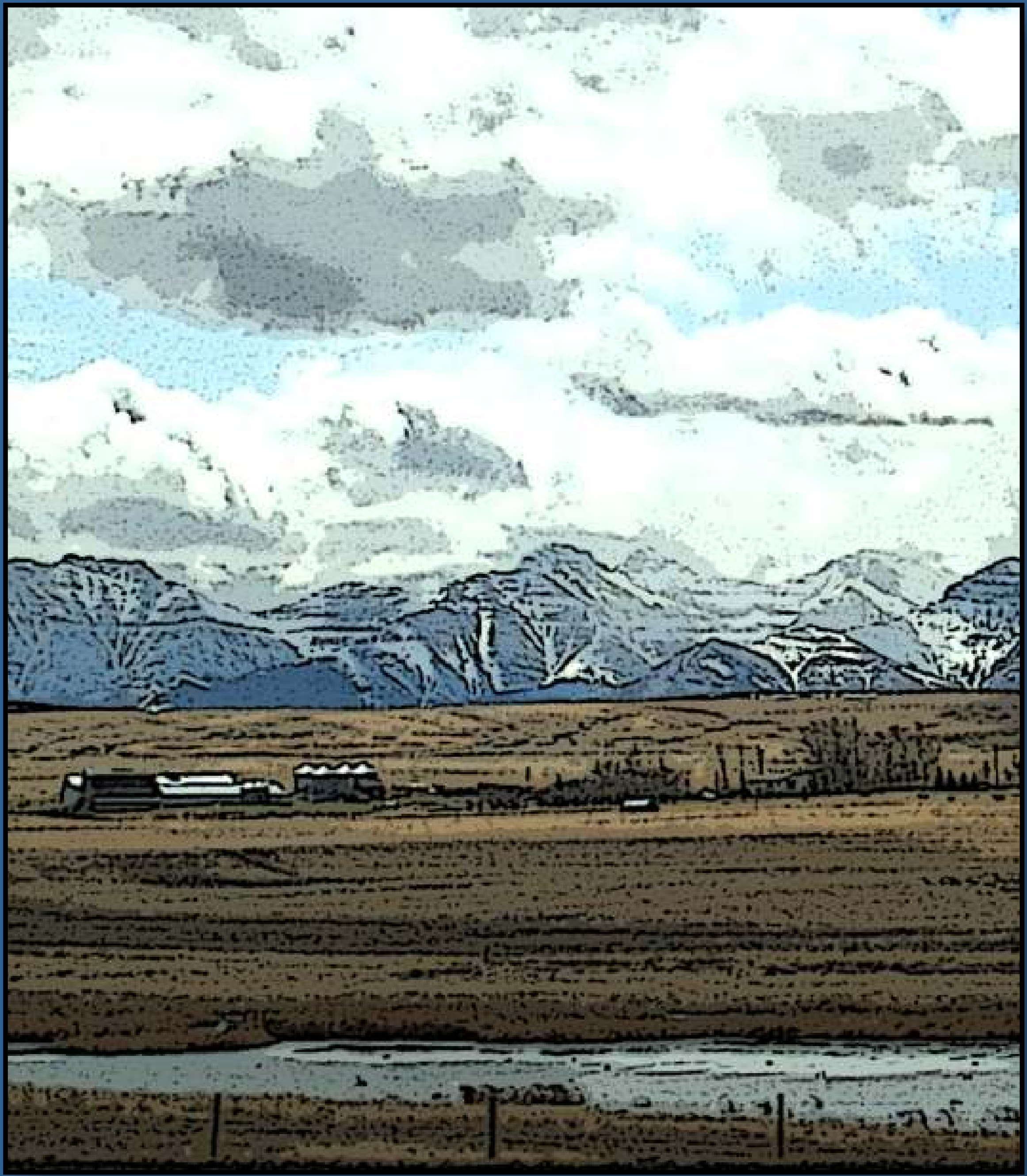

Volume 5:

Predicting Phosphorus Losses from Agricultural Areas

Assessment of Environmental Sustainability in Alberta's Agricultural Watersheds Project

Volume 5:

Predicting Phosphorus Losses from Agricultural Areas

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ABSTRACT

The loss of phosphorus (P) from agricultural land to surface water is a concern in Alberta. Studies have been carried out in Alberta examining P levels in soil and the outlets of watersheds, as well as the relationship between P in soil and P in runoff water. The purpose of this study was to analyze existing Alberta soil and runoff P data to (1) evaluate the performance of previously derived soil-runoff phosphorus relationships in Alberta, (2) calculate P export coefficients, and (3) develop P Export Risk categories for the Haynes Creek M1 (HM1) and 15 selected Alberta Environmentally Sustainable Agriculture (AESA) watersheds. The application of the soil-runoff phosphorus equations in the HM1 watershed showed that greater than 90 and 82% of total P (TP) and 49 and 54% of total dissolved P (TDP) measured in 2000 and 2001, respectively, was directly related to measured soil-test P (STP) values in the top 15-cm soil depth. Similar evaluation of the equations for the 15 AESA watersheds was not possible due to a limitation of available STP data. The calculated TP and dissolved reactive P (TDP) export coefficients were directly related to area-specific runoff potential and average STP values, and they were used to develop P Export Risk categories. In the HM1 watershed, the High P Export Risk category accounted for 45% of area and 64% of TP to the stream. There would be very little change (0.3%) in total TP load in the stream if STP was maintained below the agronomic threshold of 60 mg kg^{-1}. There would be much higher reduction (6.4%) in TP load if runoff potential was reduced by 10% in the High risk area. The additional analyses at the 15 watersheds showed that Negligible and Low P Export Risk categories accounted for 41.8% of the total polygon area and for only 13.3% of the total amount of TP export. But, High and Extreme P Export Risk categories accounted for similar (40.7%) total polygon area and for larger (71.1%) total amount of TP exported.

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LIST OF ABBREVIATIONS

AESA	Alberta Environmental Sustainable Agriculture
AGRASID	Agricultural Region of Alberta Soil Database
CV	Coefficient of Variation
DEM	Digital Elevation Model
FWMC	Flow Weighted Mean Concentrations
HM1	Haynes Creek M1
HRU	Hydrologic Response Unit
P	Phosphorus
RD	Runoff Depth
RF	Runoff Factors
STP	Soil-Test Phosphorus
SWAT	Soil and Water Assessment Tool
TDP	Total Dissolved Phosphorus
TP	Total P
WEPP	Water Erosion Prediction Model

INTRODUCTION

Background

The loss of phosphorus (P) from agricultural land to surface water is a concern in Alberta. Province-wide studies have shown that as agricultural intensity in watersheds increased the amount of P in the streams also increased (Anderson et al. 1998; Lorenz et al. 2008). Two additional studies (Wright et al. 2003; and Little et al. 2006, 2007) reported strong correlations between soil-test phosphorus (STP) and total phosphorus (TP) and dissolved reactive phosphorus (TDP) runoff in field-scale catchments (0.5 to 248 ha). The soil-runoff P relationships reported by Little et al. (2006) were used to calculate soil P limits in Alberta by Jedrych et al. (2006). The performance of the relationships developed by Little et al. (2006, 2007) has not been tested to calculate TP and TDP concentrations in agricultural streams. While these relations were developed using field-scale catchment data, they may also be applicable to explain the contribution of TP and TDP loads from agricultural land to streams at a larger watershed scale.

Movement of P from agricultural areas to the stream is mainly controlled by transport and P-source factors (Sharpley et al. 1993). The transport factors accounts for runoff and erosion potential, and the P source factors relate to STP, and method and rate of P application. The magnitude of these factors varies greatly within each watershed among contributing areas. An area where high runoff potential coincides with elevated STP is referred as critical source area (Laura et al. 2006). Previous studies (Sharpley and Rekolainen 1997; Pionke et al. 1997) showed that on an annual basis, critical source areas account for a relatively small portion of the watershed and exports a large proportion of P to water bodies. These studies suggest that implementation of better land management practices in critical source areas will be most efficient in reducing P loads in streams. Recent development of Geographic Information System (GIS) extension tools (Di Luzio et al. 2002; Renschler et al. 2002) and hydrological models (Arnold et al. 1998, Flanagan and Livingston 1995) has simplified identification of critical source area based on the existing land management, soil, and topographic conditions.

Scale of Application

Two different scales were used to define polygon landscape boundaries for the application of the soil-runoff P relationships. The 25-m grid resolution Digital Elevation Model (DEM) data were used to delineate sub-basin boundaries and landscape characteristic at the 1:20 000 scale within the Haynes Creek M1 (HM1) sub-watershed. The Agricultural Region of Alberta Soil Database (AGRASID) (MacMillan and Pettapiece 2000) was used to derive landscape and soil characteristics at the 1:100 000 scale within 15 Alberta Environmental Sustainable Agriculture (AESA) program watersheds. The AGRASID database represents the most detailed soil information in Alberta, and it generalizes Alberta topography into 1 of 53 landform models. In reality, each landform model may contain a large number of unique field-scale landscape conditions, which are not identified.

Objectives

The objectives of this project were to analyze existing Alberta soil and runoff P data to:

(1) evaluate the performance of previously derived Alberta soil-runoff P relationships at small (Haynes Creek M1) and moderate (AESA) watershed scales,

(2) apply soil-runoff relationships to calculate P export coefficients at small and moderate watershed scales, and

(3) identify critical source areas in terms of the contribution of P loads at a small watershed scale and develop P Export Risk Categories for both small and moderate sized watersheds.

HAYNES CREEK M1 WATERSHED

Materials and Methods

Site description. The Haynes Creek M1 (HM1) watershed has a 2600-ha drainage area and is part of Haynes Creek M6 watershed (Figure 1). The HM1 is about 100 km south of Edmonton near Lacombe, Alberta. The watershed is in the Pine Lake Upland EcoDistrict. The landscape is rolling due to the bedrock topography, where till overlies the bedrock. In some locations, a lacustrine veneer overlies the till. The soils are Eluviated Black Chernozems. Soil texture ranges from medium to moderately fine, with only a few stones throughout the topsoil layer. In some places there are significant coarse-textured soils along streams and in bedrock outcrops.

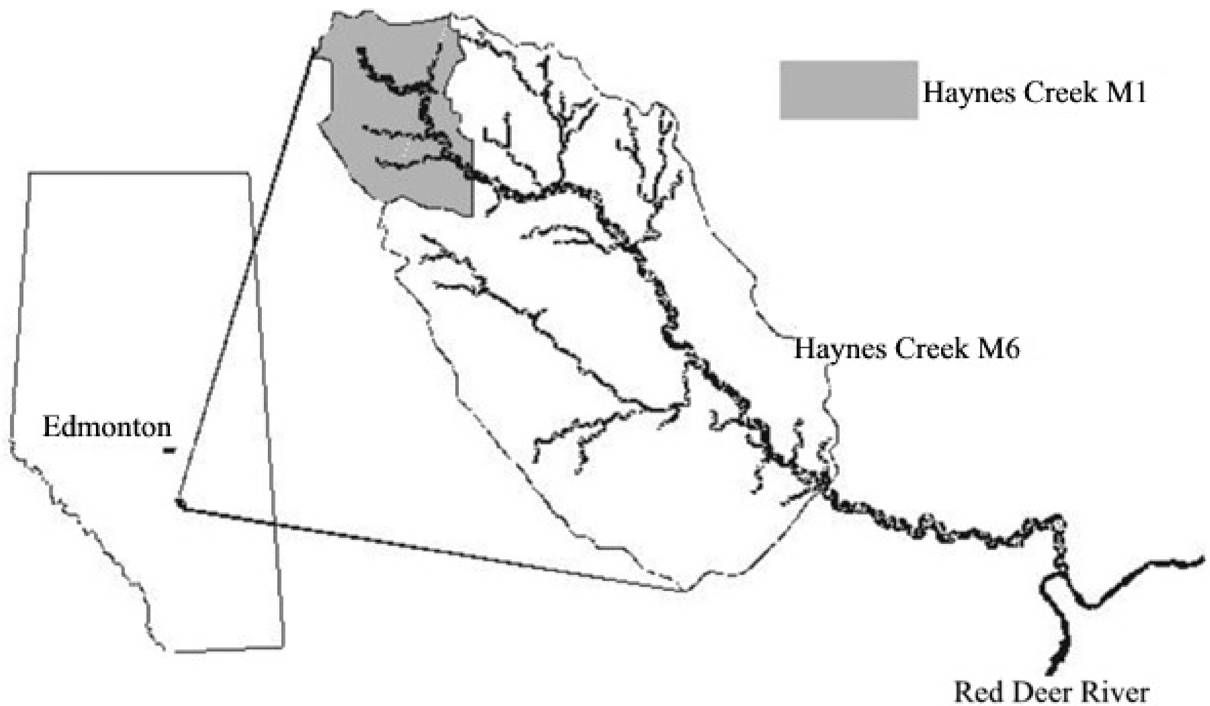

Figure 1. Location of the Haynes Creek M1 watershed.

A survey of producers, carried out during a previous study (Svederus et al. 2006), showed that, in 2000 there were approximately 125 summer grazed cow-calf and about 1,500 hogs in the HM1 watershed. Cattle numbers in the winter increased to about 900 animals, and manure from wintering sites and hog operations were spread on several cultivated fields. In addition, there were 12 homes with septic systems.

Alberta-derived soil-runoff phosphorus equations. The soil-runoff phosphorus relationships were developed in a previous study using 3 yr of field data obtained from 8 catchments located throughout Alberta (Little et al. 2006; 2007). In the study, soil samples were collected from various depths and runoff samples were collected during snowmelt, rainfall, and irrigation events. The study concluded that there is a strong linear relationship between STP in contributing areas and TP and TDP Flow Weighted Mean Concentrations (FWMC) in runoff. In this project, only the 0- to 15-cm depth equations were used since the majority of soil sampling in Alberta is conducted at this depth. The equations were as follows:

$$TP\ FWMC = 0.014 * STP_{(0\text{-}15cm)} + 0.16 \qquad R^2 = 0.87 \qquad (1)$$
$$TDP\ FWMC = 0.014 * STP_{(0\text{-}15cm)} - 0.175 \qquad R^2 = 0.89 \qquad (2)$$

Where:
TP FWMC = total phosphorus flow weight mean concentration in runoff (mg L^{-1})
TDP FWMC = dissolved reactive phosphorus flow weight mean concentration in runoff (mg L^{-1})
$STP_{(0\text{-}15cm)}$ = soil-test phosphorus in the top 15 cm of soil (mg kg^{-1})

Application of the SWAT model. The Soil and Water Assessment Tool (SWAT) model (Arnold et al. 1998) was used to estimate the distribution of runoff potential within the HM1 watershed. The SWAT model is a continuous-time simulation model designed to predict the impact of management practices on soil and water quality at river basin scales on a daily basis. The model divides large watersheds into sub-basins and hydrologic response unit (HRU) areas. Each HRU represents unique land use, management and soil conditions. The main assumptions in the SWAT model are that there is no interaction among HRUs and spatial relationships can only be defined at the sub-basin level. This type of configuration allows SWAT to efficiently perform long-term computations for large watersheds. The model requires the input of four datasets, which characterize soil, topography, climate, and land use conditions.

Soil data were derived from the AGRASID database. The database defines the type and proportional distribution of the soil series in each soil polygon; however, the spatial distribution of these soil series is not available at this time. Due to this limitation, it was assumed that a dominant soil could be assigned to the entire soil polygon area. The HM1 watershed includes 6 soil polygons (Figure 2a). The Cygent soil series was dominant in all of the polygons, and therefore, this soil series was selected for SWAT simulations.

The existing 25-m DEM data and GIS extension tools called AvSWAT (Di Luzio et al. 2002) were used to define landscape polygon characteristics. In the process, DEM data was overlaid with hydrographic image data to delineate sub-watershed areas, calculate their dominant slope steepness and length, and estimate channel characteristics. In total, 35 sub-watersheds were defined within the HM1 watershed (Figure 2b). The average calculated slope ranged from 1.4% in sub-watershed # 22 to 6.7% in sub-watershed # 34.

The climate data consisted of 34 yr (1970 to 2003) of daily precipitation, temperature, solar radiation, wind speed, and relative humidity values for the Lacombe area, as developed for the AESA Soil Quality Program (Shen et al. 2000).

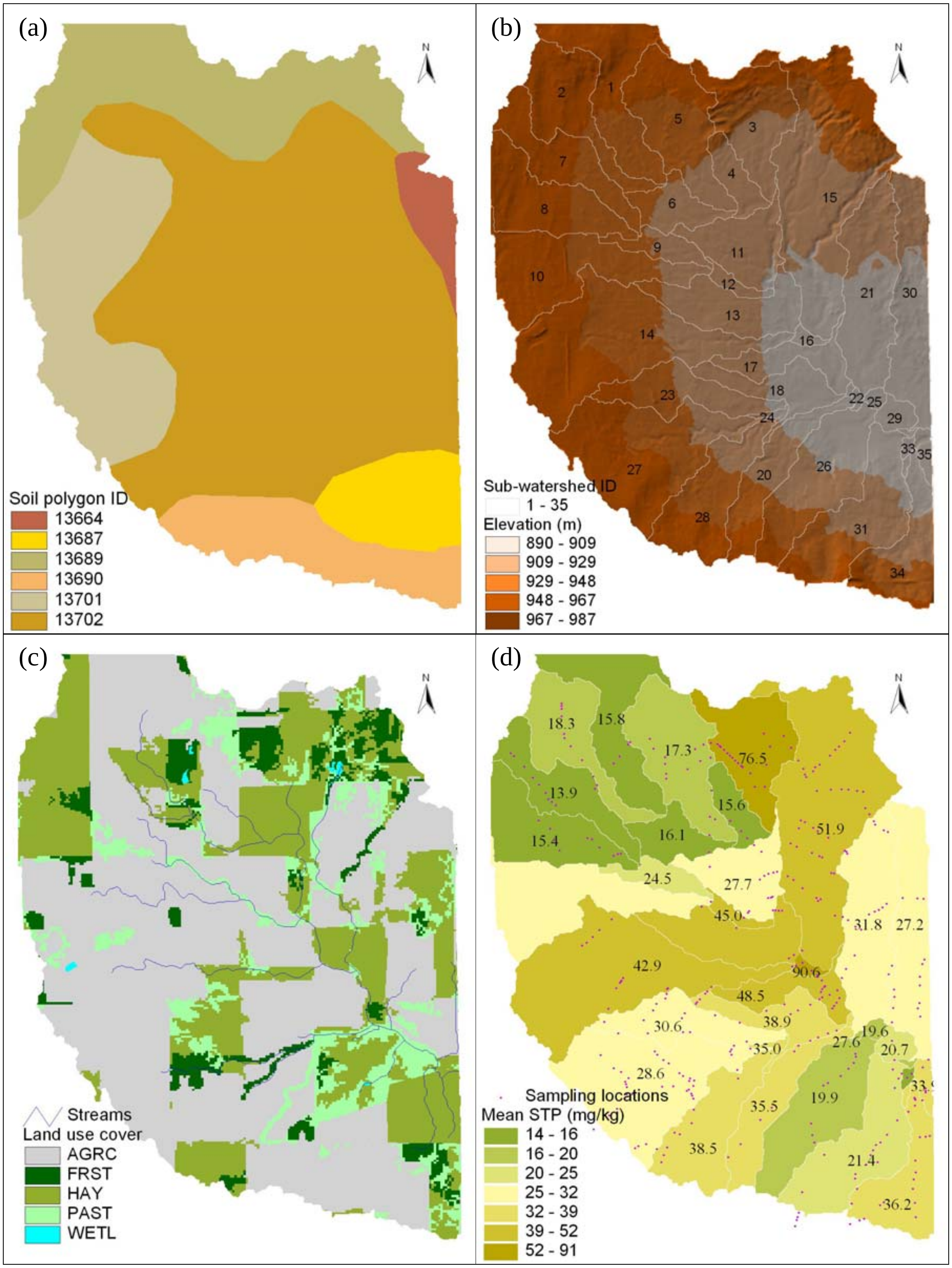

Figure 2. Distribution of (a) AGRASID soil polygons, (b) sub-watersheds and elevations, (c) streams and land use, and (d) soil sampling locations and calculated mean STP within the HM1 watershed.

The land use data were extracted from satellite images acquired between October 1993 and June 1995 and interpreted for the Western Grain Transition Payments Program of Agriculture and Agri-Food Canada. Within the HM1 watershed, annual crops accounted for 57% of the area, hay fields for 27% of the area, pastures for 10% of the area, forests for 6% of the area, and wetlands for 0.2% of the area (Figure 2c). In the simulations, it was assumed that all annual crops used a barley – barley – canola rotation, hay fields were harvested twice per year, and pasture fields were grazed for 90 consecutive days. All of the above land management operations were scheduled based on SWAT defined heat units. The forest and wetland fields did not include any land management operations.

Daily-continuous simulations were conducted for the 1970 to 2003 period. The first 25 yr (1970 to 1995) of simulations were considered as "equilibration period" for the model, and the last 9 yr (1995 to 2003) of simulations were used for assessing SWAT runoff predictions. In the SWAT calibration process, a number of simulation runs were conducted. After each run, parameters controlling water balance and surface runoff in the "basin.bsn" file were adjusted in order to match the predicted flow values with the observed values.

Water quality and quantity data. The observed annual runoff depth from HM1 (Lorenz et al. 2008) ranged from 1.0 mm in 2004 to 44.9 mm in 1999, and the 12 yr average runoff was 21.7 mm. The annual average TP FWMC ranged from 0.492 in 1998 to 1.835 mg L^{-1} in 2005, and the overall average was 1.046 mg L^{-1}. During the 12-yr period, there was high variability in measured runoff depths and TP FWMCs. The annual average runoff depths varied by an order of magnitude, while the TP FWMC varied by a factor of three. Also, there was a strong correlation between observed flow volumes and total dissolved phosphorus (TDP) (R^2 = 0.69) and TP (R^2 = 0.76) loadings in stream. Larger runoff volumes generated larger amounts of TDP and TP in the stream. However, the data suggests that there was no correlation between annual runoff volumes and FWMCs.

Soil-test phosphorus data. Composite soil samples from two depths (0- to 5-cm and 0- to 15-cm) were collected from 351 sites within the HM1 watershed in October 2000 during a previous study (Svederus. et al. 2006). Each sample was a composite of 10, 5-cm diameter cores. Sampling sites were selected based on management units and landscape position, and their distribution varied within the watershed (Figure 3d). On average, the sampling density was 1 sample per 7.7 ha. The collected samples were analyzed for STP using the Modified Kelowna method (Ashworth and Mrazek 1995). The STP values ranged from 2.5 (half the detection limit) to 453 mg kg^{-1} for the 0- to 5-cm soil depth, and from 2.5 to 358 mg kg^{-1} for the 0- to 15-cm soil depth (Table 2). The STP variability among sampling locations of 0- to 5-cm and 0- to 15-cm depths was high with coefficient of variation (CV) values of 93 and 105%, respectively. However, the majority (89%) of the 0- to 15-cm depth soil samples had STP values less than or equal to 60 mg kg^{-1}, which is considered the agronomic threshold in the 0- to 15-cm soil layer (Howard 2006). The calculated mean STP values for 0- to 5-cm and 0- to 15-cm soil samples were 45.7 and 33.4 mg kg^{-1}, respectively.

Table 1. Measured annual-flow volumes, TP and TDP loads, and TP and TDP Flow Weighted Mean Concentrations (FWMC) within the HM1 watershed. Annual data represents the monitoring period from March 1 to October 31 of each year (Lorenz et al. 2008).

Year	Runoff		Total Dissolved Phosphorus (TDP)		Total Phosphorus (TP)	
	Volume (m^3)	Depth (mm)	Load (kg)	FWMC (mg L^{-1})	Load (kg)	FWMC (mg L^{-1})
1995	91000	3.5	144.9	1.596	162.3	1.787
1996	1019000	39.2	798.4	0.783	977.4	0.959
1997	968000	37.2	1059.7	1.094	1259.6	1.301
1998	83000	3.2	37.2	0.448	40.8	0.492
1999	1167000	44.9	932.6	0.799	1021	0.875
2000	348000	13.4	208.2	0.599	241.7	0.695
2001	54000	2.1	29.0	0.541	41.1	0.768
2002	693000	26.6	315.0	0.455	369.6	0.533
2003	1154000	44.4	597.2	0.518	987.5	0.856
2004	27000	1.0	17.1	0.642	18.4	0.691
2005	710000	27.3	1128.9	1.591	1302.4	1.835
2006	461000	17.7	569.1	1.235	664.8	1.443
Total	6775000	260.4	5837.3		7086.6	
Mean	564583	21.7		0.862		1.046

In addition to calculating the arithmetical mean STP, an areal mean STP was calculated for the 0- to 15-cm depth samples using the inverse distance weighted algorithm method (Figure 2d). Svederus et al. 2006 did similar calculation using different STP categories. The objectives of the second method were to estimate mean STP values for each sub-watershed, determine its effect on the overall estimated mean STP value, and provide input data in order to calculate runoff TP and TDP loading from each sub-watershed. The calculation showed that the overall areal mean STP was closely related to the arithmetical mean and equaled 33.6 mg kg^{-1}. The sub-watershed mean STP values ranged from 13.9 to 90.6 mg kg^{-1}, and only two sub-watersheds (# 3 and # 16) had STP levels greater than 60 mg kg^{-1}.

Table 2. Calculated mean STP for the 0- to 5-cm and 0- to 15-cm soil samples from the Haynes Creek M1 sub-watershed (Svederus et al. 2006).

Soil sampling depth(cm)	Number of observations	STP (mg kg^{-1})			CV (%)
		Mean	Minimum	Maximum	
0 to 5	351	45.7	2.5	453	93
0 to 15	351	33.4	2.5	358	106

Results and Discussion

Assessment of SWAT predictions. At a watershed scale, SWAT predicted an annual average runoff depth (runoff volume divided by contributing area) of 22.8 mm for the 34 yr period, and it ranged from 0.5 mm in 2001 to 58.9 mm in 1974. The majority of the runoff occurred during snowmelts events (about 62%), and the annual runoff depth was related more to spring weather conditions rather than annual total precipitation. At a sub-watershed scale, the model predicted annual average runoff depth ranged from 0.3 mm in sub-watershed #19 to 34.8 mm in sub-watershed # 27 (Table 3). At this scale, the predicted runoff depths were related to land cover conditions, where perennial crop fields had lower values than those fields under annual crops.

Table 3. SWAT predicted sub-watershed scale runoff depths within the HM1 watershed.

Sub-watershed ID	Area (ha)	Predicted annual runoff depth (mm)	Sub-watershed ID	Area (ha)	Predicted annual runoff depth (mm)
1	117.22	23.7	19	1.03	0.3
2	90.63	16.9	20	70.15	25.9
3	97.05	2.0	21	125.29	22.8
4	30.01	0.9	22	1.52	2.7
5	116.54	24.7	23	68.34	21.0
6	41.08	34.2	24	3.41	17.6
7	77.19	18.6	25	5.69	12.4
8	99.01	10.6	26	118.40	15.8
9	26.51	34.0	27	179.99	34.8
10	133.17	33.8	28	96.88	23.6
11	68.36	23.4	29	14.35	17.8
12	11.75	21.5	30	108.48	19.8
13	82.64	34.3	31	121.58	23.3
14	228.28	30.1	32	1.28	2.9
15	268.71	15.8	33	2.74	1.1
16	5.56	20.4	34	81.69	19.9
17	44.40	34.1	35	11.32	1.1
18	51.47	34.2			

The evaluation of SWAT predictions involved comparisons between SWAT predicted and stream observed runoff depths during the 1995 to 2003 period. The comparison showed that the SWAT predicted 9 yr total runoff depth of 210.9 mm was very closely related to the observed value of 214.2 mm. Additional comparisons of the 9 yr of annual runoff depths also showed a good correlation (R = 0.86) between the observed and predicted values (Figure 3). Based on these results, it was assumed that the SWAT predicted 34 yr runoff depth values are acceptable for TP and TDP load calculations in the HM1 watershed.

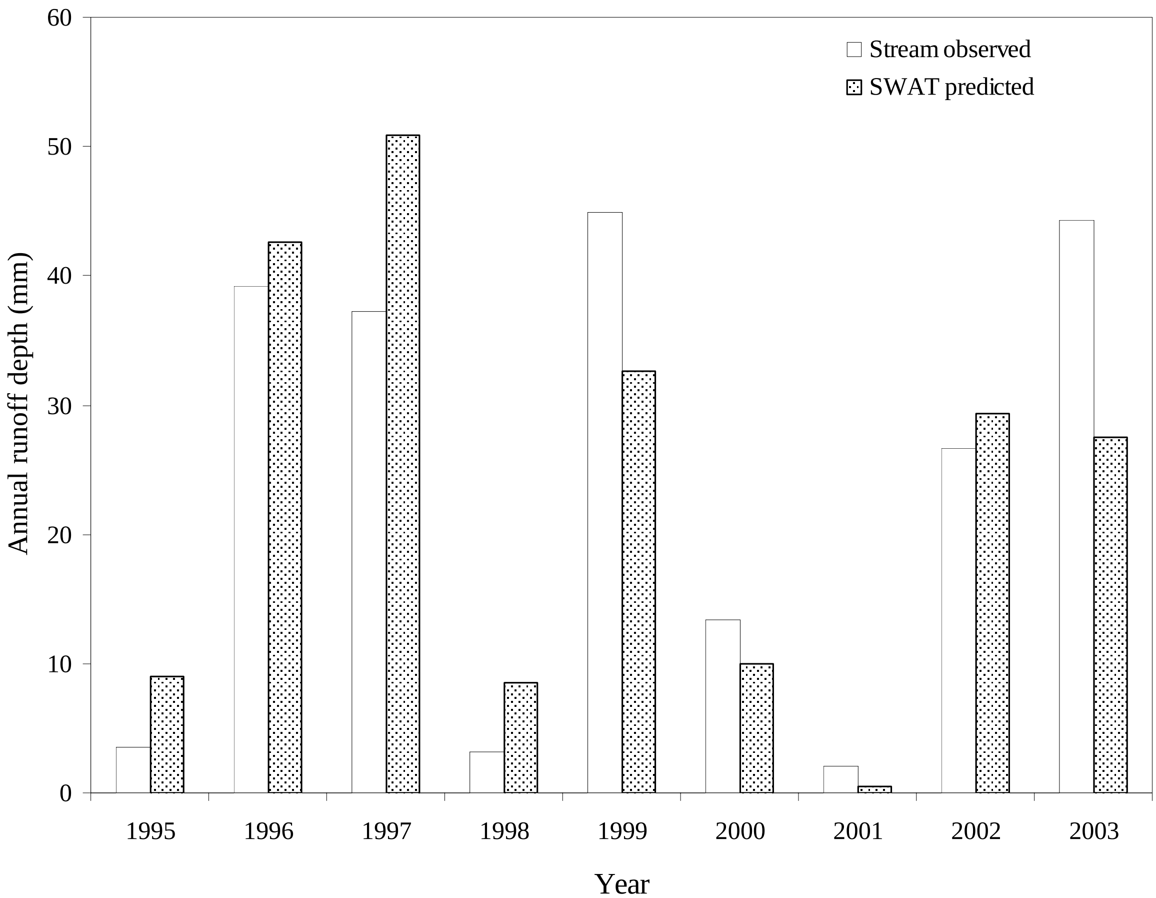

Figure 3. Comparison of observed and SWAT predicted annual runoff depths within the HM1 watershed**.**

Assessment of soil-runoff phosphorus relationship equations. The evaluation of the equations involved comparison of in-stream TP and TDP FWMCs measured in 2000 and 2001 with the TP and TDP FWMC estimated from the soil-runoff Equations 1 and 2. Even though the TDP was measured and Equation 2 is for TDP, for the purpose of this study, the two parameters were considered comparable. Two years of stream data (2000 and 2001) were selected to match soil sampling (Svederus et al. 2006), which occurred in October 2000, after the 2000 and before the 2001 runoff sampling seasons. Applying Equation 1 showed that more than 90 and 82% of measured TP in 2000 and 2001, respectively, can be directly related to measured STP values in top 15 cm of soil (Table 4). The results also show that only 10 and 18% of TP in the stream can be attributed to other sources, such as confined cattle wintering sites or other point sources. The above results suggest that STP is a good predictor for TP in runoff using Equation 1 and can be used at a watershed scale. In addition, Equation 2 was evaluated since the TDP and TDP represent similar P fraction. The application of Equation 2 showed that the predicted TDP values accounted for 49 and 54% of TDP measured in the stream in 2000 and 2001, respectively. The result suggests that STP is not as good predictor for TDP as for TP in runoff. It is possible that the attenuation of TDP is more variable from the edge-of-field to the stream. Elrashidi et al. (2005a) cautioned comparing edge-of-field predictions with in-stream values, and suggested that for NO_3-N, factors affecting N concentrations in runoff water after leaving the field could reduce NO_3-N concentration by 45 to 50%. Similarly, Elrashidi et al. (2005b) suggested that P concentration could be reduced by 17% after leaving the edge-of-field due to factors such as a change in water chemistry and removal by aquatic weeds and algae.

It is interesting to note that there were large variations in the observed TP and TDP FWMC between some years (1995 and 1996; 2004 and 2005) in HM1 (Table 1). This phenomenon may be attributed to a larger contribution of P from point sources since STP values usually do not drastically change from one year to another within an entire watershed.

Table 4. Comparison between measured and estimated TP and TDP FWMC in Haynes Creek M1 watershed.

Year	Estimated Mean STP ($mg\ kg^{-1}$)	Stream observed FWMC ($mg\ L^{-1}$)		Estimated FWMC ($mg\ L^{-1}$)	
		TDP	TP	TDP	TP
2000	33.6	0.599	0.695	0.295	0.630
2001		0.541	0.768		

Defining critical source areas and calculating phosphorus export risk. Two factors were considered while defining critical source areas: SWAT calculated runoff potential and estimated STP sub-watershed values within the HM1 watershed. The SWAT prediction showed that there was high variability in annual mean runoff potential within the HM1 watershed (Table 3). The magnitude of variability was a combined effect of interactions among land cover, landscape, soil, and climate conditions. Also, the calculated STP values for the 2000 data had high variability among sub-watersheds. The STP variability can be related directly to land management, particularly to actual manure and fertilizer application rates within the HM1 watershed. In the TP export analyses, it was assumed that the 2000 STP values were typical (average) for the HM1 watershed. Equations 1 and 2 were used to calculate expected annual average TP and TDP FWMC in each sub-watershed. Then, the TDP and TP loads were estimated by multiplying the calculated FWMCs with corresponding predicted runoff volumes. The export coefficients were estimated by dividing the loads by the contributing areas (Table 5).

It is interesting to note that some sub-watersheds with a higher STP level did not export the highest TP, while other watersheds with a lower STP did not export the lowest TP. For example sub-watershed #3, with 76.5 $mg\ kg^{-1}$ STP had a very low TP export (0.025 $kg\ ha^{-1}$). The export from sub-watershed #3 was one order of magnitude lower than sub-watershed #16, which had 90.6 $mg\ kg^{-1}$ STP (Table 5). In addition, the TP export in sub-watershed #3 was only 67% higher than in sub-watershed # 22, which had almost three times lower STP value and only 35% higher runoff depth. In contrast, sub-watershed #17 had 48.5 $mg\ kg^{-1}$ STP, and the calculated TP load was only 2% lower than sub-watershed #16, which had almost twice as high an STP value but only 67% lower runoff depth.

Anderson (2006) reported calculated the maximum acceptable TDP export coefficients for four ecological areas in Alberta: Boreal Forest, Parkland, Grassland, and Alpine. The calculations were based on the product of the 50th percentile FWMC and the annual unit runoff volume. The HM1 watershed is located in the Parkland area, and its export targets calculated by Anderson (2006) are 0.069, 0.035, and 0.015 kg ha^{-1} yr^{-1} of TDP for high, medium, and low agricultural intensity areas, respectively. In this section, the calculated export coefficients were generalized into three categories: (1) areas exporting more than 0.069 kg TDP ha^{-1} yr^{-1} were assigned a "High" risk category, (2) areas exporting between 0.069 and 0.035 kg TDP ha^{-1} yr^{-1} were assigned a "Medium" risk category, and (3) areas exporting less than 0.035 kg TDP ha^{-1} yr^{-1} were assigned a "Low" risk category (Table 5, columns 8 and 9). The results were used to generate a TDP Export Risk map (Figure 4).

Figure 4 shows that the "High" risk area accounts for 45% of the HM1 area and contributes 64% of TDP to the stream. Additional calculations (not included in the report) indicate that there would be very little change (0.3%) in total TDP load in the stream if the STP values in sub-watersheds #3 and #16 were reduced to 60 mg kg^{-1}. If the runoff volume was reduced by 10% in the "High" risk area, it was predicted that there would be a much higher reduction (6.4%) in the TDP export.

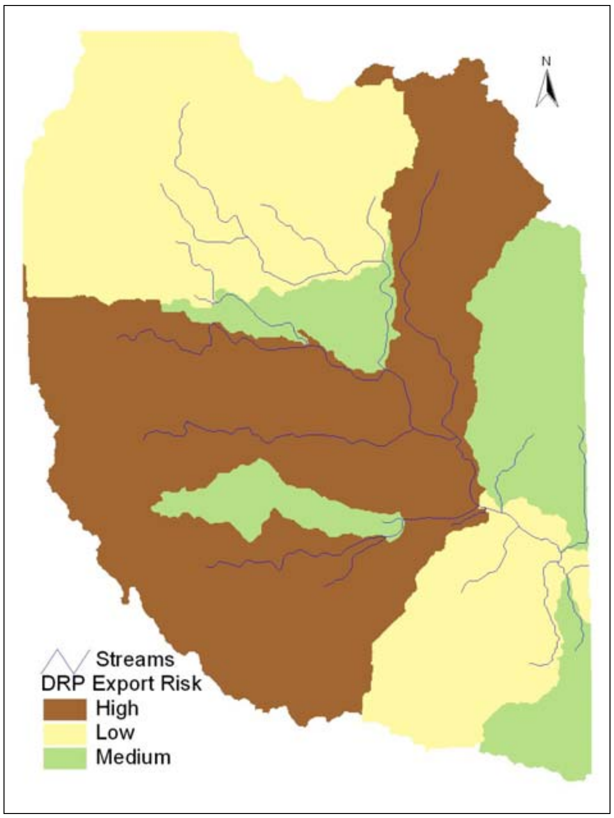

Figure 4. Phosphorus (TDP) Export Risk areas within the HM1 watershed.

The above results illustrate that if our objective were to reduce P load in HM1 stream, the reduction of STP values to agronomic limits (60 mg kg^{-1}) would not yield the best results. We would be much more effective, if we were able to combine the reduction of STP with the restriction of run-on and runoff potential in "High" P export risk areas or in potential point source areas. For example, sub-watershed #16 has a potential to be a point source for P export because it is located on the main stem of the stream, and it has elevated STP values (Figure 2b).

Table 5. Calculated annual TP and TDP FWMC and export coefficient in the HM1 sub-watersheds. The bolded values are referenced in the above text.

Sub-watershed ID	Area (ha)	SWAT runoff depth (mm)	Average STP (mg kg^{-1})	Estimated TP (Eq. 1)		Estimated TDP (Eq. 2)		TDP Export Risk
				FWMC (mg L^{-1})	Export coefficient (kg ha^{-1} yr^{-1})	FWMC (mg L^{-1})	Export coefficient (kg ha^{-1} yr^{-1})	
4	30.01	0.9	15.6	0.378	0.0034	0.043	0.0004	Low
33	2.74	1.1	15.8	0.381	0.0042	0.046	0.0005	Low
19	1.03	0.3	34.8	0.648	0.0019	0.313	0.0009	Low
32	1.28	2.9	17.8	0.410	0.0119	0.075	0.0022	Low
35	11.32	1.1	33.9	0.634	0.0070	0.299	0.0033	Low
7	77.19	18.6	13.9	0.354	0.0658	0.019	0.0035	Low
8	99.01	10.6	15.4	0.376	0.0399	0.041	0.0043	Low
22	**1.52**	**2.7**	**27.6**	**0.546**	**0.0147**	**0.211**	**0.0057**	**Low**
1	117.22	23.7	15.8	0.381	0.0903	0.046	0.0109	Low
25	5.69	12.4	19.6	0.435	0.0539	0.100	0.0124	Low
2	90.63	16.9	18.3	0.417	0.0704	0.082	0.0138	Low
26	118.40	15.8	19.9	0.438	0.0692	0.103	0.0163	Low
5	116.54	24.7	17.3	0.402	0.0994	0.067	0.0166	Low
6	41.08	34.2	16.1	0.386	0.1319	0.051	0.0174	Low
3	**97.05**	**2**	**76.5**	**1.231**	**0.0246**	**0.896**	**0.0179**	**Low**
29	14.35	17.8	20.7	0.450	0.0801	0.115	0.0204	Low
31	121.58	23.3	21.4	0.459	0.1070	0.124	0.0290	Low
30	108.48	19.8	27.2	0.540	0.1070	0.205	0.0406	Medium
11	68.36	23.4	27.7	0.548	0.1283	0.213	0.0499	Medium
23	68.34	21	30.6	0.588	0.1235	0.253	0.0532	Medium
24	3.41	17.6	35.0	0.650	0.1144	0.315	0.0554	Medium
9	26.51	34	24.5	0.503	0.1709	0.168	0.0570	Medium
21	125.29	22.8	31.8	0.605	0.1380	0.270	0.0616	Medium
34	81.69	19.9	36.2	0.667	0.1328	0.332	0.0662	Medium
10	133.17	33.8	28.6	0.560	0.1894	0.225	0.0762	High
27	179.99	34.8	28.6	0.560	0.1950	0.225	0.0784	High
20	70.15	25.9	35.5	0.658	0.1703	0.323	0.0836	High
28	96.88	23.6	38.5	0.699	0.1649	0.364	0.0858	High
15	268.71	15.8	51.9	0.886	0.1401	0.551	0.0871	High
12	11.75	21.5	45.0	0.790	0.1698	0.455	0.0978	High
18	51.47	34.2	38.9	0.705	0.2410	0.370	0.1264	High
14	228.28	30.1	42.9	0.760	0.2289	0.425	0.1281	High
13	82.64	34.3	42.9	0.761	0.2611	0.426	0.1462	High
17	**44.40**	**34.1**	**48.5**	**0.838**	**0.2859**	**0.503**	**0.1717**	**High**
16	**5.56**	**20.4**	**90.6**	**1.428**	**0.2914**	**1.093**	**0.2231**	**High**

SELECTED AESA WATERSHEDS

Materials and Methods

Existing STP data. A large soil-test database has been developed during the past 50 yr in Alberta (Manunta et al. 2000). It includes soil nutrient data collected by Alberta Agriculture and Rural Development and Norwest Labs (now Bodycote Testing Group). For the project, two soil-test data sets (1993 to 1997 and 2000 to 2005) were selected to match the AESA 1995 to 2006 water quality sampling period. In total, only 15 out of the 23 AESA watersheds had soil-test data available for this period (Table 6).

Generally, soil sampling density was very low with the number of samples per watershed ranging from 3 to 336. Soil-test P means ranged from 6 to 54 mg kg^{-1} among the 15 watersheds. These low values indicate that the sampling was biased towards fields that had low nutrient concentrations and may not represent the spatial variability of the actual soil nutrient levels within each watershed (Table 6). Due to these limitations, the above STP data was considered not suitable for evaluation of the soil-runoff phosphorus equations or for the critical source area analyses. Instead, two hypothetical STP scenarios were assumed. Scenario 1 and 2 assumed that STP was 30 and 60 mg kg^{-1}, respectively, and is uniformly distributed among all polygons within each watershed. Scenario 1 can be related to a mean STP level expected in a high agricultural intensity, similar to HM1. The Manunta et al. (2000) study showed that over 70% of dryland area in Alberta had STP lower than 25 mg kg^{-1} during the 1993 to 1997 period. Scenario 2 can be associated with the agronomic STP threshold reported by Howard (2006).

Table 6. Statistics of measured STP, and TP and TDP FWMC in selected watersheds.

Selected AESA Watersheds	Number of samples	STP ($mg\ kg^{-1}$)			FWMC ($mg\ L^{-1}$)					
					TP			TDP		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Battersea Drain	196	54	0	240	0.284	0.038	1.342	0.176	0.007	0.969
Blindman River	14	21	3	60	0.324	0.136	0.536	0.160	0.058	0.338
Buffalo Creek	164	21	0	60	0.184	0.117	0.327	0.117	0.076	0.212
Crowfoot Creek	336	56	8	200	0.326	0.109	0.742	0.147	0.060	0.281
Grande Prairie Creek	7	18	11	24	0.249	0.125	0.473	0.104	0.067	0.145
Haynes Creek [z]	3	21	11	38	0.892	0.360	1.893	0.794	0.269	1.708
New West Coulee	32	38	19	63	0.096	0.060	0.135	0.046	0.032	0.072
Paddle River	11	31	7	60	0.235	0.073	0.494	0.076	0.035	0.129
Ray Creek	13	28	0	55	0.320	0.178	0.571	0.244	0.145	0.475
Renwick Creek	17	26	7	39	0.717	0.476	0.920	0.619	0.386	0.750
Strawberry Creek	107	13	2	60	0.681	0.189	1.249	0.148	0.047	0.319
Stretton Creek	11	23	9	60	0.469	0.361	0.580	0.356	0.235	0.445
Tomahawk Creek	3	6	3	9	0.381	0.201	0.700	0.121	0.055	0.186
Trout Creek	5	11	0	29	0.340	0.020	2.614	0.011	0.004	0.041
Wabash Creek	39	18	0	52	0.468	0.214	0.945	0.278	0.055	0.730

[z] Haynes Creek M6

Water quality sampling. Table 6 also includes annual average, minimum and maximum TP and TDP FWMCs for the 1995 to 2006 runoff sampling period (Lorenz et al. 2008). Water sampling was flow biased, so intensity varied in each watershed and ranged from 3 to 35 samples per year per watershed.

Runoff depth. The AGRASID database includes only the agricultural areas of Alberta. The AESA watersheds that contain large forested areas are not within the AGRASID database. In addition, some AESA watersheds had some uncertainty associated with delineation of effective drainage area. Based of these limitations, only 15 of 23 AESA watersheds were selected for the runoff depth analyses (Figure 5).

The observed annual runoff depth ranged from 7.7 mm at Wabash Creek to 90.3 mm at Blindman River (Figure 5). Distribution of runoff depth within these watersheds was not measured in the field. However, Jedrych et al. (2006) estimated the runoff distribution within agricultural area of Alberta using the Water Erosion Prediction Model (WEPP) (Flanagan and Livingston 1995). Since additional SWAT simulations were beyond the scope of this project, the WEPP estimates were adopted for the following critical source area analyses.

Jedrych et al. (2006) used the WEPP model to estimated runoff factors (RF) for all AGRASID soil polygons within each watershed. The RF is the WEPP-predicted average annual runoff depth for all polygons within each watershed divided by the WEPP predicted average annual runoff depth for individual polygons. Using the WEPP model simulations to calculate RF values provided a means to determine the relative contribution of runoff from each soil polygon to the whole watershed. The RF values were then used to partition the observed watershed average runoff depth, derived from AESA hydrometric station data, among the soil polygons within each watershed (Appendix).

Two major assumptions were made to predict RF values: (1) continuous barley production within entire watershed, (2) uniform landscape conditions within each AGRASID polygon. In reality, land use and landscape variability is high within each polygon, and this would greatly affect the distribution of predicted RF values. However, RF calculation at such a detailed scale would require substantial resources, and was beyond the scope of this project.

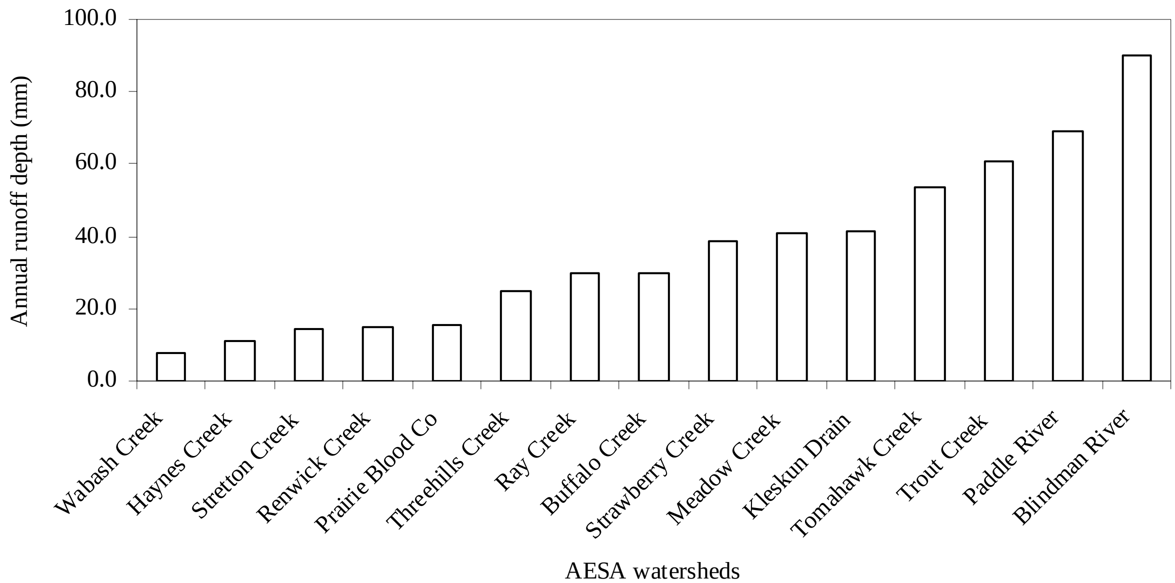

Figure 5. Observed runoff depth in 15 selected AESA watersheds.

Results and Discussion

Comparison between the observed average STP and TP and TDP FWMCs. The 15 AESA watersheds included in Table 6 were used in the analyses. The comparison of the existing soil and water quality data sets did not show any correlation (Figure 6). This is not a surprise, since the mean STP results were in a narrow range (6 to 54 mg kg^{-1}) and most likely did not represent the actual spatial STP variability within each watershed. Similarly, Little et al. (2006; 2007) did not observe any relationship for the same STP range after monitoring small agricultural watersheds in Alberta for 3 yr, but did report a strong relationship for a wider STP range. It appears there may be other significant factors that are not being accounted for when examining a narrow range of STP values. Due to these limitations and the fact that the Alberta-derived soil-runoff phosphorus equations were developed using a wider STP range (3 to 512 mg kg^{-1}; Little et al. 2007), the existing AESA STP data were considered not suitable for the soil-runoff P equations evaluation or for defining critical source areas and estimating export coefficients in these watersheds.

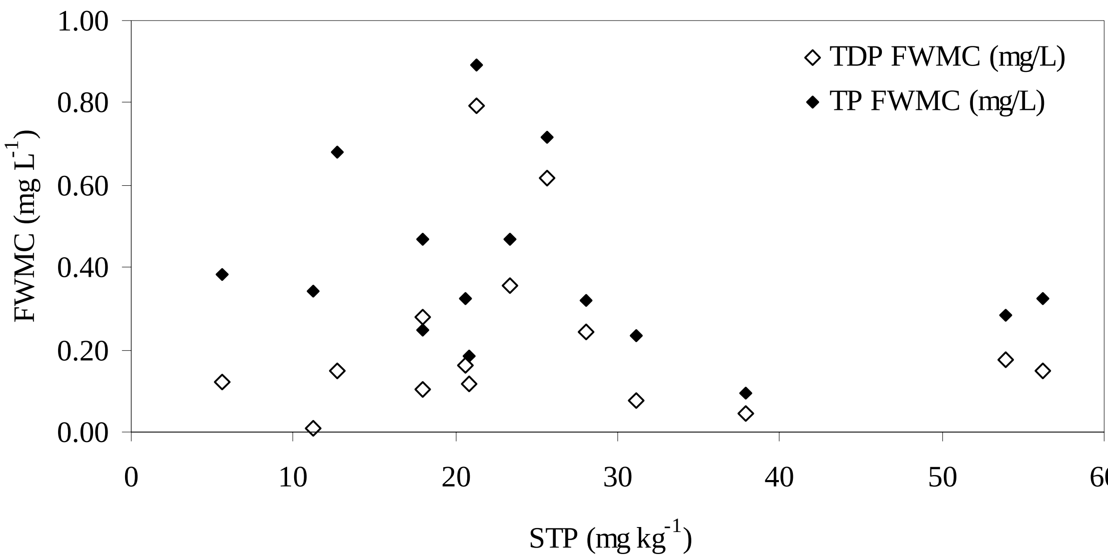

Figure 6. Comparison between observed average STP and TP and TDP FWMCs in selected AESA watersheds**.**

Defining critical source areas and calculating P Export Risk. The estimated TDP and TP export coefficients were calculated for the 15 AESA watersheds using the 30 and 60 mg kg $^{-1}$ hypothetical STP scenarios and observed runoff depth values (Table 7). The coefficients were directly related to the change of STP and runoff depth values. Generally, the TDP coefficient increased approximately by 170% when STP was changed from 30 to 60 mg kg^{-1}, and the TP coefficient increased by 70% when STP was changed in the same range. In addition, an increase of runoff depth by approximately 100% enlarged the TDP and TP coefficients by a similar proportion. The median measured *AESA Stream Survey* export coefficients, from 1999 to 2006, are also included in Table 7. Although the estimated export coefficient did not necessarily correspond with the actual measured export coefficient, both were generally within the same order of magnitude. The inconsistency between measured and estimated export coefficients can be attributed to the limitation of available STP and runoff data.

Table 7. Summary of runoff depths and estimated TDP and TP export coefficients

Natural Region	Watershed	2001 Ag-Intensity Ranking	Observed Runoff Depth (mm)	Estimated Export Coefficient (kg ha^{-1} yr^{-1}) for:				Median Measured Export Coefficient (kg $ha^{-1}yr^{-1}$) for:	
				STP = 30 mg kg^{-1}		STP = 60 mg kg^{-1}		1999 to 2006	
				TDP	TP	TDP	TP	TDP	TP
Parkland	Haynes Creek [z]	High	11.1	0.027	0.064	0.074	0.111	0.088	0.100
Parkland	Stretton Creek	High	14.1	0.035	0.082	0.094	0.141	0.093	0.104
Parkland	Renwick Creek	High	15.4	0.038	0.089	0.102	0.154	0.086	0.103
Parkland	Threehills Creek	High	24.9	0.061	0.144	0.166	0.249	0.106	0.139
Parkland	Ray Creek	High	29.6	0.073	0.172	0.197	0.296	0.062	0.072
Parkland	Buffalo Creek	Medium	29.9	0.073	0.174	0.199	0.300	0.023	0.035
Boreal Forest	Wabash Creek	Medium	7.7	0.019	0.045	0.052	0.078	0.020	0.022
Boreal Forest	Strawberry Creek	Medium	38.5	0.097	0.229	0.262	0.394	0.030	0.169
Boreal Forest	Tomahawk Creek	Low	53.8	0.153	0.361	0.414	0.623	0.036	0.125
Boreal Forest	Blindman River	Low	90.3	0.230	0.544	0.623	0.937	0.130	0.214
Grassland	Prairie Blood Coulee	Medium	15.4	0.038	0.089	0.102	0.154	0.007	0.012
Grassland	Meadow Creek	High	40.7	0.100	0.236	0.271	0.407	0.003	0.017
Grassland	Trout Creek	Low	60.5	0.148	0.351	0.402	0.605	0.002	0.020
Peace Lowland	Kleskun Drain	Low	40.9	0.100	0.237	0.272	0.409	0.120	0.161
Western Upland	Paddle River	Low	69.2	0.174	0.412	0.472	0.710	0.032	0.067

[z] Haynes Creek M6

The analyses of critical source areas at the HM1 watershed showed that the TDP and TP export coefficients and TDP Export Risk were directly related to STP and runoff potential among its sub-watersheds. In the selected AESA watersheds, the TDP Export Risk categories used by Anderson (2006) for HM1 were not applied because they did not account for local variability of runoff and STP in each watershed. Instead, the TDP and TP export coefficients were estimated using WEPP predicted runoff depths in Appendix and the 30 and 60 mg kg^{-1} hypothetical STP scenarios. The maximum TDP and TP export coefficients were calculated by sorting the estimated runoff potential in ascending order and by selecting 5 percentile categories (Table 8). Then the corresponding runoff and export coefficient were categorize into five P Export Risk groups: “Negligible” - Runoff depth (RD) less than 15 mm, “Low” - RD between 15 and 23 mm, “Medium” - RD between 23 and 39 mm, “High” - RD between 39 and 58 mm, and “Extreme” - RD greater than 58 mm (Table 8). In total, the proposed P Export Risk was assigned to 944 polygons. The corresponding TDP and TP export coefficients ranged from 0.037 to 1.347 kg ha^{-1} yr^{-1} and from 0.087 to 2.332 kg ha^{-1} yr^{-1} when STP was assumed to be 30 and 60 mg kg^{-1}, respectively. Reckhow et al. (1980) reported similar range of TP export coefficients (0.08 to 3.25

kg ha^{-1} yr^{-1}) while reviewing available literature on mixed agricultural watersheds in Ontario (Canada) and in Indiana, Ohio, Iowa, Florida, Washington, DC, (United States).

Table 8. Calculated runoff depths and TDP and TP maximum export coefficients based on selected percentiles.

Selected percentiles	Annual runoff depth (mm)	Estimated maximum export coefficient (kg ha^{-1} yr^{-1}) for : STP = 30 mg kg^{-1}		STP = 60 mg kg^{-1}		P Export Risk
		TDP	TP	TDP	TP	
20	<15	0.037	0.087	0.100	0.150	Negligeble
40	15-23	0.057	0.136	0.155	0.234	Low
60	23-39	0.094	0.223	0.256	0.385	Medium
80	39-58	0.143	0.338	0.388	0.583	High
100	>58	0.569	1.347	1.544	2.322	Extreme

Additional calculations were conducted for Scenario 1 to evaluate the effects of the proposed categories on the overall calculated TP export in the selected AESA watersheds (Table 9). Scenario 1 was selected because it represents more realistic STP values in Alberta soils. The results showed that the Negligible and Low P Export Risk categories accounted for 41.8% of the total AGRASID defined polygon area, and only 13.3% of the total amount of TP load. In addition, the High and Extreme P Export Risk categories can be related to a smaller (40.7% of total) polygon area and to a much larger amount of TP exported (71.1% of total). Blindman River and Paddle River watersheds had the largest estimated proportion of the area in the Extreme and High P Export Risk categories, while Haynes Creek and Wabash Creek had the largest areas in the Negligible and Low categories (Figures 7). The Buffalo Creek, Ray Creek, and Threehills Creek watersheds are examples of watersheds with large proportions of the area in the Medium P Export Risk category. The estimated TDP and TP export coefficients were also directly related to runoff and STP values. For example, Blindman River and Paddle River watersheds had the highest estimated coefficients because these watersheds had the highest estimated runoff potential. At the soil polygon scale, the data suggests that the maximum acceptable TDP and TP export coefficient should also be based on these parameters.

Table 9. Distribution of the estimated area and estimated TP load among the P Export Risks categories based on available data for the 15 selected AESA watersheds.

P Export Risk categories	Number of selected AGRASID polygons	Polygon area		TP load (assumed STP = 30 mg kg^{-1})	
		ha	% of total	kg year^{-1}	% of total
Negligible	140	75693.3	21.2	596541.7	5.1
Low	131	67264.5	18.8	950514.7	8.2
Medium	150	68802.5	19.2	1797642.3	15.5
High	131	58354.6	16.3	2135826.6	18.4
Extreme	140	87352.1	24.4	6112710.6	52.7
Total	692	357467.0	100.0	11593235.9	100.0

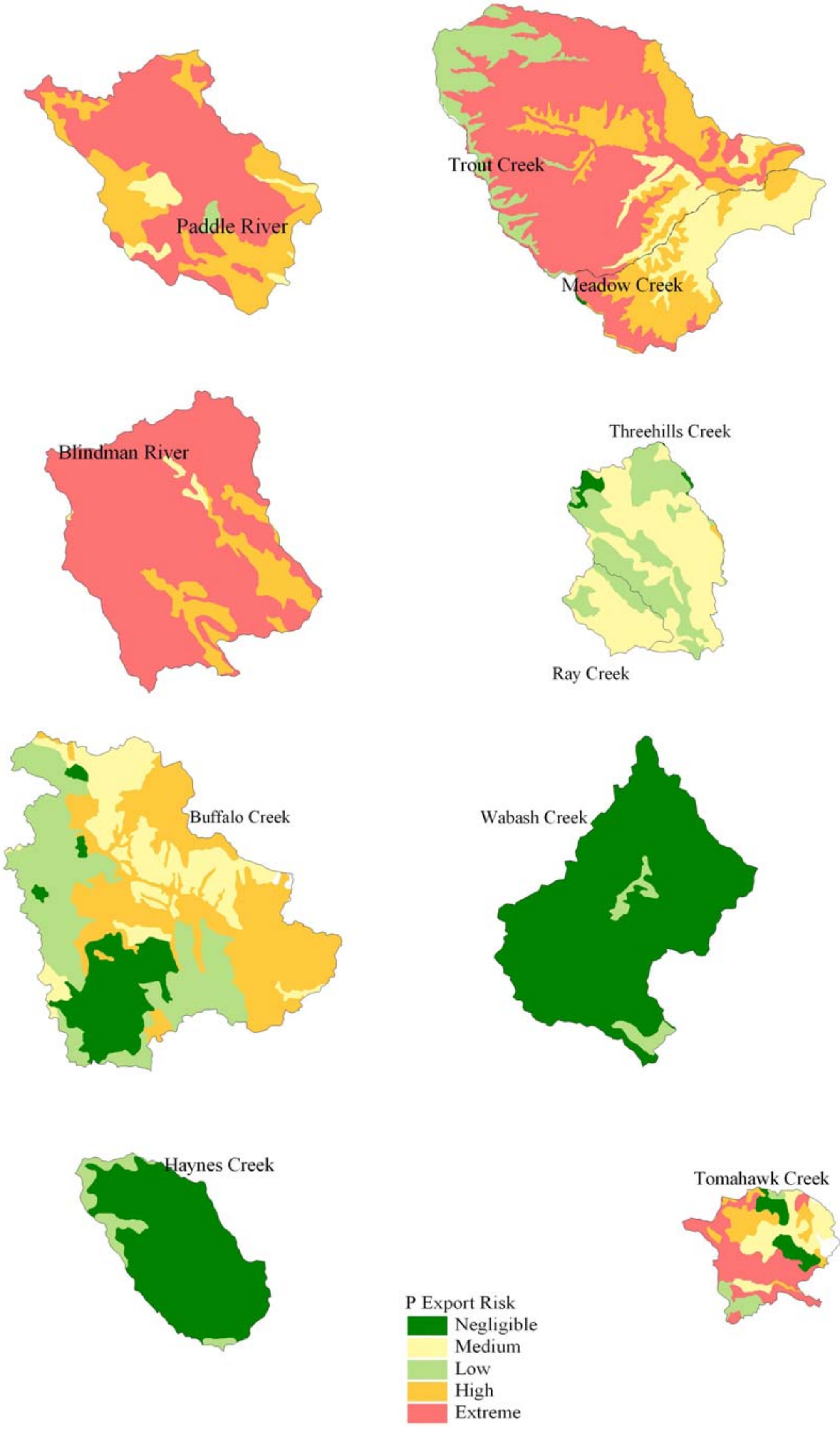

Figure 7. Distribution of P Export Risk categories within selected AESA watersheds. Haynes Creek represents Haynes Creek M6 watershed.

CONCLUSIONS

Application of the SWAT model at HM1 watershed showed high variability in runoff potential within the watershed, and this variability ranged from 0.3 mm in sub-watershed #19 to 34.8 mm in sub-watershed #27. The majority of the runoff (62%) occurred during snowmelt events, and the annual runoff depths were related more to spring weather conditions than annual total precipitation. The predicted runoff depths were also related to land cover conditions, and perennial crop fields had lower values than the annual crop fields.

The application of the soil-runoff relationship equations in the HM1 watershed suggested that over 90 and 82% of TP and 49 and 54% of TDP measured in 2000 and 2001, respectively, can be directly related to measure STP values in the top 15-cm soil depth. The data also showed that only 10 and 18% of TP and 51 and 46% of TDP in stream water can be attributed to other sources, such as confined cattle wintering sites or other point sources. The results are very encouraging for prediction of TP and suggest that the equation can also be used successfully at a watershed scale providing there is adequate STP data. However the TDP results are less promising and suggest that STP data are not a good predictor of TDP in runoff.

The comparison of observed STP values in 15 AESA watersheds and their respective TP and TDP FWMCs showed no correlation. The lack of correlation was attributed to a narrow range of AESA STP values (6 to 54 mg kg^{-1}) relative to the wider STP range (3 to 512 mg kg^{-1}) used in the Alberta-derived soil-runoff phosphorus equations as well as poor representation of the actual spatial STP variability within each watershed. Due to these limitations, the AESA STP data was considered not suitable for evaluation of the Alberta derived soil-runoff phosphorus equations or for defining critical source areas and estimating export coefficients in these watersheds.

Estimated TDP and TP export coefficients were calculated using measured STP data in the HM1 watershed and the 30 and 60 mg kg^{-1} hypothetical STP scenarios for the 15 AESA watersheds. However, even with these two scenarios, the limitations of measured AESA STP and runoff values and the extrapolation of data from a field to a watershed scale resulted in the estimated P export coefficients being quite different than the actual P export coefficients of 15 AESA watersheds with the exception that the values were within the same magnitude. On the other hand, the analyses illustrate the process of defining critical source areas, identifies gaps in the availability of the exiting data, and provides a starting point for the ground-truthing of critical source areas (i.e. collection of additional STP data and detailed runoff potential information).

Overall, critical source areas, areas where high runoff potential coincides with elevated STP, are likely responsible for the majority of nutrient losses from agricultural land. A reduction in STP concentrations and control of runoff from high-risk areas (i.e. run-on and run-off management practices) would be the most effective way to reduce TP loading into surface waters. Identification of critical source areas will help to direct land management practices to areas that will provide the greatest environmental benefit.

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APPENDIX

Appendix 1. Distribution of runoff depths, P Export Risks categories, and estimated TDP and TP export coefficients within the 15 selected AESA watersheds.

Watershed name	AGRASID polygon	Observed runoff depth	Drainage area	WEPP predicted runoff factor	Estimated runoff		Estimated export coefficient (kg ha^{-1} yr^{-1})			
					Depth	P export risk	STP = 30 mg kg^{-1}		STP = 60 mg kg^{-1}	
	ID	(mm)	(m^2)	(RF)	(mm)		TDP	TP	TDP	TP
BLI	18048	90.3	152590	1.4	65.7	Extreme	0.161	0.381	0.437	0.66
BLI	18029	90.3	1760256	0.9	98.6	Extreme	0.242	0.572	0.656	0.99
BLI	26868	90.3	8624508	0.8	113.0	Extreme	0.277	0.655	0.751	1.13
BLI	18085	90.3	832511	n.a	90.3	Extreme	0.221	0.524	0.600	0.90
BLI	18053	90.3	1404374	0.4	232.2	Extreme	0.569	1.347	1.544	2.32
BLI	26859	90.3	14420600	0.7	135.6	Extreme	0.332	0.787	0.902	1.36
BLI	26866	90.3	25999983	0.7	123.3	Extreme	0.302	0.715	0.820	1.23
BLI	26876	90.3	1473454	0.9	96.6	Extreme	0.237	0.560	0.642	0.97
BLI	26843	90.3	1391759	3.7	24.7	Medium	0.060	0.143	0.164	0.25
BLI	26856	90.3	23133998	0.8	119.2	Extreme	0.292	0.691	0.792	1.19
BLI	26873	90.3	9685318	1.1	84.2	Extreme	0.206	0.489	0.560	0.84
BLI	18092	90.3	2884441	1.2	74.0	Extreme	0.181	0.429	0.492	0.74
BLI	18108	90.3	15134437	1.1	84.2	Extreme	0.206	0.489	0.560	0.84
BLI	26837	90.3	4807530	1.0	86.3	Extreme	0.211	0.501	0.574	0.86
BLI	26831	90.3	2445065	3.1	28.8	Medium	0.070	0.167	0.191	0.29
BLI	26858	90.3	1247473	0.4	232.2	Extreme	0.569	1.347	1.544	2.32
BLI	26852	90.3	7485003	0.7	137.7	Extreme	0.337	0.798	0.915	1.38
BLI	18122	90.3	1735712	1.9	47.3	High	0.116	0.274	0.314	0.47
BLI	26857	90.3	3828838	0.4	232.2	Extreme	0.569	1.347	1.544	2.32
BLI	26853	90.3	2710526	1.4	65.7	Extreme	0.161	0.381	0.437	0.66
BLI	18115	90.3	10442667	2.2	41.1	High	0.101	0.238	0.273	0.41
BLI	26874	90.3	3102840	1.3	71.9	Extreme	0.176	0.417	0.478	0.72
BLI	18100	90.3	3677544	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	28306	90.3	15347805	1.3	69.9	Extreme	0.171	0.405	0.465	0.70
BLI	28307	90.3	11729386	1.5	61.6	Extreme	0.151	0.358	0.410	0.62
BLI	26875	90.3	215901	2.7	32.9	Medium	0.081	0.191	0.219	0.33
BLI	18113	90.3	2721463	1.1	82.2	Extreme	0.201	0.477	0.547	0.82
BLI	26869	90.3	8264723	0.7	135.6	Extreme	0.332	0.787	0.902	1.36
BLI	18105	90.3	1442137	1.3	67.8	Extreme	0.166	0.393	0.451	0.68
BLI	26851	90.3	10794503	0.8	113.0	Extreme	0.277	0.655	0.751	1.13
BLI	26846	90.3	2059629	1.0	90.4	Extreme	0.221	0.524	0.601	0.90
BLI	26871	90.3	9059650	1.0	90.4	Extreme	0.221	0.524	0.601	0.90
BLI	18129	90.3	6836693	1.4	65.7	Extreme	0.161	0.381	0.437	0.66
BLI	18107	90.3	12924747	1.1	84.2	Extreme	0.206	0.489	0.560	0.84
BLI	18110	90.3	3525192	1.3	69.9	Extreme	0.171	0.405	0.465	0.70
BLI	18088	90.3	3553577	1.2	74.0	Extreme	0.181	0.429	0.492	0.74
BLI	18125	90.3	5279575	0.8	117.1	Extreme	0.287	0.679	0.779	1.17
BLI	18093	90.3	7566328	2.1	43.1	High	0.106	0.250	0.287	0.43
BLI	18123	90.3	3570966	1.3	71.9	Extreme	0.176	0.417	0.478	0.72
BLI	18126	90.3	12062528	n.a	90.3	Extreme	0.221	0.524	0.600	0.90
BLI	26850	90.3	919560	0.5	178.8	Extreme	0.438	1.037	1.189	1.79
BLI	18109	90.3	4735412	2.2	41.1	High	0.101	0.238	0.273	0.41

Note: BLI represents Blindman River

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
BLI	18103	90.3	2677882	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	26845	90.3	22925135	1.0	90.4	Extreme	0.221	0.524	0.601	0.90
BLI	26849	90.3	4308613	0.9	96.6	Extreme	0.237	0.560	0.642	0.97
BLI	18101	90.3	2149645	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	18091	90.3	2580476	1.4	63.7	Extreme	0.156	0.369	0.424	0.64
BLI	18099	90.3	10555542	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	18116	90.3	4117157	0.7	121.2	Extreme	0.297	0.703	0.806	1.21
BLI	26848	90.3	3391609	0.9	96.6	Extreme	0.237	0.560	0.642	0.97
BLI	18124	90.3	1241700	0.6	147.9	Extreme	0.362	0.858	0.984	1.48
BLI	18098	90.3	3396250	0.9	98.6	Extreme	0.242	0.572	0.656	0.99
BLI	18104	90.3	947635	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	18119	90.3	306271	0.6	141.8	Extreme	0.347	0.822	0.943	1.42
BLI	18102	90.3	1599465	1.6	55.5	High	0.136	0.322	0.369	0.55
BLI	18097	90.3	593498	1.3	71.9	Extreme	0.176	0.417	0.478	0.72
BUF	26844	90.3	6657104	0.8	106.8	Extreme	0.262	0.620	0.710	1.07
BUF	16588	29.9	1427943	1.5	20.5	Low	0.050	0.119	0.136	0.21
BUF	16844	29.9	1520985	0.6	50.3	High	0.123	0.292	0.335	0.50
BUF	16675	29.9	6724947	1.2	25.9	Medium	0.063	0.150	0.172	0.26
BUF	16588	29.9	99472613	1.5	20.5	Low	0.050	0.119	0.136	0.21
BUF	28185	29.9	737141	0.5	55.7	High	0.136	0.323	0.370	0.56
BUF	16483	29.9	42097272	0.6	48.8	High	0.120	0.283	0.325	0.49
BUF	16514	29.9	35332776	1.0	30.8	Medium	0.075	0.178	0.205	0.31
BUF	16538	29.9	2236845	n.a	29.9	Medium	0.073	0.173	0.199	0.30
BUF	16495	29.9	2568627	0.8	37.1	Medium	0.091	0.215	0.247	0.37
BUF	16607	29.9	2851038	2.3	13.2	Negligible	0.032	0.076	0.088	0.13
BUF	16615	29.9	2725386	1.7	18.1	Low	0.044	0.105	0.120	0.18
BUF	16479	29.9	4614692	0.6	49.8	High	0.122	0.289	0.331	0.50
BUF	16604	29.9	5531093	0.7	44.4	High	0.109	0.258	0.296	0.44
BUF	16511	29.9	47235096	1.2	25.9	Medium	0.063	0.150	0.172	0.26
BUF	16530	29.9	8387590	0.7	44.9	High	0.110	0.261	0.299	0.45
BUF	16518	29.9	3442443	1.0	29.3	Medium	0.072	0.170	0.195	0.29
BUF	16537	29.9	6898643	0.6	52.3	High	0.128	0.303	0.348	0.52
BUF	16517	29.9	613320	1.1	28.3	Medium	0.069	0.164	0.188	0.28
BUF	16526	29.9	1239515	0.6	49.8	High	0.122	0.289	0.331	0.50
BUF	16440	29.9	783449	0.7	43.5	High	0.107	0.252	0.289	0.43
BUF	16441	29.9	1486600	0.7	43.5	High	0.107	0.252	0.289	0.43
BUF	16471	29.9	822246	0.7	44.4	High	0.109	0.258	0.296	0.44
BUF	16579	29.9	1402975	0.6	46.4	High	0.114	0.269	0.309	0.46
BUF	16557	29.9	650375	0.7	40.1	High	0.098	0.232	0.266	0.40
BUF	16515	29.9	522180	1.1	28.3	Medium	0.069	0.164	0.188	0.28
BUF	16608	29.9	588690	1.2	23.9	Medium	0.059	0.139	0.159	0.24
BUF	16516	29.9	1366505	1.1	28.3	Medium	0.069	0.164	0.188	0.28
BUF	16578	29.9	2082530	2.3	13.2	Negligible	0.032	0.076	0.088	0.13
BUF	16513	29.9	1997185	1.0	29.8	Medium	0.073	0.173	0.198	0.30
BUF	16594	29.9	18200437	2.0	15.1	Low	0.037	0.088	0.101	0.15
BUF	16533	29.9	1444631	1.2	25.4	Medium	0.062	0.147	0.169	0.25

Note: BLI represents Blindman River, BUF represents Buffalo Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
BUF	16535	29.9	1737999	1.1	27.8	Medium	0.068	0.161	0.185	0.28
BUF	16506	29.9	1177829	0.6	53.2	High	0.130	0.309	0.354	0.53
BUF	16575	29.9	724016	1.9	16.1	Low	0.039	0.093	0.107	0.16
BUF	16534	29.9	739560	1.2	25.4	Medium	0.062	0.147	0.169	0.25
BUF	16473	29.9	15653281	0.7	44.4	High	0.109	0.258	0.296	0.44
BUF	16512	29.9	3882070	1.0	30.3	Medium	0.074	0.176	0.201	0.30
BUF	16528	29.9	6055755	0.6	50.3	High	0.123	0.292	0.335	0.50
BUF	16674	29.9	5339822	0.6	52.3	High	0.128	0.303	0.348	0.52
BUF	16486	29.9	1633288	0.6	46.4	High	0.114	0.269	0.309	0.46
BUF	16529	29.9	26083225	0.7	44.9	High	0.110	0.261	0.299	0.45
BUF	16510	29.9	6677889	1.1	27.4	Medium	0.067	0.159	0.182	0.27
BUF	16539	29.9	1980629	2.2	13.7	Negligible	0.034	0.079	0.091	0.14
BUF	16523	29.9	1274037	0.7	43.0	High	0.105	0.249	0.286	0.43
BUF	16527	29.9	4448364	0.6	53.2	High	0.130	0.309	0.354	0.53
BUF	16658	29.9	5023863	0.7	44.9	High	0.110	0.261	0.299	0.45
BUF	16550	29.9	1430178	1.0	30.8	Medium	0.075	0.178	0.205	0.31
BUF	16545	29.9	3238468	0.6	48.8	High	0.120	0.283	0.325	0.49
BUF	16503	29.9	1683382	0.7	43.5	High	0.107	0.252	0.289	0.43
BUF	16519	29.9	3787858	1.1	27.8	Medium	0.068	0.161	0.185	0.28
BUF	16553	29.9	729992	0.6	46.9	High	0.115	0.272	0.312	0.47
BUF	16613	29.9	8713899	0.6	50.3	High	0.123	0.292	0.335	0.50
BUF	16540	29.9	1048420	0.6	46.4	High	0.114	0.269	0.309	0.46
BUF	16524	29.9	1296043	0.6	53.7	High	0.132	0.312	0.357	0.54
BUF	29104	29.9	70018555	1.6	18.6	Low	0.045	0.108	0.123	0.19
BUF	16507	29.9	7221582	1.0	30.8	Medium	0.075	0.178	0.205	0.31
BUF	16504	29.9	3655406	0.7	41.5	High	0.102	0.241	0.276	0.42
BUF	16488	29.9	24357239	0.6	50.3	High	0.123	0.292	0.335	0.50
BUF	16536	29.9	22567532	0.6	52.3	High	0.128	0.303	0.348	0.52
BUF	16532	29.9	48712549	6.1	4.9	Negligible	0.012	0.028	0.032	0.05
BUF	16476	29.9	1648343	0.6	50.3	High	0.123	0.292	0.335	0.50
BUF	16465	29.9	7594119	0.6	47.4	High	0.116	0.275	0.315	0.47
BUF	16595	29.9	23787744	0.6	46.9	High	0.115	0.272	0.312	0.47
BUF	16609	29.9	1298583	0.6	53.7	High	0.132	0.312	0.357	0.54
BUF	16521	29.9	14083171	3.6	8.3	Negligible	0.020	0.048	0.055	0.08
BUF	16525	29.9	1181018	0.7	45.4	High	0.111	0.263	0.302	0.45
BUF	16601	29.9	9772396	0.6	48.4	High	0.118	0.280	0.322	0.48
BUF	16631	29.9	6538778	1.2	24.4	Medium	0.060	0.142	0.162	0.24
BUF	16522	29.9	1512228	8.7	3.4	Negligible	0.008	0.020	0.023	0.03
BUF	16617	29.9	2616074	0.8	38.6	Medium	0.095	0.224	0.257	0.39
BUF	16531	29.9	1315537	8.7	3.4	Negligible	0.008	0.020	0.023	0.03
BUF	16520	29.9	6661668	3.4	8.8	Negligible	0.022	0.051	0.058	0.09
BUF	16509	29.9	2758354	5.1	5.9	Negligible	0.014	0.034	0.039	0.06
BUF	16502	29.9	8419421	4.1	7.3	Negligible	0.018	0.042	0.049	0.07
BUF	16644	29.9	4449190	1.4	21.5	Low	0.053	0.125	0.143	0.21
BUF	16616	29.9	2856346	0.6	46.9	High	0.115	0.272	0.312	0.47
BUF	16591	29.9	1489677	2.0	15.1	Low	0.037	0.088	0.101	0.15

Note: BUF represents Buffalo Creek

Watershed name	AGRASID polygon	Observed runoff depth	Drainage area	WEPP predicted runoff factor	Estimated runoff		Estimated export coefficient (kg ha^{-1} yr^{-1})			
					Depth	P export risk	STP = 30 mg kg^{-1}		STP = 60 mg kg^{-1}	
	ID	(mm)	(m^2)	(RF)	(mm)		TDP	TP	TDP	TP
BUF	16508	29.9	11409105	4.1	7.3	Negligible	0.018	0.042	0.049	0.07
BUF	16610	29.9	2572114	0.6	48.8	High	0.120	0.283	0.325	0.49
BUF	16611	29.9	892358	0.6	48.8	High	0.120	0.283	0.325	0.49
BUF	16640	29.9	2735312	1.5	19.5	Low	0.048	0.113	0.130	0.20
HAY	13689	11.1	3237	0.7	15.0	Negligible	0.037	0.087	0.100	0.15
HAY	13689	11.1	4416097	0.7	15.0	Negligible	0.037	0.087	0.100	0.15
HAY	13678	11.1	1464007	0.9	11.9	Negligible	0.029	0.069	0.079	0.12
HAY	13664	11.1	8895378	1.1	10.3	Negligible	0.025	0.060	0.069	0.10
HAY	13702	11.1	17007018	0.8	13.4	Negligible	0.033	0.078	0.089	0.13
HAY	13701	11.1	3181252	0.7	16.5	Low	0.041	0.096	0.110	0.17
HAY	13684	11.1	6946331	1.5	7.2	Negligible	0.018	0.042	0.048	0.07
HAY	13713	11.1	7919703	1.8	6.2	Negligible	0.015	0.036	0.041	0.06
HAY	13665	11.1	5744426	1.1	10.3	Negligible	0.025	0.060	0.069	0.10
HAY	13687	11.1	8212651	1.7	6.7	Negligible	0.016	0.039	0.045	0.07
HAY	13690	11.1	5726556	0.7	15.0	Negligible	0.037	0.087	0.100	0.15
HAY	13707	11.1	3884406	1.3	8.8	Negligible	0.022	0.051	0.058	0.09
HAY	13652	11.1	8180899	1.7	6.7	Negligible	0.016	0.039	0.045	0.07
HAY	13699	11.1	35006769	0.8	14.5	Negligible	0.035	0.084	0.096	0.14
HAY	13650	11.1	3954271	1.1	10.3	Negligible	0.025	0.060	0.069	0.10
HAY	13723	11.1	6848053	2.4	4.7	Negligible	0.011	0.027	0.031	0.05
HAY	13730	11.1	1584881	1.3	8.3	Negligible	0.020	0.048	0.055	0.08
HAY	13718	11.1	3763874	2.0	5.7	Negligible	0.014	0.033	0.038	0.06
HAY	13675	11.1	4037770	0.9	11.9	Negligible	0.029	0.069	0.079	0.12
HAY	13746	11.1	3247531	0.9	12.4	Negligible	0.030	0.072	0.082	0.12
HAY	13668	11.1	10034424	1.1	10.3	Negligible	0.025	0.060	0.069	0.10
HAY	13775	11.1	199838	1.1	10.3	Negligible	0.025	0.060	0.069	0.10
HAY	13735	11.1	2224049	0.8	13.4	Negligible	0.033	0.078	0.089	0.13
HAY	13733	11.1	7863657	1.0	11.4	Negligible	0.028	0.066	0.076	0.11
HAY	13736	11.1	47466	0.9	12.4	Negligible	0.030	0.072	0.082	0.12
HAY	13759	11.1	1272623	0.7	17.1	Low	0.042	0.099	0.113	0.17
KLE	22319	40.9	82425	2.3	18.1	Low	0.044	0.105	0.121	0.18
KLE	22385	40.9	1322600	0.9	46.4	High	0.114	0.269	0.308	0.46
KLE	23411	40.9	5977128	0.6	63.7	Extreme	0.156	0.370	0.424	0.64
KLE	22253	40.9	1497705	1.3	31.1	Medium	0.076	0.180	0.207	0.31
KLE	22391	40.9	1774649	1.3	31.1	Medium	0.076	0.180	0.207	0.31
KLE	22254	40.9	212558	1.0	41.1	High	0.101	0.239	0.274	0.41
KLE	22388	40.9	1465671	1.6	25.8	Medium	0.063	0.150	0.172	0.26
KLE	23411	40.9	3252491	0.6	63.7	Extreme	0.156	0.370	0.424	0.64
KLE	22253	40.9	1944151	1.3	31.1	Medium	0.076	0.180	0.207	0.31
KLE	22391	40.9	4340922	1.3	31.1	Medium	0.076	0.180	0.207	0.31
KLE	22254	40.9	1309883	1.0	41.1	High	0.101	0.239	0.274	0.41
KLE	22388	40.9	4774963	1.6	25.8	Medium	0.063	0.150	0.172	0.26
KLE	22353	40.9	2198383	1.0	40.7	High	0.100	0.236	0.271	0.41
KLE	22284	40.9	331483	1.1	37.5	Medium	0.092	0.218	0.249	0.38
KLE	22351	40.9	414646	1.2	35.5	Medium	0.087	0.206	0.236	0.35
KLE	22294	40.9	1379158	1.7	23.8	Medium	0.058	0.138	0.158	0.24

Note: BUF represents Buffalo Creek, HAY represents Haynes Creek M6, KLE represents Kleskun Drain

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m²)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient (kg ha⁻¹ yr⁻¹) STP = 30 mg kg⁻¹ TDP	STP = 30 mg kg⁻¹ TP	STP = 60 mg kg⁻¹ TDP	STP = 60 mg kg⁻¹ TP
MEA	5966	40.7	4963	1.1	36.1	Medium	0.089	0.210	0.240	0.36
MEA	5968	40.7	12834	1.4	29.1	Medium	0.071	0.169	0.194	0.29
MEA	5967	40.7	2814284	1.0	41.5	High	0.102	0.241	0.276	0.42
MEA	10697	40.7	387164	1.3	30.2	Medium	0.074	0.175	0.201	0.30
MEA	5982	40.7	2709742	1.3	31.3	Medium	0.077	0.181	0.208	0.31
MEA	5970	40.7	6769554	1.4	29.1	Medium	0.071	0.169	0.194	0.29
MEA	5952	40.7	1641568	1.4	29.7	Medium	0.073	0.172	0.197	0.30
MEA	5966	40.7	1592607	1.1	36.1	Medium	0.089	0.210	0.240	0.36
MEA	5965	40.7	1974961	1.1	36.1	Medium	0.089	0.210	0.240	0.36
MEA	5940	40.7	5063398	1.6	25.9	Medium	0.063	0.150	0.172	0.26
MEA	10674	40.7	224669	1.2	34.0	Medium	0.083	0.197	0.226	0.34
MEA	5985	40.7	99036	1.2	33.4	Medium	0.082	0.194	0.222	0.33
MEA	10664	40.7	3076468	1.4	28.6	Medium	0.070	0.166	0.190	0.29
MEA	5966	40.7	1468445	1.1	36.1	Medium	0.089	0.210	0.240	0.36
MEA	5965	40.7	575790	1.1	36.1	Medium	0.089	0.210	0.240	0.36
MEA	27854	40.7	14787769	0.7	61.0	Extreme	0.149	0.354	0.405	0.61
MEA	5940	40.7	1070861	1.6	25.9	Medium	0.063	0.150	0.172	0.26
MEA	10674	40.7	9705247	1.2	34.0	Medium	0.083	0.197	0.226	0.34
MEA	10664	40.7	2713849	1.4	28.6	Medium	0.070	0.166	0.190	0.29
MEA	27960	40.7	43523912	0.9	45.9	High	0.112	0.266	0.305	0.46
MEA	10752	40.7	725919	1.4	29.7	Medium	0.073	0.172	0.197	0.30
MEA	10693	40.7	11368998	1.7	24.3	Medium	0.059	0.141	0.161	0.24
MEA	27950	40.7	3170234	1.1	35.6	Medium	0.087	0.207	0.237	0.36
MEA	10681	40.7	3628043	1.1	37.2	Medium	0.091	0.216	0.248	0.37
MEA	27868	40.7	4562302	0.7	59.3	Extreme	0.145	0.344	0.395	0.59
MEA	27853	40.7	283477	0.9	45.3	High	0.111	0.263	0.301	0.45
MEA	27866	40.7	193442	3.8	10.8	Negligible	0.026	0.063	0.072	0.11
MEA	27949	40.7	972343	0.7	58.8	Extreme	0.144	0.341	0.391	0.59
MEA	5970	40.7	419324	1.4	29.1	Medium	0.071	0.169	0.194	0.29
MEA	27854	40.7	28005	0.7	61.0	Extreme	0.149	0.354	0.405	0.61
MEA	5940	40.7	278626	1.6	25.9	Medium	0.063	0.150	0.172	0.26
MEA	5985	40.7	106316	1.2	33.4	Medium	0.082	0.194	0.222	0.33
MEA	10664	40.7	1307271	1.4	28.6	Medium	0.070	0.166	0.190	0.29
MEA	27960	40.7	371984	0.9	45.9	High	0.112	0.266	0.305	0.46
MEA	10752	40.7	96941	1.4	29.7	Medium	0.073	0.172	0.197	0.30
MEA	10693	40.7	47200	1.7	24.3	Medium	0.059	0.141	0.161	0.24
MEA	10681	40.7	365142	1.1	37.2	Medium	0.091	0.216	0.248	0.37
MEA	27949	40.7	277387	0.7	58.8	Extreme	0.144	0.341	0.391	0.59
PAD	26974	69.2	5831043	1.4	50.8	High	0.124	0.294	0.337	0.51
PAD	27016	69.2	3214992	1.2	58.3	Extreme	0.143	0.338	0.388	0.58
PAD	27007	69.2	814017	0.9	76.1	Extreme	0.187	0.442	0.506	0.76
PAD	27000	69.2	4785028	1.4	50.8	High	0.124	0.294	0.337	0.51
PAD	26956	69.2	5198458	1.1	63.2	Extreme	0.155	0.366	0.420	0.63
PAD	27059	69.2	359927	n.a	69.2	Extreme	0.170	0.401	0.460	0.69
PAD	27028	69.2	12723745	1.1	61.0	Extreme	0.149	0.354	0.406	0.61
PAD	27006	69.2	11719425	0.9	81.0	Extreme	0.198	0.470	0.539	0.81

Note: MEA represents Meadow Creek, PAD represents Paddle River

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient (kg ha^{-1} yr^{-1}) STP = 30 mg kg^{-1} TDP	STP = 30 mg kg^{-1} TP	STP = 60 mg kg^{-1} TDP	STP = 60 mg kg^{-1} TP
PAD	26969	69.2	888	0.6	113.4	Extreme	0.278	0.658	0.754	1.13
PAD	27012	69.2	14419744	0.5	133.4	Extreme	0.327	0.773	0.887	1.33
PAD	27037	69.2	3423764	1.7	41.6	High	0.102	0.241	0.276	0.42
PAD	28256	69.2	16711131	0.5	128.5	Extreme	0.315	0.745	0.854	1.28
PAD	28255	69.2	6581827	1.1	60.5	Extreme	0.148	0.351	0.402	0.60
PAD	27054	69.2	7394548	0.7	94.5	Extreme	0.231	0.548	0.628	0.94
PAD	26971	69.2	10127	1.0	67.5	Extreme	0.165	0.391	0.449	0.67
PAD	27031	69.2	4156404	1.1	62.1	Extreme	0.152	0.360	0.413	0.62
PAD	26952	69.2	7281784	1.3	52.4	High	0.128	0.304	0.348	0.52
PAD	27050	69.2	2290878	0.7	93.9	Extreme	0.230	0.545	0.625	0.94
PAD	26954	69.2	5313226	1.0	66.4	Extreme	0.163	0.385	0.442	0.66
PAD	27046	69.2	5488796	1.6	42.1	High	0.103	0.244	0.280	0.42
PAD	27030	69.2	5521429	0.7	105.8	Extreme	0.259	0.614	0.704	1.06
PAD	27011	69.2	20468065	0.7	102.6	Extreme	0.251	0.595	0.682	1.03
PAD	27045	69.2	7087999	1.8	38.9	Medium	0.095	0.225	0.259	0.39
PAD	19273	69.2	4641514	n.a	69.2	Extreme	0.170	0.401	0.460	0.69
PAD	27024	69.2	11622226	1.3	51.3	High	0.126	0.297	0.341	0.51
PAD	19323	69.2	2045511	2.1	32.9	Medium	0.081	0.191	0.219	0.33
PAD	27020	69.2	5853	1.3	51.8	High	0.127	0.301	0.345	0.52
PAD	19304	69.2	5852490	1.5	45.4	High	0.111	0.263	0.302	0.45
PAD	19295	69.2	2591854	1.1	65.9	Extreme	0.161	0.382	0.438	0.66
PAD	26999	69.2	1628295	1.4	50.8	High	0.124	0.294	0.337	0.51
PAD	27015	69.2	1430060	1.2	55.6	High	0.136	0.323	0.370	0.56
PAD	27040	69.2	2843280	3.5	20.0	Low	0.049	0.116	0.133	0.20
PAD	27036	69.2	7952907	1.1	62.1	Extreme	0.152	0.360	0.413	0.62
PAD	19343	69.2	1533164	1.0	67.5	Extreme	0.165	0.391	0.449	0.67
PAD	26997	69.2	1451665	n.a	69.2	Extreme	0.170	0.401	0.460	0.69
PAD	27027	69.2	691259	1.1	61.0	Extreme	0.149	0.354	0.406	0.61
PAD	27057	69.2	2212531	1.6	42.7	High	0.104	0.247	0.284	0.43
PAD	27001	69.2	7176682	1.5	45.4	High	0.111	0.263	0.302	0.45
PAD	27039	69.2	6037351	1.7	40.5	High	0.099	0.235	0.269	0.40
PAD	27017	69.2	9235297	1.5	45.4	High	0.111	0.263	0.302	0.45
PAD	27049	69.2	180204	2.0	34.0	Medium	0.083	0.197	0.226	0.34
PAD	27043	69.2	2709747	2.7	25.4	Medium	0.062	0.147	0.169	0.25
PAD	27029	69.2	1140474	1.1	61.0	Extreme	0.149	0.354	0.406	0.61
PAD	27035	69.2	13167542	1.1	62.1	Extreme	0.152	0.360	0.413	0.62
PAD	26990	69.2	1632427	0.8	89.6	Extreme	0.220	0.520	0.596	0.90
PAD	27047	69.2	749501	2.0	34.0	Medium	0.083	0.197	0.226	0.34
PAD	26989	69.2	3935959	1.7	40.0	High	0.098	0.232	0.266	0.40
PAD	26956	69.2	327588	1.1	63.2	Extreme	0.155	0.366	0.420	0.63
PAD	26971	69.2	43183	1.0	67.5	Extreme	0.165	0.391	0.449	0.67
PAD	26952	69.2	188582	1.3	52.4	High	0.128	0.304	0.348	0.52
PAD	26954	69.2	5567	1.0	66.4	Extreme	0.163	0.385	0.442	0.66
PAD	19304	69.2	1775906	1.5	45.4	High	0.111	0.263	0.302	0.45
PAD	27039	69.2	5104	1.7	40.5	High	0.099	0.235	0.269	0.40
PAD	27017	69.2	27757	1.5	45.4	High	0.111	0.263	0.302	0.45

Note: PAD represents Paddle River

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
PAD	27049	69.2	5305	2.0	34.0	Medium	0.083	0.197	0.226	0.34
PRA	5576	15.4	21480	1.7	9.1	Negligible	0.022	0.053	0.060	0.09
PRA	5996	15.4	26932	1.4	10.7	Negligible	0.026	0.062	0.071	0.11
PRA	5567	15.4	15578	1.7	8.8	Negligible	0.022	0.051	0.059	0.09
PRA	10054	15.4	26493	1.0	15.1	Low	0.037	0.088	0.100	0.15
PRA	10048	15.4	21386	0.9	17.4	Low	0.043	0.101	0.116	0.17
PRA	5573	15.4	73040	1.6	9.5	Negligible	0.023	0.055	0.063	0.10
PRA	10052	15.4	107910	1.1	13.5	Negligible	0.033	0.078	0.090	0.13
PRA	10055	15.4	173598	0.8	18.8	Low	0.046	0.109	0.125	0.19
PRA	10035	15.4	145419	0.8	20.4	Low	0.050	0.119	0.136	0.20
PRA	10039	15.4	118673	0.8	18.3	Low	0.045	0.106	0.122	0.18
PRA	10033	15.4	77606	0.8	20.0	Low	0.049	0.116	0.133	0.20
PRA	5573	15.4	824	1.6	9.5	Negligible	0.023	0.055	0.063	0.10
PRA	5570	15.4	377792	1.7	9.1	Negligible	0.022	0.053	0.060	0.09
PRA	5781	15.4	1852411	1.1	14.6	Negligible	0.036	0.085	0.097	0.15
PRA	5793	15.4	409990	0.9	16.3	Low	0.040	0.094	0.108	0.16
PRA	10046	15.4	132936	0.8	18.6	Low	0.046	0.108	0.124	0.19
PRA	10049	15.4	843066	0.9	17.2	Low	0.042	0.100	0.114	0.17
PRA	10047	15.4	281318	0.9	17.4	Low	0.043	0.101	0.116	0.17
PRA	5576	15.4	17181158	1.7	9.1	Negligible	0.022	0.053	0.060	0.09
PRA	5580	15.4	4951647	1.2	12.5	Negligible	0.031	0.073	0.083	0.13
PRA	5996	15.4	1968224	1.4	10.7	Negligible	0.026	0.062	0.071	0.11
PRA	5790	15.4	12614622	1.1	14.4	Negligible	0.035	0.084	0.096	0.14
PRA	5567	15.4	2326679	1.7	8.8	Negligible	0.022	0.051	0.059	0.09
PRA	10054	15.4	1399182	1.0	15.1	Low	0.037	0.088	0.100	0.15
PRA	5785	15.4	943775	0.9	16.3	Low	0.040	0.094	0.108	0.16
PRA	10048	15.4	2842295	0.9	17.4	Low	0.043	0.101	0.116	0.17
PRA	5800	15.4	14265108	2.1	7.4	Negligible	0.018	0.043	0.049	0.07
PRA	5571	15.4	2645551	1.2	13.0	Negligible	0.032	0.075	0.086	0.13
PRA	5573	15.4	1636317	1.6	9.5	Negligible	0.023	0.055	0.063	0.10
PRA	5572	15.4	11086390	1.5	10.2	Negligible	0.025	0.059	0.068	0.10
PRA	5806	15.4	2265304	0.8	18.8	Low	0.046	0.109	0.125	0.19
PRA	5570	15.4	3447527	1.7	9.1	Negligible	0.022	0.053	0.060	0.09
PRA	10052	15.4	1950093	1.1	13.5	Negligible	0.033	0.078	0.090	0.13
PRA	5787	15.4	19843746	0.6	23.9	Medium	0.059	0.139	0.159	0.24
PRA	10055	15.4	1972418	0.8	18.8	Low	0.046	0.109	0.125	0.19
PRA	10035	15.4	4137379	0.8	20.4	Low	0.050	0.119	0.136	0.20
PRA	5781	15.4	8853171	1.1	14.6	Negligible	0.036	0.085	0.097	0.15
PRA	10038	15.4	2709937	0.9	16.3	Low	0.040	0.094	0.108	0.16
PRA	10039	15.4	8635514	0.8	18.3	Low	0.045	0.106	0.122	0.18
PRA	5793	15.4	9347505	0.9	16.3	Low	0.040	0.094	0.108	0.16
PRA	10037	15.4	1600795	1.0	14.9	Negligible	0.036	0.086	0.099	0.15
PRA	10056	15.4	2102319	0.9	17.0	Low	0.042	0.098	0.113	0.17
PRA	10040	15.4	25552686	1.0	15.6	Low	0.038	0.090	0.103	0.16
PRA	10044	15.4	3258164	0.8	18.1	Low	0.044	0.105	0.120	0.18
PRA	10046	15.4	820999	0.8	18.6	Low	0.046	0.108	0.124	0.19

Note: PAD represents Paddle River, PRA represents Prairie Blood Coulee

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	STP = 30 mg kg^{-1} TDP	STP = 30 mg kg^{-1} TP	STP = 60 mg kg^{-1} TDP	STP = 60 mg kg^{-1} TP
							Estimated export coefficient (kg ha^{-1} yr^{-1})			
PRA	10043	15.4	7752524	0.8	18.6	Low	0.046	0.108	0.124	0.19
PRA	10042	15.4	1652425	0.9	17.7	Low	0.043	0.102	0.117	0.18
PRA	10049	15.4	5814545	0.9	17.2	Low	0.042	0.100	0.114	0.17
PRA	10051	15.4	9272852	1.0	14.9	Negligible	0.036	0.086	0.099	0.15
PRA	10036	15.4	3024758	1.0	14.9	Negligible	0.036	0.086	0.099	0.15
PRA	10033	15.4	3411457	0.8	20.0	Low	0.049	0.116	0.133	0.20
PRA	10034	15.4	7397118	0.8	19.7	Low	0.048	0.115	0.131	0.20
PRA	10025	15.4	2681907	0.8	20.0	Low	0.049	0.116	0.133	0.20
PRA	10047	15.4	2085236	0.9	17.4	Low	0.043	0.101	0.116	0.17
PRA	10041	15.4	3605232	0.8	19.5	Low	0.048	0.113	0.130	0.20
PRA	10029	15.4	3290	0.8	18.1	Low	0.044	0.105	0.120	0.18
RAY	13984	29.6	6048	1.3	22.0	Low	0.054	0.127	0.146	0.22
RAY	13994	29.6	8211	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	13986	29.6	239626	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	13987	29.6	362657	0.6	46.5	High	0.114	0.270	0.310	0.47
RAY	13984	29.6	6535021	1.3	22.0	Low	0.054	0.127	0.146	0.22
RAY	13972	29.6	1858082	1.0	29.7	Medium	0.073	0.172	0.198	0.30
RAY	13994	29.6	5110855	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	13986	29.6	15543021	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	12894	29.6	4688516	1.5	20.0	Low	0.049	0.116	0.133	0.20
RAY	13977	29.6	2997388	0.7	40.1	High	0.098	0.232	0.267	0.40
RAY	12904	29.6	3140608	0.9	33.0	Medium	0.081	0.191	0.219	0.33
RAY	13987	29.6	778362	0.6	46.5	High	0.114	0.270	0.310	0.47
RAY	13986	29.6	770429	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	13986	29.6	144577	1.0	31.0	Medium	0.076	0.180	0.206	0.31
RAY	12894	29.6	20777	1.5	20.0	Low	0.049	0.116	0.133	0.20
RAY	12902	29.6	27138	1.3	22.0	Low	0.054	0.127	0.146	0.22
RAY	12904	29.6	646552	0.9	33.0	Medium	0.081	0.191	0.219	0.33
REN	13938	15.4	785248	1.2	13.4	Negligible	0.033	0.078	0.089	0.13
REN	13938	15.4	61619	1.2	13.4	Negligible	0.033	0.078	0.089	0.13
REN	13939	15.4	31953	1.2	13.4	Negligible	0.033	0.078	0.089	0.13
REN	7656	15.4	8042	0.8	18.4	Low	0.045	0.107	0.122	0.18
REN	7670	15.4	793455	0.3	48.8	High	0.120	0.283	0.324	0.49
REN	13952	15.4	356199	2.0	7.7	Negligible	0.019	0.045	0.051	0.08
REN	11590	15.4	665825	1.0	16.0	Low	0.039	0.093	0.107	0.16
REN	13960	15.4	995	2.4	6.3	Negligible	0.016	0.037	0.042	0.06
REN	13938	15.4	6199441	1.2	13.4	Negligible	0.033	0.078	0.089	0.13
REN	7674	15.4	104396	0.8	18.4	Low	0.045	0.107	0.122	0.18
REN	13939	15.4	5778003	1.2	13.4	Negligible	0.033	0.078	0.089	0.13
REN	7656	15.4	1380750	0.8	18.4	Low	0.045	0.107	0.122	0.18
REN	13937	15.4	3059468	1.1	14.4	Negligible	0.035	0.083	0.096	0.14
REN	13930	15.4	237216	1.0	15.0	Low	0.037	0.087	0.100	0.15
REN	13935	15.4	8569394	0.9	16.4	Low	0.040	0.095	0.109	0.16
REN	13963	15.4	3243973	0.8	19.4	Low	0.047	0.112	0.129	0.19
REN	13953	15.4	2758544	2.0	7.7	Negligible	0.019	0.045	0.051	0.08
REN	13958	15.4	1823660	1.6	9.4	Negligible	0.023	0.054	0.062	0.09

Note: PRA represents Prairie Blood Coulee, RAY represents Ray Creek, REN represents Renwick Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
REN	13931	15.4	4031697	1.0	15.0	Low	0.037	0.087	0.100	0.15
REN	7670	15.4	783178	0.3	48.8	High	0.120	0.283	0.324	0.49
REN	11595	15.4	4617649	0.8	19.4	Low	0.047	0.112	0.129	0.19
REN	11572	15.4	5110240	1.2	12.4	Negligible	0.030	0.072	0.082	0.12
REN	13952	15.4	2368562	2.0	7.7	Negligible	0.019	0.045	0.051	0.08
REN	11590	15.4	4105649	1.0	16.0	Low	0.039	0.093	0.107	0.16
STW	19482	38.5	564029	0.3	129.5	Extreme	0.317	0.751	0.861	1.29
STW	19470	38.5	51477	2.5	15.6	Low	0.038	0.090	0.104	0.16
STW	19479	38.5	506814	0.9	40.9	High	0.100	0.237	0.272	0.41
STW	19451	38.5	53843	2.1	18.0	Low	0.044	0.104	0.120	0.18
STW	19448	38.5	23498	2.4	16.1	Low	0.039	0.093	0.107	0.16
STW	18607	38.5	188775	1.9	20.4	Low	0.050	0.119	0.136	0.20
STW	19446	38.5	1005204	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18610	38.5	315429	1.4	27.3	Medium	0.067	0.158	0.181	0.27
STW	18618	38.5	149826	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	19455	38.5	1342798	2.1	18.0	Low	0.044	0.104	0.120	0.18
STW	18611	38.5	502003	1.8	21.9	Low	0.054	0.127	0.146	0.22
STW	18625	38.5	1035619	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	19468	38.5	123524	2.3	17.0	Low	0.042	0.099	0.113	0.17
STW	19471	38.5	146526	2.4	16.1	Low	0.039	0.093	0.107	0.16
STW	18622	38.5	300561	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18639	38.5	345571	4.0	9.7	Negligible	0.024	0.056	0.065	0.10
STW	18653	38.5	1177954	2.0	19.5	Low	0.048	0.113	0.129	0.19
STW	18614	38.5	1215066	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	18624	38.5	89333	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18591	38.5	883388	1.3	29.7	Medium	0.073	0.172	0.197	0.30
STW	18623	38.5	19600	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18629	38.5	1595	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	18593	38.5	113102	1.4	26.8	Medium	0.066	0.155	0.178	0.27
STW	18655	38.5	364189	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18595	38.5	562458	1.4	28.2	Medium	0.069	0.164	0.188	0.28
STW	18651	38.5	440488	4.7	8.3	Negligible	0.020	0.048	0.055	0.08
STW	18588	38.5	125728	1.4	28.2	Medium	0.069	0.164	0.188	0.28
STW	18657	38.5	382862	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18659	38.5	15093	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	17982	38.5	650	1.7	22.9	Low	0.056	0.133	0.152	0.23
STW	17978	38.5	5	1.4	26.8	Medium	0.066	0.155	0.178	0.27
STW	17391	38.5	18034048	1.4	27.7	Medium	0.068	0.161	0.184	0.28
STW	19482	38.5	57902408	0.3	129.5	Extreme	0.317	0.751	0.861	1.29
STW	19452	38.5	152907	2.2	17.5	Low	0.043	0.102	0.117	0.18
STW	19457	38.5	255292	1.9	20.0	Low	0.049	0.116	0.133	0.20
STW	19470	38.5	557464	2.5	15.6	Low	0.038	0.090	0.104	0.16
STW	19462	38.5	1305619	2.3	16.5	Low	0.041	0.096	0.110	0.17
STW	19479	38.5	4531652	0.9	40.9	High	0.100	0.237	0.272	0.41
STW	19477	38.5	9661308	0.7	56.5	High	0.138	0.327	0.375	0.56
STW	19487	38.5	1011341	0.6	65.2	Extreme	0.160	0.378	0.434	0.65

Note: REN represents Renwick Creek, STW represents Strawberry Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff		Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$)			
					Depth (mm)	P export risk	STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
STW	19466	38.5	616007	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	19469	38.5	2933541	2.5	15.6	Low	0.038	0.090	0.104	0.16
STW	18607	38.5	3222633	1.9	20.4	Low	0.050	0.119	0.136	0.20
STW	19450	38.5	484390	2.8	13.6	Negligible	0.033	0.079	0.091	0.14
STW	19446	38.5	49113027	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18616	38.5	1646060	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	19453	38.5	3216325	2.2	17.5	Low	0.043	0.102	0.117	0.18
STW	19475	38.5	1379815	1.8	21.4	Low	0.052	0.124	0.142	0.21
STW	18610	38.5	796047	1.4	27.3	Medium	0.067	0.158	0.181	0.27
STW	18605	38.5	2333928	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	19476	38.5	1808964	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	19465	38.5	934714	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	19467	38.5	1787837	2.3	17.0	Low	0.042	0.099	0.113	0.17
STW	18652	38.5	3042610	1.9	20.0	Low	0.049	0.116	0.133	0.20
STW	18618	38.5	14563009	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	19455	38.5	2728442	2.1	18.0	Low	0.044	0.104	0.120	0.18
STW	18611	38.5	1676180	1.8	21.9	Low	0.054	0.127	0.146	0.22
STW	18625	38.5	4832012	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	18646	38.5	3530534	0.5	72.5	Extreme	0.178	0.421	0.482	0.73
STW	19458	38.5	12944690	0.5	80.8	Extreme	0.198	0.469	0.537	0.81
STW	18630	38.5	1241013	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	19497	38.5	2347193	0.9	41.9	High	0.103	0.243	0.278	0.42
STW	19471	38.5	905551	2.4	16.1	Low	0.039	0.093	0.107	0.16
STW	19496	38.5	3494275	1.4	27.7	Medium	0.068	0.161	0.184	0.28
STW	19459	38.5	4687962	0.6	59.9	Extreme	0.147	0.347	0.398	0.60
STW	18622	38.5	1685418	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18634	38.5	2869243	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18609	38.5	743193	1.8	21.4	Low	0.052	0.124	0.142	0.21
STW	18631	38.5	668481	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18627	38.5	7722973	2.0	19.5	Low	0.048	0.113	0.129	0.19
STW	18648	38.5	2141923	0.7	55.5	High	0.136	0.322	0.369	0.55
STW	18639	38.5	1347997	4.0	9.7	Negligible	0.024	0.056	0.065	0.10
STW	18653	38.5	7092414	2.0	19.5	Low	0.048	0.113	0.129	0.19
STW	19484	38.5	2885343	0.8	46.7	High	0.114	0.271	0.311	0.47
STW	19494	38.5	827497	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18614	38.5	12796915	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	18649	38.5	1495257	9.9	3.9	Negligible	0.010	0.023	0.026	0.04
STW	18617	38.5	11759259	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	18628	38.5	6947200	1.3	28.7	Medium	0.070	0.167	0.191	0.29
STW	18666	38.5	4222493	1.0	38.0	Medium	0.093	0.220	0.252	0.38
STW	18667	38.5	2767993	0.9	41.9	High	0.103	0.243	0.278	0.42
STW	18603	38.5	4487574	2.4	16.1	Low	0.039	0.093	0.107	0.16
STW	18613	38.5	1315227	1.3	28.7	Medium	0.070	0.167	0.191	0.29
STW	18647	38.5	967597	0.3	148.5	Extreme	0.364	0.861	0.987	1.48
STW	18624	38.5	110531	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18591	38.5	77516037	1.3	29.7	Medium	0.073	0.172	0.197	0.30

Note: STW represents Strawberry Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
STW	18623	38.5	9540089	3.3	11.7	Negligible	0.029	0.068	0.078	0.12
STW	18629	38.5	1541279	2.9	13.1	Negligible	0.032	0.076	0.087	0.13
STW	18615	38.5	10392883	1.6	23.4	Medium	0.057	0.136	0.155	0.23
STW	18594	38.5	1896238	1.7	22.9	Low	0.056	0.133	0.152	0.23
STW	18608	38.5	1816281	1.9	20.4	Low	0.050	0.119	0.136	0.20
STW	18606	38.5	2077747	1.4	28.2	Medium	0.069	0.164	0.188	0.28
STW	18593	38.5	960734	1.4	26.8	Medium	0.066	0.155	0.178	0.27
STW	18633	38.5	1217396	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18587	38.5	12597117	1.3	29.2	Medium	0.072	0.169	0.194	0.29
STW	18644	38.5	7954660	0.4	99.3	Extreme	0.243	0.576	0.660	0.99
STW	18645	38.5	4931401	0.8	48.7	High	0.119	0.282	0.324	0.49
STW	18660	38.5	1615723	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18655	38.5	727467	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18595	38.5	51733502	1.4	28.2	Medium	0.069	0.164	0.188	0.28
STW	18651	38.5	1294201	4.7	8.3	Negligible	0.020	0.048	0.055	0.08
STW	18664	38.5	813467	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18600	38.5	3197410	1.3	28.7	Medium	0.070	0.167	0.191	0.29
STW	18588	38.5	2599110	1.4	28.2	Medium	0.069	0.164	0.188	0.28
STW	18602	38.5	1530942	1.8	21.9	Low	0.054	0.127	0.146	0.22
STW	18589	38.5	15681014	1.5	26.3	Medium	0.064	0.152	0.175	0.26
STW	18597	38.5	1713675	1.4	27.7	Medium	0.068	0.161	0.184	0.28
STW	18657	38.5	929715	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18659	38.5	39783	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	18598	38.5	6541584	1.5	25.3	Medium	0.062	0.147	0.168	0.25
STW	18654	38.5	1783729	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	18604	38.5	1571592	1.6	23.8	Medium	0.058	0.138	0.159	0.24
STW	18658	38.5	4915959	2.0	19.0	Low	0.047	0.110	0.126	0.19
STW	17982	38.5	32781784	1.7	22.9	Low	0.056	0.133	0.152	0.23
STW	18663	38.5	4419398	n.a	38.5	Medium	0.094	0.223	0.256	0.39
STW	17978	38.5	2266197	1.4	26.8	Medium	0.066	0.155	0.178	0.27
STW	17984	38.5	4328859	2.4	16.1	Low	0.039	0.093	0.107	0.16
STW	17995	38.5	526602	2.6	15.1	Low	0.037	0.088	0.100	0.15
STT	16197	14.1	143154	16.9	0.8	Negligible	0.002	0.005	0.006	0.01
STT	16210	14.1	40347	0.7	20.0	Low	0.049	0.116	0.133	0.20
STT	16210	14.1	1521177	0.7	20.0	Low	0.049	0.116	0.133	0.20
STT	16169	14.1	296006	0.5	29.2	Medium	0.071	0.169	0.194	0.29
STT	16197	14.1	586809	16.9	0.8	Negligible	0.002	0.005	0.006	0.01
STT	16201	14.1	555338	0.6	23.3	Medium	0.057	0.135	0.155	0.23
STT	16212	14.1	582337	0.7	20.0	Low	0.049	0.116	0.133	0.20
STT	16196	14.1	45850	16.9	0.8	Negligible	0.002	0.005	0.006	0.01
STT	16169	14.1	123129	0.5	29.2	Medium	0.071	0.169	0.194	0.29
STT	16228	14.1	175318	1.1	13.3	Negligible	0.033	0.077	0.089	0.13
STT	16198	14.1	862633	0.8	18.3	Low	0.045	0.106	0.122	0.18
STT	16197	14.1	24779961	16.9	0.8	Negligible	0.002	0.005	0.006	0.01
STT	16210	14.1	9178705	0.7	20.0	Low	0.049	0.116	0.133	0.20
STT	16201	14.1	8333038	0.6	23.3	Medium	0.057	0.135	0.155	0.23

Note: STW represents Strawberry Creek, STT represents Stretton Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
STT	16253	14.1	1031253	0.3	41.6	High	0.102	0.242	0.277	0.42
STT	16212	14.1	26084407	0.7	20.0	Low	0.049	0.116	0.133	0.20
STT	16196	14.1	2020183	16.9	0.8	Negligible	0.002	0.005	0.006	0.01
STT	16169	14.1	1649270	0.5	29.2	Medium	0.071	0.169	0.194	0.29
STT	16228	14.1	371933	1.1	13.3	Negligible	0.033	0.077	0.089	0.13
STT	16169	14.1	48492	0.5	29.2	Medium	0.071	0.169	0.194	0.29
THR	13793	24.9	34912	1.8	13.5	Negligible	0.033	0.078	0.090	0.13
THR	13819	24.9	1846866	1.3	18.9	Low	0.046	0.110	0.126	0.19
THR	13817	24.9	28055182	1.0	25.9	Medium	0.064	0.150	0.172	0.26
THR	13831	24.9	1429459	1.0	25.4	Medium	0.062	0.148	0.169	0.25
THR	13826	24.9	8445596	1.1	22.9	Low	0.056	0.133	0.153	0.23
THR	13343	24.9	2625580	2.4	10.5	Negligible	0.026	0.061	0.070	0.10
THR	13980	24.9	888822	0.9	27.4	Medium	0.067	0.159	0.182	0.27
THR	13835	24.9	597078	1.2	20.4	Low	0.050	0.119	0.136	0.20
THR	13803	24.9	4285218	1.3	18.9	Low	0.046	0.110	0.126	0.19
THR	13838	24.9	553987	1.8	14.0	Negligible	0.034	0.081	0.093	0.14
THR	13988	24.9	10578333	0.6	38.4	Medium	0.094	0.223	0.255	0.38
THR	13983	24.9	1480430	1.7	14.5	Negligible	0.035	0.084	0.096	0.14
THR	13823	24.9	3037803	1.6	16.0	Low	0.039	0.093	0.106	0.16
THR	13969	24.9	884179	1.6	15.5	Low	0.038	0.090	0.103	0.15
THR	13973	24.9	3325602	1.1	22.9	Low	0.056	0.133	0.153	0.23
THR	13812	24.9	191622	1.2	21.4	Low	0.053	0.124	0.143	0.21
THR	13815	24.9	91511	1.2	21.4	Low	0.053	0.124	0.143	0.21
THR	13846	24.9	1636363	1.5	16.5	Low	0.040	0.095	0.109	0.16
THR	13832	24.9	7131832	0.8	30.9	Medium	0.076	0.179	0.206	0.31
THR	13976	24.9	5827797	1.1	22.9	Low	0.056	0.133	0.153	0.23
THR	13978	24.9	3225247	0.8	30.9	Medium	0.076	0.179	0.206	0.31
THR	13839	24.9	670950	0.6	41.4	High	0.101	0.240	0.275	0.41
THR	13979	24.9	888449	0.9	27.4	Medium	0.067	0.159	0.182	0.27
THR	13991	24.9	3399068	1.6	16.0	Low	0.039	0.093	0.106	0.16
THR	13842	24.9	7274903	0.6	38.4	Medium	0.094	0.223	0.255	0.38
THR	13974	24.9	3961128	0.9	28.9	Medium	0.071	0.168	0.192	0.29
THR	13992	24.9	3076563	1.5	17.0	Low	0.042	0.098	0.113	0.17
THR	13984	24.9	16554588	1.5	17.0	Low	0.042	0.098	0.113	0.17
THR	13858	24.9	212615	1.3	18.9	Low	0.046	0.110	0.126	0.19
THR	13975	24.9	4050030	0.9	28.9	Medium	0.071	0.168	0.192	0.29
THR	13993	24.9	7616708	1.6	16.0	Low	0.039	0.093	0.106	0.16
THR	13994	24.9	775168	1.0	23.9	Medium	0.059	0.139	0.159	0.24
THR	13995	24.9	1188535	0.8	31.4	Medium	0.077	0.182	0.209	0.31
THR	13986	24.9	70114	1.0	23.9	Medium	0.059	0.139	0.159	0.24
THR	13830	24.9	3997800	0.8	30.9	Medium	0.076	0.179	0.206	0.31
THR	13841	24.9	1458425	1.0	24.9	Medium	0.061	0.145	0.166	0.25
THR	13802	24.9	4369533	1.0	24.9	Medium	0.061	0.145	0.166	0.25
THR	13977	24.9	2062627	0.8	30.9	Medium	0.076	0.179	0.206	0.31
THR	13987	24.9	1370180	0.7	35.9	Medium	0.088	0.208	0.239	0.36
TOM	26774	53.5	833335	0.5	102.6	Extreme	0.251	0.595	0.682	1.03

Note: STT represents Stretton Creek, THR represents Threehills Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff: Depth (mm)	Estimated runoff: P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$), STP = 30 $mg\ kg^{-1}$: TDP	STP = 30 $mg\ kg^{-1}$: TP	STP = 60 $mg\ kg^{-1}$: TDP	STP = 60 $mg\ kg^{-1}$: TP
TOM	18911	53.8	15847916	1.7	31.1	Medium	0.076	0.181	0.207	0.31
TOM	18455	53.8	2078732	1.6	33.9	Medium	0.083	0.197	0.225	0.34
TOM	18415	53.8	30268	1.3	41.5	High	0.102	0.241	0.276	0.42
TOM	18403	53.8	471607	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26728	53.8	4871430	3.7	14.5	Negligible	0.036	0.084	0.097	0.15
TOM	26747	53.8	959799	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	18943	53.8	921843	2.7	20.1	Low	0.049	0.116	0.133	0.20
TOM	19083	53.8	621082	0.4	128.0	Extreme	0.314	0.742	0.851	1.28
TOM	26720	53.8	5259838	0.3	177.1	Extreme	0.434	1.027	1.178	1.77
TOM	18391	53.8	33296	1.4	39.4	High	0.097	0.229	0.262	0.39
TOM	26774	53.8	907470	0.5	103.1	Extreme	0.253	0.598	0.686	1.03
TOM	18456	53.8	241201	1.4	38.7	Medium	0.095	0.225	0.258	0.39
TOM	19002	53.8	2828232	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26791	53.8	5277962	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26751	53.8	1552748	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26740	53.8	1823748	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26753	53.8	1194092	n.a	53.8	High	0.132	0.312	0.358	0.54
TOM	26676	53.8	903568	1.3	42.2	High	0.103	0.245	0.281	0.42
TOM	26758	53.8	6328677	0.4	146.0	Extreme	0.358	0.847	0.971	1.46
TOM	26725	53.8	791483	0.4	127.3	Extreme	0.312	0.738	0.847	1.27
TOM	18420	53.8	5902680	3.7	14.5	Negligible	0.036	0.084	0.097	0.15
TOM	18448	53.8	5665663	0.9	59.5	Extreme	0.146	0.345	0.396	0.60
TOM	18457	53.8	119880	1.2	45.0	High	0.110	0.261	0.299	0.45
TOM	18446	53.8	2362648	0.8	64.3	Extreme	0.158	0.373	0.428	0.64
TOM	18443	53.8	4895214	0.6	94.1	Extreme	0.231	0.546	0.626	0.94
TOM	18442	53.8	2677583	0.8	64.3	Extreme	0.158	0.373	0.428	0.64
TOM	18444	53.8	812115	0.9	58.1	Extreme	0.142	0.337	0.387	0.58
TOM	18447	53.8	209202	0.9	59.5	Extreme	0.146	0.345	0.396	0.60
TOM	18450	53.8	2622757	1.9	28.4	Medium	0.070	0.165	0.189	0.28
TOM	18424	53.8	4908993	2.4	22.8	Low	0.056	0.132	0.152	0.23
TOM	18451	53.8	708413	1.2	45.7	High	0.112	0.265	0.304	0.46
TOM	18429	53.8	1695865	0.5	110.0	Extreme	0.270	0.638	0.732	1.10
TOM	18441	53.8	2712414	0.8	64.3	Extreme	0.158	0.373	0.428	0.64
TOM	18426	53.8	307215	0.4	120.4	Extreme	0.295	0.698	0.801	1.20
TRO	29159	60.5	393231	0.9	68.3	Extreme	0.167	0.396	0.454	0.68
TRO	27959	60.5	23377169	0.9	66.7	Extreme	0.163	0.387	0.444	0.67
TRO	27863	60.5	48245227	2.9	21.2	Low	0.052	0.123	0.141	0.21
TRO	10630	60.5	17214265	1.2	48.8	High	0.120	0.283	0.325	0.49
TRO	27955	60.5	1415619	0.9	66.7	Extreme	0.163	0.387	0.444	0.67
TRO	27971	60.5	8078774	1.0	63.5	Extreme	0.155	0.368	0.422	0.63
TRO	10688	60.5	1620511	1.3	48.0	High	0.118	0.278	0.319	0.48
TRO	27963	60.5	17638744	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	27860	60.5	25523304	0.7	83.0	Extreme	0.203	0.481	0.552	0.83
TRO	27978	60.5	2957995	0.9	68.3	Extreme	0.167	0.396	0.454	0.68
TRO	27948	60.5	1396175	0.9	69.1	Extreme	0.169	0.401	0.460	0.69
TRO	27939	60.5	1601265	0.9	65.1	Extreme	0.159	0.377	0.433	0.65

Note: TOM represents Tomahawk Creek, TRO represents Trout Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
TRO	10679	60.5	4282157	1.0	57.8	High	0.142	0.335	0.384	0.58
TRO	10649	60.5	1213697	0.9	64.3	Extreme	0.157	0.373	0.427	0.64
TRO	10687	60.5	238817	1.0	58.6	Extreme	0.144	0.340	0.390	0.59
TRO	10625	60.5	8987236	1.0	59.4	Extreme	0.145	0.344	0.395	0.59
TRO	27966	60.5	8944782	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	10706	60.5	6379533	0.8	75.7	Extreme	0.185	0.439	0.503	0.76
TRO	27859	60.5	55085091	0.7	83.0	Extreme	0.203	0.481	0.552	0.83
TRO	27940	60.5	11399099	1.0	57.8	High	0.142	0.335	0.384	0.58
TRO	27943	60.5	5940280	1.1	56.1	High	0.138	0.326	0.373	0.56
TRO	27934	60.5	1251370	1.2	49.6	High	0.122	0.288	0.330	0.50
TRO	10691	60.5	1640782	1.1	56.9	High	0.140	0.330	0.379	0.57
TRO	27938	60.5	2030769	0.9	65.1	Extreme	0.159	0.377	0.433	0.65
TRO	27942	60.5	3495554	1.1	56.1	High	0.138	0.326	0.373	0.56
TRO	10765	60.5	10318375	0.9	68.3	Extreme	0.167	0.396	0.454	0.68
TRO	10756	60.5	557255	1.1	53.7	High	0.132	0.311	0.357	0.54
TRO	10685	60.5	3214662	1.0	58.6	Extreme	0.144	0.340	0.390	0.59
TRO	27964	60.5	11406980	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	10696	60.5	4608914	1.3	48.0	High	0.118	0.278	0.319	0.48
TRO	10738	60.5	258430	1.0	61.0	Extreme	0.149	0.354	0.406	0.61
TRO	27941	60.5	1679184	1.5	41.5	High	0.102	0.241	0.276	0.41
TRO	27944	60.5	1328063	1.1	56.1	High	0.138	0.326	0.373	0.56
TRO	27953	60.5	22201958	0.9	65.1	Extreme	0.159	0.377	0.433	0.65
TRO	27965	60.5	11274322	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	27937	60.5	3650314	0.9	65.1	Extreme	0.159	0.377	0.433	0.65
TRO	27945	60.5	1468698	1.1	56.1	High	0.138	0.326	0.373	0.56
TRO	10697	60.5	15609333	1.3	45.6	High	0.112	0.264	0.303	0.46
TRO	27979	60.5	1442977	0.9	68.3	Extreme	0.167	0.396	0.454	0.68
TRO	27973	60.5	803001	3.5	17.1	Low	0.042	0.099	0.114	0.17
TRO	27936	60.5	1643308	0.9	65.1	Extreme	0.159	0.377	0.433	0.65
TRO	27974	60.5	2194349	0.9	66.7	Extreme	0.163	0.387	0.444	0.67
TRO	27962	60.5	2665383	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	27935	60.5	7790043	1.1	54.5	High	0.134	0.316	0.362	0.55
TRO	5966	60.5	1975474	1.1	54.5	High	0.134	0.316	0.362	0.55
TRO	27976	60.5	2033322	0.8	78.1	Extreme	0.191	0.453	0.519	0.78
TRO	27854	60.5	20153811	0.7	91.9	Extreme	0.225	0.533	0.611	0.92
TRO	27961	60.5	2863278	1.0	61.8	Extreme	0.151	0.359	0.411	0.62
TRO	27861	60.5	7635185	2.9	21.2	Low	0.052	0.123	0.141	0.21
TRO	10674	60.5	2035035	1.2	51.3	High	0.126	0.297	0.341	0.51
TRO	27960	60.5	2839315	0.9	69.1	Extreme	0.169	0.401	0.460	0.69
TRO	27950	60.5	880145	1.1	53.7	High	0.132	0.311	0.357	0.54
TRO	27957	60.5	2901300	0.9	66.7	Extreme	0.163	0.387	0.444	0.67
TRO	27946	60.5	2320984	1.9	31.7	Medium	0.078	0.184	0.211	0.32
TRO	27868	60.5	2330174	0.7	89.5	Extreme	0.219	0.519	0.595	0.89
TRO	27865	60.5	102239	3.7	16.3	Low	0.040	0.094	0.108	0.16
TRO	29159	60.5	4715435	0.9	68.3	Extreme	0.167	0.396	0.454	0.68
TRO	5984	60.5	30173	1.5	39.9	High	0.098	0.231	0.265	0.40

Note: TRO represents Trout Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient (kg ha^{-1} yr^{-1}) STP = 30 mg kg^{-1} TDP	STP = 30 mg kg^{-1} TP	STP = 60 mg kg^{-1} TDP	STP = 60 mg kg^{-1} TP
TRO	10687	60.5	2860561	1.0	58.6	Extreme	0.144	0.340	0.390	0.59
TRO	5969	60.5	4104228	1.9	32.5	Medium	0.080	0.189	0.216	0.33
TRO	10696	60.5	439462	1.3	48.0	High	0.118	0.278	0.319	0.48
TRO	5941	60.5	1201011	1.3	45.6	High	0.112	0.264	0.303	0.46
TRO	10738	60.5	298961	1.0	61.0	Extreme	0.149	0.354	0.406	0.61
TRO	5974	60.5	3123837	1.1	54.5	High	0.134	0.316	0.362	0.55
TRO	5968	60.5	878275	1.4	43.9	High	0.108	0.255	0.292	0.44
TRO	5967	60.5	1114128	1.0	62.6	Extreme	0.153	0.363	0.417	0.63
TRO	5982	60.5	987567	1.3	47.2	High	0.116	0.274	0.314	0.47
TRO	5966	60.5	237939	1.1	54.5	High	0.134	0.316	0.362	0.55
TRO	5965	60.5	828510	1.1	54.5	High	0.134	0.316	0.362	0.55
TRO	5940	60.5	123375	1.5	39.0	High	0.096	0.226	0.260	0.39
WAB	19597	7.7	3896580	0.6	13.2	Negligible	0.032	0.077	0.088	0.13
WAB	19593	7.7	3730737	1.6	4.7	Negligible	0.012	0.027	0.031	0.05
WAB	19658	7.7	1344617	1.2	6.3	Negligible	0.015	0.036	0.042	0.06
WAB	19617	7.7	591244	1.6	4.9	Negligible	0.012	0.029	0.033	0.05
WAB	19640	7.7	239518	1.4	5.4	Negligible	0.013	0.031	0.036	0.05
WAB	19597	7.7	2577073	0.6	13.2	Negligible	0.032	0.077	0.088	0.13
WAB	19658	7.7	3585854	1.2	6.3	Negligible	0.015	0.036	0.042	0.06
WAB	19617	7.7	8348336	1.6	4.9	Negligible	0.012	0.029	0.033	0.05
WAB	19640	7.7	6491939	1.4	5.4	Negligible	0.013	0.031	0.036	0.05
WAB	19649	7.7	66222	1.4	5.6	Negligible	0.014	0.032	0.037	0.06
WAB	19663	7.7	42818639	1.4	5.4	Negligible	0.013	0.031	0.036	0.05
WAB	19669	7.7	2690458	n.a	7.7	Negligible	0.019	0.045	0.051	0.08
WAB	19660	7.7	3232585	1.2	6.3	Negligible	0.015	0.036	0.042	0.06
WAB	19654	7.7	18604493	1.3	5.8	Negligible	0.014	0.034	0.039	0.06
WAB	28206	7.7	33788743	1.4	5.6	Negligible	0.014	0.032	0.037	0.06
WAB	19648	7.7	273638	1.2	6.5	Negligible	0.016	0.038	0.043	0.06
WAB	19659	7.7	6069659	0.4	20.4	Low	0.050	0.118	0.135	0.20
WAB	19661	7.7	4429842	1.0	7.8	Negligible	0.019	0.045	0.052	0.08
WAB	19641	7.7	20887363	1.2	6.5	Negligible	0.016	0.038	0.043	0.06
WAB	19636	7.7	946985	0.8	9.2	Negligible	0.022	0.053	0.061	0.09
WAB	19645	7.7	8001639	1.4	5.4	Negligible	0.013	0.031	0.036	0.05
WAB	19643	7.7	2456377	1.0	8.1	Negligible	0.020	0.047	0.054	0.08
WAB	14050	7.7	2308568	0.9	8.3	Negligible	0.020	0.048	0.055	0.08
WAB	19642	7.7	18107283	1.1	6.7	Negligible	0.016	0.039	0.045	0.07
WAB	19667	7.7	4073421	0.8	9.2	Negligible	0.022	0.053	0.061	0.09
WAB	19652	7.7	4935614	0.9	8.3	Negligible	0.020	0.048	0.055	0.08
WAB	19633	7.7	27227940	0.9	8.5	Negligible	0.021	0.049	0.057	0.09
WAB	19639	7.7	3604856	0.9	8.5	Negligible	0.021	0.049	0.057	0.09
WAB	19653	7.7	3784291	0.9	8.3	Negligible	0.020	0.048	0.055	0.08
WAB	14080	7.7	808581	1.2	6.5	Negligible	0.016	0.038	0.043	0.06
WAB	19634	7.7	10163894	0.7	10.3	Negligible	0.025	0.060	0.068	0.10
WAB	19638	7.7	4481057	0.8	9.6	Negligible	0.024	0.056	0.064	0.10
WAB	19635	7.7	46248859	0.8	9.6	Negligible	0.024	0.056	0.064	0.10
WAB	19632	7.7	377270	0.8	9.4	Negligible	0.023	0.055	0.063	0.09

Note: TRO represents Trout Creek, WAB represents Wabash Creek

Watershed name	AGRASID polygon ID	Observed runoff depth (mm)	Drainage area (m^2)	WEPP predicted runoff factor (RF)	Estimated runoff Depth (mm)	Estimated runoff P export risk	Estimated export coefficient ($kg\ ha^{-1}\ yr^{-1}$) STP = 30 $mg\ kg^{-1}$ TDP	STP = 30 $mg\ kg^{-1}$ TP	STP = 60 $mg\ kg^{-1}$ TDP	STP = 60 $mg\ kg^{-1}$ TP
WAB	14065	7.7	401019	1.4	5.6	Negligible	0.014	0.032	0.037	0.06
WAB	14064	7.7	456962	1.1	6.9	Negligible	0.017	0.040	0.046	0.07
WAB	18748	7.7	1136731	0.9	8.3	Negligible	0.020	0.048	0.055	0.08
WAB	14077	7.7	6248861	0.5	16.1	Low	0.039	0.093	0.107	0.16
WAB	18738	7.7	3155646	0.5	14.8	Negligible	0.036	0.086	0.098	0.15
WAB	14071	7.7	123868	0.5	14.3	Negligible	0.035	0.083	0.095	0.14

Note: WAB represents Wabash Creek