Browns River Phase 1- Watershed Assessment Summary

Introduction

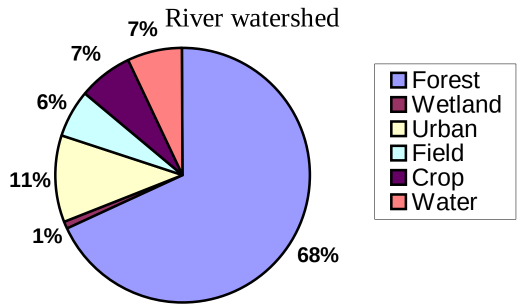
Watershed planning in Vermont is experiencing rapid and positive change. The most significant changes are the growing recognition of environmental concerns and the broad acceptance of public participation in decision-making processes. Currently the Agency of Natural Resources (ANR) is actively involved in watershed planning throughout the State.

The principle purpose of this summary is to: (a) describe the need and the role of public participation in watershed planning; (b) outline the methods used to study the Browns River Watershed; (c) define the top water quality issues to be addressed to revitalize the Browns River; and (d) outline steps to begin protecting and restoring the future of the Browns River.

Background

The Browns River is a sub watershed of the lower Lamoille River watershed and flows through the towns of Westford, Essex, Jericho and Underhill. Figure 1 denotes the watershed location. The Browns River has been listed as impaired for 7.5 miles due to severe streambank erosion through the town of Essex and portions of Westford and Jericho. The pollutant is listed as sediment and the possible causes of the impairment are stated as streambank erosion due to agricultural encroachments and previous in-stream gravel mining operations (Department of Environmental Conservation (DEC), 2001). The impaired reach runs through predominately agricultural land that is currently in corn, hay and pastureland. The uplands and tributaries have transitioned from agricultural to residential and commercial land uses. The generalized land uses within the Browns River watershed are compared in Figure 2.

Figure 2: Generalized Land Use/Land Cover in the Browns River watershed



Data taken from the most downstream reach (M1) on the Browns River. This data gives a general representation of the land uses throughout the watershed.

The river is described as a meandering riffle-pool sand bottom system with a wide valley and broad floodplain. These stream systems are extremely susceptible to instability when natural vegetation is removed. Aerial photos indicate that woody riparian buffers are sparse in much of the defined reach. This appears to be a concern throughout much of the watershed. See Figure 4 for these areas of high impact, denoted in red, due to a lack of riparian vegetation. Streambank erosion also dominates this impaired reach on the outside bends even where buffers exist; see Table 1.

DEC has brought together various local, state, and federal partners in an effort to implement agricultural, stormwater, and road infrastructure Best Management Practices (BMPs) and stream corridor protection within the Browns River watershed. These watershed restoration efforts aim to reduce stream instability and in so doing reduce phosphorus loads in the Browns River and ultimately Lake Champlain. Partners include DEC, U.S. Fish & Wildlife Service, Williston and Berlin USDA Natural Resources Conservation Service (NRCS) offices, Winooski Natural Resources Conservation District (NRCD), Chittenden County Regional Planning Commission (CCRPC), and Vermont Agency of Agriculture.

Two grants from the Lake Champlain Basin Program have been secured to undertake a geomorphic assessment of the entire watershed. A watershed assessment using the Agency of Natural Resources Phase 1 protocols have been recently completed. The Phase 1 assessment identified existing stream conditions at the watershed scale using Geographic Information System (GIS) tools and ground truth methods. Bridge and culvert assessments have been completed to inventory these crossings and to identify structures contributing to stream instability and hindering fish passage. These failing structures will be targeted for removal or repair during the second more detailed phase of the assessment.

Looking upstream at the Lee River

Public Participation

The Winooski Natural Resources Conservation District has distributed letters to farmers discussing the impairments, notifying them of the watershed-wide assessment planned for the next few years, and sharing the voluntary cost share programs that are available in the state. A public forum was recently held in the town of Underhill to present the results of the Phase 1 watershed geomorphic assessment. The Winooski NRCD, DEC, and CCRPC presented information at the forum. A second public forum is scheduled for January in Westford. This meeting will be co-sponsored by the Westford Conservation Commission. Volunteers will be recruited at the public forums to assist in the data collection in the Phase 2 in-stream geomorphic and fisheries habitat assessment. Copies of the Phase 1 geomorphic assessment results will be distributed to all partners, municipalities within the watershed, and residents requesting copies. Local acceptance and participation is helpful in completing this process but essential in adopting the proposed changes. Successful restoration and protection projects are impossible without support and understanding of the issues concerning human influence on stream morphology.

Phase 1 Watershed Assessment Methodology and Results

Bridge and culvert surveys

A watershed-wide bridge and culvert inventory and assessment was conducted to determine if stream crossings were contributing to localized streambank erosion, sedimentation, and impaired fish passage. The Agency of Natural Resources Bridge and Culvert Phase 1 protocols were used (ANR, 2003). A sample data sheet is included in the Appendix as Figure 3. Bridge spans and culvert diameter measurements were compared to calculated bankfull width measurements. The bankfull width, also known as the channel forming flow, is directly related to watershed drainage area. The bankfull flow is the discharge at which the majority of erosion and deposition takes place. Undersized bridges and culverts are not designed to accommodate both flow and sediment. During flood events large point bars can consequently deposit upstream of undersized bridges and culverts. During catastrophic flood events crossings can become outflanked, taking out large sections of roads and driveways. Significant sediment discharges to waterways can result. Twenty-eight bridges and culverts were assessed on the Browns River main stem. Fourteen crossings were undersized, or measured at less than 75% of bankfull flow.

Culvert assessment on Morgan Brook

Bridge and culvert inventories and assessments were also conducted on Morgan Brook, Rogers Brook, Abbey Brook, Steinhour Brook, Stevensville Brook, Clay Brook, Crane Brook, Lee River and Roaring Brook. Thirty-two bridges and culverts were assessed on these tributaries. Sixteen tributary crossings were undersized. Other "red flagging" criteria included sharp approaching river bends to the structures, free fall culvert outlets, and large point bar development and significant streambank erosion both upstream and downstream of crossings.

Red flagged crossings in the Browns River d

	Browns River	**Tributaries**
ridge or Culvert totals 3 or C)	26B + 2C *28 total*	19B + 13C *32 total*
Undersized structure	**14**	**16**
gnificant streambank erosion	9	4
Large point bars- sedimentation	5	7
Sharp approaching bend	5	3
Free fall culverts	0	5

Most important parameter observed

Phase 1 Watershed Assessment Results

Methodology- Stream reaches were defined by creating reach breaks using valley width and slope, geologic materials, and tributary influence. Twenty-one reaches were delineated on the Browns River main stem and 47 reaches on the tributaries. Reaches were numbered to efficiently organize, track, and communicate reach-related data. After stream reaches were defined, watershed, sub-watershed, tributary, and reach watershed areas were delineated and calculated. Stream reach identification map can be found in the Appendix, Figure 5.

Reaches assessed on the Browns River and ten major tributaries

	Reach Number	**Number of reaches**	**Drainage Area at downstream most location in square miles**
Browns River	M	21	92.32
Morgan Brook	T1	5	11.57
Rogers Brook	T2	5	6.27
Abbey Brook	T3	6	3.5
Lee River	T4	6	15.41
The Creek	T5	6	10.87
Roaring Brook	T5S1	5	3.81
Steinhour Brook	T6	3	1.81
Crane Brook	T7	3	2.58
Clay Brook	T8	4	2.52
Stevensville Brook	T9	4	3.06
TOTAL		**68**	

SGAT

Using the Stream Geomorphic Assessment Tool (SGAT), several parameters were calculated including: valley width, length, and slope; channel length and slope; stream confinement; sinuosity; and reference channel width. Based on this data, reference stream types were classified according to characteristics of the valley, geology, and climate of the stream. The reference stream type describes the natural channel tendency of channel form and process in the absence of human-related changes to the channel.

Reference stream type classification

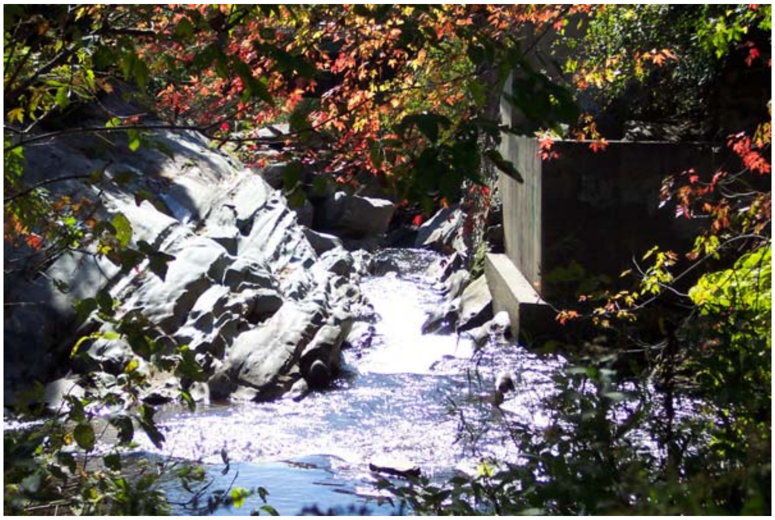
Stream Type	**A**	**B**	**C**	**E**	**Unclassified**	**Total**
Browns River reaches	**2**	**3**	**9**	**7**	**0**	**21**
Major Tributary reaches	**9**	**14**	**7**	**6**	**11**	**47**
Total						**68**

Classification of Rosgen (1996) Stream Type

SGAT, Remote Sensing, Local Knowledge, and Field Verification

Using a combination of SGAT, remote sensing, local knowledge, and windshield surveys (field verification) the following parameters and their respective impacts were inventoried and/or calculated, and assessed:

- Valley side slopes
- River corridor delineation
- River corridor and reach land use and land cover
- Riparian buffer condition
- Hydrologic groups
- Soils and geology influences
- Alluvial fans
- Grade controls
- River corridor development
- Bank armoring
- Bridge and culverts



Old Mill in Jericho

Depositional feature on the Browns River in Essex

- Flow regulation and water withdrawal
- Channel modifications
- Flood plain encroachments
- Dredging and channel mining history
- Depositional features
- Meander migration
- Meander width ratio
- Stream wavelength
- Debris jam potential
- Dominant bed form and materials

Conclusions

Seventy-nine miles of stream, on the Browns River and nine major tributaries, were assessed during Phase I watershed geomorphic assessment. Results indicate that 18% of the stream channel has undergone significant channel straightening and windrowing. This stream channel modification changes the natural path and morphology of the river. The stream evolutional process of degradation (cutting down of the stream bed due to increased velocity and slope) and consequent aggradation (the building up of sediment downstream in the channel bed) is set in motion by this plan-form change. A state of aggradation can result in bed and bank instability, which can be detrimental to riparian land and aquatic habitat (VT ANR, 2003). There has been significant plan-form adjustment that may be an indicator of system-wide rather than local instability. Identifying the locations in the watershed where this instability is most prominent has helped prioritize candidate reaches for restoration and protection projects. Table 2 demonstrates these areas of significant adjustment in the watershed.

Much of the lower main stem was classified as a dune-ripple E stream type. These stream types are generally very sinuous and stable systems in natural conditions. These stream types are also extremely sensitive to disturbance. This section of the Browns River has been channelized and vegetation removed for agricultural purposes. These once highly sinuous reaches are now straight and in some cases channel degradation has occurred.

Stream impact ratings for each reach in the watershed were assigned based upon the following parameters:

1. Land Cover and Reach Hydrology
   - Watershed land use
   - River corridor land use
   - Riparian buffer impact
2. In-stream Channel Modification
   - Bridges and culverts
   - Channel modifications
   - Bank armoring
   - Dredging and gravel mining
3. Floodplain Modification
   - Corridor development
   - Berms and roads
   - Depositional features
   - Meander migrations
   - Meander width ratio
   - Wavelength ratio
4. Bed and Bank Windshield Observations
   - Bank erosion
   - Debris and ice jam potential

The top overall impact rating in the watershed was land use. High land and land cover impact ratings indicated that greater than 10% of the reach corridor (4 times the channel width on either side of the channel) was in row crop production and or developed (residential, commercial, industrial, and road systems). High impact scores in the area of riparian buffers showed that M1, M2, M7, M9, and M14 had little or no woody buffers along the top of bank. Abbey Brook, Clay Brook, Roaring Brook, and Morgan Brook also received high impact ratings due to lack of woody buffers. Sedimentation impact ratings indicated that the reaches described as riffle-pool stream systems (M10-12, M 15-19 and T3, T4, T6, T8) were the most susceptible to significant sediment deposits. Riffle-pool streams are generally dominated by gravel substrate. These reaches were heavily mined for commercial gravel extraction in the Underhill and Jericho areas of the watershed. These areas indicate the largest areas of sediment discharge and the possible associated phosphorus contributions.

The entire main stem and many tributaries scored high impact ratings in the area of meander migration, especially M7-M16. Table 4 illustrates this lack of sufficient riparian buffer watershed wide.

Deliverables:

Objective	Task	Product	Work Completed	
Identify significant physical watershed features of the Browns River	Complete Phase I, Vermont Stream Geomorphic Assessment on the Browns River Watershed.	• Watershed database • GIS Watershed map with stream and valley type classifications. Stream impact ratings, stream stability ratings, and current and historic land use.	CCRPC, Winooski NRCD & DEC used aerial photos, orthophotos, USGS topographical maps and collected existing data from VT ANR to enter data into SGAT database	
Secure landowner permission and cooperation	Mailings, phone calls and/or visits	• Cooperator Database	Letters were sent to all adjacent landowners identified along the Browns River & its major tributaries; follow up visits with concerned/interested landowners were also done by Winooski NRCD employees	
Verify the accuracy of data collected by remote sensing	Groundtruthing	Accurate Data/Field verification	Windshield survey, bridge and culvert assessment were conducted on the Browns River main stem and 8 of 9 tributaries identified with major watershed influence	
Community outreach	Hold public forums and send out press releases	Informational meeting presenting the Phase I geomorphic protocol to landowners.	An initial public meeting was held to explain and share the Phase I geomorphic assessment process with project partners and a local volunteer group; outreach to community and landowners was conducted through a watershed-wide mailing	
Community outreach	Produce and distribute assessment summary, include this in a press release. Hold a public forum to present this to landowners.	A lay-person friendly summary of the geomorphic assessment	Winooski NRCD, CCRPR & DEC held 2 public meetings, in towns of Underhill and Westford, to share results with the community and town officials; press releases printed in local newspapers; copies of the final report will be mailed to interested community members, all town municipalities, and to each project partnering agency	
Project coordination & administration	Communication among partners, project timing, technical assistance, administration, fund distribution, two press releases, quarterly reports and a final report.	Work plan submittal, invoice submittal, & overall project coordination	Project coordination achieved through weekly email correspondence & bimonthly team meetings for identifying priorities; DEC technical assistance was provided on a weekly basis with SGAT and field data collection; quarterly reports were also completed & submitted	

Next Steps for the Browns River Watershed Assessment

The Winooski NRCD and its partners will conduct the second phase of a stream geomorphic assessment on all of the Browns River main stem reaches and in at least one reach of all of the major tributaries in summer of 2004. The results of the Phase I

Geomorphic Assessment will be used to target reaches for additional detailed in-stream evaluation in the Phase II Rapid Geomorphic and Fisheries Habitat Assessments. The results of the assessment will be used to direct water quality improvement projects throughout the Browns River watershed. This second phase of assessment will field verify data collected at the remote sensing level of the first assessment using in-stream quantitative criteria to determine fisheries habitat health and stream stability. The Phase I database will be used to compare stream segments and reaches within the watershed to each other and regional reference conditions. Current stream conditions and types of instability will provide the basis for the alternatives analysis and a prioritization of restoration reaches and restoration strategies within the basin. Reaches identified as reference streams will be targeted for additional protection.

Questions and concerns expressed at our public meeting will also be addressed as this stream assessment continues. Numerous community members asked that closer attention be paid to fish habitat criteria in the second assessment. The Town of Underhill identified a specific crossing in town that they are concerned with. The town recently invested in a town road and new bridge; we will be sure to include this bridge crossing (M18) in our assessment. Two areas that we have preliminarily targeted as problem areas are Underhill Center and Westford, along Route 128 and Route 15, respectively. We will spend considerable time on an in-stream assessment in these areas.

The potential to use the results from this watershed assessment in other jurisdictions, for example town plans, is possible since Jericho, Westford and Underhill town plans are up for renewal in spring of 2004. Westford and Underhill have agreed to include watershed planning concerns into the approval of their town plan.

References:

Rosgen, Dave, 1996. Applied River Morphology, Pagosa Springs, Colorado

"Town of Jericho Comprehensive Town Plan", adopted June 25 2001, Jericho, VT

"Underhill Town Plan", adopted February 25th, 1999, Underhill, VT

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Vermont Center for Geographic Information (VCGI), 1993-2003, GIS Data, Waterbury, VT

Vermont Department of Environmental Conservation, 2001. *Lamoille River Watershed Assessment Report.* Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Mapping Program, 1999, Orthophotos, Waterbury, VT

"Westford Town Plan", adopted May 10, 1999, Westford, VT

APPENDIX

Figures & Tables

Figure 1: The Browns River watershed

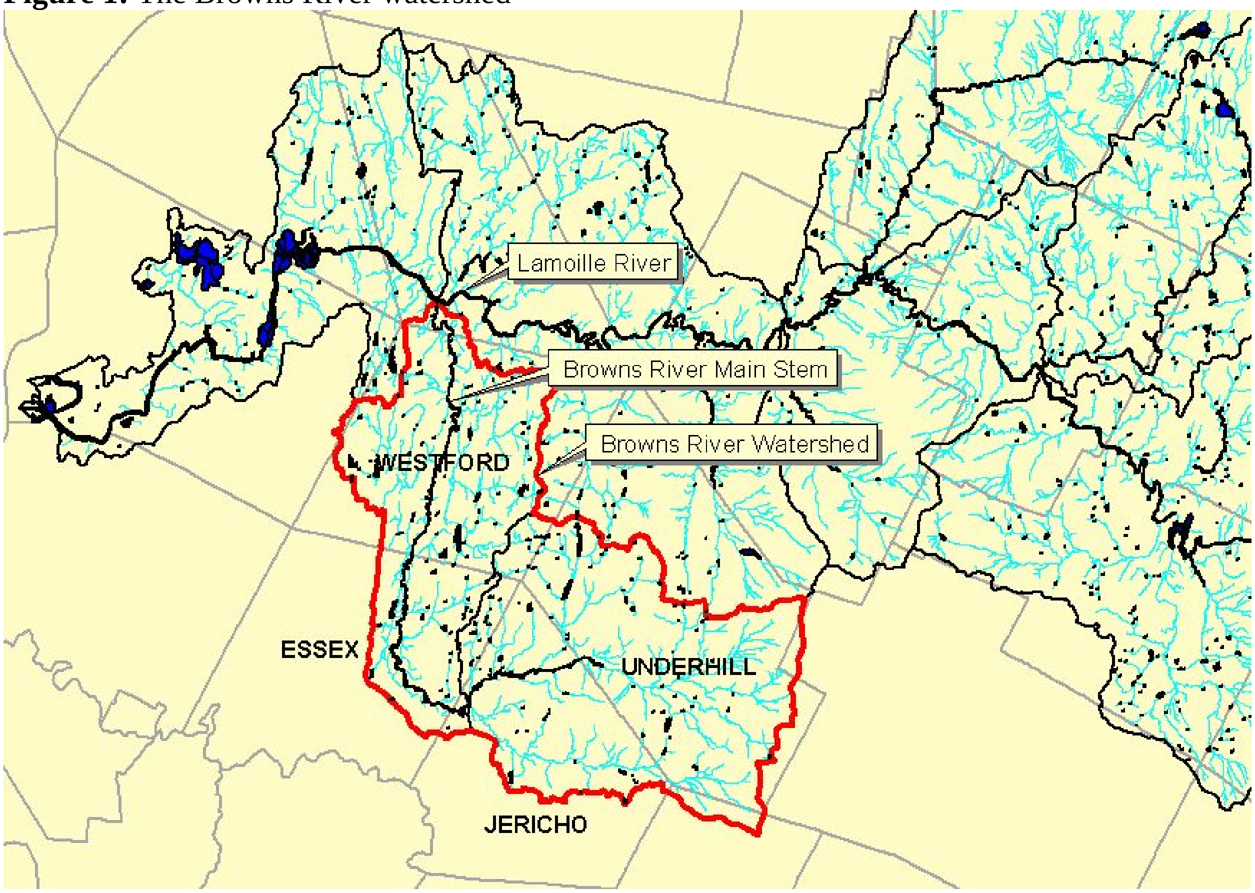

Figure 4: Riparian buffers in the Browns River watershed

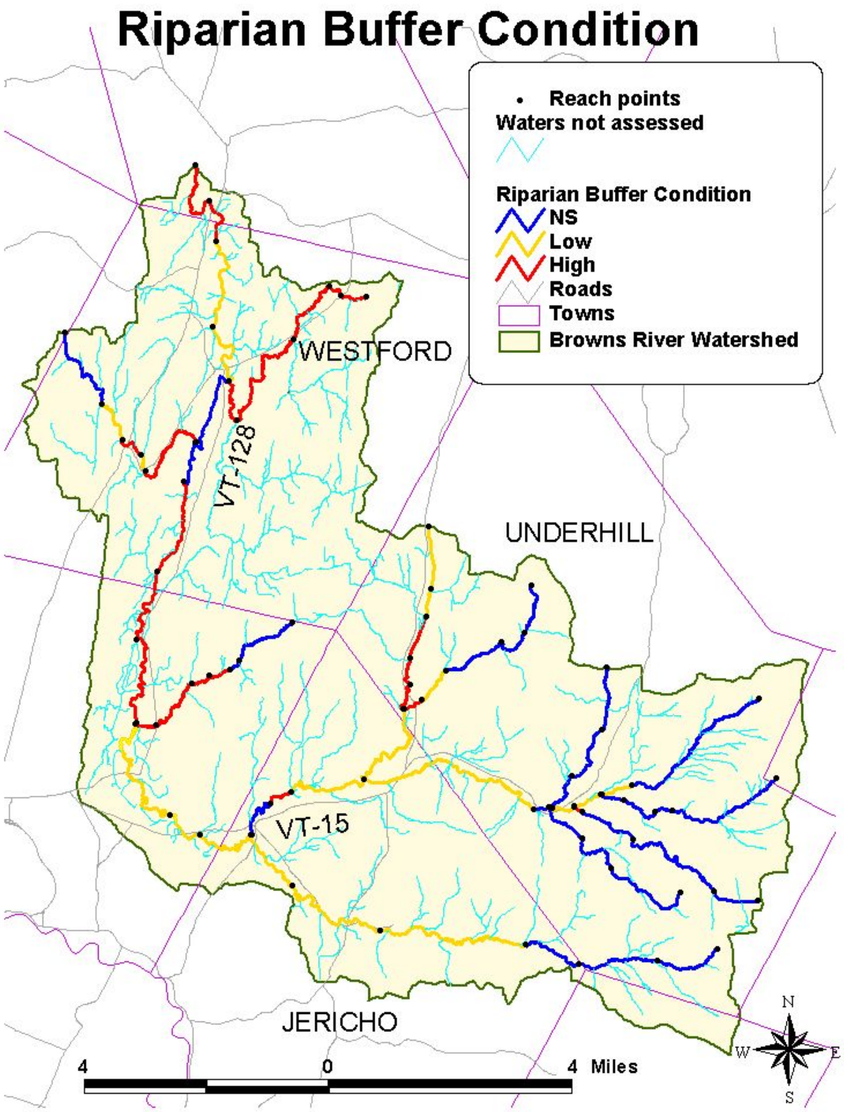

Table 1. Streambank erosion impacts on the Browns River main stem

Reach Number	Bed form	Dominant Bed Material	Bank Erosion	Bank Height	Bank Erosion / Height Impact
M01	Riffle-Pool	Cobble	Low	No Info	Low
M02	Dune-Ripple	Sand	Low	No Info	NS
M03	No Info	No Info	No Info	No Info	No Info
M04	Riffle-Pool	Boulder	None	No Info	NS
M05	Riffle-Pool	Boulder	Low	No Info	NS
M06	No Info	No Info	No Info	No Info	No Info
M07	Dune-Ripple	Sand	Low	No Info	NS
M08	Dune-Ripple	Sand	Low	No Info	NS
M09	Dune-Ripple	Sand	High	No Info	High
M10	Dune-Ripple	Sand	High	High > 15 ft	High
M11	Dune-Ripple	Sand	Low	No Info	NS
M12	Riffle-Pool	Gravel	Low	High > 15 ft	High
M13	Step-Pool	Bedrock	None	No Info	NS
M14	No Info	No Info	No Info	No Info	No Info
M15	Riffle-Pool	Gravel	Low	No Info	NS
M16	Riffle-Pool	Gravel	Low	No Info	NS
M17	Riffle-Pool	Gravel	Low	No Info	High
M18	Plane-Bed	Gravel	High	No Info	Low
M19	No Info	No Info	No Info	No Info	No Info
M20	Step-Pool	Cobble	None	No Info	NS
M21	Step-Pool	Cobble	None	No Info	NS

Table 2. Significant depositional features and meander migrations in the watershed

Reach Number	Channel Bars	Channel Bars Impact	Meander Migration	Migration Impact
T3.01	Point	Low	No Info	No Info
T3.02	None	NS	No Info	No Info
T3.03	Multiple	High	No Info	No Info
T3.04	Point	Low	No Info	No Info
T3.05	No Info	No Info	No Info	No Info
T3.06	No Info	No Info	No Info	No Info
M01	Multiple	NS	None	NS
M02	None	NS	None	NS
M03	None	NS	None	NS
M04	Point	NS	Bifurcation	Low
M05	Mid-channel	Low	None	NS
M06	Multiple	Low	Avulsion	Low
M07	Multiple	Low	Avulsion	High
M08	Multiple	Low	Avulsion	High
M09	Point	Low	Avulsion	High
M10	Point	High	Migration	High
M11	Point	High	Migration	High
M12	Multiple	High	Migration	High
M13	Mid-channel	Low	None	NS
M14	None	NS	Multiple	High
M15	Multiple	High	Multiple	High
M16	Multiple	High	Multiple	High
M17	Point	High	Migration	Low
M18	Point	High	Migration	Low
M19	Point	High	None	NS
M20	Point	Low	Migration	Low
M21	None	NS	None	NS
T8.01	Multiple	High	None	NS
T8.02	Point	Low	No Info	No Info
T8.03	No Info	No Info	No Info	No Info
T8.04	No Info	No Info	No Info	No Info
T4.01	Point	High	Multiple	High
T4.02	Point	High	Multiple	Low
T4.03	Multiple	High	Multiple	High
T4.04	No Info	No Info	No Info	No Info
T4.05	No Info	No Info	No Info	No Info
T4.06	No Info	No Info	No Info	No Info
T6.01	Point	NS	None	NS
T6.02	Multiple	High	No Info	No Info

T6.03	No Info	No Info	None	No Info

Table 3. Summary of stream types and total impact scores in the Browns River watershed

Reach Number	Stream Type	Bed Feature	Watershed Size	Confinement	Total Impact Score (out of 32)
T9.01			3.06		2.00
T5.S1.03			2.78	3-VB	5.00
T5.06			0.62	3-VB	7.00
T5.05			1.63	3-VB	7.00
T5.04			3.85	3-VB	8.00
T5.S1.02			3.74	3-VB	9.00
T5.02			6.21	3-VB	9.00
T5.03			5.79	3-VB	9.00
T2.02			5.00	3-VB	10.00
T5.01			10.87	3-VB	11.00
T4.03			10.86	3-VB	13.00
T8.04	A		0.99		0.00
T5.S1.05	A		1.14		0.00
T4.05	A		3.67		0.00
T4.06	A		0.79		0.00
T6.03	A		0.81		1.00
T5.S1.04	A		2.32		2.00
M21	A	Step-Pool	3.64	1-NC	2.00
T9.04	A		2.39		2.00
T9.02	A		2.94		3.00
T9.03	A	Plane Bed	2.58		3.00
M20	A	Step-Pool	6.76	1-NC	6.00
T8.03	B		2.08		0.00
T3.05	B		1.06		2.00
T3.06	B		0.62		2.00
T2.05	B		1.18		3.00
T7.03	B		1.23		4.00
T7.02	B	Riffle-Pool	1.70		4.00
T7.01	B	Riffle-Pool	2.58		7.00
M13	B	Step-Pool	53.89	2-NW	8.00
T4.04	B		5.38		9.00
T1.04	B		0.91	3-VB	9.00
T6.01	B	Riffle-Pool	1.81		10.00
T6.02	B	Riffle-Pool	1.51		10.00
T8.02	B	Step-Pool	2.47	3-VB	11.00
M04	B	Plane Bed	88.47	2-NW	15.00
T5.S1.01	B	Riffle-Pool	3.81	3-VB	17.00
M18	B	Plane Bed	11.09	1-SC	18.00

T8.01	B		2.52	3-VB	18.00
M03	C		90.29	3-BD	7.00
T2.01	C		6.27	3-VB	8.00
T1.05	C		0.82		10.00
M19	C		8.49	3-VB	10.00
M01	C	Riffle-Pool	92.32	3-BD	11.00
T3.02	C	Riffle-Pool	2.64	3-VB	12.00
M05	C	Riffle-Pool	75.18	3-BD	12.00
M06	C		68.54	3-BD	12.00
T2.03	C	Riffle-Pool	4.11	3-VB	13.00
T1.01	C	Riffle-Pool	11.57	3-VB	13.00
M14	C		37.11	3-VB	15.00
M17	C	Riffle-Pool	16.22	3-VB	15.00
M15	C	Riffle-Pool	36.90	3-VB	16.00
M16	C	Riffle-Pool	32.23	3-VB	16.00
T3.01	C	Riffle-Pool	3.50	3-VB	17.00
T3.03	C	Riffle-Pool	1.76	3-VB	20.00
T2.04	E	Dune-Ripple	3.74	3-VB	10.00
T1.03	E	Dune-Ripple	1.85	3-VB	11.00
M02	E	Dune-Ripple	90.83	3-BD	13.00
T3.04	E	Dune-Ripple	1.63	3-VB	14.00
T1.02	E	Dune-Ripple	5.31	3-VB	16.00
M07	E	Dune-Ripple	68.24	3-VB	17.00
T4.01	E	Dune-Ripple	15.41	3-VB	17.00
M11	E	Dune-Ripple	56.58	3-VB	18.00
T4.02	E	Dune-Ripple	13.64	3-VB	18.00
M09	E	Dune-Ripple	64.21	3-VB	20.00
M08	E	Dune-Ripple	67.36	3-VB	21.00
M10	E	Dune-Ripple	58.11	3-VB	21.00
M12	E	Riffle-Pool	54.79	3-VB	22.00

Table 4: Impacts of riparian buffers in the Browns River watershed

Reach Number	Width of Right Bank Riparian Buffer	Width of Left Bank Riparian Buffer	Riparian Buffer Impact
T3.01	0 to 25 ft	0 to 25 ft	High
T3.02	0 to 25 ft	> 100 ft	High
T3.03	0 to 25 ft	0 to 25 ft	High
T3.04	0 to 25 ft	0 to 25 ft	High
T3.05	> 100 ft	> 100 ft	NS
T3.06	> 100 ft	> 100 ft	NS
M01	0 to 25 ft	0 to 25 ft	High
M02	> 100 ft	0 to 25 ft	High
M03	0 to 25 ft	0 to 25 ft	Low
M04	0 to 25 ft	0 to 25 ft	Low
M05	0 to 25 ft	> 100 ft	NS
M06	> 100 ft	> 100 ft	NS
M07	> 100 ft	0 to 25 ft	High
M08	0 to 25 ft	0 to 25 ft	High
M09	0 to 25 ft	0 to 25 ft	High
M10	0 to 25 ft	0 to 25 ft	Low
M11	0 to 25 ft	0 to 25 ft	Low
M12	0 to 25 ft	> 100 ft	Low
M13	> 100 ft	0 to 25 ft	NS
M14	26 to 50 ft	0 to 25 ft	High
M15	0 to 25 ft	0 to 25 ft	Low
M16	0 to 25 ft	0 to 25 ft	Low
M17	> 100 ft	0 to 25 ft	NS
M18	51 to 100 ft	0 to 25 ft	Low
M19	51 to 100 ft	26 to 50 ft	Low
M20	> 100 ft	0 to 25 ft	Low
M21	> 100 ft	> 100 ft	NS

T8.01	0 to 25 ft	0 to 25 ft	High
T8.02	> 100 ft	> 100 ft	NS
T8.03	> 100 ft	> 100 ft	NS
T8.04	> 100 ft	> 100 ft	NS

T1.01	0 to 25 ft	0 to 25 ft	High
T1.02	0 to 25 ft	0 to 25 ft	High
T1.03	0 to 25 ft	0 to 25 ft	High
T1.04	0 to 25 ft	0 to 25 ft	High
T1.05	0 to 25 ft	0 to 25 ft	High

T5.S1.01	0 to 25 ft	0 to 25 ft	High
T5.S1.02	> 100 ft	> 100 ft	Low
T5.S1.03	> 100 ft	> 100 ft	NS
T5.S1.04	51 to 100 ft	> 100 ft	NS
T5.S1.05	> 100 ft	> 100 ft	NS

T2.01	0 to 25 ft	0 to 25 ft	High
T2.02	0 to 25 ft	> 100 ft	Low
T2.03	0 to 25 ft	0 to 25 ft	High
T2.04	> 100 ft	51 to 100 ft	Low
T2.05	> 100 ft	> 100 ft	NS

T5.01	0 to 25 ft	0 to 25 ft	Low
T5.02	0 to 25 ft	0 to 25 ft	High
T5.03	0 to 25 ft	0 to 25 ft	High
T5.04	0 to 25 ft	> 100 ft	High
T5.05	0 to 25 ft	0 to 25 ft	Low
T5.06	0 to 25 ft	> 100 ft	Low

Table 5: High impact reaches influenced by channelization efforts

	Meander Width			Wavelength Ratio		
Reach Number	Belt width	Ratio	Total Impact	Average wavelength	Ratio	Total Impact
T3.01	19	1	High	19	1	High
T3.02	17	1	High	17	1	High
T3.03	13	1	High	13	1	High
T3.04	13	1	High	13	1	High
T3.05	0	0	N/A	0	0	N/A
T3.06	0	0	N/A	0	0	N/A
M01	270	3	High	854	9	NS
M02	97	1	High	97	1	High
M03	283	3	High	792	8	NS
M04	96	1	High	96	1	High
M05	88	1	High	88	1	High
M06	84	1	High	84	1	High
M07	162	2	High	610	7	Low
M08	84	1	High	84	1	High
M09	273	3	Low	484	6	High
M10	197	3	High	347	4	High
M11	77	1	High	77	1	High
M12	276	4	Low	574	8	Low
M13	544	7	NS	903	12	NS
M14	62	1	High	62	1	High

M15	329	5	NS	512	8	NS
M16	213	4	Low	606	10	NS
M17	155	4	Low	497	12	NS
M18	41	1	High	41	1	High
M19	34	1	High	34	1	High
M20	0	0	N/A	0	0	N/A
M21	0	0	N/A	0	0	N/A

T8.01	16	1	High	16	1	High
T8.02	0	0	N/A	0	0	N/A
T8.03	0	0	N/A	0	0	N/A
T8.04	0	0	N/A	0	0	N/A

T4.01	110	3	High	275	7	Low
T4.02	385	10	High	675	18	High
T4.03	180	5	NS	406	12	NS
T4.04	24	1	High	24	1	High
T4.05	0	0	N/A	0	0	N/A
T4.06	0	0	N/A	0	0	N/A

T1.01	115	3	Low	213	6	Low
T1.02	29	1	High	126	5	High
T1.03	14	1	High	14	1	High
T1.04	55	6	NS	256	26	High
T1.05	10	1	High	10	1	High

T5.S1.01	20	1	High	20	1	High
T5.S1.02	20	1	High	20	1	High
T5.S1.03	146	9	Low	755	45	High
T5.S1.04	0	0	N/A	0	0	N/A
T5.S1.05	0	0	N/A	0	0	N/A

T2.01	131	5	NS	163	6	Low
T2.02	23	1	High	23	1	High
T2.03	21	1	High	21	1	High
T2.04	20	1	High	20	1	High
T2.05	0	0	N/A	0	0	N/A

T5.01	34	1	High	34	1	High
T5.02	25	1	High	25	1	High
T5.03	24	1	High	24	1	High
T5.04	20	1	High	20	1	High
T5.05	13	1	High	13	1	High
T5.06	8	1	High	8	1	High