

INTRODUCTION

This document summarizes recently-completed updates to the Phase 1 & 2 Stream Geomorphic Assessment database for the Lewis Creek Watershed, Addison & Chittenden Counties, Vermont. Updates were completed by South Mountain Research & Consulting Services (SMRC) of Bristol, VT, working from a May 2004 version of the database and associated *Stream Geomorphic Assessment Tool* output completed by Staci Pomeroy of the VTDEC Water Quality Division, River Management Section. Updates were performed to enhance database usability for the Lewis Creek Association (LCA) and watershed communities and landowners. Funding for this effort was provided by a FEMA Project Impact grant under contract to the Addison County Regional Planning Commission (ACRPC), Middlebury, VT.

Updates were carried out for two main reasons: (1) to address changes to the Stream Geomorphic Assessment protocols (VTANR, 2004), data sheets and associated databases which occurred between 2001 and 2004, and (2) to incorporate field-verified information now available for reaches/ segments that have undergone Phase 2 and/or Phase 3 assessment. Specific update tasks are outlined in Table 1.

In May 2004, Staci Pomeroy of the VTANR transmitted to LCA the current Phase 1 & 2 geomorphic database, Land Cover / Land Use database, and output from version 3 of SGAT for the Lewis Creek watershed. Accompanying that transmittal was a memorandum of suggested updates and an indication of the degree of uncertainty of some parameters originally collected in 2001-2002. This memo is included for reference in Attachment A. To the extent that budget constraints would allow, SMRC incorporated some of these suggestions in addition to the specific tasks outlined in Table 1.

Updates to address changes to protocols

LCA was a participant in a 2001-2002 Pilot Project (VTDEC, 2003) which has resulted in the current set of geomorphic protocols being used around the State. LCA's early involvement in the development and refinement of the protocols means that much of the data collected in 2001 and 2002 was completed using working drafts of the field data sheets, rapid geomorphic assessment (RGA) forms, and rapid habitat assessment (RHA) forms. Phase 1 was originally completed by Staci Pomeroy of the VTDEC River Management Section in 2001. Steps 1 through 4, in particular, were completed manually before the availability of the *Stream Geomorphic Assessment Tool* (SGAT) GIS extension that now computes elements of these Steps automatically and in a standardized way.

Between 2001 and 2004, the Phase 1 & 2 protocols, the associated field data sheets, RGA and RHA forms, and associated database were substantially modified and refined by the VTANR. The current database utilized for entry of LCA's Phase 1 and 2 data is a version completed in 2004 and reflects the parameters and categories of values available for assessments by the 2004 version of the protocols. Thus, several database categories had not been filled out, since information collected under 2001-2002 protocols did not reflect all the categories present under current protocols.

To populate these all these parameters in the database, after the fact, would in many cases require more research and/or repeat field evaluations. Quickly diminishing returns on the dollar would be realized in pursuing a perfectionist updating of all 2000-2001 assessments to the standard of the 2004 protocols. Recognizing this, and given budget limitations, Staci Pomeroy and LCA arrived at a reasonable short list of key parameters that LCA would benefit from



updating to the current protocols. These are generally reflected in Table 1 which formed the basis for the SMRC contract to complete this review. No repeat field assessments were conducted for these updates.

**Table 1. Phase 1 Stream Geomorphic Assessment Database – Selected Update Tasks
Lewis Creek Watershed, Addison & Chittenden Counties**

Phase 1 Step	Description	Description of Update Task
2.1	Elevations	QC check elevations
3.2	Grade Controls	Update with Phase 2 data; QC check db entries
3.3 / 3.5	Geologic Materials / Soil Char.	Have been clipped w/ new SGAT; enter new values into db; QC check
4.1	Land cov/ land use - wshd	Have been clipped w/ new SGAT; enter new values into db; QC check
4.2	Land cov/ land use - corr.	Have been clipped w/ new SGAT; enter new values into db; QC check
5.1	Flow Modifications	Update w/ Phase 2 data; revise and QC check db entries
5.2	Bridge and Culverts	Update w/ Phase 2 data; revise and QC check db entries
5.3	Bank Armoring	Update w/ Phase 2 data; revise and QC check db entries
5.4	Channel Modification	Update w/ Phase 2 data; revise and QC check db entries
5.5	Dredging / Gravel Mining	Update w/ Phase 2 data; revise and QC check db entries
6.1	Berms, Roads, Railroads, Paths	Update w/ Phase 2 data; revise and QC check db entries
6.2	Floodplain Developments	Update w/ Phase 2 data; revise and QC check db entries
6.3	Depositional Features	Update w/ Phase 2 data; revise and QC check db entries
6.4	Meander Migration	Update w/ Phase 2 data; revise and QC check db entries
6.5	Meander Width Ratio	Update w/ Phase 2 data; revise and QC check db entries
6.6	Wavelength Ratio	Update w/ Phase 2 data; revise and QC check db entries
7.2	Bank Erosion / Bank Heights	Update w/ Phase 2 data; revise and QC check db entries
7.3	Ice / Debris Jam Potential	Update w/ Phase 2 data; revise and QC check db entries
8	Stream Impact Ratings	Update based on revised steps
n/a	Phase 1 Analysis	Review data for outliers, inconsistencies; evaluate, address, record

As per the contract with ACRPC, 53 of the 80 reaches delineated in the Lewis Creek watershed were subjected to the updates for select tasks under Phase 1, Steps 2-4. These are referred to as the "major reaches" in the text below, and are comprised of the reaches along the main stem of Lewis Creek, and along the main stems of the major tributaries: Cedar Lake (T2), Pond Brook (T3), Hollow Brook (T4), Hogback Brook (T5), and the Headwater tributary (T7). The remaining 27 reaches are considered "minor reaches" along minor tributaries to the Lewis Creek main stem or along minor tributaries to the major tributaries. These 27 minor reaches were not comprehensively reviewed in this update, due to budget constraints. In conversations between SMRC and Staci Pomeroy, it was determined that usability of the database will not be significantly compromised by not updating these minor reaches, as they comprise a small percentage of the watershed and are often located in lesser developed areas.

Updates to incorporate Phase 2 / 3 information

The second main objective of this update of the Lewis Creek Phase 1 database was to populate certain parameters with information acquired during field work conducted in Phase 2 and/or Phase 3 assessments in select reaches.

Eighteen (18) major reaches went through Phase 2 and / or Phase 3 in 2001 or 2002 during the two-year Pilot Project directed by the VTANR (Table 2).



**Table 2. Reaches Assessed in Phase 2 to Date
Lewis Creek Watershed, Addison & Chittenden Counties**

Reach	Town	Channel Length (ft)	Drainage Area (sq. mi.)	Year Phase 2 Completed
Lewis Creek Mainstem:				
M3	Ferrisburg	5,161	78.61	2001
M7	Ferrisburg / Charlotte	9,240	73.51	2001
M10	Charlotte	13,885	69.12	2001
M14	Hinesburg	3,162	37.87	2001
M15	Monkton/Starksb./Hinesb.	9,556	37.51	2001
M16	Starksboro	6,125	35.41	2001
M17	Starksboro	12,721	22.70	2002
M18	Starksboro	1,615	18.29	2002
M19	Starksboro	10,032	18.21	2001
M20	Starksboro	3,437	16.45	2002
M21	Starksboro	4,708	10.85	2002
M22	Starksboro	7,392	10.44	2002
M23	Bristol / Starksboro	5,016	8.46	2002
Cedar Lake Tributary (T2)				
T2.1	Hinesburg	2,814	5.20	2001
Pond Brook Tributary (T3)				
T3.2	Monkton	3,350	16.62	2001
T3.4	Monkton	26,166	15.48	2001
Hollow Brook Tributary (T4)				
T4.1	Hinesburg / Starksboro	8,233	8.74	2002
Hogback Brook Tributary (T5)				
T5.5	Starksboro	4,300	0.42	2001
Headwater Tributary (T7)				

Phase 1 Steps 5 through 7 for these 18 major reaches were updated with Phase 2 / 3 results in these 18 reaches. Several of these 18 reaches were segmented as a result of Phase 2 findings:

- M3 (A, B)
- M17 (A, B, C)
- M19 (A, B)
- M20 (A, B)
- T4.01 (A, B)

Since Phase 1 considers the reach as a whole, segment data was reviewed to typically identify the dominant condition for the entire reach.

A few other reaches were, in effect, segmented since only a portion(s) of the reach was accessed for Phase 2 assessment in 2001.

- M7 (A, B) – only Segment B assessed
- M10 (A, B) – only Segment B assessed
- M15 (A, B, C, D, rest) – Segments A through D assessed
- M16 (A, B) – Segment A assessed
- T2.01 (A, B) - Segment A assessed

To update Phase 1 for these reaches, Phase 2 data sheets were reviewed for the accessed segments, and orthophotos were reviewed for the remainder of the reach.



SUMMARY OF UPDATES

The following sections summarize updates performed for individual Phase 1 steps.

Step 2.1 – Elevations

Downstream and upstream reach break elevations (Step 2.1) were QC checked through review of reach breaks on topographic map bases. Slight changes were made to the elevations of a majority of the 53 reaches. Generally, changes were necessary due to:

- 1) reach breaks shifting location slightly from their original 2001 locations (delineated manually on USGS maps) to their 2002-2003 locations (delineated in GIS, based on digital 1:5000 surface waters, which often are slightly offset from the topo coverage);
- 2) data entry errors resulting from the fact that USGS topo coverage for the Lewis Creek watershed includes Metric 5-meter contours (Tile #214), English 10-foot contours (Tile #313), and English 20-foot contours (Tiles #314, 414, and 413). See Attachment B.

These changes to downstream and upstream elevations, in turn, resulted in slight changes to valley and channel slopes (Steps 2.3 and 2.5). With two exceptions (see table below), none of the slope revisions was significant enough to result in a change in the assigned stream type.

**Table 3. Phase 1 Step 2 Slope Revisions Resulting in Stream Type Changes
Lewis Creek Watershed, Addison & Chittenden Counties**

Reach		Valley Slope (%)	Channel Slope (%)	Stream Type
T2.06	former:	0.32	0.31	C
	revised:	7.7	7.43	A
T4.07	former:	10.79	10.52	A
	revised:	2.3	2.22	B

Original elevations for T2.06 appeared to be a typographical error. The change in reach break elevations for T4.07 appears to have resulted from locating this terminal reach break on the end of the surface water line (1:5000 VCGI coverage) for SGAT delineations, and not on the end of the blue line on the USGS topo map (as it was originally in 2001).

In reviewing reach break elevations, it was noted that reach T3.07 is actually a terminal reach break (at least on the updated SGAT outputs from 2003-2004, and therefore should not have a record in the database or calculated slopes, channel lengths, etc.

Step 3.2 – Grade Controls

Grade controls for the 53 major reaches were reviewed. If any value other than “no info” was present for a reach that had not been visited in Phase 2 or 3, then “no info” was selected to replace the value.

QC checking of the 18 major reaches which went through Phase 2 resulted in changes to three reaches. An original response of “Dam” for M10 was changed to “Multiple”, since there was also bedrock ledge noted in that reach during a 2002 Phase 2. Where “wood” was indicated for



reach M15, this was omitted and replaced with "none", since Wood is not an option on the current Grade Control menu. An original response of "Ledge" for M23 was replaced with "None"; at least two boulder grade controls were noted along this reach, at upstream and downstream extents, but no channel-spanning bedrock. However, boulder is not a choice for grade control in the database. The Phase 2 check box for Step 3.2 was filled in for these 18 reaches.

Step 3.3 – Dominant & Subdominant Geological Materials

By May 2004, Staci Pomeroy of the VTANR had run the Lewis Creek watershed and updated (Appendix E) corridor delineations through version 3 of SGAT to generate an updated land cover / land use and soils database. Standard report outputs from this updated database were used to update the Phase 1 & 2 database with Dominant and Subdominant geologic parent materials and estimated percentages of each category for each of the 53 major reaches. Previous estimates (Year 2001) had been made by VTANR before the availability of SGAT, following manual review of soil survey maps. Several of the assigned dominant and subdominant geologic parent materials were revised as a result of this update. Changes can generally be attributed to differences in accuracy and precision of manual review methods versus automated clipping of the soils in GIS.

Where "Water" was identified as the Dominant or Subdominant category of soils types in any given reach-based corridor, this result was ignored and the next dominant category was chosen (e.g., reach M07, T2.05, T3.05, T5.02, etc).

Step 3.5 – Soil Properties

Standard report outputs from the Land Cover / Land Use and Soils database updated in May 2004 by VTANR were used to update the Phase 1 & 2 database with the category and percentage of the Dominant hydrologic group, flooding frequency, water table depths, and erodibility for each of the 53 major reaches. Several of the assigned dominant categories were revised as a result of this update; the percentage fields were generally populated for the first time during this update. As with Step 3.3, changes can generally be attributed to automated (SGAT) versus manual methods for "clipping" soils to the corridor and quantifying the various categories.

It is important to note that soil **erodibility** defined by NRCS ("HELCLASS" in Table 20) has to do with the susceptibility of soils to erosion in the presence of surface runoff. NRCS erodibility, therefore, is more directly correlated with topographic slopes of the soil deposits, than it is with the nature (cohesiveness) of the parent material from which the soils were derived (e.g., till versus glacial outwash).

Step 4.1 Watershed Land Cover / Land Use

Standard report outputs from the Land Cover / Land Use and Soils database updated in May 2004 by VTANR were used to update the Phase 1 & 2 database with the category and percentage of the Dominant and Subdominant land cover / land use in the ***upstream watershed*** draining to each of the 53 major reaches. The Impact score was also recalculated based on updated percentages of Urban and Crop categories.

Dominant and subdominant land cover / land use category assignments changed for many of the reaches. Of the 53 major reaches, 38 had Impact scores increased by one point, 11 had scores increased by 2 points, and 1 had its score reduced by one point.



As with previous steps, changes can in part be attributed to automated (SGAT) versus manual methods for "clipping" land cover / land use to the upstream watershed and quantifying the various categories.

Step 4.2 Corridor Land Cover / Land Use

Standard report outputs from the Land Cover / Land Use and Soils database updated in May 2004 by VTANR were used to update the Phase 1 & 2 database with the category and percentage of the Dominant and Subdominant land cover / land use in the reach-based **corridor** for each of the 53 major reaches. The Impact score was also recalculated based on updated percentages of Urban and Crop categories.

Dominant and subdominant land cover / land use category assignments changed for many of the reaches. Of the 53 major reaches, 21 had Impact scores increased by one point, 14 had scores increased by 2 points, and 2 had their score reduced by one point.

As with previous steps, changes can in part be attributed to automated (SGAT) versus manual methods for "clipping" land cover / land use to the corridor and quantifying the various categories.

Step 4.3 Riparian Buffer Width

As per the 14 May 2004 QA memo from Staci Pomeroy, buffer width estimates were reviewed to update reaches with fallow fields for which a value of "None" was originally entered into the database. Step 4.3 updates were also undertaken, since original estimates were performed using manual review of orthophotographs. Suggested methods in the current protocols, include use of buffering methods and the measuring tool in ArcView 3.x to increase the precision and comparability of buffer width estimates. SMRC also notes that previous drafts of the Phase 1 protocols calculated the Impact ratings differently than current protocols (see past protocols for details).

Buffer widths were re-estimated following current Phase 1 protocols for those 18 major reaches that have been assessed to date in Phase 2. Estimates were made using the buffer command and the measuring tool in ArcView 3.x. Approximate lengths of channel with buffer widths in each of the four quartiles (0-25 ft, 26 – 50 ft, 51-100 ft, and >100ft) were measured and recorded in the spreadsheet included as Attachment C. Impact ratings were assigned based on the 2004 protocols (Step 4.3).

For the 18 reaches (36 reach-banks) where buffer widths were remeasured on the orthophotographs, on 22 occasions the estimated percentages differed enough from the original estimates to result in a change in the assigned dominant buffer width category.

For 8 out of 18 reaches, the revised percentages caused the Buffer Width Impact score to change: two reaches were upgraded by one Impact score, from NS to Low; two reaches were downgraded by two points from High to NS; and four reaches were downgraded by one point from Low to NS or from High to Low. In these cases, either the revised percentages from re-estimating caused the Buffer Width Impact score to change, or the difference in the way the Impact rating is assigned (2001 vs. 2004 protocols) caused the change, or both.



Many affected reaches were ones which either had measurable percentages of all four buffer width quartiles represented fairly equally, or which had a subdominant buffer width close in percentage points to the dominant buffer width. In these cases the resolution of the orthophotographs (i.e., distinguishing between one quartile and the next) and operator variability have a much greater influence on the accuracy of estimating percentages than when one category clearly dominates. There can be considerable variability between observers, resulting in a difference in the determination of dominant buffer width and/or the assigned rating for Buffer Width Impact if the 0-25 ft category is affected.

Comparison to Phase 2 results for Buffer Width

Re-estimated Phase 1 buffer values could be compared to buffer widths estimated in Phase 2 during 2001 and 2002 - for insight into riparian conditions that may have changed between 1995 (date of orthos; see Attachment B) and 2001-2002 when the Phase 2 assessments were completed. On-the-ground results would also prove more accurate than remote sensing for fallow fields.

However, even for reaches unchanged between 1995 and 2002, direct agreement would not be expected between Phase 1 and Phase 2 buffer width estimates, because the 2002 and 2001 drafts of the Phase 2 protocols asked the observer to indicate the **average** buffer width along the reach, not the **dominant** condition, as is estimated in Phase 1 (and incidentally, as is now assessed under 2004 Phase 2 protocols). Also, several of the reaches were segmented as a result of Phase 2, and average buffer widths were thus estimated in Phase 2 for individual segments, not the entire reach length.

Step 5.0 Instream Channel Modifications

Step 6.0 Floodplain Modifications / Planform Adjustment

Step 7.0 Bed and Bank Windshield Survey

Databases and field notes for the 18 major reaches (24 reaches / segments total) that have been assessed through Phase 2 to date, were reviewed to update select parameters in Phase 1, Steps 5, 6 & 7. The appropriate check boxes in the Phase 1 database were selected to indicate where Phase 2 data was used to confirm or change the Phase 1 results. Often, these updates resulted in changes to the Impact ratings applicable under each step.

Another change of note relevant to Step 6 is the revised Appendix E corridor available now in digital form as an export from the current version (v3) of SGAT. Having this digital boundary available to review berms/roads/RRs (Step 6.1) and Development (Step 6.2) resulted in improved estimates for Phase 1. Phase 2 estimates of these same features (Step 1.3 of the Phase 2) on the one hand are more accurate for picking out new development or roads that have occurred since the fly-date of the orthophotographs (usually 1995 for Lewis Creek; see Attachment B), and for picking out berms (not visible on the orthos). However, the considerable difficulty and inaccuracy in estimating the position of the Appendix E boundary in the field means that the length of these features within or outside the corridor boundary is often under- or (more commonly) over-estimated during Phase 2 field assessments.



Step 5.1 Instream Channel Modifications – Flow Regulation

Phase 2 assessments revealed small-diameter pipes (apparent irrigation or private water intakes) in four of the 18 major reaches: M03, M09, M14, and M15. Flow regulation Type was changed from "none" to "irrigation" for these. However, given the small, non-channel-spanning nature of these apparent intakes, the impact rating was left at "NS" for each of these. Also, while a Phase 2 has not yet been performed on reach M09, field work in the area confirms that the Scott Pond Dam impoundment is located at the upstream extent of this reach along Lewis Creek Road in Charlotte. For reach M09, Step 5.1 Type category was changed from "none" to "Impoundment", and a "NS" impact was upgraded to "Low".

The remaining reaches had "none" entered for type in Step 5.1, because "No Info" was not a choice available under the 2001 protocols. Therefore, they were edited to reflect "No Info" in the Type category and "No Info" in the Impact category.

Step 5.2 Instream Channel Modifications – Bridges & Culverts

Phase 2 assessments generally confirmed Phase 1 information for bridges and culverts. Originally, one crossing structure was indicated for reach M16. However, Phase 2 data sheets did not indicate a crossing structure in the reach, so the number was revised to "0" for this reach. The original impact rating for this reach of "NS" remained the same.

Reviewing the orthophotographs and notes from Phase 2 assessments, impacts from crossing structures were identified and lengths of impacts were estimated for each of the 18 major reaches. Following protocol, those reaches with less than 20% of their length affected by crossing structures, were rated with a LOW impact; those with 20% or greater of their length affected were assigned a HIGH impact. Re-review of these lengths, resulted in an upgrade of impact rating from "NS" to "LOW" for six reaches: M03, M07, M10, M17, M19, and M22. Generally, Phase 2 field assessments revealed Bridge and Culvert impacts that had not been apparent from remote sensing during Phase 1.

Also, Step 5.2 results for reach M04 were changed, even though it was not one of the 18 major reaches scheduled for review. Originally, one bridge crossing had been noted for this reach, due to a requirement in the 2001 protocols to count bridges or culverts at the immediately upstream or downstream end of the reach in the case where the reach break occurred at a crossing structure. This is no longer a requirement in the 2004 protocols, so the "1" culvert noted for M04 was changed to "0". The original impact rating for this reach of "NS" remained the same.

Step 5.3 Instream Channel Modifications – Bank Armoring

Reviewing the notes from Phase 2 assessments for each of the 18 major reaches, percentages of reach lengths armored were estimated. Following protocol, those reaches with less than 10% of their length armored were rated with a NS impact; those between 10% and 30% armored were assigned a LOW impact, and those with 30% or greater of their length armored were assigned a HIGH impact. Updating Phase 1 data with Phase 2 data, resulted in an upgrade of impact rating from "NS" to "LOW" for two reaches: M16 and M22. M14 was downgraded from LOW to NS, and M19 was downgraded from HIGH to LOW.



Where Phase 2 notes and field sketches did not clearly indicate if bank armoring overlapped on the left and right banks, a conservative assumption was made that overlap did not occur, and the total lengths of reported armoring (Left Bank plus Right Bank) were entered into Step 5.3.

For the remaining reaches which were not assessed in Phase 2 and for which no data was obtained from Windshield Surveys or local knowledge, values of "None" were replaced with "No Info", and the corresponding Impact rating was changed from "NS" to "No Info".

Step 5.4 Instream Channel Modifications – Channel Modifications

For the estimation of channel straightening, SMRC deferred to data provided by VTANR River Management Section as an attachment to the memo from Staci Pomeroy (Attachment A). Approximate lengths of channel estimated by VTANR to be straightened were entered into Step 5.4 to calculate percentage of the reach straightened or otherwise modified, so that a corresponding Impact rating could be assessed.

Also, an interview with VTDEC River Management Program Stream Alteration Engineer, Barry Cahoon was conducted on 1 April 2004 to identify channel management histories in the Lewis Creek watershed. Straightening was indicated by Mr. Cahoon for the area surrounding Tyler Bridge Road Bridge on reach M15. Dredging and straightening were indicated from the Route 116 bridge crossing on reach M22. It was assumed that the significant lengths of straightened channel already estimated by VTANR for these two reaches included these past channel modifications cited by Mr. Cahoon.

As a result of the revisions noted above, impact ratings for 10 reaches were upgraded from LOW to HIGH: M02, T2.04, T3.04, T3.04S1.01, T3.04S2.01, T3.04S3.01, T3.06, T3.06S1.01, T4.01, and T4.04. Two reaches (M17 and M21) were downgraded from a HIGH to LOW impact rating.

Subsequent sections of this report (see Steps 6.5 / 6.6) discuss the geology of Lewis Creek watershed and the potential for shallow and outcropping bedrock to have influenced channel planform and sinuosity in those reaches determined by VTANR to be straightened.

Step 5.5 Instream Channel Modifications – Dredging History

Step 5.5 for reach M22 was modified to reflect "Dredging" and a LOW impact following observation during a 2002 Phase 2 & 3 assessment of dredging to create a new channel on the inside of a meander bend, and given the information provided by Barry Cahoon for the Route 116 crossing. Following observations made of substantial channel dredging and limited apparent gravel mining in reach T4.01, during a 2002 Phase 2 assessment, Step 5.5 for this reach was modified to reflect "Dredging" and a HIGH impact.

The remaining reaches, for which no information regarding dredging or gravel extraction was available, were edited to replace "none" with "no info".



Step 6.1 Floodplain Modifications and Planform Adjustments – Berms & Roads & Railroads & Improved Paths

Reviewing the notes from Phase 2 assessments for each of the 18 major reaches, percentages were estimated of reach lengths along which roads, berms, railroads and/or improved paths were present within the Appendix E corridor. Following protocol, those reaches with less than 5% of their length paralleled by this infrastructure were rated with a NS impact; those between 5% and 20% paralleled were assigned a LOW impact, and those with 20% or greater of their length paralleled by infrastructure within the corridor were assigned a HIGH impact. Updating Phase 1 data with Phase 2 data and the new SGAT-derived Appendix E corridor, resulted in an upgrade of impact rating from either NS to LOW or LOW to HIGH for ten reaches: M3, M7, M10, M14, M15, M17, M22, M23, T4.01, and T4.3S6.01. One reach was upgraded from NS to HIGH (M18).

During this review, the following errors or data inconsistencies were identified in Phase 2 results for Step 1.3 for select reaches. The Phase 2 field notes and database were revised accordingly. Note that the Phase 2, Step 1.3 evaluates floodplain modifications within a corridor defined as two times the bankfull width or 100 feet, whichever is greater, on either side of the channel. This Phase 2 corridor is often less than the Phase 1 Appendix E corridor (particularly in downstream broader-valley reaches).

- M14 – Originally, a berm had been noted along the full length (3162 ft) of the reach on the right bank. Kristen Underwood from SMRC walked this reach in October 2001 and recalls that the right bank is a steep valley wall into which is carved the Lewis Creek Road, a gravel road. This right bank represents a naturally, confined, bedrock-controlled valley wall more than it does a berm. Therefore, the length of 3162 feet entered in the berm category for Phase 2 Step 1.3 was revised to a 0 value. Interestingly, with the revised Appendix E corridor, the roadway was determined to be located within the corridor for the full length of the reach. So, the Step 6.1 impact rating, was still HIGH, - but due to presence of the road, rather than a berm.
- M17 – Upon reviewing orthophotographs for this update, an approximate length of 200 feet of private road was noted along the upstream extent of reach M17 (segment C). The presence of this road was not originally noted on the Phase 2 field data sheets. These data sheets were revised, and a value of 200 ft was entered into the road category (Step 1.3) of the Phase 2 database.

Step 6.2 Floodplain Modifications and Planform Adjustments – River Corridor Development

Reviewing the notes from Phase 2 assessments for each of the 18 major reaches, percentages were estimated of reach lengths along which development was present within the Appendix E corridor. Following protocol, those reaches with less than 5% of their length paralleled by this development were rated with a NS impact; those between 5% and 20% paralleled were assigned a LOW impact, and those with 20% or greater of their length paralleled by development within the corridor were assigned a HIGH impact. Updating Phase 1 data with Phase 2 data and consideration of the SGAT-derived Appendix E corridor, resulted in an upgrade of impact rating from either NS to LOW or LOW to HIGH for five reaches: M07, M14, M15, M19, and M23. One reach was upgraded from NS to HIGH (M18). Two reaches (M22, T4.3S6.01) were downgraded from HIGH to LOW or LOW to NS.

During this review, the following errors or data inconsistencies were identified in Phase 2 results for Step 1.3 for select reaches. The Phase 2 field notes and database were revised accordingly.



- M17 – Upon reviewing orthophotographs and original data sheets for this update, 3000+ feet of channel along the RB and LB of segment A of reach M17 had been identified as having development along it in the Phase 2 database. This segment is heavily pastured, and pasture does not appear to fall into the definition of “Development” stated on p16 of the Phase 2 protocols (“buildings, parking lots, and fill”). Therefore, these values were revised to 0 on the LB and RB for segment M17-A in the Phase 2 field notes and database.
- M21 – Original data sheets for reach M21 indicated development along the LB for approx. 300 ft (near the Tatro Road bridge crossing). However, the buildings are positioned outside the Appendix E corridor. Therefore, this value of 300 ft was revised to 0 ft in the Phase 2 field notes and database.
- M22, M23 – Original data sheets and the database indicated development lengths that include agricultural development (i.e., crop or pasture). Since the Development category includes only buildings, parking lots, and fill, lengths of Development were revised (by reviewing orthos) to reflect only buildings, parking lots, and fill.
- T4.01 – Original data sheets and the database indicated development lengths on the LB and RB that were longer (700, 700) than that measured using the updated Appendix E corridor on orthophotographs (415, 230). The data sheets and database were revised to reflect these updated estimates.

Step 6.3 Floodplain Modifications and Planform Adjustments – Depositional Features

Phase 2 results (Step 5.1) and sketch maps were reviewed for the 18 major reaches to update Phase 1 Step 6.3 with information obtained from field observation along the reach. In Phase 1, orthophotographs are reviewed to identify largely unvegetated point bars, mid-channel bars, and delta deposits at tributary confluences or stormwater input channels. The flyover dates of the orthophotos reviewed for the Lewis Creek (1995) were conducted in Spring months. Typically, water levels are higher in the Spring months, and depositional features can be submerged below water surface. Also, orthophoto review is not sufficient for identifying depositional features in upstream portions of the watershed where canopy cover can obscure the channel from view. Field-based observations from Phase 2 were incorporated to improve the data set for Step 6.3.

Also, original Phase 1 responses for the remaining reaches were revised, where appropriate, to conform to the Menu choices available in the current database (e.g., “Mid” changed to “Mid-channel”; “Mid/Point” changed to “Multiple”). All “None” / “NS” responses for reaches that had not been field visited and/or were too small to be clearly visible on the orthophotographs were changed to “No Info” / “No Info”.

- M12 and T3.03 - an original response of Mid-channel was confirmed by reviewing the orthos, and the Impact rating was revised from NS to LOW, since by current protocol a NS impact rating applies to a reach with no mid-channel bars.
- M14 - an original response of Mid-channel was revised to None, as the MCB referenced is actually a tree-vegetated island upstream of the Turkey Lane bridge. By current protocol, well-vegetated islands are not to be considered under Step 6.3. The impact rating for M14 was revised, accordingly, from LOW to NS.



Phase 1 updates to Step 6.3 resulted in an upgrade of impact rating from either NS to LOW or LOW to HIGH for nine reaches: M03, M07, M12, M16, M20, M21, M22, M23, and T4.3S6.01. Two reaches were upgraded from NS to HIGH (M17, T4.01). One reach (M14) was downgraded from LOW to NS.

Step 6.4 Floodplain Modifications and Planform Adjustments – Meander Migration

Phase 2 results (Step 5.2) and sketch maps were reviewed for the 18 major reaches to update Phase 1 Step 6.4 with information obtained from field observation along the reach. In reviewing Step 6.4, flood chutes (dry channel-like depressions alongside the main channel, usually well-vegetated but with trees mostly absent) accessed only in bankfull or flood flows were not counted as an indication of meander migration, avulsion or bifurcation. However, abandoned channels (well-formed, unvegetated stream beds currently dry or occupied by wetlands) that were abandoned by the active channel and may be occupied by bankfull or flood flows, were counted as avulsions.

- M19 – In addition to the meander migration originally noted by VTANR through review of photos, Phase 2 assessments in 2001 and continued visitations to the reach for training and education/outreach in 2002-2004 have identified a bifurcation just upstream of the ballfields parking lot, and a neck cutoff (avulsion) at a tight meander bend in the mid-portion of the reach upstream of the Lewis Creek Farm bridge. The Phase 1 database was revised from "Migration" / "LOW" to "Multiple" / "HIGH".
- T2.01 – Phase 2 field notes indicated a Chute Cut-off present "at Delta Bar" on this reach. Notes and sketches do not provide further details. Conservatively, this feature was designated as an Avulsion with LOW impact.
- T3.04 – Phase 2 field notes indicated presence of both Chute Cut-offs and Channel Avulsions. Notes and sketches do not provide further details. Step 6.4 was revised from "None / NS" to "Avulsion / LOW".
- T5.05 – Phase 2 field notes indicated presence of Chute Cut-offs. Notes and sketches do not provide further details. Step 6.4 Type was not revised; the original Phase 1 response of "None" was retained under the assumption the Chute Cut-off was a Flood Chute(s). For an unspecified reason (possible typo), the original Impact rating for Step 6.4 for this reach was "HIGH". SMRC revised the impact rating to "NS" to be consistent with a Type response of "None".
- T4.01 – A bifurcated channel in localized spots noted from Phase 2 field work, and meander migration noted by VTANR from review of historic aerial photos, resulted in a Multiple designation for this reach and a LOW impact. The significant channel planform change resulting from dredging, berming and channelization by a landowner in the mid-portion of this reach was not identified as an "Avulsion" since Step 6.4 is intended to capture natural, river adjustments (often in response to human-induced stressors elsewhere in the channel/ watershed). Impacts of this human-controlled channel planform change were captured in Step 6.1 and Steps 5.4 and 5.5.

A comprehensive review of 1970s era aerial photographs was *not* undertaken as part of this database update to QC check the original Phase 1 responses for Step 6.4 for those reaches which have not undergone Phase 2. With a couple of exceptions noted below, the original Phase 1



response generated by VTANR was retained for those reaches which had not gone through Phase 2.

All "None" / "NS" responses for reaches that had not been field visited and/or were too small to be clearly visible on the orthophotographs were changed to "No Info" / "No Info", consistent with Step 6.3.

Also, original responses for the remaining reaches were revised, where appropriate, to conform to the Menu choices available in the current database. All "None" / "NS" responses for reaches that had not been field visited and/or were too small to be clearly visible on the orthophotographs were changed to "No Info" / "No Info".

- M01 – An original response of "More Defined / NS" was changed to "None / NS"
- M06 - "Bifurcated" changed to "Bifurcation"
- T2.02 – Step 6.4 was originally designated as "Widened / HIGH" for this reach. No Phase 2 was apparent for this reach, and the scale and resolution of the orthophoto were insufficient to identify Step 6.4 features. Therefore, this response was revised to "No Info / No Info".
- T4.06 – An original response of "Pond" was revised to "No Info"

In summary, Phase 1 updates to Step 6.4 resulted in an upgrade of impact rating from either NS to LOW or LOW to HIGH for four reaches: M19, M21, T3.02 and T3.04. One reach was upgraded from NS to HIGH (M22). Two reaches (T2.02 and T5.05) were downgraded from HIGH to NS or No Info.

Step 6.5 Floodplain Modifications and Planform Adjustments – Meander Width Ratio

Step 6.6 Floodplain Modifications and Planform Adjustments – Meander Wavelength Ratio

Step 6.5 and 6.6 data were reviewed for two main purposes: (1) a QC review for adherence to protocol; and (2) a review of data outliers and potential governing factors.

QC Review for Adherence to Protocol

Calculation of MBW/MWL for C & E Type Streams Only

By VTANR protocol, calculations of meander belt width (MBW) and meander wavelength (MWL) and their respective ratios to channel width (Steps 6.5 and 6.6) are completed only for "C or E riffle-pool or ripple-dune reference stream types in narrow (NW) and unconfined (BD and VB) valleys in Step 2.10" (Phase 1 protocols [2004], p. 60). The 53 Lewis Creek major reaches were reviewed to confirm that Steps 6.5 and 6.6 had been completed for the applicable reach types. MBW and MWL values in the database for many of these reaches were measured in 2001 by VTANR. Shape files or maps indicating the location of meander geometry measurements were not available for review.

Thirty-seven of the 53 major reaches were C or E stream types, requiring calculation of MBW and MWL by protocol. However, five of these did not contain MBW / MWL values in the database:

- M07, M10, M11 – While these reaches type out as C streams in narrow (NW) valley confinement settings, they were originally listed as "N/A" under Steps 6.5 and 6.6. Upon



consultation with Staci Pomeroy, it was confirmed that "N/A" was entered for these reaches given the abundance of bedrock control observed through the reach in Phase 2 / 3 assessments performed in 2001.

- M12 – While the stream types out as a C stream with NW valley setting, no values were present in the database for MBW and MWL. This is likely due to the short length of this reach and the lack of a sufficient number of meander sets to measure.
- T4.06 – while the stream type for this reach (C – NW) is appropriate for calculation of MBW and MWL, Steps 6.5/6.6 were not calculated. The majority of this reach is located in a ponded wetland area.

Each of the remaining 16 major reaches not of C or E stream types, was updated to reflect a "N/A" value (Not Applicable) entered into the Impact rating for Steps 6.5 and 6.6 (where previously these cells had been empty). For the remaining minor reaches, a value of "No Info" was entered for the impact ratings.

Correction of Apparent Typographical Errors

While measurement locations of meander sets were not available for QC checking, SMRC did perform a QC check of Impact assignments based on the reported MBW and MWL ratios. Apparent typographic errors were noted and corrections resulted in revisions to impact ratings for some reaches. These "errors" may also have been a result of differences in rounding methods for the calculated impacts. SMRC considered out to two decimal places in the calculated ratios.

MBW/MWL forced to Channel Width Value for Reaches with Straightening Greater than 50%

Protocols define that if a reach was more than 50% straightened (as evaluated in Step 5.4, resulting in a "HIGH" impact), then for Step 6.5, the channel width should be entered rather than the meander width, which forces the MBW ratio (meander belt width / channel width) to a value of "1", resulting in a "HIGH" impact rating for MBW ratio. Similarly, for Step 6.6, the channel width should be entered rather than the meander wavelength, forcing the MWL ratio to 1, with a corresponding impact rating of HIGH.

The Phase 1 data were reviewed to confirm adherence to the above protocol. Five of the major reaches, all located on Cedar Lake Trib (T2), were characterized as having been straightened for 50% or more of the reach: T2.02, T2.03, T2.04, T2.05, and T2.06. Original data entries for Steps 6.5 and 6.6 did conform to the above requirement to enter the channel width for all but reach T2.02. Steps 6.5 and 6.6 were revised for T2.02 to represent the channel width, forcing the impact ratings to HIGH from previous ratings of LOW in each case.

While QC checking Impact assignments for these Steps, two minor reaches were noted to apparently have their channel widths entered even though they were found not to be straightened for 50% or more of their length in Step 5.4. These reaches were T3.4S2.01 and T3.6S1.01. Since they were minor reaches, data entries were revised to "No Info".

Review of Data Outliers for Steps 6.5 and 6.6

An evaluation of meander geometries in the watershed was undertaken to identify data outliers. Discussions below serve to characterize the uncertainty associated with measurements of these parameters, and the assignment of corresponding impacts.

Researchers (Leopold, 1994; Williams, 1986) have suggested empirical relationships between channel width and MBW as well as MWL. Regime equations developed for gravel-bed, low



gradient (< 2%), alluvial channels flowing through narrow to broad valleys underlain by reasonably homogeneous surficial deposits, indicate that MWL can be expected to approximate 10 to 14 channel widths (Leopold, 1994). MWLs in these stream types that are significantly more or less than 10 to 14 channel widths, and MBWs greater or lesser than 5 to 8 channel widths, are therefore highlighted in the Phase 1 protocols as an indication that a channel reach is out of equilibrium or otherwise disturbed or manipulated, presumably from human-induced channel or watershed stressors. Impact scores are assigned in Steps 6.5 & 6.6 to flag ratios that fall outside these expected ranges.

At first glance, the majority of the MWL & MBW ratios calculated for Lewis Creek fall outside of expected ratios; exceptions include reaches M20, T3.03, T3.04, and T3.05.

Discussions below focus on how meander ratios in the Lewis Creek basin may be influenced by underlying geology, as well as past channel management activities. Also discussed are the limitations inherent in the regional relationships expressed by Williams and others.

Assessment of Lateral and Vertical Bedrock Controls and Potential Influence on Ratios

The role of underlying geology in the region was explored as a contributing factor to the data outliers under Steps 6.5 and 6.6, as well as. The Lewis Creek watershed provides a clear demonstration that meander geometry data outliers (i.e., low sinuosity, lower-than-predicted MBW, higher-than-predicted MWL) are not exclusively an indication of channel straightening, dredging or other channel management activities. Geologic influence on MBW and MWL ratios have been noted in other mountainous basins in Vermont (e. g., New Haven River).

The Williams' equations relating MBW and MWL to channel width that are the basis for the Impact ratings in Steps 6.5 and 6.6 are applicable only to alluvial stream channels, and should not be used to evaluate meander geometries in stream channels controlled laterally and/or vertically by bedrock.

The Lewis Creek is partly a bedrock-controlled watershed. Approximately 30% of the watershed occupies the Northern Green Mountain province (Capen, 1998), where channel gradients and valley confinement are largely controlled by underlying bedrock topography and structure (joints, faults, strike and dip of bedding planes and schistosity) (Dipietro, 1983; Stewart, 1973). Reaches M24 through M26 along the main stem, all of the T7 Headwater Trib reaches, and upstream reaches of the Hollow Brook from T4.02 through T4.07 are located in the Northern Green Mountain province. Many of these Green Mountain province reaches have already been discounted from consideration of MBW and MWL by virtue of their bedrock-controlled stream types (A and B channels). In exception to this are the C-type NW channels of T4.03, T4.04 and T4.06. T4.06 was eliminated from consideration given the predominance of the mid-reach pond. Bedrock controls should be considered as a governing factor for MBW and MWL geometries calculated for reaches T4.03 and T4.04.

The remaining 70% of the Lewis Creek watershed is positioned in the Champlain Valley province. Even the valley sediments of boulder clays and silts from former Lake Vermont and local alluvium, are punctuated in many locations by outcropping or shallowly buried limestone and dolostone bedrock (e.g., Hogback Mountain and Monkton Ridge) (Stewart & MacClintock, 1969; Stewart, 1973). Bedrock outcroppings in the Valley appear to have influenced channel planform in reaches M05, M07, M08, M09, M10, M11, M13, M14, M18, T5.01 and T5.05, based on a review of Phase 2 data sheets, Phase 1 windshield surveys, and surficial geologic maps (Stewart & MacClintock, 1969). Future Phase 2 assessments may reveal bedrock lateral or vertical controls in additional reaches. Arguably, these bedrock-influenced reaches should be removed from consideration under Steps 6.5 and 6.6; in fact, no values were recorded by VTANR for reaches



M07, M09, M10, M11, M14, M18, T5.01 and T5.05. For the remaining reaches (M08 and M13), if available MBW and MWL ratios exhibit different-than-regime geometries, this should not automatically be considered a symptom of human-induced channel disturbance; impact ratings may be overstated for these reaches.

Additional Limitations of Williams' Equations

It should be noted that Williams' equations were derived for stream channels of sinuosity greater than 1.2 and gradients of 2 % or less. Technically, these equations should not be applied for reaches with sinuosities less than 1.2 (in the case of Lewis Creek this would include reaches M06 (1.12), M12 (1.18), M20 (1.17), M22 (1.14) and the Cedar Lake reaches T2.02, T2.03, T2.05 and T2.06 (1.02 – 1.05), T3.06 (1.15), T5.04 (1.03). . Often these are reaches in bedrock controlled locations of the watershed (e.g., M07, M14, M18).

Williams' publication does not specify whether the reaches in his study were located in developed areas with the potential for channel management activities that would disturb the natural meander patterns. The criterion of considering only channels of sinuosity 1.2 or greater could have been a way to exclude heavily straightened channels. It could also have been a way (along with the gradient restriction) to exclude B and A type streams confined by their valley walls and presumably controlled by underlying bedrock topography and structure.

Heterogeneity of streambank sediments has been identified as a causal factor in reduction of channel sinuosity (Friedkin, 1945 as cited in Leopold et al, 1964); this may account for some of the low sinuosities in the Valley reaches which do not appear to be bedrock-influenced (e.g., M06).

Finally, the inherent subjectivity in these methods of graphically analyzing river planform patterns should be recognized as a source of data outliers in Steps 6.5 and 6.6. Williams (1986), himself, acknowledged a 15 % variability between two observers measuring wavelength, bend lengths and belt width on the same set of meanders ("well-defined...with no intervening straight reaches").

Final Subset of Reaches for Which MBW and MWL ratios were compared to Williams

To appropriately compare measured MBW and MWL ratios in the Lewis Creek watershed with predicted values based on Williams (1986), the following C and E reaches (in NW, BD, or VB settings) were removed from consideration:

- bedrock-controlled reaches
- reaches estimated to be straightened along 50% or more of their length
- Reach M12 which was insufficient in length to have meander sets for measurement
- all minor reaches

This left 23 major reaches in the Champlain Valley lowlands for evaluation. Steps 6.5 and 6.6 were reviewed to identify where the meander belt width and wavelength ratios reported for the Lewis Creek reaches in Phase 1 appeared inconsistent with each other. For example, if a given reach's belt width is lower than the expected range, one would expect its wavelength to be higher than the expected range, and visa-versa.

A majority of the subset of reaches exhibited lower-than-expected MBW ratio while at the same time exhibiting a lower-than-expected MWL ratio (M01, M03, M04, M05, M06, M12.5, M15, M16, M17, M21, M22, T3.01). These Champlain Valley reaches are located on heterogeneous soils including boulder clays and silts, varved clays, and alluvium. It is possible that low MBW and



MWL ratios are related to the heterogeneities of soils types present in the valley, as well as being influenced by localized historic channel management in select cases. VTANR estimated straightening (Step 5.4) in these reaches ranging from 0 to 45 %. Sinuosity (Step 2.6) of these reaches ranged from 1.02 to 1.81.

One reach, T3.06, had much higher-than-expected MBW ratio while at the same time having a much higher-than-expected MWL ratio. This reach is located adjacent to croplands, and it is possible that past straightening has resulted in higher-than-expected MWL (VTANR estimated 37% of the reach straightened). However, a higher-than-expected MBW is counter-intuitive to straightening. Without documentation of the meander sets measured it is not possible to understand the derivation of the MBW and MWL values reported by VTANR.

Remaining reaches had:

- ratios that were within expected ranges (M20, T3.03, T3.04, T3.05);
- MBW ratio higher-than-expected with MWL lower than expected (M02);
- MBW ratio higher-than-expected with MWL ratio in expected range (T4.01, T5.02, T5.03, T5.04); or
- MBW ratio in expected range with MWL lower-than-expected (M19).

Step 7.0 Bed and Bank Windshield Survey

SMRC updated Step 7.0 database records for the 18 major reaches assessed in Phase 2 and/or 3.

For Step 7.1, the dominant bedform and material noted from field inspection of the entire reach, often differed from the conditions noted in vehicle-accessible discrete locations along the reach. Similarly, walking the whole reach in Phase 2 often revealed more extensive erosion along streambanks (Step 7.2), and the locations and nature of potential or current debris jams / ice jams (Step 7.3).

In summary, Phase 1 updates to Step 7.2 resulted in an upgrade of impact rating from either NS to LOW or LOW to HIGH for three reaches: M17, M18, and T4.01. Two reaches were upgraded from NS to HIGH (M14, M22). Phase 1 updates to Step 7.3 resulted in an upgrade of impact rating from either NS to LOW for seven reaches: M14, M18, M20, M21, M22, M23 and T4.01. Two reaches were upgraded from NS to HIGH (M17, M19).

Step 8 – Total Stream and Watershed Impact Ratings

In consideration of the above updates, the Total Stream and Watershed Impact Ratings (Table 8 of the Phase 1 data) were revised considerably (see Table 4). Fifty-seven (71%) of the 80 reaches increased in Total Impact Score. Twenty-three of the 80 reaches (29%) remained the same. None of the 80 reaches were downgraded in Total Impact Score as a result of the updates. Reach-specific changes can be examined by comparing Step 8 reports from the updated database (Attachment D and enclosed CD) with Step 8 report from the database prior to July 2004 revisions.



**Table 4. Changes to Total Impact Scores Resulting from Phase 1 Updates
Lewis Creek Watershed, Addison & Chittenden Counties**

Change to Total Impact Score	Number of Reaches	Percent of Reaches
+ 10	1 (M18)	1 %
+ 9	0	0 %
+ 8	1 (M22)	1 %
+ 7	5 (M14, M15, M17, M23, T4.01)	6 %
+ 6	2 (M07, T3.06)	3 %
+ 5	5	6 %
+ 4	5	6 %
+ 3	10	13 %
+ 2	15	19 %
+ 1	13 (including M24, M25 and tributary reaches)	16 %
0	23 (none of the Main Stem reaches)	29 %

In general, reaches that exhibited a significant increase in Total Impact Score (e.g., more than a 5-point increase) are those for which Phase 2 and/or Phase 3 information was available.

Previously, reach M19 exhibited the highest Total Impact Score (of 14). Following this update, reaches M17 and M22 now have the highest Total Impact Score in the watershed based on currently available data. M19 has the second highest score (see Table 5).

**Table 5. Highest Scoring Reaches Following Phase 1 Updates
Lewis Creek Watershed, Addison & Chittenden Counties**

Total Impact Score	Number of Reaches
19	2 (M17 and M22)
18	1 (M19)
17	1 (M15)
16	1 (T4.01)
15	1 (M03)

CONCLUSIONS AND RECOMMENDATIONS

Updates to the Lewis Creek Phase 1 & 2 Geomorphic Database resulted in substantial changes to Phase 1 impact scores for a majority of the 53 major reaches. Revisions occurred for two main reasons.

For 18 reaches, field inspection of the entire reach in Phase 2 / 3 provided information otherwise unavailable from Phase 1 windshield surveys, particularly for the following Steps:

- Step 5.1 Flow Regulation



- Step 5.2 Bridges & Culverts (locations were available from remote sensing, but impacts were not easily assessed at the Phase 1 level for structures not accessed in Windshield Surveys – particularly, private or remote-access bridges)
- Step 5.3 Bank Armoring
- Step 6.3 Depositional Features
- Step 6.4 Meander Migration
- Step 7.2 Bank Erosion
- Step 7.3 Debris / Ice Jams

For all 53 major reaches, the second major category of revisions to Lewis Creek Phase 1 impact scores was related to improved accuracy, precision and comparability offered by automation of select steps as compared to the manual methods used to populate the original database. SGAT-delineation of the Appendix E corridor and automated (GIS-based) quantification of values and impact ratings for Steps 4.1, 4.2 (Dominant and Subdominant Watershed and Corridor Land Cover / Land Use), resulted in a large majority of the reaches experiencing at least a 1- or 2-point increase in Total Impact Score. Digital representation of the watershed and corridor delineations in GIS and use of ArcView's standard buffering and measuring tools, facilitated more accurate estimates of values and impacts under Step 4.3 (Buffer Width), Step 6.1 (Berms/Roads/RRs/Improved Paths), and Step 6.2 (River Corridor Development).

Phase 2 assessments of approximately 25 Lewis Creek reaches will be completed during the 2004 season using current (2004) protocols. As part of that separate contract, SMRC will perform an update of Phase 1 database parameters for those reaches assessed under the LCBP Annual Priorities Grant.

Step 4.3 should also be recalculated for the 35 major reaches not yet assessed through Phase 2, as the calculation of Impact ratings has changed significantly since these were first estimated in 2001. Also, GIS methods (buffer tool and measuring tool) have improved accuracy and precision of these estimates as compared to the manual review methods utilized for original measurements.

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July 2004

*Updates to Phase 1 & 2 Stream Geomorphic Assessment Database
Lewis Creek Watershed, Addison & Chittenden Counties, VT*

Attachment A

Memo from Staci Pomeroy, VTDEC River Management Section



July 2004

*Updates to Phase 1 & 2 Stream Geomorphic Assessment Database
Lewis Creek Watershed, Addison & Chittenden Counties, VT*

Attachment B

Remote Sensing Resources, Lewis Creek Watershed



Attachment C

Documentation of Step 4.3 Buffer Width Calculations



July 2004

*Updates to Phase 1 & 2 Stream Geomorphic Assessment Database
Lewis Creek Watershed, Addison & Chittenden Counties, VT*

Attachment D

**Updated Phase 1 & 2 Geomorphic Database Report
Steps 1 through 8**



Attachment E

Project CD

- Summary Report – Updates to Phase 1 & 2 Stream Geomorphic Assessment Database, July 2004, Lewis Creek Watershed (pdf)
- Remote Sensing Resources, Lewis Creek Watershed (pdf)
- Documentation of Step 4.3 Buffer Width Calculations (Excel)
- Updated Phase 1 & 2 Geomorphic Database Report
- Steps 1 through 8 (Access)
- May 2004 Phase 1 & 2 Database prior to updates (Access)

