TOWN OF WINDHAM
RSMS PAVED ROAD EVALUATION
APRIL 2017

Windham Hill Road (11/11/2016)

Total Miles of Paved Roads				
Maintenance Type	State Paved Class 1	Town Paved Class 2	Town Paved Class 3	Paved Roads Class 1, 2, 3
No Maintenance	0	1.66	2.35	4.01 (43%)
Routine	0	1.44	0.04	1.48 (16%)
Preventative	0	0.00	0.08	0.08 (1%)
Rehabilitate	0	2.24	0.00	2.24 (24%)
Reconstruct	0	1.50	0.05	1.55 (16%)
Total Miles	**0 miles**	**6.84 miles**	**2.52 miles**	**9.36 miles**

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Road Surface Management System (RSMS)

The field evaluation of the Town of Windham's paved roads was completed on December 1, 2016 by Everett Hammond, PE (Hammond Engineering) with the assistance of Josh Dryden (Windham Highway Foreman). Road Surface Management System (RSMS) is a management system for roads provided by the Maine Local Roads Center. RSMS 2010 version provides a condition survey of all roads based on data from roughness and road condition and ranks the roads in order of traffic volume and importance. This data is utilized to provide a recommended Annual Paving Budget and a long term Capital Plan for the Town's paved roads. If applied correctly, this plan can be used to apply timely, cost effective road improvements for paved roads. This RSMS evaluation is a snapshot in time of the condition of Windham's roads which may need to be adjusted over time to reflect unexpected pavement changes.

According to the University of New Hampshire technology transfer Center the goal of a Road Surface Management Plan should be the following:

- **Maximize Return on Investment (ROI) for each dollar spent on road maintenance**
- **Maintain highest possible town-wide road quality**
- **Create a transparent, systematic and non-biased methodology for road repairs**
- **Generate long term budgetary estimates and work plans**

Developing the Road Surface Management System involved the following steps:

1 Data Collection:

The following data was collected and utilized in the RSMS Program:

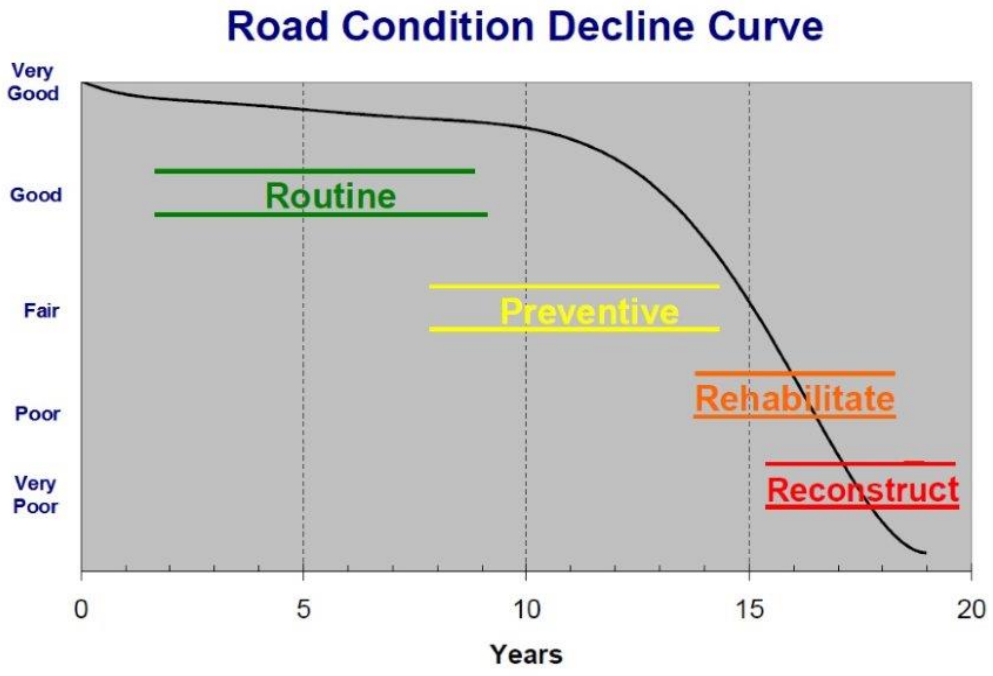
- **Roughness:** Roughness is used as an importance in calculating the condition assessments. This is based on the severity and extent for each road.
- **Road Condition:** Road condition has many factors that determine its level of importance. This consists of alligator cracks, longitudinal/transverse cracks, edge cracks, rutting and drainage. This is also based on the severity and extent for each road.
- **Traffic Volume:** The program uses traffic volume when establishing the priorities of repairs within each repair strategy. The traffic volumes were estimated by Everett Hammond and based on the Classification of the roads.
- **Importance:** The RSMS 2010 version utilizes road importance as an additional factor when establishing the priorities of repairs within each repair strategy. This is one area where local officials can offer their input.

2 Inventory Results – Paved Roads:

A list of the results from the RSMS of this data is attached. The basis of the rating system on the older version of RSMS was based on Pavement Condition Index (PCI). That program would use the roughness and the condition of the road to compute the PCI Index. The PCI is based on a scale of 0-100 with 0 being the worst and 100 being the best. This 2010 version of RSMS does not utilize the PCI index as it was found that Towns were concentrating their efforts on the worst roads with less emphasis on the roads that should be preserved. The new version of RSMS uses the following categories:

- No Maintenance (very good)
- Routine (good)
- Preventative (fair)
- Rehabilitate (poor)
- Reconstruct (very poor)

The average condition for Windham's paved roads is between Preventative (Fair) and Rehabilitate (poor).



The above chart is from the Maine RSMS Program. The TIME element on the above chart will vary greatly from road to road depending on how well it was initially constructed.

3 Repair Strategies – Paved Roads:

There are many road repair strategies used on Town Highways. In general, the better the condition of the road results in a lower cost repair strategy. The following repair strategies have been used in the attached Capital Plan.

- **No Maintenance:** No work is required (generally newly surfaced roads)
- **Routine Maintenance:** This is the most cost effective use of funds and includes ditching, cleaning culverts and patching.
- **Preventative:** This strategy includes crack filling, chip seals, shimming, overlays or a combination of these depending on the nature of the road surface.
- **Rehabilitate:** This strategy generally includes milling/shimming/overlaying or reclamation of the existing pavement followed by a minimum of 4" of new

pavement. It is important to review the existing base material prior to any type of rehabilitation, as an undesirable base will not adequately support a reclaim project even if stabilized with cement, asphalt or chloride. In some cases the road may require preservation of the road such as a shim or shim/chip seal in order to buy time for a complete rehabilitation.

- **Reconstruct:** This includes the complete excavation of the existing pavement and inadequate base material, installation of new drain pipes and underdrains where appropriate, installation of fabric as needed, 1.5' to 2' of new gravel base (depending on the road) and new pavement (2.5" minimum base, 1.5" minimum top). Some of the heavier travelled roads may require up to 2.5' of base and 5" to 6" of pavement.
- **Defer:** It is important to recognize when a road has gone beyond the point of rehabilitation than it should be classified as a candidate for Reconstruction. There are cases where capital funds can be saved on this type of road by simply deferring maintenance until the road has reached the end of its useful life. Deferring can free up Capital funding for use on other roads. If selected appropriately deferred roads can save money by preventing overlays and reclamations on roads subject to failure. Deferring a road needing Capital Improvements may require a shim or shim and chip seal to hold the road in place long enough to obtain funding for Capital Improvements, however once a shim is completed it is important to get another 10 years +/- prior to prior to reconstructing.

4 Repair Concepts:

According to the Chart from the Maine Local Roads Center on the previous page, it is more cost effective to take care of the good roads than to address the poor or failed roads. For this reason it is imperative to preserve the GOOD roads (Preventative Category) with chip seals and or pavement overlays prior to the significant drop in condition.

According to the University of New Hampshire technology transfer the guiding principals of a Road Surface Management Plan should be as follows:

- **Use money as efficiently as possible**
- **Make repair decisions based on road surveys**
- **Avoid "worst first" methodology"**
- **Avoid arbitrary repair selection**
- **Prepare multi – year road maintenance plan**

The strategy used in this RSMS preserves the good roads first prior to starting on Capital Improvements. The essential part of this plan is to avoid "WORST FIRST".

5 Pavement Management, Rehabilitation and Reconstruction techniques and cost estimates:

There are many techniques to choose from with a wide range of cost for each technique. The following list contains costs in 2015 dollars based on the RSMS road width program of 20':

- Defer to Reconstruction (defer): Cost = cost of patching/year
- Reclaim pavement, revert to gravel: $20,000/mile
- Chip seal (cs) with 3/8" washed stone: $34,000/mile

- Chip Seal (cs 10%) 3/8" washed stone with 10% rubber added: $45,000/mile
- Chip Seal (cs 20%) 3/8" washed stone with 20% rubber added: $60,000/mile
- Shim (s) based on an average thickness of ½ ": $30,000/mile
- Shimlay (sl) used as a 1" avg. shim without an overlay: $60,000/mile
- Overlay (o) based on a thickness of 1": $60,000/mile
- Overlay (o) based on a thickness of 1.25": $75,000/mile
- Overlay (o) based on a thickness of 1.5": $90,000/mile
- Mill (m) based on 2" depth: $30,000/mile
- Shim/chip seal (s/cs): $64,000/mile
- Shim/chip seal (s/cs 10% rubber): $75,000/mile
- Shim/chip seal (s/cs 20% rubber): $90,000/mile
- Shim/overlay (s/o) ½" shim, 1" overlay: $90,000/mile
- Mill/shim/overlay (m/s/o) 2" mill, ½" shim, 1.5" overlay: $120,000/mile (plus adjust. Structures)
- Reclamation (reclaim): $300,000/mile (minor ditching, reclaim, grade, compact, traffic control, 4" mix)
- Reclaim, stabilize base (reclaim, stabilize): $350,000/mile
- Reclaim, add 6" gravel (reclaim, 6" gravel): $400,000/mile
- Reclaim (reclaim, 6" gravel, stabilize): add 6" gravel, stabilize: $450,000/mile
- Reclamation (reclaim +): $400,000/mile (includes ditching, reclaim, tree removal, traffic control, new culverts, 4" mix)
- Reclaim, add 12" gravel, 4" pavement: $500,000/mile
- Reconstruction-100% contracted (rebuild): $1,000,000/mile (depending on aggregate source and excavation depth)

NOTE 1: For paved roads wider than 20', the program calculates the additional gravels and pavement.
NOTE 2: Costs based on the following unit prices:

- Asphalt placed: $80/TON
- Milling: $1.00/SY to $2.50/SY (price depends on the depth)
- Reclaim only (no pavement): $1.00/SY to $2.00/SY
- Chip Seal (traditional): $2.50/SY (20,000 SY minimum)
- Chip Seal (10% rubber): $3.50/SY (20,000 SY minimum)
- Chip Seal (20% rubber): $4.50/SY (20,000 SY minimum)

6 Basics of a Good Road: From Vermont Local Roads Fact Sheet (1984 – updated 2009):

- Get water away from the road
- Build on a firm foundation
  "A highway wears from the top, but it falls apart from the bottom."
  "The road base determines the service life of a road."
  "If adequate support does not exist, the road will rapidly deteriorate."
  "A good road requires a suitable foundation which in turn requires stable material."
- Use the best soils possible
  "In deciding what is affordable, towns should consider the long-term consequences of using lower quality material."

"Using inferior base materials may require excessive maintenance during the roads life and perhaps costly rehabilitation before paving."
"The adage <pay me now or pay me later> applies to road building."

- Compact soils well
- Design for winter maintenance
- Design for traffic loads and volumes
- Pave only those roads that are ready
  "Some towns make the mistake of paving a road that is not properly prepared."
- Build from the bottom up
  "A road that has a poor base and poor drainage cannot be adequately improved with a top dressing of gravel and new pavement."
  "It may be necessary in some cases to dig out the old road, put in new material and build up the road in layers."
- Protect your investment
- Keep good records

A Vermont Local Roads article printed in December 2011 titled "Pay now or later: Tips for saving dollars for the long haul" points out the following:

- **"Spending money before rapid depreciation is money well spent"**
- **"Providing good foundations is good road management"**
- **"Cheaper is not always better"**
- **"It may mean the Town does not accomplish all it wants to"**

7 Annual Pavement Maintenance Budget

The Town of Windham's average Annual Pavement Maintenance Budget should be a minimum of $103,000 to preserve the roads in their present state. This represents an average of $11,000/mile of paved roads in the 2017 budget.

- 9.36 miles x $11,000/mile = $103,000/year

This level of paving will only hold the condition of the roads in their present state. In order to improve on the condition it is recommended that the Town of Windham increase funding to the level identified in either Option 1 or Option 2 described below. The driving force behind this is the condition of Windham Hill Road (section 5) and Windham Hill Road (section 6).

Annual Paving Budget: In order to improve on the conditions of the Paved Roads I have identified 2 paving capital plan options for the next 15 years. Option 1 is the most affordable plan pushes out a potential bond to 2031. The 2 options are described in further detail in the Capital Plan.

8 Capital Plan (see attached):

In order to address the reconstruction of Windham Hill Road (section 5) between Abbott Road and Burpee Pond Road and the rehabilitation of Windham Hill Road (section 6) between Burpee Pond Road to the Town line it is likely that a Road Construction Bond will need to be considered. The amount of the bond will be determined when the bond is considered.

The Town of Windham may elect to defer the Capital Work to 2031 as outlined in the affordable Option 1 or to choose the more aggressive Option 2. Should Option 2 be chosen, it is recommended to begin with Windham Hill Road (section 6) and rehabilitee this section of road prior to reconstructing Windham Hill Road (section 5) in 2031. The reason for this is that the completion of section 6 will not be impacted by future construction trucks.

The attached Annual Pavement Management Budget and the Capital Improvement Budget is designed to first preserve the Town Roads, including Capital Projects planned for more than 10 years out. The Town of Windham's Annual Paving and Capital Budget has been developed to address the paved roads in 2 options:

1. Starting at $90,000/year in 2017, increasing by $10,000/year through 2031. A $2,200,000 road bond is proposed in 2030.
2. Starting at $90,000/year in 2017, increasing to $300,000 by 2024, then hold at $300,000 through 2031. This option includes a $2,000,000 road bond with equal payments estimated at $250,000/year beginning in 2019.

The difference between Option 1 and 2 is the affordability and the pace of aggressiveness of both options. Both options address all of the Towns paved roads over the next 5 years.

Paved Road Recommendations

- Beginning in FY2018, provide a minimum funding of $90,000 for Pavement Management. From this point on there are 2 options considered in this plan.
    1. Option 1 increases at a rate of $10,000/year to $230,000 in FY2031.
    2. Option 2 is a more aggressive option and would increase funding rapidly to $300,000 by 2024 and then hold at $300,000 until 2031.
- The gravel base should be verified prior to any Capital Improvement Project to ensure there is adequate support. Windham Hill Road (section 6) is a good example of where test pits may determine whether a reclaim will be sufficient or full depth reconstruction is required.
- All road improvements should be recorded in the Annual Town Report by the Selectboard. The Annual Town Report not only serves as a report to the tax payers but is the best source creating a log of road preservation and Capital Improvements that will be beneficial for future Road Evaluations and Capital Planning.
- The Capital Budget should carry over excess funds to the following years Capital Budget.
- All road material should meet the State of Vermont Specifications for Construction.
- The Capital Plan should be included in the Town Plan.

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Horsenail Hill Road (section 1): Mill, shim, overlay, chip seal (10% rubber) in 2016

White Road: Mill, overlay, chip seal (10% rubber) in 2016

Rte #121: Shim, overlay in 2016

Rte #121: Shim, overlay in 2016

Windham Hill Road (Section 1 overlayed in 2016)

Windham Hill Road (Section 2)

Windham Hill Road (section 3 near Corn Hill Road)

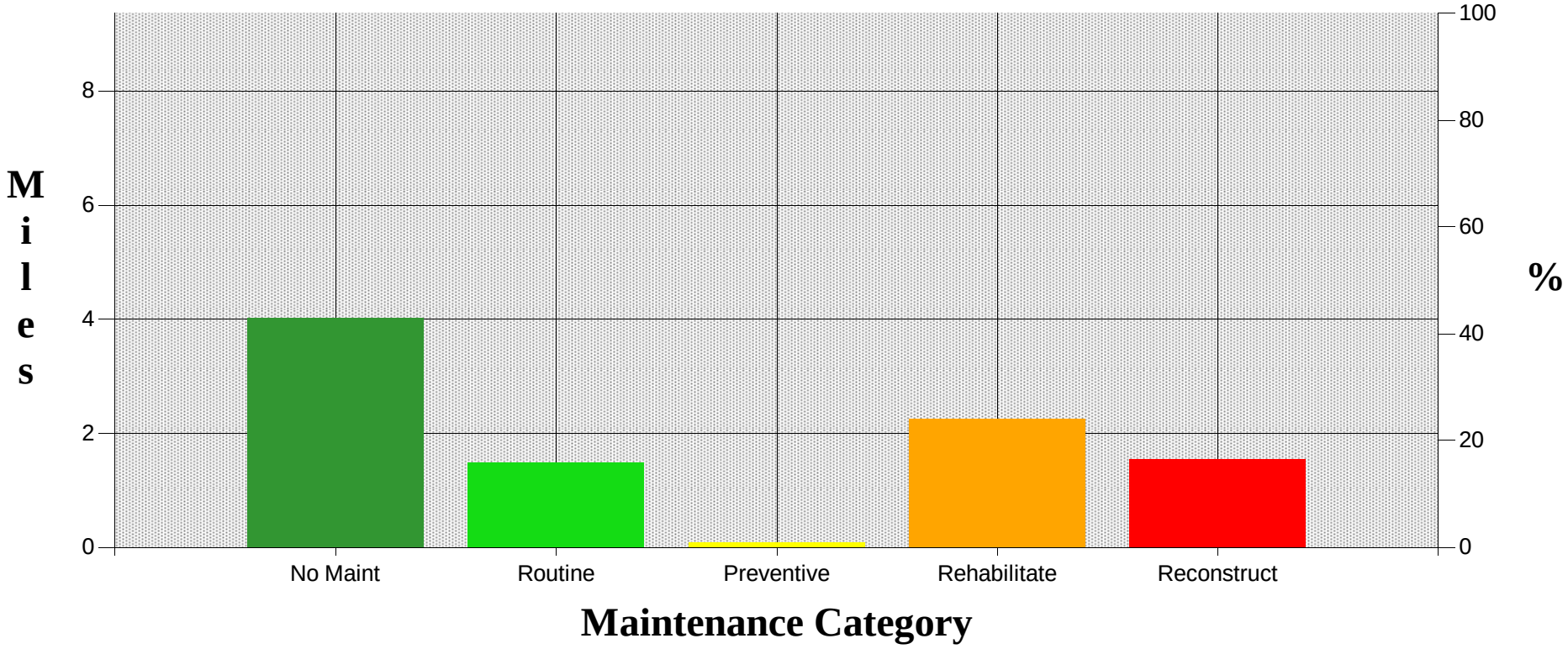
Windham Hill Road (section 4 at Cross Road)

Windham Hill Road (section 5)

Windham Hill Road (section 6 at Wheeler Road)

Windham VT Network Overview

Paved



RSMS 2016: Town of Windham

Date: ____________

PAVED ROADS

		Extent				
	None: 0	low	med	high	Cracks	Rutting
Severity	low	1	2	3	< 1/4"	< 1"
	med	4	5	6	up to 3/4"	1" to 3"
	high	7	8	9	> 3/4"	> 3"

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

Street: ______________________ Length: ________ Width: ________

Alligator cracks	Edge cracks	roughness
Longitudinal cracks	Patches/potholes	Rutting
NOTES:		Drainage

RSMS 2015: Town of Windham

Date: ____________

GRAVEL ROADS

Extent

	None: 0	low	med	high
Severity	low	1	2	3

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Street: ______________________ Length: __________ Width: __________

rock/clay	Corrugations	cross section
Rutting	potholes	drainage
loose agregate	dust	

NOTES:

Paved Network Inventory

By Surface Status
Windham VT

(Prio) Road/Section Name	Sec	From Road/Section	To Road/Section	Length	division	Import	Traffic	Drainage Status
No Maint								
(6) Horsenail Hill Road		Rte 11	White Road	1.26		medium	medium	Good
(6) Rte 121	1	Londonderry TL	Paving joint	1.03		medium	medium	Good
(6) Rte 121	2	Paving joint	End of pavement	0.63		medium	medium	Good
(2) Burpee Pond Road	1	Windham Hill Road	Apron (0.02 miles)	0.02		low	low	Good
(2) Harrington Road (S)	1	Windham Hill Road	End of pavement	0.08		low	low	Good
(2) Hitchcock Hill Road	1	Horsenail Hill Rd	Apron (0.02 miles)	0.02		low	low	Good
(2) Hitchcock Hill Road	4	Apron	Rte 121	0.02		low	low	Good
(2) Popple Dungeon Road	1	Horsenail Hill Rd	Apron (0.02 miles)	0.02		low	low	Good
(2) Scott Pet Road	1	Horsenail Hill Roa	Apron	0.01		low	low	Good
(2) White Road	1	Hitchcock Hill Rd	End of pavement	0.92		low	low	Good
				4.01				
Routine								
(6) Windham Hill Road	1	Rte 121	Paving joint	0.90		medium	medium	Good
(6) Windham Hill Road	3	Paving joint	Just past gargae	0.54		medium	medium	Good
(2) Burpee Pond Road	7	1.72 miles	West Windham Road	0.04		low	low	Good
				1.48				
Preventive								
(2) Abbott Road	1	Windham Hill Road	0.01 miles (apron)	0.01		low	low	Good
(2) Chase Road	1	Windham Hill Road	Apron (0.05 miles)	0.05		low	low	Good
(2) Cross Road	1	Rte 121	Apron (0.02 miles)	0.02		low	low	Good
				0.08				
Rehabilitate								
(6) Windham Hill Road	2	Paving joint	Paving joint	0.30		medium	medium	Good
(6) Windham Hill Road	4	Just past gargae	Abbott Road	0.76		medium	medium	Good
(4) Windham Hill Road	6	Burpee Pond Road (	Town Line	1.18		low-med	low-med	Good
				2.24				

Paved Network Inventory

By Surface Status
Windham VT

(Prio) Road/Section Name	Sec	From Road/Section	To Road/Section	Length	division	Import	Traffic	Drainage Status
Reconstruct								
(6) Windham Hill Road	5	Abbott Road	Burpee Pond Road (	1.50		medium	medium	Good
(2) Corn Hill Road	1	Rte 121	End of pavement	0.05		low	low	Good
				1.55				
				9.36				

Maintenance Financial Plan

Windham VT

2018

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Harrington Road (S)	1	Windham Hill R	End of pavement	0.08		shim (3/4") = 50 Ton	3,750	0
Harrington Road (S)	1	Windham Hill R	End of pavement	0.08		chip seal (10% rubber)	3,150	0
Windham Hill Road	1	Rte 121	Paving joint	0.90		crack fill, chip seal	62,000	0
Windham Hill Road	2	Paving joint	Paving joint	0.30	Overlay & chip seal (1", 10% rubber)		37,800	0
Windham Hill Road	3	Paving joint	Just past gargae	0.54	Overlay & chip seal (1", 10% rubber)		68,040	0
Windham Hill Road	4	Just past garga	Abbott Road	0.76	Overlay & chip seal (1", 10% rubber)		95,760	0
Windham Hill Road	5	Abbott Road	Burpee Pond Roa	1.50	Mill, shim, overlay (2" total), shoulder gra		234,000	0
Total Paved							**504,500**	**0**
Total 2018							**504,500**	**0**

2021

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Rte 121	1	Londonderry Tl	Paving joint	1.03		shim & cs 20%	73,000	0
Rte 121	2	Paving joint	End of pavement	0.63		cf & cs 20%	47,000	0
Windham Hill Road	6	Burpee Pond R	Town Line	1.18	Mill, shim, overlay (2" total)		169,920	0
Total Paved							**289,920**	**0**
Total 2021							**289,920**	**0**

2023

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Corn Hill Road	1	Rte 121	End of pavement	0.05		Engineering	5,000	0
Total Paved							**5,000**	**0**
Total 2023							**5,000**	**0**

Maintenance Financial Plan

Windham VT

2024

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Corn Hill Road	1	Rte 121	End of pavement	0.05	Reconstruct		37,500	0
Corn Hill Road	1	Rte 121	End of pavement	0.05		Engineering/testing	7,500	0
Total Paved							**45,000**	**0**
Total 2024							**45,000**	**0**

2030

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Windham Hill Road	5	Abbott Road	Burpee Pond Roa	1.50		Engineering	50,000	0
Total Paved							**50,000**	**0**
Total 2030							**50,000**	**0**

2031

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Windham Hill Road	5	Abbott Road	Burpee Pond Roa	1.50	Reconstruct		1,800,000	0
Windham Hill Road	5	Abbott Road	Burpee Pond Roa	1.50		Engineering/testing	150,000	0
Total Paved							**1,950,000**	**0**
Total 2031							**1,950,000**	**0**

Maintenance Financial Plan

Windham VT

2036

Road/Section Name	#	From	To	Length	Recommended Repair	Other	Budget	Actual
Paved								
Windham Hill Road	6	Burpee Pond R	Town Line	1.18	Reclaim, add 12" gravel, stabilize base, 4		778,800	0
Windham Hill Road	6	Burpee Pond R	Town Line	1.18		Eng/Contingency	221,200	0
Total Paved							**1,000,000**	**0**
Total 2036							**1,000,000**	**0**
							3,844,420	**0**

TOWN OF WINDHAM, VT
GRAVEL ROAD EVALUATION
JULY 2017

Total miles of Town Gravel Roads			
Miles Town Road	Town Gravel Roads Class 2	Town Gravel Roads Class 3	Town Gravel Roads Class 2 & 3
Routine	1.53 miles	14.30 miles	15.83 (76%)
Add 4" Gravel	0.77 miles (4,050')	3.22 miles (17,010')	3.99 (19%)
Rehabilitate		0.42 miles (2,200')	0.42 (2%)
Reconstruct		0.59 miles (3,100')	0.59 (3%)
Total Miles	**2.30 miles**	**miles**	**20.83 miles**

Total miles of Windham Town Roads				
Miles Road	Town Roads Class 1	Town Roads Class 2	Town Roads Class 3	Total Town Roads
Paved	0.00	6.84	2.52	9.36
Gravel	0.00	2.30	18.53	20.83
Total Miles	**0.00 miles**	**9.14 miles**	**21.05 miles**	**30.19 miles**

Road Surface Management System (RSMS)

The evaluation of the Town of Windham's roads was completed in the fall of 2016 utilizing RSMS 11 and modified during mud season 2017. This 2016 survey was completed by Everett Hammond (Hammond Engineering) with the assistance of Josh Dryden (Windham Highway Foreman). RSMS or Road Surface Management System is a management system for roads provided by the Maine Local Roads Center. RSMS 11 provides a condition survey of all gravel roads based on the collection of a wide range of data listed below. This data is utilized to provide a capital plan used in the improvement of the Town's gravel roads. If applied correctly, this plan can be used to apply timely, cost effective road improvements for gravel roads. This RSMS evaluation is a snapshot in time of the condition of Windham's roads to be used as a tool for future planning. Variations of this plan over time may be needed to reflect unexpected changes.

According to the University of New Hampshire technology transfer Center the goal of a Road Surface Management Plan should be the following:

- **Maximize Return on Investment (ROI) for each dollar spent on road maintenance**
- **Maintain highest possible town-wide road quality**
- **Create a transparent, systematic and non-biased methodology for road repairs**
- **Generate long term budgetary estimates and work plans**

Developing the Road Surface Management System involved the following steps:

1. **Data Collection:**
   The following data was collected and utilized in the RSMS Program:

16-17 Rock/Clay
16-18 Rutting
16-19 Loose Aggregate
16-20 Corrugations
16-21 Potholes
16-22 Dust
16-23 Cross Section
16-24 Roadside Drainage

2. **Inventory Results – Gravel Roads:**
   A list of the results from the RSMS Program is attached. The Town of Windham has 20.83 miles of gravel roads with 15.83 miles (76%) of the roads requiring normal maintenance and 3.99 miles (19%) in need of an added 4" of quality gravel, 0.42 miles (2%) in need of rehabilitation and 0.59 (3%) in need of reconstruction.

3. **Repair Strategies – Gravel Roads:**
   There are fewer repair strategies available for gravel roads. The following is a list of these and their respective costs in 2016 dollars based on an average road width of 22'. The following repair strategies have been used in the attached Capital Plan.

- **Routine Maintenance:** This is the most cost effective use of funds and includes ditching, cleaning culverts, grading and the periodic addition of gravel due to natural erosion, washouts and dust.
- **Add 4" of new gravel:** Cost = $50,000/mile ($10/foot)
- **Scrape 6" of new gravel; add 12" of high quality gravel:** Cost = $200,000/mile ($40/foot)
- **Reconstruction (Exc. 18", fabric, Install 22" gravel, 6" underdrain):**
  Cost = $500,000/mile ($100/foot)
  This includes the complete excavation of the existing gravels, installation of fabric and underdrain where necessary and the installation and compaction of 24" new state approved gravels.
  NOTE: All gravel shall meet VT State Specifications.

4. **Basics of a Good Road: From Vermont Local Roads Fact Sheet (1984 – updated 2009):**
   These basic guidelines meant for paved roads also apply to gravel roads with one modification highlighted below.
   - Get water away from the road
   - Build on a firm foundation
     "A highway wears from the top, but it falls apart from the bottom."
     "The road base determines the service life of a road."
     "If adequate support does not exist, the road will rapidly deteriorate."
     "A good road requires a suitable foundation which in turn requires stable material."
   - Use the best soils possible
     "In deciding what is affordable, towns should consider the long-term consequences of using lower quality material."
     "Using inferior base materials may require excessive maintenance during the roads life and perhaps costly rehabilitation before paving."
     "The adage <pay me now or pay me later> applies to road building."
   - Compact soils well
   - Design for winter maintenance
   - Design for traffic loads and volumes
   - **Do not pave a gravel road unless it has been designed to take the traffic. "Some local towns have made the mistake of paving a gravel road only to tear it up within a few short years."**
   - Build from the bottom up
     "A road that has a poor base and poor drainage cannot be adequately improved with a top dressing of gravel."
     "It may be necessary in some cases to dig out the old road, put in new material and build up the road in layers."
   - Protect your investment
   - Keep good records

5. **Annual Gravel quantities/treatment**
   The 20.83 miles of gravel roads in the Town of Windham, VT can lose as much as 1" of gravel on an untreated road. This loss is attributable to erosion and dust. Treating the roads with calcium chloride or magnesium chloride will help to hold the gravel surface in place

during light to moderate rainfall. The following table is a guideline for estimated annual gravel quantities within the Town of Windham.

Town of Windham Gravel Roads: 20.83 miles (average width of 20')		
Gravel Loss	**Cubic Yards per Year (estimated)**	**Cost at $15/CY**
1" per year (untreated)	6,600 Cubic Yards/year	$100,000
½" per year (treated)	3,300 Cubic Yards/year	$50,000

In order to keep the gravel loss to a minimum it is recommended to apply the minimum amount of chloride to the level of application that works for each section of road. Some sections of road that are well shaded may need a minimum amount of chloride or possible no chloride. Chloride should not be applied within 24 to 36 hours of a scheduled heavy rain event. The Town of Windham's average Annual Gravel Budget should be a minimum of $50,000 to keep roads in their present state. This amount of gravel to be used on gravel roads should not be confused with Capital work on those gravel roads in need.

6. Capital Plan (see attached):

The attached Capital Improvement Budget for Gravel Roads is designed to address the concerns of the gravel roads observed over the course of the 2017 mud season. The Capital Plan has been extended to the year 2032. With 24% of Windham's gravel roads needing some degree of Capital Improvement, it will take approximately 20 years to complete at the recommended funding beginning at a level of $5,000/year increase by $5,000/year until at least 2032. The Town of Windham may elect to slow the pace of Capital Work down or pick up the pace by adjusting the average annual Capital Improvements. The proposed level of funding will allow for $525,000 of the $762,100 to be completed over the next 15 years.

Gravel Road Recommendations

- Beginning in FY2019, provide a minimum funding of 50,000 for Gravel Road annual funding.
- Beginning in FY2019, provide a minimum funding of $5,000 for Gravel Road Capital Improvements, increasing by $5,000/year until a desired level of funding level of Capital funding has been obtained. The attached Capital Plan reached the level of $70,000 in the year 2032; however this level may vary depending on the quality of road desires of the Town.
- The existing gravel base should be verified prior to any Capital Improvement Project to ensure there is adequate support.
- All road improvements should be recorded in the Annual Town Report. The Annual Town Report is an excellent location in logging past work history for use in future Road Evaluations and Capital Planning.
- The Capital Budget should carry over excess funds to the following years Capital Budget.

Everett Hammond, PE
Hammond Engineering
Springfield, VT 05156
802-885-3872

Town of Windham: Gravel Roads				Add 4" gravel		Rehabilitation		Reconstruct		
						(Exc. 6", Add 12")		(Exc. 18", add 24")		
Town Road	**From**	**To**	**Length**	**Unit Cost**	**Total**	**Unit Cost**	**Total**	**Unit**	**Total**	
Abbott Road: Section 1	800	1700	900	$10	$9,000					
Abbott Road: Section 2	1700	2000	300					$100	$30,000	
Abbott Road: Section 3	3400	5000	1600	$10	$16,000					
Abbott Road: Section 4	5500	12000	6500	$10	$65,000					
Burpee Pond Rd Section 1	4000	4850	850	$10	$8,500					
Burpee Pond Rd Section 2	8200	9225	1025	$10	$10,250					
Chase Road: Section 1	500	1300	800	$10	$8,000					
Chase Road: Section 2	2400	5000	2600	$10	$26,000					
Cross Road: Section 1	200	1400	1200	$10	$12,000					
Cross Road: Section 2	1500	2900	1400					$100	$140,000	
Cross Road: Section 3	3100	3500	400					$100	$40,000	
Hitchcock Hill Road 1	5500	6185	685	$10	$6,850					
Old Cheney Road 1	250	700	450	$10	$4,500					
Old Cheney Road 2	1000	3200	2200	$10	$22,000					
Old Cheney Road 3	3500	4650	1150	$10	$11,500					
Popple Dungeon Road 1	2500	2700	200	$10	$2,000					
Popple Dungeon Road 2	3500	4000	500	$10	$5,000					
Popple Dungeon Road 3	4900	5900	1000					$100	$100,000	
Popple Dungeon Road 4	6000	6400	400	$10	$4,000					
Popple Dungeon Road 5	6400	8500	2100			$40	$84,000			
Popple Dungeon Road 6	9300	9400	100			$40	$4,000			
Subtotal (page 1):					$210,600		$88,000		$310,000	
Subtotal (page 2):					$87,500		$66,000		$0	
										Total
										$762,100.00
	Total (Page 1 and Page 2):				$298,100		$154,000		$310,000	

Town of Windham: Gravel Roads				Add 4" gravel		Rehabilitation		Reconstruct		
						(Exc. 6", Add 12")		(Exc. 18", add 24")		
Town Road	**From**	**To**	**Length**	**Unit Cost**	**Total**			**Unit**	**Total**	
Rte #121 Section 1	0	1000	1000	$10	$10,000					
Rte #121 Section 2	2000	3000	1000	$10	$10,000					
Rte #121 Section 3	4150	4300	150	$10	$1,500					
Rte #121 Section 4	6000	6800	800	$10	$8,000					
Rte #121 Section 5	7300	7500	200	$10	$2,000					
Rte #121 Section 6	8650	8850	200	$10	$2,000					
Rte #121 Section 7	11500	12200	700	$10	$7,000					
West Windham Road 1	500	2700	2200	$10	$22,000					
West Windham Road 2	5700	6100	400	$10	$4,000					
West Windham Road 3	9700	10700	1000			$40	$40,000			
West Windham Road 4	10900	11400	500			$40	$20,000			
Wheeler Road 1	4000	4500	500	$10	$5,000					
Wheeler Road 2	4800	5400	600	$10	$6,000					
White Road 1	2800	3800	1000	$10	$10,000					
Woodburn Road	350	500	150			$40	$6,000			
Subtotal (page 2):					$87,500		$66,000		$0	
Subtotal (page 1):					$210,600		$88,000		$310,000	
										Total
										$762,100.00
		Total (Page 1 and Page 2):			$298,100		$154,000		$310,000	

TOWN OF WINDHAM, VT
TOP EROSION SITES
JULY 2017

Site 2 - Burpee Pond Road (4,000’ to 6,200’ from the north end of Burpee Pond Road): Surface erosion from the gravel road washes into Burpee Pond.

Total length of Erosion on Town Roads			
Miles Town Road	**Begin station**	**End Station**	**Total Length**
1.White Road	4,200’	5,000’	800’
2.Burpee Pond Road	4,000’	6,200’	2,200’
3.Christmas Tree Road	1100’	1300’	200’
			3,200 feet

NOTE: Stream bank erosion was not included as part of this evaluation.

Site 1 - White Road (4,200’ to 5,000’ from end of pavement): View of the deposited material at the bottom of the hill.

Site 1 - White Road (4,200’ to 5,000’ from end of pavement): View of the erosion on the hill up around the corner.

Site 1 - White Road (4,200’ to 5,000’ from end of pavement): View of the erosion near the top of the hill.

Site 3 - Christmas Tree Road: 1100’ to 1300’ from Popple Dungeon Road.

APPENDIX

LEGEND: PAVED ROADS

- RECONSTRUCT
- REHABILITATE
- PREVENTATIVE
- ROUTINE
- NO MAINTENANCE

ANDOVER
CHESTER
LONDONDERRY
GRAFTON
JAMAICA
TOWNSHEND

Horsenail
TH-4
Hill Rd
Williams River
Monet Ln
Branch
Middle
Scott Pet Rd
Howard Hill Rd
Christmas Tree Rd
Williams River
Dungeon
Edson Dr
Rd
Popple
Branch
South
White Rd
Hidden Newton Rd
0' PAVED
Hitchcock Hill Rd
Mercy Rd
White Rd
Saxtons
Dillion Dr
River
Windham Springs
Glebe Mountain Rd
Timberside (see inset)
Lawrence Four Corners
WINDHAM HILL ROAD
Glebe Mtn Rd
Harrington Rd
Windham Hill Rd
Corn Hill Rd
Windham
TH-27
town garage
Old Farm Rd
Stone Bridge Rd
Cross Rd
Woodburn Rd
town office
school
Abbott Rd
Cobb Brook
Golding Rd
Ingalls Rd
Cobb Brook Rd
Burbee Pond
Burbee Pond Rd
West Windham Rd
Under the Mtn. Rd
Toad Rd
West Windham Rd
Turkey Mountain Brook
Old Cheney Rd
Windham Hill Rd
Wheeler Rd
Windham Hill Rd
Farr Ln
South Windham
Chase Rd

0 1,500 ft 3,000 ft 6,000 ft

Scale: 1"=3,000'

Hammond Engineering Everett T. Hammond, PE 5 Lincoln St, Springfield, VT 05156 Phone: (802) 885-3872	**Town of Windham, VT 2016 RSMS PAVEMENT CONDITION ASSESSMENT**	Date	Revision	**1 / 1**	Project No. WINDHAM Scale 1"=3000' Date 7/1/17

LEGEND: GRAVEL ROADS

- GRAVEL ROADS
- GRAVEL (ADD 4")
- GRAVEL (REHAB)
- GRAVEL (RECONST)

ANDOVER
CHESTER
LONDONDERRY
GRAFTON
JAMAICA
TOWNSHEND

Horsenail Hill Rd
TH-4
Williams River
Monet Ln
Scott Pet Rd
Middle Branch
Howard Hill Rd
Christmas Tree Rd
Williams River
Dungeon
Edson Dr
Rd
Popple Branch
South White Rd
61+85
55+00
0' PAVED
Hidden Newton Rd
Hitchcock Hill Rd
121
Windham Springs
Glebe Mountain Rd
Timberside (see inset)
Glebe Mtn Rd
Harrington Rd
Windham Hill Rd
WINDHAM HILL ROAD
Mercy Rd
Saxtons River
Dillion Dr
0' GRAVEL
Lawrence Four Corners
White Rd
Corn Hill Rd
Windham
town garage
TH-27
Old Farm Rd
Cobb Brook
Stone Bridge Rd
Cross Rd
Woodburn Rd
town office
school
Abbott Rd
Golding Rd
Cobb Brook Rd
Ingalls Rd
West Windham Rd
48+50
Burbee Pond Rd
Toad Rd
Under the Mtn. Rd
West Windham Rd
Turkey Mountain Brook
Old Cheney Rd
Wheeler Rd
Farr Ln
South Windham
Chase Rd

0 1,500 ft 3,000 ft 6,000 ft

Scale: 1"=3,000'

Hammond Engineering Everett T. Hammond, PE 5 Lincoln St, Springfield, VT 05156 Phone: (802) 885-3872	**Town of Windham, VT 2016 RSMS GRAVEL CONDITION ASSESSMENT**	Date	Revision	**1 / 1**	Project No. WINDHAM Scale 1"=3000' Date 7/1/17

Town of Windham, VT: OPTION 1 ($90,000 in FY2018, increasing $10,000/yr for Paved Roads and $5,000/yr Gravel Roads

Capital Highway Plan

TOWN ROAD			Budget Year/(Calendar Year)															
		Budget Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
		Calend Year	(2016)	(2017)	(2018)	(2019)	(2020)	(2021)	(2022)	(2023)	(2024)	(2025)	(2026)	(2027)	(2028)	(2029)	(2030)	(2031)
TOTAL PAVING & GRAVEL BUDGET			338,000	90,000	105,000	120,000	135,000	150,000	165,000	180,000	195,000	210,000	225,000	240,000	255,000	270,000	220,000	235,000
Class 2 State Road Grant			165,000					175,000					175,000					175,000
Bond/Loan					320,000			130,000										2,200,000
Balance for all Paving Projects (see below)			503,000	90,000	425,000	120,000	135,000	455,000	165,000	180,000	195,000	210,000	400,000	240,000	255,000	270,000	220,000	2,610,000
PROPOSED ANNUAL PAVEMENT MANAGEMENT																		
	Miles	**Cost**	**Actual**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**	**Proposed**
Rte 121 w/ aprons (sh & cs20)	1.66	$120,000	161,000					132,300										
Harrington Road (s)					6,900													
Horsenail Hill Rd (sh/cs10)	1.26	$138,000	172,000										194,180					
White Road (sh/cs10)	0.92	$100,000	125,000										140,710					
Windham Hill Road 1 (cf & cs)	0.9	$62,000	50,000		62,000								87,240					
Windham Hill Road 2 (o & cs)	0.3	$37,800			37,800								53,188					
Windham Hill Road 3 (o & cs)	0.54	$68,040			68,040									100,526				
Windham Hill Road 4 (o & cs)	0.76	$95,760			95,760									141,481				
Windham Hill Road 5 (m,s,o)	1.5	$234,000			234,000													
Windham Hill Road 6 (m,s,o)	1.18	$169,920						187,337										
PROP CAPITAL PROJECTS	**Miles**	**Cost**																
Corn Hill Road (engineering)		$5,000									6,381							
Corn Hill Road (reconstruct)	0.04	$45,000										60,304						
Windham Hill Road 5 (engineer.)		$50,000															85,517	
Windham Hill Road 5 (reconst.)	1.5	$1,950,000																
Windham Hill Road 6 (recl +)	1.18	$1,000,000																3,501,920
(NOTE: reconstruction cost used for Windham Hill Road 6)																		
Gravel Road Improvements					5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000	50,000	55,000	60,000	65,000	70,000
Loan Payment ($320,000 @ 4% 3 yrs)						115,000	115,000	115,000										
Loan Payment ($130,000 @ 4% 1 yr)									135,000									
TOTAL MILES	9.02																	
TOTAL PROJECT COST			508,000	0	509,500	125,000	130,000	454,637	25,000	30,000	41,381	100,304	520,319	292,007	55,000	60,000	150,517	3,571,920
(2020 to 2031)																		
CAPITAL CARRYOVERS																		
Paveing Budget - Capital Projects			-5,000	90,000	-84,500	-5,000	5,000	363	140,000	150,000	153,619	109,696	-120,319	-52,007	200,000	210,000	69,483	-961,920
Capital Balance carryover from previous year			0	-5,000	85,000	500	-4,500	500	863	140,863	290,863	444,482	554,177	433,859	381,852	581,852	791,852	861,335
Capital Balance (to carry over)			(5,000)	85,000	500	(4,500)	500	863	140,863	290,863	444,482	554,177	433,859	381,852	581,852	791,852	861,335	(100,585)

Projected Paved Road Increase Factors:			1	1	1	1	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80

NOTES:

1) Test pits should be completed on all Capital Projects to verify quality & depth of existing base.
2) Projected Budgets have been increased by 5%/year beginning in 2020. The cost increase factors are listed at the bottom of the table shown above.
3) Table above reflects the Calendar Year (CY) of Construction Funds Available (Budget Year = CY +1)

Town of Windham, VT: OPTION 2 ($155,000 in FY2019, increasing $25,000/yr for Paved Roads and $5,000/yr gravel to 202

Capital Highway Plan

TOWN ROAD		Budget Year / (Calendar Year)																
		Budget Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
		Calend Year	(2016)	(2017)	(2018)	(2019)	(2020)	(2021)	(2022)	(2023)	(2024)	(2025)	(2026)	(2027)	(2028)	(2029)	(2030)	(2031)
TOTAL PAVING & GRAVEL BUDGET			338,000	90,000	155,000	185,000	215,000	245,000	275,000	305,000	310,000	315,000	320,000	325,000	330,000	335,000	340,000	345,000
Class 2 State Road Grant			165,000					175,000					175,000					
Bond/Loan						2,000,000											1,400,000	
Balance for Capital Projects (see below)			503,000	90,000	155,000	2,185,000	215,000	420,000	275,000	305,000	310,000	315,000	495,000	325,000	330,000	335,000	1,740,000	345,000
PROPOSED ANNUAL PAVEMENT MANAGEMENT																		
	Miles	**Cost**																
Rte 121 w/ aprons (cf & cs)	1.66	$120,000	161,000					132,300										
Harrington Road (s)					6,900													
Horsenail Hill Road w/ aprons	1.26	$138,000	172,000											203,889				
White Road	0.92	$100,000	125,000											147,746				
Windham Hill Road 1 (cf & cs)	0.9	$62,000	50,000		62,000													
Windham Hill Road 2 (o & cs)	0.3	$37,800			37,800													
Windham Hill Road 3 (o & cs)	0.54	$68,040			68,040													
Windham Hill Road 4 (o & cs)	0.76	$95,760			95,760													
Windham Hill Road 6 (s & cs)	1.18	$150,000						150,000										
PROP CAPITAL PROJECTS	**Miles**	**Cost**																
Corn Hill Road (reconstruct)	0.04	$37,500									47,861							
Windham Hill Road 5 (reconst.)	1.5	$2,000,000				2,000,000												
Windham Hill Road 6 (reclaim)	1.18	$1,000,000															1,710,000	
Gravel Road Improvements					5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000	50,000	55,000	60,000	65,000	70,000
Bond Payment ($2.0 M @ 4% 10 yrs)							250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000		
Loan Payment																		
TOTAL MILES	9.06																	
TOTAL PROJECT COST			508,000	0	275,500	2,010,000	265,000	552,300	275,000	280,000	332,861	290,000	295,000	651,634	305,000	310,000	1,775,000	70,000
(2020 to 2031)																		
CAPITAL CARRYOVERS																		
Paveing Budget - Capital Projects			-5,000	90,000	-120,500	175,000	-50,000	-132,300	0	25,000	-22,861	25,000	200,000	-326,634	25,000	25,000	-35,000	275,000
Capital Balance carryover from previous year			0	-5,000	85,000	-35,500	139,500	89,500	-42,800	-42,800	-17,800	-40,661	-15,661	184,339	-142,295	-117,295	-92,295	-92,295
Capital Balance (to carry over)			(5,000)	85,000	(35,500)	139,500	89,500	(42,800)	(42,800)	(17,800)	(40,661)	(15,661)	184,339	(142,295)	(117,295)	(92,295)	(127,295)	182,705

Projected Project Increase Factors:	1	1	1	1	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80

NOTES:

1) Test pits should be completed on all Capital Projects to verify quality & depth of existing base.
2) Projected Project Costs have been increased by 5%/year beginning in 2020. The cost increase factors are listed at the bottom of the table shown above.
3) Table above reflects the Calendar Year (CY) of Construction Funds Available (Budget Year = CY +1)