MAPPING SAND AND GRAVEL MINING WITHIN THE PRESUMPSCOT RIVER WATERSHED, MAINE, USING REMOTE SENSING AND OTHER DIGITAL DATA IN A G.I.S. ENVIRONMENT

Chris Jones, Justin Rich, Irwin D. Novak
Department of Geosciences
University of Southern Maine
Gorham, Maine

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ABSTRACT

The growth of gravel mining sites from 1998 to 2001 within the Presumpscot River watershed of southern Maine has been documented using ArcGIS software, Ortho-rectified Digital Images (ODIs) and digital surface water, road, watershed, town boundary and tax map data. Maine Department of Environmental Protection licensed site locations of 5 acres or more were added as a geo-referenced layer to aid in tracing and interpreting gravel pit boundaries.

The growth of the pits was calculated by hand digitizing the outlines of areas in which the surface soils have been disturbed in order to expose extractable materials as shown on 1998 ODIs. These areas were compared with the pit outlines shown on the 2001 ODIs and satellite images (2004). The total area of all licensed and non-licensed pits within the watershed was 461.49 acres in 1998 and grew to 653.24 acres in 2004, a 47% increase. There was an increase of 49 acres, from 117.49 acres to 161.29 acres for the 34 licensed sites from 1998 to 2004 a 37% increase. The average growth was 3.8 acres per pit.

More detailed analysis in the Town of Gorham, Maine, reveals that 18% of the watershed falls within Gorham and that there are 21 licensed mines. This is the second largest area of coverage after Windham, Maine, which has 22% of the watershed within its boundaries, but only 13 pits.

With respect to mining within the town, Gorham has three zoning classes: (1) mineral extraction allowed, (2) allowed with special exception approval, and (3) not allowed. Combining zones 1 and 2, and subtracting road, lake, river and stream areas along with their mining-exclusionary set-backs (buffers) of 100 and 250 feet, permitted the total acreage of possible mineable land (5,500 acres; 23%) within Gorham to be calculated. Gorham had approximately 215 acres of mining operations in 1998 and this grew to 278 acres in 2001. This growth was in both the licensed and non-licensed mining operations. Licensed sites increased by 22.7% while non-licensed pits grew by 22.6% over the three year.

INTRODUCTION

Sand and gravel mining and crushed stone operations in open pit mines – collectively known as aggregates – is the major extractive industry in Maine. Extraction of aggregate resources often generates conflicts involving municipalities, state agencies, citizens, and the aggregate industry. In southern Maine, public concerns have focused on the cumulative effects of aggregate operations that are increasingly encroached upon by “urban sprawl.” Pit operations, formerly in remote areas or rural zones, now find themselves impinged upon by residential development. Conflicts have centered on environmental and social issues (noise, truck traffic, dust, stream-water quality, reclamation, biodegradation, desertification of areas in abandoned pits) in addition to citizen doubts about the adequacy of regulatory efforts to control these negative effects.

In the introductory: “Overview of major influences – Background and context” of the Summary of Cumulative Impacts to Environmental Conditions on the Presumpscot River and its Shorelands (DRAFT) the extraction of sand and gravel is recognized as one of the activities that contributed to changes in the immediate environs of the Presumpscot River and its watershed (Presumpscot River Plan Steering Committee, 2002). Though aggregate extraction is recognized as having an impact, little detail is included in the draft report to indicate the extent of the impact(s).

Information on the extent of extractive industries within the watershed would be of benefit to understanding the environmental and economic impact of such activities. An inventory and assessment may also help towards reducing adverse impacts on the river through cooperative efforts to mitigate problem areas. As urbanization and sprawl with concurrent demand for aggregate materials grow, the interaction between the sand and gravel industry and citizen-neighbors becomes more confrontational. A better understanding of the scope of the relationship – resource distribution, resource utilization, and impacts - may connect people, industrial leaders and policy makers with the river and foster stewardship.

GEOLOGY

The large area of sand and gravel in Maine owe their existence to the great quantities of sediment washed out of melting and receding glacial ice of late Pleistocene and early Holocene time. Sometimes this occurred in or adjacent to the sea where sand and gravel accumulated as deltas and submarine fans as streams discharged along the ice front, and the finer silt and clay dispersed onto the ocean floor. Radiocarbon dates on fossils tell us that the marine submergence lasted until about 11,000 years ago, when it was terminated by uplift of the Earth's crust as the weight of the ice sheet was removed.

Some of the glacial sand and gravel was deposited by meltwater streams in tunnels within the decaying ice. These deposits were left behind as ridges (eskers) when the surrounding ice disappeared. Other sand and gravel deposits formed as mounds or terraces (kames) adjacent to melting ice, or as outwash in valleys in front of the glacier. Ridges (moraines) consisting of till or stratified sediments were constructed parallel to the ice margin in places where the glacier was still actively flowing and conveying rock debris to its terminus. Moraine ridges are abundant in the zone of former marine submergence, where they are useful indicators of the pattern of ice retreat. (Adapted from: Marvinney and Thompson).

Identification of surficial materials is critical for making a number of land use decisions, including determining the suitability of an area for development, planning major construction projects, or looking for sources of ground water. Surficial geologic maps will provide information on the location and extent of sand and gravel deposits (Maine Geological Survey).

ECONOMICS

Sand and gravel extraction is currently the major type of mining in Maine and contributes significantly to the Maine economy. Such activity plays a pivotal role in the construction industry. The industry is important to employment and local economies in the state.

US Geological Survey (USGS, 2003, Minerals Yearbook) data indicate that the value of aggregates mined in Maine range in value from $63-70 million during the years 2001-2003. No dollar value breakdown by county or the watershed could be located, but it would be very valuable, for a balanced view of sand and gravel mining issues, to have more specific figures. Presumably, the USGS state total was derived from locally derived data (See also: Rose, 2004). Though not particularly germane, the value of the 2004 Cumberland Co. lobster catch was $31,049,411.

PRESUMPSCOT RIVER WATERSHED

This investigation explores the growth of sand and gravel mining operations within the Presumpscot River watershed using digital data within a Geographic Information system (GIS). The project utilized digital mapping techniques to map and document the growth of gravel mining sites inside the approximate 131,000 acre watershed located in southern Maine (Figure 1). This project focused on combining remotely sensed and cartographic information about active and inactive aggregate operations within the PRW. This effort was undertaken to provide baseline for data on gravel extraction that could be refined and up-dated, distributed electronically or via digital media, and from which a set of paper maps could be generated. One goal of the project was to create digital outlines of mineral extraction sites using 1998, 2001, and 2004 digital imagery; other goals were the collection and calculation of area data and growth numbers.

The overall aim was to determine the past and current extent of aggregate mining within the watershed using digital imagery and other datasets. The basic air photo imagery was available from the Maine Office of Geographical Information Systems (MEGIS) website. Mine growth was measured using the online aerial photography viewer and a research copy of the SPOT 5 satellite imagery for 2004 (Figure 2a-c).

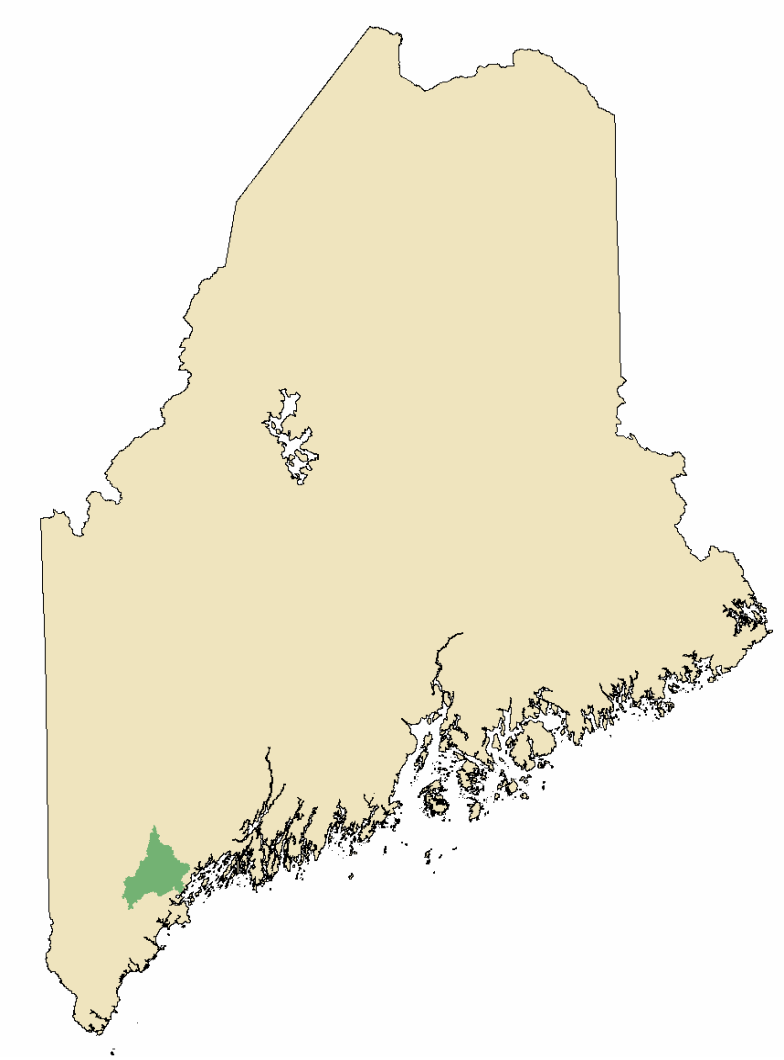

Figure 1: Location, shown in green, of the Presumpscot River Watershed in southwestern Maine.

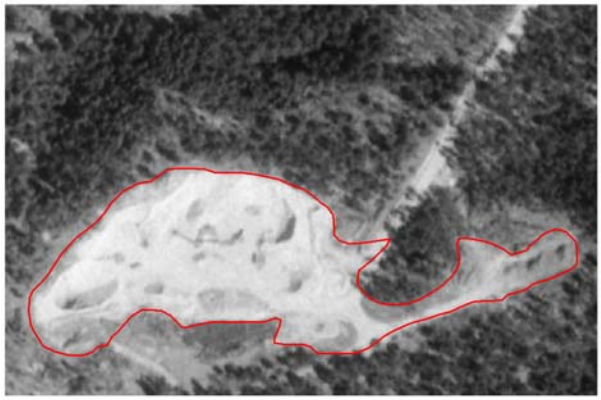

Figure 2a: High Resolution Digital Orthorectified Aerial Photography taken on April 29, 1998. Aerial Photography produced a resolution of one meter shown in Grayscale. Source: MEGIS.

Figure 2b: High Resolution Digital Orthorectified Aerial Photography taken on April 28, 2001. Aerial Photography produced a half-foot color resolution. Source: MEGIS.

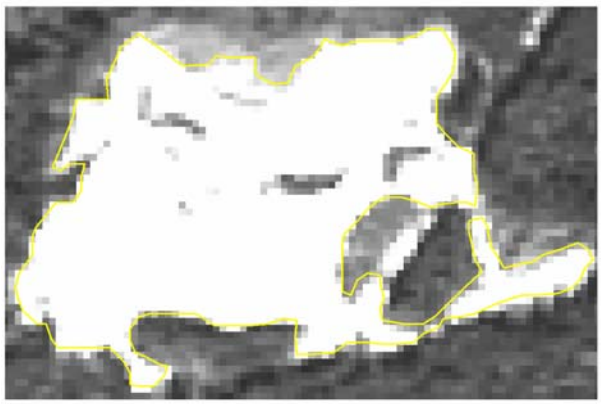

Figure 2c: SPOT 5 Panchromatic (0.48-0.71 µm) imagery obtained from MEGIS). These grayscale images have a spatial resolution of 5 meters (about 16 ft.) and were acquired during the leaf-on season of 2004.

METHODS/TECHNIQUES

Changes in mining sites were identified using the digital aerial photographs (1998, 2001) and satellite imagery (2004). This was combined with site locations (latitude/longitude) obtained from the Maine Department of Environmental Protection for licensed pits (DEP licensed sites are larger than 5 acres). This dataset also includes ownership data and other minimal ancillary data. In this way, the registration status for each site discernable on the imagery was possible. Growth of the mineral extraction sites was determined by digitally tracing the pit outlines on screen for each imagery set. The outline of the mining sites was defined as the area of the surface soils (topsoil) that had been removed to reveal the underlying, mineable material. This outline was often greater than the area where gravel extraction had actually occurred, but the land had still been altered from its natural state and thus was included (Figure 3).

Figure 3: CR Tandberg Pit in Windham, Maine showing growth comparison over approximately 5 years. 1998, outlined in Red; 2001, outlined in White (background image); 2004, outlined in Yellow.

The creation of a single layer of outlines for each year, allows the GIS software to calculate individual areas and to give the sum of all areas for a given year. As outlines were generated, "license/not licensed" status was noted and the names of the sites were applied when known. As new data (imagery) becomes available in the future, additional layers can be quickly generated to update the rate of mining growth.

Sites with a "not licensed" designation are not necessarily unknown to the towns or state. Registered status can be given to sites with town approval, but they are usually

under the five acre minimum lot size required for state licensing status. We recognize that some of the smaller sites that were included as unknown, "non-licensed" sites may not have even been mines or were in the past and are inactive now. Without detailed field investigation of every problematical site the possibility exists, for example, of having included sites of home development (foundations) as sites of possible mineral extraction.

FINDINGS/MEASUREMENTS

The digitized mined areas were used to calculate the total area of mining and the results were tabulated to analyze growth (Table 1 and Appendix 1). The years were then compared to determine the change of the total mining acreage and of the licensed sites and the non-licensed sites. The data in Table 1 are presented graphically in Figure 4 to visually show the change of mine area per year.

Table 1: Mining Areas within the Presumpscot River Watershed and Change by Year

	1998 Acres	2001 Acres	2004 Acres	% Change 1998-2004
Total Watershed	131,000	131,000	131,000	N/A
All Sites	461.49	599.51	653.24	41.64
Change	~~~~	138.02	53.73	
Licensed	344	450.23	491.95	43
Change	~~~~	106.23	41.72	
Non-Licensed	117.49	149.27	161.29	37.29
Change	~~~~	31.78	12.02	

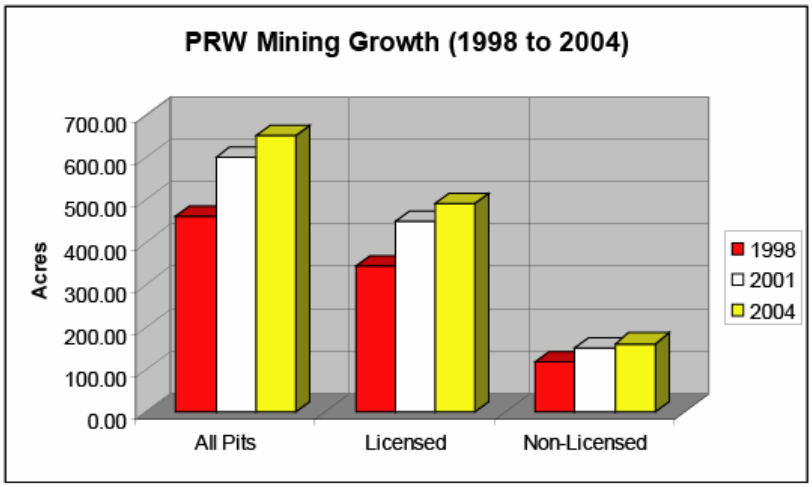

Figure 4: PRW Mining Growth (1998 to 2004).

FOCUS ON GORHAM, MAINE

The Town of Gorham was chosen for a detailed sub-study of mining growth. Gorham was selected because of the size and number of pits contained within the town boundary and because of the availability of additional digital data. The total area of the Presumpscot River watershed is 131,000 acres and Gorham covers 23,900 acres of that total or 18% of the watershed; second only to Windham's 22% of the watershed.

Gorham has a 24 of mining sites as of 2004; of these, 20 are licensed and four are unlicensed. Gorham's 24 mining sites are the largest number of sites for any single town in the watershed.

After the data was compiled it was possible to select the mining sites within Gorham and determine the total size and change of these sites from 1998 to 2004. The growth in acres is shown in Table 2 and Figure 5.

Table 2: Gorham Mining Area and Change by Year

	1998 Acres	2001 Acres	2004 Acres	% Change 1998-2004
Gorham Total	23,000	23,000	23,000	N/A
All Sites	223.36	286.93	291.45	30.48
Change	~~~~	63.57	4.52	
Licensed	154.24	205.24	219.27	42.16
Change	~~~~	51	14.03	
Non-Licensed	69.13	81.69	72.19	4.42
Change	~~~~	12.56	-9.5	

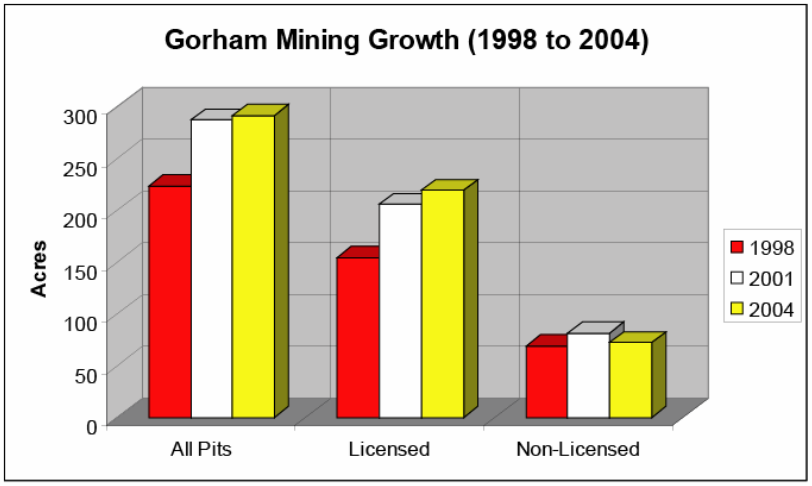

Figure 5: Gorham Mining Growth (1998 to 2004).

AREA OF LAND AVAILABLE FOR MINING

Table 3 lists the zoning and buffer criteria for each town in the watershed. This data was subtracted from the town areas within the watershed in order to identify the total percentage of land that is currently potentially minable (Table 4). However, these values do not reflect the total area which could be restricted from mining due to the development and specific zonal regulations of individual towns. In order to find the total area of the watershed available for mining, all of the specific and appropriate buffers and setbacks need to be accounted for.

Table 3: Mining Ordinances of Towns within the Presumpscot River, Maine, Watershed

Town	Setbacks					Slope	Noise, dB	Hours of Operation	
	Public Ways	Parcel Boundaries	Residence	Water bodies				Weekdays	Saturday
				Major	Minor				
Buxton	100	100	N/A	100	75	3:1	N/A	7AM - 8PM	
Cumberland	200	200	N/A	100	75	3:1	N/A		
Falmouth	100	100	N/A	250	75	N/A	N/A		
Gorham	100	200	N/A	250	75	2:1	75*****	6AM - 6PM	8AM-2PM
Gray	150	50	N/A	100#	75	N/A	75	6AM - 7PM	
Portland	25	~~	N/A	100	75	N/A	N/A		
Raymond									
Standish	150	150	N/A	100	75	N/A	75*****		
Westbrook	50		N/A	250	75	N/A	N/A		
Windham	150	25	200	100	100	2:1	60	7AM-7PM	7AM-4PM

***** Decibels at 600cps measured at property line during any consecutive 8 hour period.
Wetlands 75 ft.

Table 4: Buffer Protected and Potentially Minable Acreage by Town*

Town	Acres w/in PRW	Acres Rank	Buffer Acres[a]	Buffer Rank	% Not Minable	Potentially Minable Acres*	% Minable*
Buxton	10,160.6	6	1,988.0	6	19.6	8,172	80
Gorham	23,860.3	2	5,618.6	2	23.5	18,242#	76 (23)#
Raymond	3,520.9	9	N/A	N/A	N/A	~~	~~
Standish	5,260.9	8	1,316.4	8	25.0	3,944.5	75
Gray	18,807.3	3	5,082.9	3	27.0	13,724	73
Windham	28,951.3	1	9,157.9	1	31.6	19,793	68
Westbrook	7,695.5	7	1,775.3	7	23.1	5,920	77
Portland	3,091.9	10	437.2	9	14.1	2,655	86
Falmouth	15,911.3	4	3,979.2	4	25.0	11,932	75
Cumberland	11,636.8	5	3,199.8	5	27.5	8,437	72
Yarmouth	862.2	12	N/A	N/A	N/A	~~	~~
N. Yarmouth	1,084.1	11	N/A	N/A	N/A	~~	~~
Total Area	130,842.6	~~	24,948.7	~~	19.1	105,894	81

a Buffer Acres refers to buffers adjacent to roads and water bodies, not parcel boundary buffers.
***** Potentially allowable by ordinance without considering if there is a minable resource within the area or accounting for individual parcel line setbacks. The table suggests vulnerability in rural areas. The example of Portland shows that while zoning may allow mining, paved over streets and housing precludes this from actually happening.
After accounting for individual parcel line setbacks in Gorham, actual minable acreage is 5,500 acres (% = 23).

The use of the ModelBuilder tool utility within the GIS ArcMap software (details available on request), combined with each town's ordinances, generates the area of land in which mining is allowed and removes the land where mining is not permitted. One issue that is of importance, is that buffers along roads and water bodies in a town can be reduced down to the state minima with permission from a town or planning board even if their own ordinances initially indicate a larger buffer than those state minima. When Figure 6 was generated it used the buffering distances at their maximum as found in each town's online ordinances.

The value of the ModelBuilder utility is that it allows repetitive computation of complex graphical buffer and setback data (when available) as appropriate for each town in the watershed. When using the GIS graphical tools, one has to enter the appropriate digital data files (maps) along with the ordinance distances for the town which is selected. Once all of the data files and distances have been set, it is now possible to run the tool. The file generated will be the town selected with buffers applied to the parcels, roads, major water bodies and minor water bodies.

The output data of this process is then used to subtract those areas in which mining is not permitted from the total watershed area. A very important point to note is that this total watershed model does not take into consideration the individual parcel line buffers (buffers for each lot) if there are no digital parcel maps available. When parcel line buffers are applied (in the future) there would be a significant further decrease of the total area available for mineral extraction. The only individual parcel line setbacks determined were those for the Town of Gorham because it has a digitized parcel map (see below).

The PRW covers a total area of 131,000 acres and after the areas in which mining is not allowed* were subtracted, the total area of available land remaining was 106,000 acres (Figure 6).

Figure 7 shows the locations of mining sites (red) within Gorham and the available land for mining. Some of the mines fall on areas that mining is normally not allowed due to the existing ordinances. These mining sites may have permission or approval from the town to reduce the size of the buffers. In order to determine if a mining site falls in the appropriate area, the ModelBuilder utility tool needs to be run for that particular site using the appropriate or approved buffering distances with which they are being asked to comply (not necessarily the ones found online).

*The parcel boundary buffers were not factored into this calculation because, other than for the Town of Gorham, there is a lack of a tax maps in digital format.

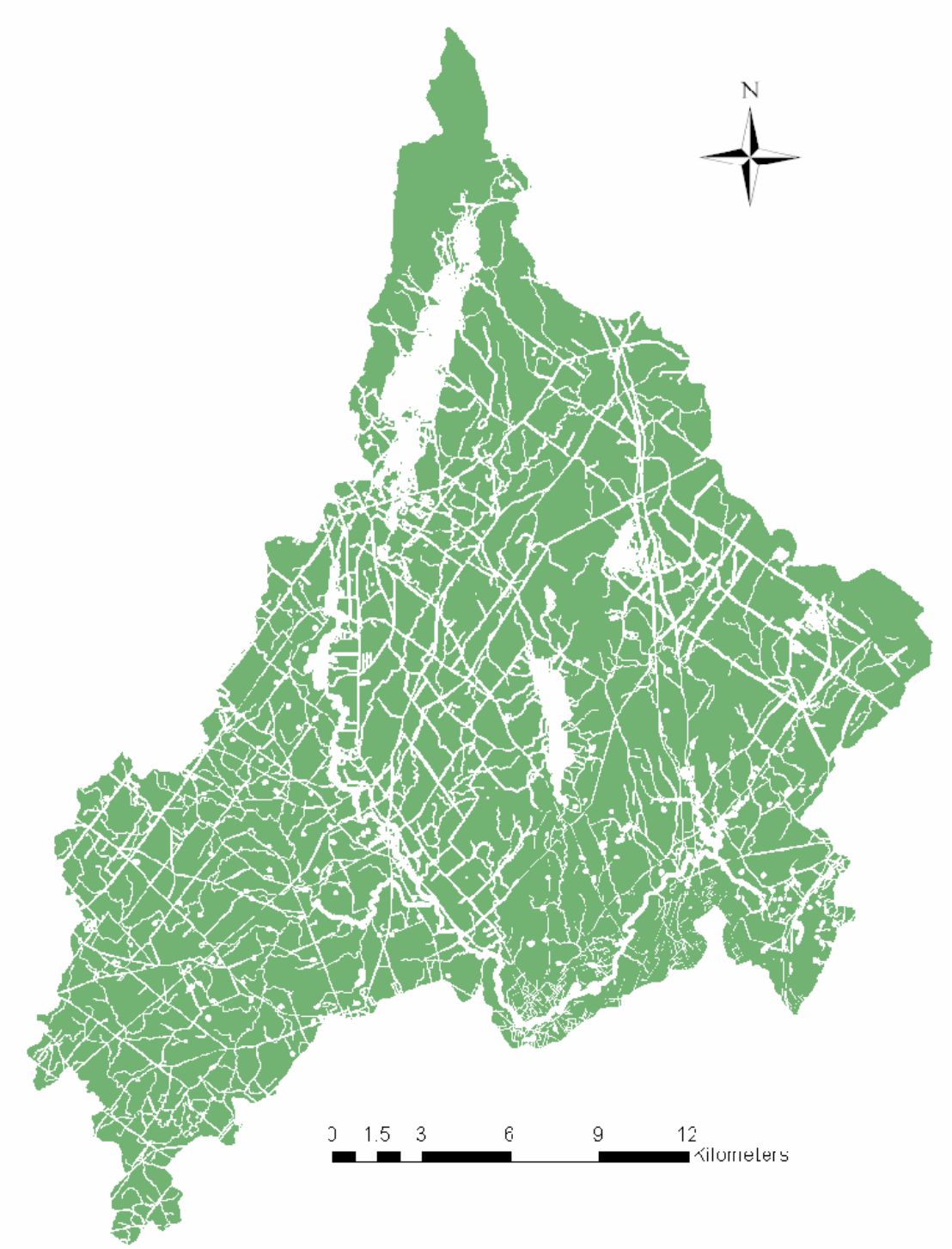

Figure 6: Available land to mine within the Presumpscot River watershed after road, waterway, and lake buffers were subtracted. At this scale it does not appear that very much land is considered “not minable” but, in fact, there are some 25,000 buffered acres derived from these attributes.

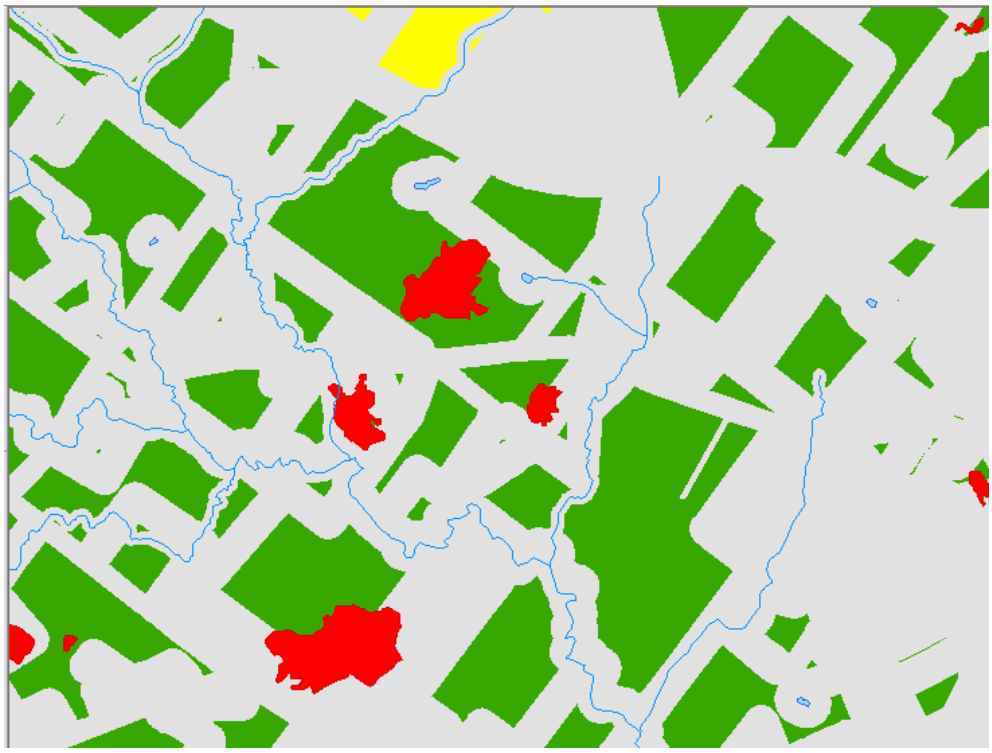

Figure 7: Detail of some Gorham mining sites and land available for mining (green). This image was generated using ArcMap ModelBuilder software tools. The map shows mining sites (red), water bodies (blue) and land not open to mining** (light gray). (**Buffers set at maximum for each buffer category).

GORHAM LAND OPEN FOR MINING

Using the Town of Gorham digitized parcel map and the town's zoning regulations it was possible to classify the town into three different categories (Figure 8): (1) mineral extraction allowed, (2) mineral extraction allowed with special exception approval, and (3) mineral extraction not allowed.

After the map was classified into these three different classes, the town's online ordinances (from Table 3) for mineral extraction sites were used to apply the appropriate setbacks and buffers around different features. This process produced a new map, one that shows the area of the town that is open to mining. When the final area was calculated, Gorham's total area of 23,900 acres decreases to 5,500 mineable acres (Figure 9).

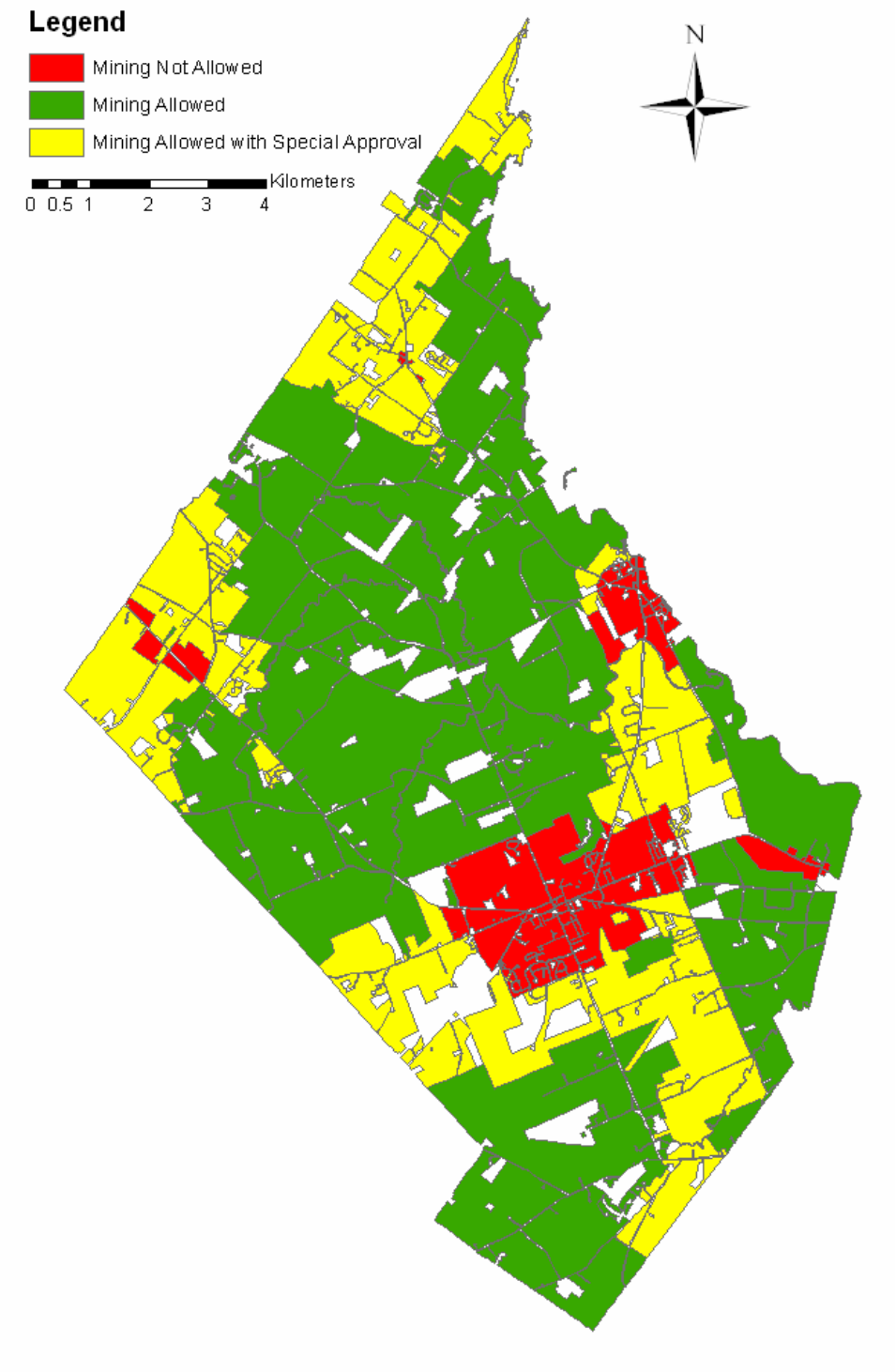

Figure 8: Allowable minable areas before applying individual parcel setbacks (See Figure 11). Source: Town of Gorham Tax Map.

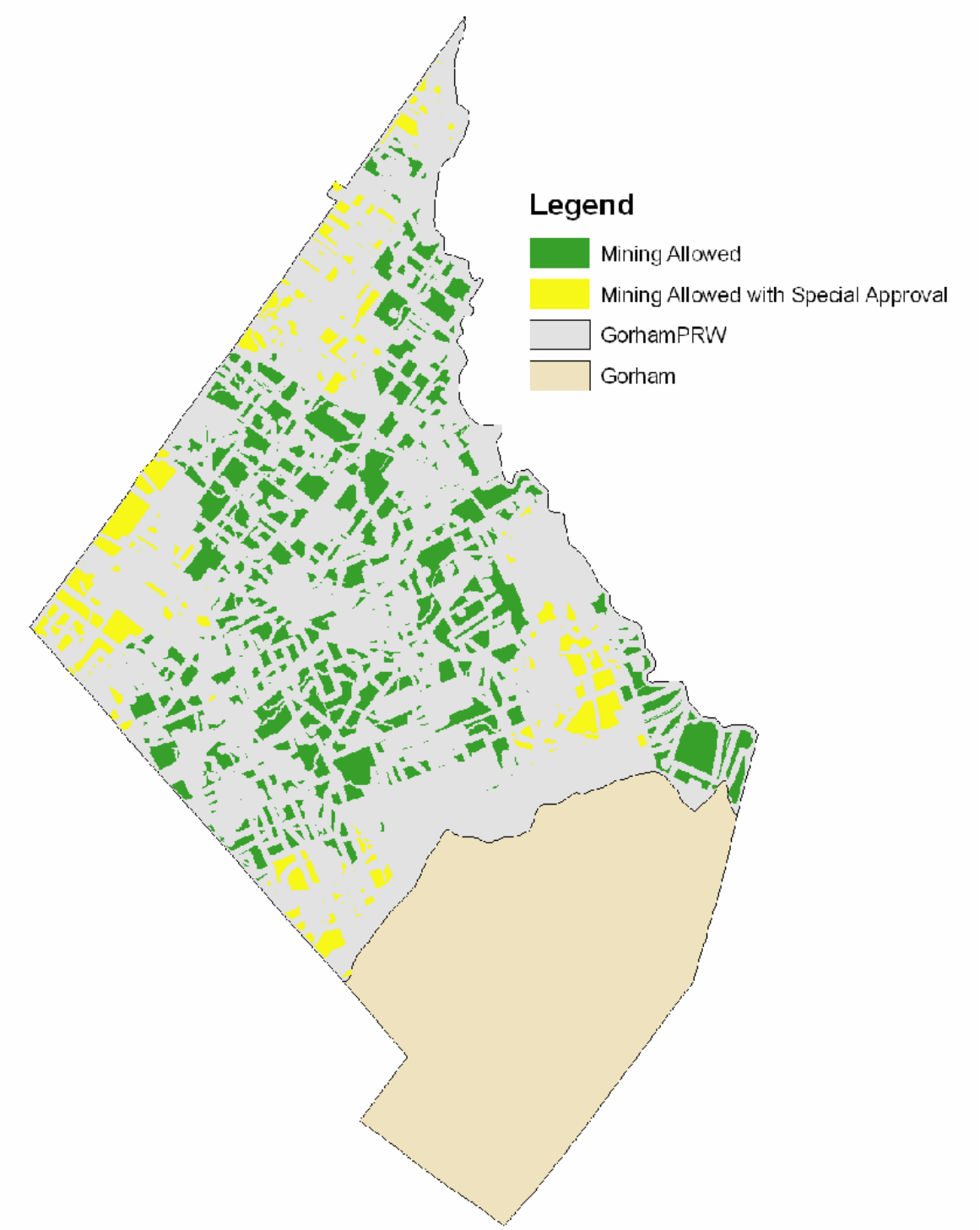

Figure 9: Land available for mining in Gorham.

METHODOLOGICAL CONCERNS

We are aware that the calculation of the total area of mining for each year has varying degrees of accuracy. During the development of this project several different issues were encountered. One of problems encountered was the different resolutions of digital imagery obtained for the various years. The 1998 one-meter (approximately 3 ft. per pixel) grayscale imagery allowed for the outlining of the mining sites with relative ease. Deciphering the outline for the mining sites was made easier with the 2001 half-foot (per pixel) color image. The 2004 SPOT satellite image of five meter (over 16 ft. per pixel) resolution presented a major problem. This loss of resolution caused the outlines of each site to vary from its actual location. The different image resolutions for each year could cause the size of the site to show change that may not have been true with respect to its actual growth.

The second issue was with the data and records for each mining site. The mines were classified into different classes depending upon whether or not they were licensed with the Maine D.E.P. This licensed status was carried back through all of the different years. This was a major assumption that is not necessarily correct - if a mine was licensed in 2005, it does not mean that that site was licensed in the other years of the investigation. The assumption of licensed status in the previous years could show that the total registered mining-site size is larger than it really was, and that the non-licensed sites would have been larger than they were determined to be. It was also assumed that the non-licensed sites were still operating in the present. However, they could have been abandoned (but still visible). These assumptions were needed in order to estimate growth with the available data.

CONCLUSIONS

Currently, only 653 acres of the 131,000 acres in the PRW are being mined. That is one-half of one percent (0.49%) of the total acreage. If the total acreage (25,000) after road, waterway, and lake buffers is taken into account (131,000 – 25,000 = 106,000 acres) the percent increases to 0.6%, a seemingly small percentage of the total area. Gorham has 23,900 acres of the total PRW acreage or 18% of the watershed, but 1.26% of that area is being mined.

The project revealed the growth of mining sites within the PRW and, more specifically, within the Town of Gorham from 1998 to 2004. Within the period under consideration the area considered to be mined grew by 42% and within Gorham area of mining grew by 30%. In Gorham, because of “grandfathering” mining operations exist in areas that are not allowed now or are in areas were the Special Exception portion of the Mining Ordinance would apply, but has not as yet been applied. This situation is responsible for citizen complaints and the clash between the desire for mining expansion, sub-division growth, and citizen desires to have the zone in which they live remain unchanged. This state of affairs (potential conflict) will continue to expand as the need for extractive resources grow. The information acquired points to the lack of a regional approach as depicted by variable ordinance requirements in adjacent towns (Table 3).

In the future an expansion of this project might proceed in different ways. First, can be the acquisition of new digital images in order to show the growth of the mines up to the present time. Second, a detailed examination of past records would help to determine each site's status in each year's image dataset. This would eliminate some of the assumptions that had been made.

Another factor that was not considered in this study was the impact of mining on the environment and the economic impact of mineral extraction in the watershed. Sand and gravel mining is a huge industry with a significant impact on the economy in Maine (estimated at $40,000,000 in 2003 for Cumberland Co. by the US Census Bureau). The environmental impact of mining has not yet been determined, and it is unknown if it has a negative or positive effect on the environment.

With the availability of the datasets and the technology for map generation, it is now possible to determine the growth within any region, town, or even on a site-by-site basis within the Presumpscot River watershed of southern Maine. This methodology can be applied anywhere in Maine. Combined with other datasets (economy; environment) other impacts of mining can be assessed.

ACKNOWLEDGEMENTS

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- Maine Office of Geographic Information Systems
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- Aaron Shields, Assistant Planner, Town of Gorham
- Mark Stebbins, Mike Smith and Molly Zogby, Maine Department of Environmental
- Kenneth N. Weaver Student Travel Award, Northeastern Section of the Geological Society of America
  Protection

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http://www.town.falmouth.me.us/planning/subordframe.html

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APPENDIX 1

YEARLY MEASUREMENTS:

1998 PRW All Mining Sites

Name	Licensed	Shape Area (sq. meters)	Acres
H-PIT	Y	113688.02	28.09
HAMLIN PIT	Y	27189.10	6.72
GRONDINS MIDDLE JAM PIT 2	Y	8068.03	1.99
GRONDINS MIDDLE JAM PIT 1	Y	10462.46	2.59
GORDON PIT	Y	38531.42	9.52
PHINNEY PIT GORHAM	Y	204031.37	50.42
RUSTY KNOLL FARM	Y	33413.81	8.26
JACKSON PIT	Y	22638.60	5.59
ELDER PIT	Y	43884.62	10.84
RUSTY KNOLL FARM	Y	12386.68	3.06
ROUTE 25 QUARRY	Y	16000.87	3.95
Unknown 12	N	40721.83	10.06
Benson Pit	Y	14225.77	3.52
Craig Pit	Y	5995.07	1.48
Walter Stevens	Y	34550.34	8.54
JAMES CUMMINGS PIT	Y	35230.20	8.71
Unknown 11	N	233004.14	57.58
TIERNEY PIT	Y	29284.49	7.24
VARNEY MILL GRAVEL PIT	Y	157343.75	38.88
THEODORE RHOADES PIT	Y	40678.66	10.05
CR TANDBERG PIT	Y	28663.43	7.08
Unknown 8	N	3123.66	0.77
TAYLOR PIT	Y	13092.88	3.24
WILKINSON PIT	Y	47053.81	11.63
Unknown 21	N	19869.34	4.91
ANDRE HENNING GRAVEL PIT	Y	36834.22	9.10
BLUEROCK INDUSTRIAL, INC	Y	123091.40	30.42
MDOT PIT	Y	81887.04	20.23
ROCKY HILL DEMO DEBRISSSP	Y	78494.59	19.40
Phinney Pit	Y	61419.69	15.18
Unknown 13	N	862.64	0.21
Unknown 14	N	53028.20	13.10
Unknown 15	N	5157.33	1.27
Unknown 16	N	660.12	0.16
Lewry Pit	Y	794.49	0.20
Libby Pit	Y	3944.15	0.97
Unknown 19	N	8888.92	2.20
Unknown 20	N	5170.89	1.28
Unknown 18	N	4546.32	1.12
Unknown 17	N	9109.91	2.25
Unknown 10	N	3384.75	0.84
Unknown 9	N	1001.36	0.25
Unknown 4	N	369.93	0.09

Unknown 6	N	8713.09	2.15
Unknown 5	N	6368.35	1.57
SB Holdings (Ruth Gravel Pit)	Y	21748.27	5.37
Unknown 3	N	25844.84	6.39
Unknown 2	N	28984.33	7.16
Unknown 1	N	11856.60	2.93
Unknown 7	N	4799.11	1.19
Grover Pit	Y	34854.32	8.61
Wilson Hubbard	Y	1648.59	0.41
Lachance Brick	Y	10977.77	2.71

2001 PRW All Mining Sites

Name	Licensed	Shape Area (sq. meters)	Acres
H-PIT	Y	169570.54	41.90
Grondin Middle Jam Pit 2	Y	13676.95	3.38
Grondin Middle Jam Pit 1	Y	11549.10	2.85
Hamlin Pit	Y	32741.73	8.09
Gordon Pit	Y	43543.76	10.76
Jackson Pit	Y	22289.97	5.51
Elder Pit	Y	43868.26	10.84
Phinney Pit Gorham	Y	234008.16	57.82
Rusty Knoll Farm	Y	57775.03	14.28
Rusty Knoll Pit	Y	12215.07	3.02
Route 25 Quarry	Y	45126.65	11.15
Craig Pit	Y	13388.97	3.31
Unknown 12	N	62560.74	15.46
Benson Pit	Y	26179.32	6.47
Walter Stevens	Y	59878.84	14.80
Phinney Pit	Y	149004.46	36.82
Tierney Pit	Y	29635.57	7.32
James Cummings Pit	Y	60713.67	15.00
CR Tandberg Pit	Y	46417.11	11.47
Rocky Hill Demo Debrisssp	Y	91967.38	22.73
Theodore Rhoades Pit	Y	24500.17	6.05
Varney Mill Gravel Pit	Y	161462.08	39.90
Blue Rock Industrial, Inc	Y	114989.45	28.41
MDOT Pit	Y	103493.27	25.57
Andre Henning Gravel Pit	Y	33503.73	8.28
Taylor Pit	Y	44299.55	10.95
Wilkinson Pit	Y	72088.06	17.81
Unknown 11	N	260177.08	64.29
Unknown 10	N	3853.84	0.95
Unknown 13	N	2650.98	0.66
Unknown 14	N	60121.08	14.86
Unknown 15	N	5209.80	1.29
Unknown 16	N	11916.56	2.94
Libby Pit	Y	6214.65	1.54
Unknown 19	N	12529.95	3.10
Unknown 1	N	13732.92	3.39
Unknown 2	N	49919.24	12.34
Unknown 7	N	8088.22	2.00
Unknown 6	N	6200.26	1.53
Unknown 5	N	30570.65	7.55
Unknown 4	N	9366.89	2.31
Unknown 3	N	27891.68	6.89
Unknown 9	N	14124.04	3.49
Grover Pit	Y	59394.43	14.68
Lewry Pit	Y	1578.31	0.39
Unknown 20	N	7298.47	1.80
Unknown 18	N	5095.42	1.26

Unknown 17	N	12771.65	3.16
Hubbard Wilson	Y	3695.00	0.91
SB Holdings (Ruth Gravel Pit)	Y	21821.80	5.39
Lachance Brick	Y	11441.85	2.83

2004 PRW All Mining Sites

Name	Licensed	Shape Area (sq. meters)	Acres
Phinney Pit	Y	165868.39	40.99
Libby Pit	Y	6795.79	1.68
Route 25 Quarry	Y	79522.04	19.65
Rusty Knoll Farm	Y	38416.93	9.49
Rusty Knoll Pit	Y	15456.84	3.82
Phinney Pit Gorham	Y	187832.43	46.41
Unknown 11	N	228888.93	56.56
Tierney Pit	Y	58632.42	14.49
Lewry Pit	Y	1698.97	0.42
Lewry Pit	Y	14431.11	3.57
Hamlin Pit	Y	25317.87	6.26
Gordon Pit	Y	90468.80	22.36
Benson Pit	Y	10832.09	2.68
Unknown 12	N	54576.51	13.49
Jackson Pit	Y	16830.45	4.16
Elder Pit	Y	40944.54	10.12
Walter Stevens	Y	58264.21	14.40
Unknown 15	N	6597.39	1.63
H-Pit	Y	201446.05	49.78
Unknown 13	N	2069.39	0.51
Unknown 16	N	35747.75	8.83
Unknown 14	N	60902.25	15.05
Unknown 20	N	5281.55	1.31
Unknown 18	N	4940.22	1.22
Unknown 19	N	20136.91	4.98
Unknown 17	N	1514.88	0.37
Rocky Hill Demo Debrisssp	Y	78419.73	19.38
Unknown 10	N	1015.06	0.25
James Cummings Pit	Y	29281.17	7.24
Craig Pike	Y	16440.93	4.06
Unknown 8	N	9552.08	2.36
CR Tandberg Pit	Y	57885.92	14.30
Unknown 7	N	8241.82	2.04
Unknown 9	N	12502.30	3.09
Grondin Middle Jam Pit 1	Y	18655.77	4.61
Grondin Middle Jam Pit 2	Y	23799.80	5.88
Libby Pit	Y	55865.31	13.80
Unknown 4	N	16021.76	3.96
Unknown 5	N	38549.88	9.53
Unknown 6	N	18442.70	4.56
Theodore Rhoades Pit	Y	23338.62	5.77
Varney Mill Gravel Pit	Y	209794.18	51.84
Unknown 3	N	26896.14	6.65
Unknown 2	N	34862.84	8.61
Unknown 1	N	42048.82	10.39
MDOT	Y	101731.18	25.14
Blue rock Industrial, INC	Y	117757.81	29.10

Unknown 21	N	23936.00	5.91
Wilkinson Pit	Y	60377.44	14.92
Taylor Pit	Y	47646.20	11.77
SB Holding (Ruth Gravel Pit)	Y	23913.99	5.91
Andre Henning Gravel Pit	Y	37122.36	9.17
Grover Pit	Y	59788.51	14.77
Hubbard Wilson	Y	3706.24	0.92
Lachance Brick	Y	12561.73	3.10