

Oak Hill Outdoor Center

Mountain Biking

Trail Plan



Hanover, NH

August 2024

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Table of Contents

Introduction	2
Executive Summary	3
Mountain Biking in the Upper Valley Region	5
Other User Groups at Oak Hill	8
Survey Results	9
Problem Spots on Current Bike Trails	12
Steepness of Current Bike Trails	15
Recommended Actions on Current Bike Trails	17
Terrain Suitability for New Bike Trails	22
Planned New Bike Trails	23
Signage on Bike Trails	32
Adaptive Mountain Biking	35
Potential Event & Race Courses	37
Fat Biking	41
Trail Maintenance	42
Risk Management	44
Cost Estimates	45
Appendix A - Permitting	
Appendix B - Doubletrack & Ski Trails	
Appendix C - Soils & Geology Maps	
Appendix D - Wildlife & Ecological Resources	
Appendix E – Mountain Bike Trail Glossary	

Introduction

The Oak Hill Outdoor Center's trail system is situated on approximately 530 acres, owned by Dartmouth College and the Trustees of Dartmouth College, and managed by the non-profit Oak Hill Outdoor Center. It is best-known for the nordic ski trails that are home to the Dartmouth Ski Team and are open to the public, with a pass. Next door is Storrs Pond, a popular summertime outdoor recreation resource with swimming, picnic areas, camping, playgrounds, and disc golf.

There are nearly 7 miles of singletrack mountain bike trails that use the woods in between the ski trails. The singletrack was built mostly using the "rake-and-ride" method, with some bench-cut and rock-armored sections built with hand tools. The trail surface on the singletrack is nice for intermediate riders – it has some roots and rocks to challenge riders, but is not too rough. The trails are laid out well to take advantage of the terrain – many sections of trail have the perfect amount of downhill pitch that allows riders to carry speed, without needing to brake too much.

The bike trails at Oak Hill are used by individual mountain bikers and by organized groups. School mountain biking teams like Dartmouth College, Hanover High School, and Borderline Race Team (Vermont Youth Cycling) use the trails at Oak Hill for training. Summer youth camps like Coyote Hill and Little Bellas also use Oak Hill. Organized group rides, like those by GLOW (Glorious Ladies on Wheels) occasionally use Oak Hill, along with informal shop rides, friend groups, and families.

The trail network currently appeals mostly to intermediate-level riders. New trails recommended in this plan will broaden the appeal of this trail network towards both ends of the mountain biking spectrum – for both the expert riders and the novice riders. The new style of trails will be progressive and refreshing for local riders who currently have to travel to find such trails.

Oak Hill (and neighboring Trescott) is not a weekend destination that draws in riders from other regions, like Kingdom Trails in East Burke, VT does. The recommendations in this plan will not make Oak Hill into a major destination, but will allow Oak Hill to reach its full potential as a community resource for Dartmouth, Hanover, and the Upper Valley. The Oak Hill mountain bike trails could become the summer version of the nordic ski trails – a place where community members of all ages and abilities can get some outdoor exercise, while also serving as a training and racing center for future Olympians.

Trescott Trails

Right next door to Oak Hill is the Trescott Water Supply lands, with a network of 11 miles of singletrack bike trails. The Trescott trails are also mostly intermediate in difficulty, but there are more beginner-friendly options at Trescott than at Oak Hill. The parking areas at the Trescott trailheads are smaller than Oak Hill and are on back roads, so many mountain bikers park at Oak Hill and ride up Old Wolfeboro Road to access Trescott. Although Oak Hill and Trescott are two different properties, mountain bikers can do a ride that utilizes both trail networks seamlessly, as if it is one big trail network.

Executive Summary

This plan is 47 pages long, plus Appendices, so key takeaways from this plan are summarized below. This plan contains some mountain bike and trail building jargon; Appendix E is a glossary of mountain bike and trail building terminology, with photos and illustrations.

The existing trails are mostly in good condition.

There are some muddy spots that should be rock-armored, but most of the trails take a good, sustainable route and don't need significant changes.

The “Bandit” Downhill Trail does not take a good route and has poorly designed features.

There is a clear desire for advanced and expert-level trails at Oak Hill, so this plan includes improving the “Bandit” trail to make it more fun and safe, and includes the construction of several more challenging descents.

The existing singletrack trails are all very similar in character, so they appeal to a somewhat narrow group of mountain bikers.

The current trail system at Oak Hill caters to intermediate/advanced bikers, but excludes bikers at the extreme beginner and expert ends of the spectrum. There are some sustained descents, but most of the trails are rolling or pedally, which excludes riders who want a flatter trail system and also riders who want “gravity-oriented” trails that have minimal pedalling on the descents. Many of the planned new trails will also be accessible to adaptive mountain bikers.

There is room to build more trails to broaden the appeal of this trail network.

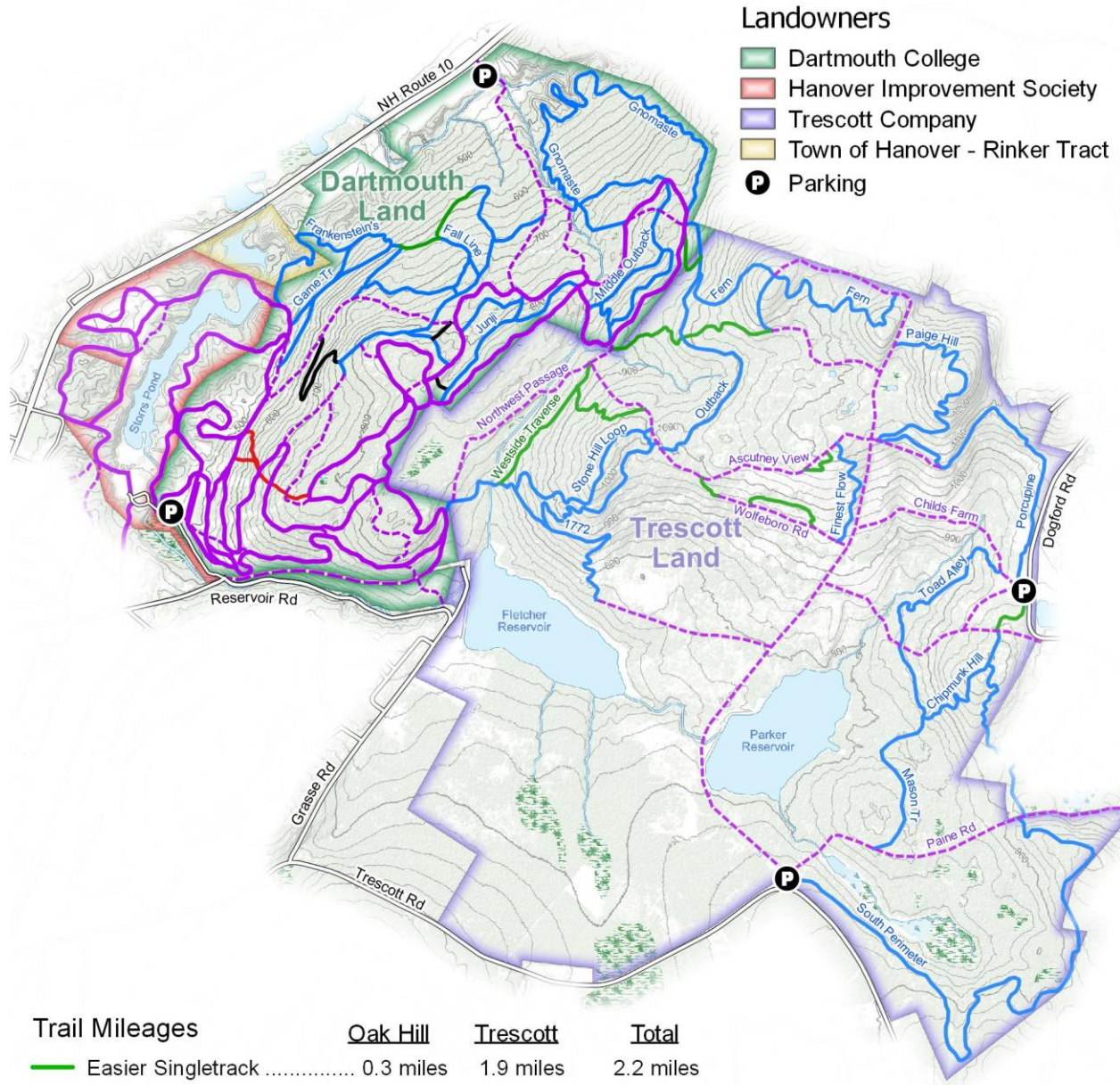
New trails should take advantage of the unique character and terrain of Oak Hill in the following ways:

- The steep, loamy, hemlock slopes north of the old ski hill are perfect for hand-built “gravity” trails.
- The steep, ledgy slopes on the west side of the old ski hill should incorporate rocky outcrops to provide a fun challenge for advanced and expert riders.
- The south-facing slope above Reservoir Road and Old Wolfeboro Road should have machine-built “flow trails” bench-cut into the hillside for beginner and intermediate riders.
- The terraces in the lower elevations can have flatter trails that are great for kids on strider bikes and accessible mountain bikers that may not want to do long sustained climbs.
- A beginner-friendly trail can connect Fullington Field to the rest of the network. This should be built by a mini-excavator so that drainage can be built into the trail as it goes across the moist, rich hillside.
- Skills areas can be built at the two best parking spots: the Oak Hill Outdoor Center and Fullington Field so that riders can practice their technique on pump tracks and jump lines.

Oak Hill Outdoor Center will become a great community resource and a hub for local mountain bikers, when this plan’s recommendations are implemented.

Oak Hill will never be a huge tourist destination, but that is fine. This planned trail system will appeal to a broad range of mountain bikers, making it great for families and friend-groups with varying abilities. It can be great location for the Dartmouth Mountain Bike Club to train, and for youth programs and races.

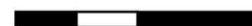
Current Trail System Oak Hill & Trescott



- Landowners**
- Dartmouth College
 - Hanover Improvement Society
 - Trescott Company
 - Town of Hanover - Rinker Tract
 - P Parking

Trail Mileages	Oak Hill	Trescott	Total
— Easier Singletrack	0.3 miles	1.9 miles	2.2 miles
— Intermediate Singletrack	5.7 miles	9.2 miles	14.9 miles
— Advanced Singletrack	0.4 miles	0 miles	0.4 miles
— Expert-Only Singletrack	0.4 miles	0 miles	0.4 miles
Total singletrack	6.8 miles	11.1 miles	17.9 miles
- - - Ski Trails & Doubletrack ...	10.9 miles	6.9 miles	17.8 miles

0 0.25 0.5 mi



Map: G. DiSanto, June 2024

Mountain Biking in the Upper Valley

In addition to Oak Hill and Trescott, mountain bikers in Hanover have many places to ride within a reasonable drive, as shown on the map on the following page. The Landmark Trails (a.k.a. “Boston Lot”) in Lebanon is a popular trail system, known for its challenging trails. There is no shortage of good, fun, cross-country trails in the Upper Valley; across the river in Vermont, Mt. Peg, Acqueduct, Parcel 5, Hurricane Hill, and Ascutney are popular destinations within a 30-45 minute drive. On the New Hampshire side of the river, there are several small trail systems within a half-hour drive that have natural, hand-built cross-country trails similar to Oak Hill, like Moody Park, Lyme Pinacple, Lyme Town Forest, Moody Mountain, and Cornish Town Forest. The Green Woodlands trails in Dorchester are nearly all machine-built, offering bikers a distinctly different experience with smoother trails that are more beginner-friendly.



Photo: JVMBA,
Landmark Trails



Powder Horn Trail Company,
Ascutney Trails Association



Photo: T. Peck,
Green Woodlands

Left-to-right: a rock roll at Landmark Trails, the skills park at Ascutney Trails Association, a banked turn at Green Woodlands.

For gravity-oriented riders, there are a some sustained descents at Landmark Trails, Trescott, and Oak Hill, but the nearest trails with enough sustained descents for “enduro” riding are in Woodstock, where Mt. Peg and Saskadena Six have hosted enduro races. Similarly, Arrowhead is just over a half-hour away in Claremont. The nearest major chairlift-assisted bike park is just under an hour away at Killington. Within a 90-minute drive, there are many more bike parks for gravity riders – Highland, Loon, Burke, Sugarbush, Granite Gorge, Sunapee, and Okemo.

For riders looking to practice their jumping skills, there is a skills area at Ascutney with a few jump lines, allowing bikers to progress from smaller features to larger features. Skills areas like this allow riders to do repeat laps in an accessible setting to build their skills before they encounter jumps on trails further out in the woods. These types of skills areas are very popular among kids, but are used by bikers of all ages and abilities to improve their skills. White River Junction and Norwich, VT have pump tracks – circular loops with rollers so that riders can practice the important skill of “pumping” their bikes to gain and maintain momentum.

Regional Needs

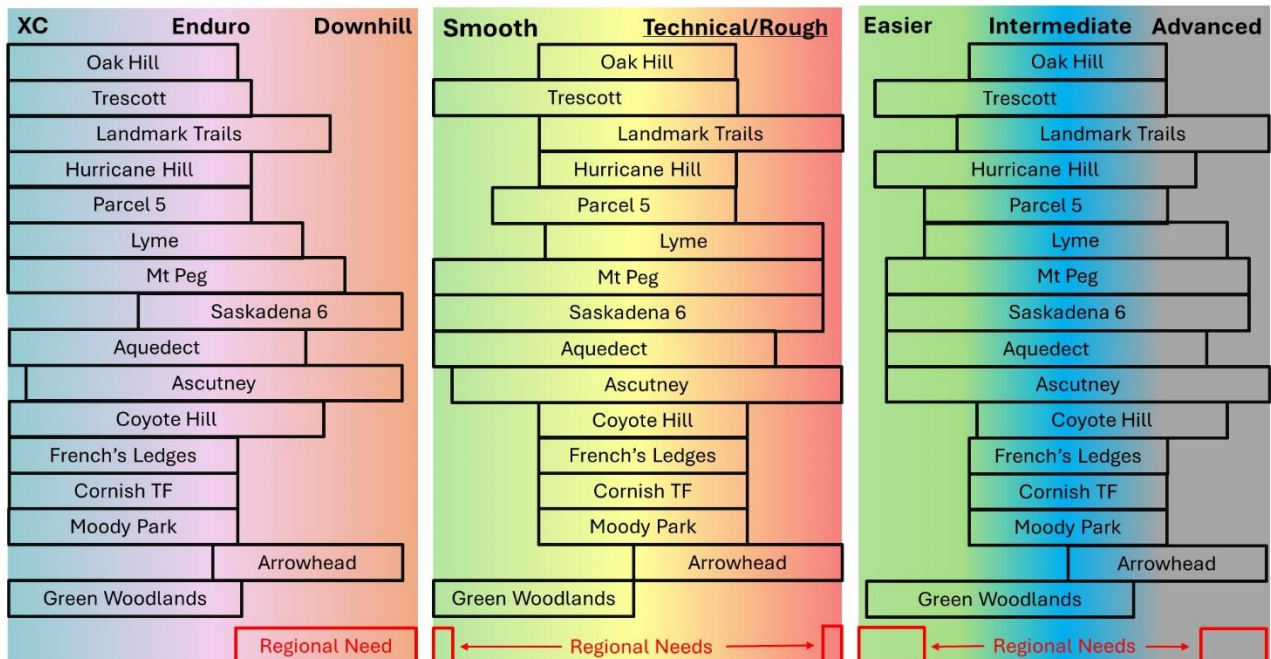
There is no shortage of intermediate-level cross-country trails within a half-hour drive of Hanover, but this region could use more variety in its types of trails. Some types of trails that are lacking include:

- Truly beginner-friendly trails.

The Green Woodlands and Trescott Trails are the smoothest trails in the region, but both have a lot of uphill climbing for beginners. The silt-sand terraces on the lower slopes of Oak Hill offer a place to build beginner-friendly trails that do not have too much climbing. This could be important for kids on “strider bikes” that don’t have pedals, but also for adaptive bikes that use hand-crankers to climb up hills.
- Skills parks, pump tracks, and jump lines

Ascutney, Mt Peg, Aqueduct, Landmark Trails, and Green Woodlands all have some form of a skills park, but these are all 15-45 minutes away from Hanover. Having a skills park at Oak Hill would be a tremendous resource to the school and the youth bike programs that use Oak Hill. “Jump lines” – short trails that can be lapped repeatedly, with separate lines for small, medium, and large tabletop jumps – would allow bikers to progress their jumping skills in a safe way. “Pump tracks” are a circular track of rollers which allow bikers to propel themselves around the track by “pumping” their bike instead of pedalling.
- Expert-level gravity trails.

There is no shortage of intermediate-level cross-country trails within a half-hour to an hour of Hanover, but there is a shortage of gravity-oriented trails within a short drive. The trails with long, sustained descents at Oak Hill and Trescott are mostly intermediate-level, which are still fun for expert riders, but the creation of bootleg gravity trails like “Bandit” indicates that there is a need for this type of trail that is not being met.



Nearby Trail Systems

Travel Time (from Hanover)

- 15 minutes
- 30 minutes
- 45 minutes
- 60 minutes

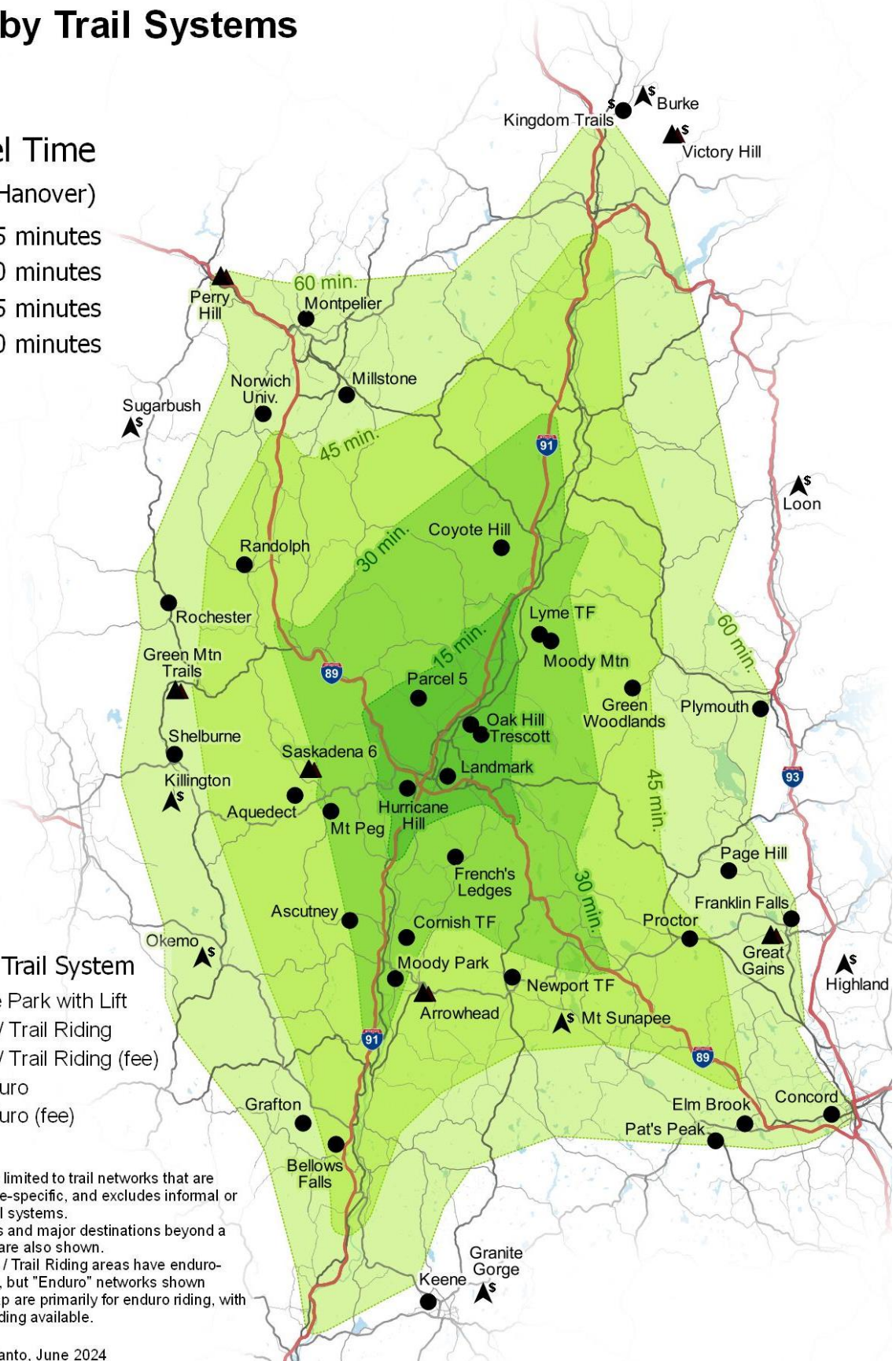
Type of Trail System

- ▲^s Bike Park with Lift
- XC / Trail Riding
- ^s XC / Trail Riding (fee)
- ▲ Enduro
- ▲^s Enduro (fee)

Notes:

- This list is limited to trail networks that are mostly bike-specific, and excludes informal or "secret" trail systems.
- Bike parks and major destinations beyond a 1-hr drive are also shown.
- Some XC / Trail Riding areas have enduro-style trails, but "Enduro" networks shown on this map are primarily for enduro riding, with little XC riding available.

Map: G. DiSanto, June 2024



Other User Groups at Oak Hill

The ski trails are the most visible use of the property, with excavated trails, snowmaking pipes, buried power, and ski jumps that need to be considered before building new bike trails. A disc golf with 18 holes has 9 holes on the Storrs Pond property and 9 holes on the lower slopes of Oak Hill. There are aerial ropes courses and “challenge courses” on top of Oak Hill and on the lower terraces. Some of these appear well used and maintained, others seem to be abandoned.

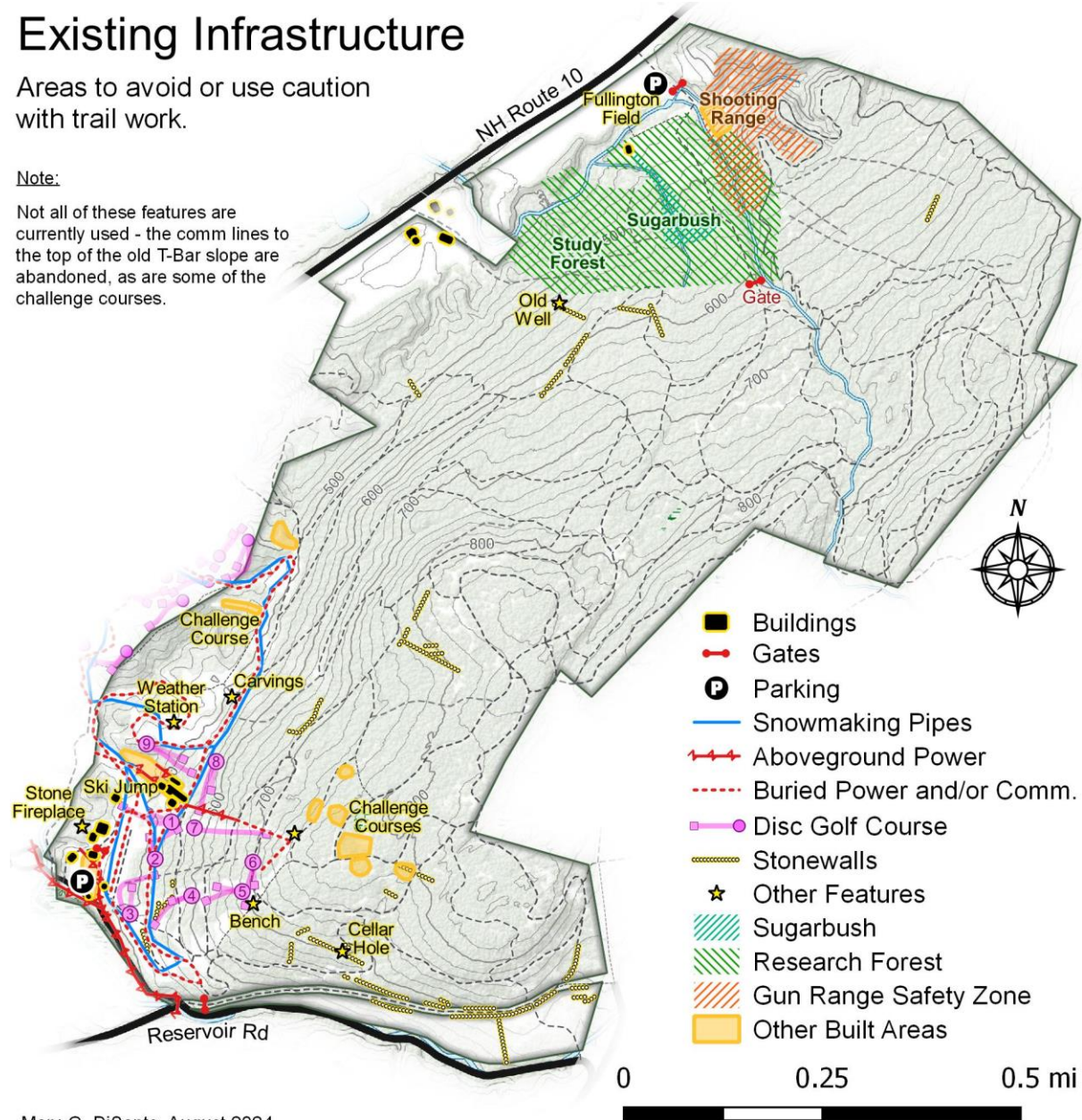
The Fullington Field along NH Route 10 is used for soccer, outdoor education, and circus events. Just uphill of the Fullington Field is a shooting range, sugarbush and sap house, and a study forest with tagged trees.

Existing Infrastructure

Areas to avoid or use caution with trail work.

Note:

Not all of these features are currently used - the comm lines to the top of the old T-Bar slope are abandoned, as are some of the challenge courses.



Survey Results

A survey with multiple-choice and open-ended questions was emailed to a mailing list of regular Oak Hill riders in April. The results from 58 responses are summarized below.

Who Uses Oak Hill

In addition to individuals and small groups who mountain bike at Oak Hill, the bike trails are used by the following groups:

- School Clubs & Teams
 - Dartmouth Mountain Bike Club
 - Hanover High School
 - Borderline Race Team
 - Ray School & Richmond School
- Summer Programs
 - Coyote Hill
 - Little Bellas
- Group Rides
 - GLOW (Glorious Ladies on Wheels)
 - Local Shop Rides

Signage

The most common suggestions (multiple selections allowed) were:

- Permanent trail maps at key locations (50%)
- Better signage around the network (48%)
- “On-the-line” navigation tools like Trailforks (33%)

Trails that Need Work

Existing trails that received multiple mentions for needing improvement are:

- Middle Outback (4 mentions)
- Gnomaste (3)
- Goat (2)
- Juni (2)

The most common problem that respondents noted was muddy spots, with suggestions to do more rock armoring, trail hardening, and bridges. Another common theme was that some of the existing singletrack is difficult because it is very rooty, but many other respondents said they like the challenging nature of these trails.

Favorite Trail

Respondents were asked to identify their favorite trails (they could select more than one), with the following results:

- Gnomaste (78% mentioned)
- Juni (37%)
- Crystal Ridge (31%)
- Frankensteins Folly (26%)
- Middle Outback/Middle Upper Outback (25%)
- Hunters Track (20%)
- Fall Line (14%)
- Bandit (8%)

Most Frequently Used Climbing Trail

To get to the top of Oak Hill, most respondents use Old Wolfeboro Rd, or they come in from the Trescott Trails which enter the Oak Hill property near the top of the hill.

- Up Old Wolfeboro Road (80%)
- From Trescott Trails (69%)
- Up the ski trails from Oak Hill parking lot (29%)
- Up from Fullington Field (9%)

Style of Trail Desired

Most respondents wanted to see at least some machine-built banked turns (“berms”) and features like rollers and table-top jumps incorporated into trails and skills areas. When asked what type of trail building they wanted to see more of at Oak Hill, the most popular answer was a combination of machine-built and natural trails.

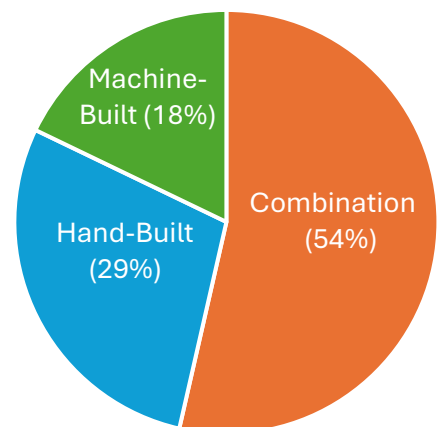
Types of Features on Trails

Berms	21
Jumps	11
All / Combination	10
Natural Only – No Features	9
Wooden Features	7
Drops	7
Flow Trail	5
Rock Gardens	4
Roots	1

Skills Park Features

Jump Lines	18
Pump Track	16
Drops	4
Wood Features	4
Rock Features	1
All of the above	7
N/A, Not my thing	4

Type of Trail



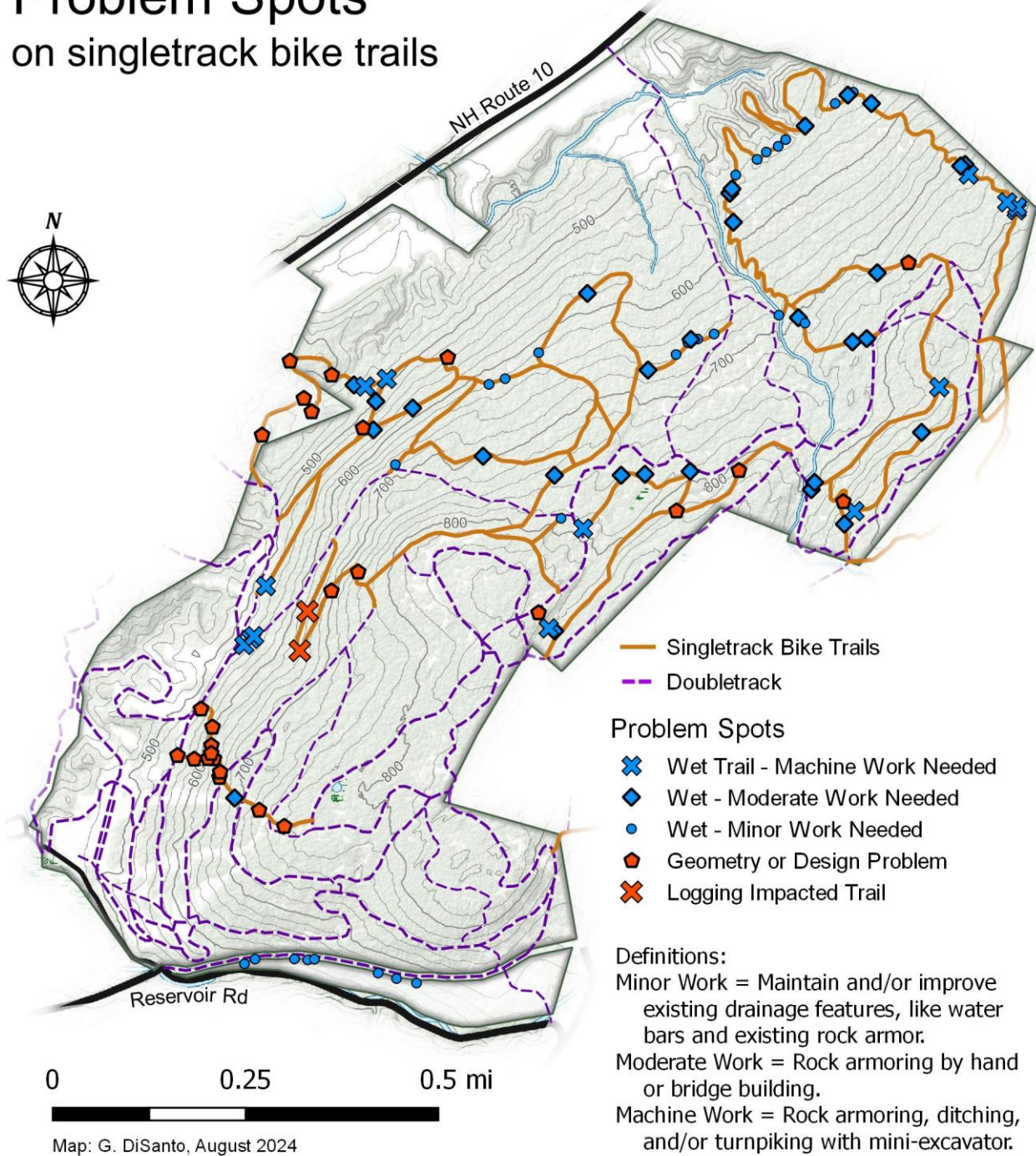
Trailhead Facilities

Many respondents said the trailhead facilities are adequate. A few common themes were:

- Restrooms: There are port-a-potties at the gravel parking lot, but a few respondents suggested better restrooms and changing rooms.
- Parking Lot: Some respondents mentioned that the parking lot is adequate at Oak Hill, but the Trescott parking areas are small, which may be why many bikers park at Oak Hill and access Trescott via Old Wolfeboro Rd.
- Trailhead map kiosks were mentioned by several respondents.

One respondent mentioned adding shade trees, which have since been added to the newly re-designed parking lot. In addition to the new shade trees in the parking lot islands, there is a small slope between the parking area and the nordic ski racing start/finish area where some native hardwoods could potentially be planted just uphill of the power lines. This slope is east of the parking area, which would provide some shade in the morning, along with acting as a wind-break for the start/finish area in the winter.

Problem Spots on singletrack bike trails



The most common problem on the bike trails is wet spots. Many of these spots already have some rock-armoring or bridges, but could use some more. Other problems include steep sidehill sections that could use some bench-cutting, logging debris that has obscured part of the “Goat” trail, geometry and design problems on the “Bandit” downhill trail, and steep pitches on Frankenstein’s Folly.

Some of this work could be done by volunteers with hand tools. Some of it should be hired out to an experienced trail builder; in some cases, a mini-excavator would be the best tool to make these improvements. See page 45 for cost estimates.

On Frankenstein’s Folly, some excessively steep pitches exist on the Town of Hanover’s land. No recommendations are made to address these spots in this plan, because it is on a different property and there is no erosion at this time – it is currently just a problem of the trail being too difficult for many riders.



Above, left: The bottom of the Screaming DH / Goat Trail is muddy. Some water bars were installed by loggers, and some hand work was done, but the tread could be elevated and hardened with a mini-excavator, especially since a mini-excavator might need to go through here anyways to build planned trails.

Above, right: This section of the Game Trail, at the junction with Frankenstein’s Folly, uses an old skid trail that is wet. Use a mini-excavator to build an elevated, hardened trail, with a rock-armored dip for cross-drainage.



Above, left: Existing rock armoring at a wet crossing on Gnomaste. This rock armoring could be extended on both sides of the crossing to deal with the muddy approach to the crossing.

Above, right: a muddy section with no rock armoring. Rock-armoring should be added for approximately 20 linear feet.



Above, left: the top of Bandit has a deeply rutted track and uses the 7th hole tee box on the disc golf course as a jump. The section in this photo should be completely re-routed.

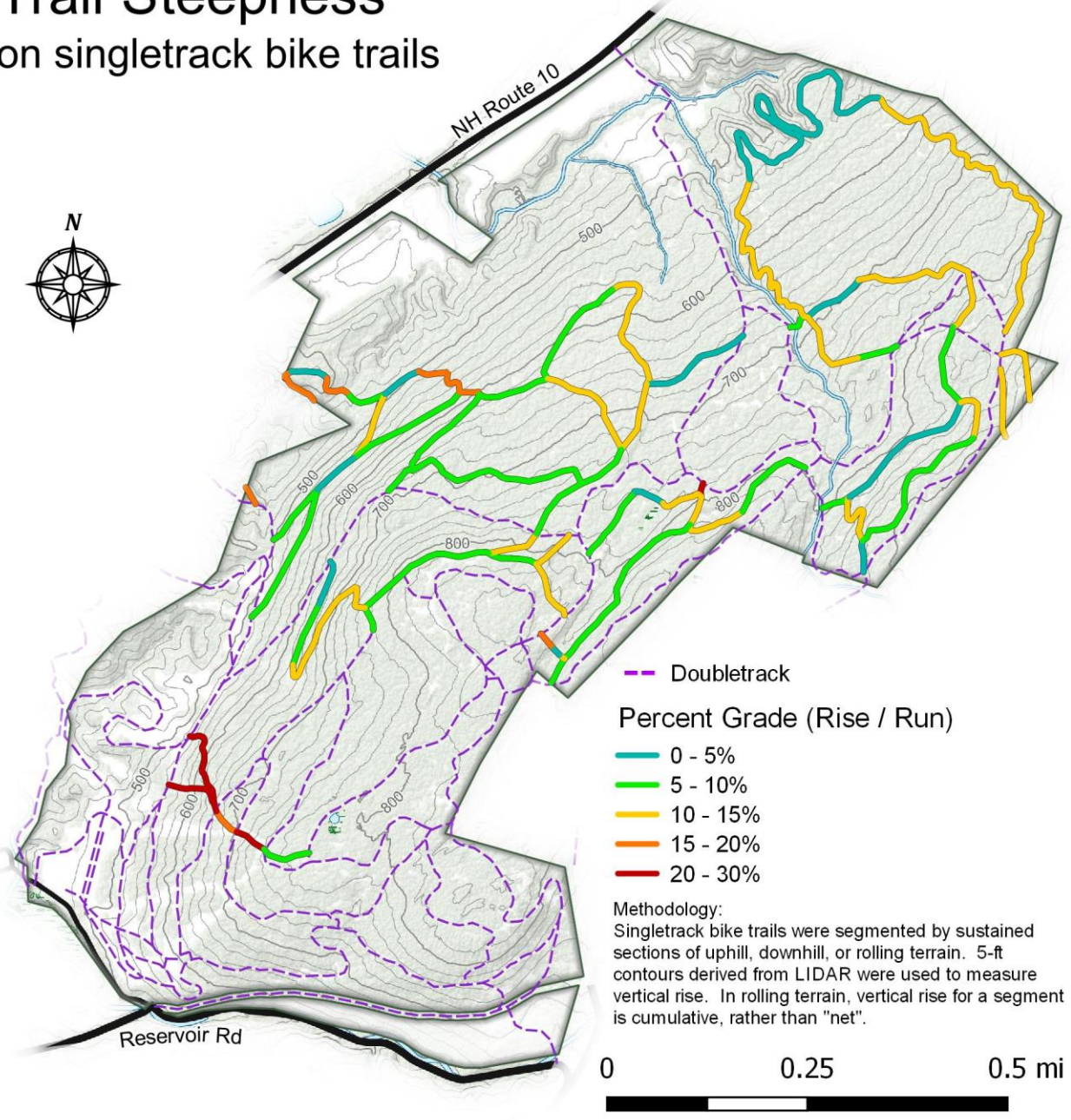
Above, right: two jumps on Bandit, where the trail splits into two lines. Both of these jumps have steep approaches (not pictured) which generate a lot of speed going into the jumps. The jumps are too abrupt and the landings are too close for the speed that riders have. Riders can easily overshoot the landings on these, which is a problem because the trail makes a turn immediately after both of these jumps. The jumps are also poorly-built, using rotting logs and loose rocks. There are too many problems with these jumps to make changes to them – the trail should be re-routed above this section.



Above, left: a poorly-built “stump jump” on Bandit, which has a loose rock and dirt on top, to make the jump taller. This gives it a take-off angle that is too steep for the flat landing. Any jumps and features at Oak Hill that use dirt and rocks should be constructed with well-compacted dirt, and any rocks used in the feature should be set solidly in the dirt.

Above, right: the final rock drop on Bandit. This drop is a fun and challenging feature that should be kept, with some improvements. This is roll-able if you ride off the short end; signage should be added to indicate “▲Easier” and “Drop! ▲”. If riders drop off the taller end, their front wheel could get sucked into a low spot or could hit a small stump in the landing. The stump should be removed and the low spot filled in, so that the landing is wide and predictable. The landing and the section of trail below this (not pictured) should also be re-aligned so that the trail exits onto the ski hill in a different location.

Trail Steepness on singletrack bike trails



Most of the singletrack at Oak Hill is the perfect pitch for intermediate riders. The uphill can be tiring, but they are not too steep to ride up. The descents are steep enough to give riders the momentum they need to carry speed over roots and rocks, but not so steep that they are braking too much.

An exception to this is the “Bandit” downhill trail – the red-colored trail near the old T-Bar on the map above, which has sustained pitches of 20-30% slopes. Slopes of 20-30%, and steeper, are fine for short sections (< 100 ft long) on rocky and well-drained soils that resist erosion, but long

sections this steep will force bikers to over-use their brakes and make the trail more susceptible to erosion.

Many of the trails have sustained descents, where riders don't have to pedal too much once they are going downhill, which is a nice reward for all the climbing they need to do to get to the top of Oak Hill. (Gnomaste, Crystal Ridge, Fall Line).

Still, there are some trails which are rolling, with short descents followed by punchy climbs, which appeal less to gravity-oriented bikers and more to old-school cross-country riders who enjoy a good cardio workout. (Junji, Middle Outback, Upper Middle Outback, Frankenstein's Folly).

Recommended Actions on Existing Trails

Before any new trails are built, improving the existing trails should be a priority. Many of the recommended improvements could be done by volunteers with hand tools, but there are a few spots where a mini-excavator with a professional builder would be the best tool.

See page 45 for estimated costs of these recommendations.

Hand-Tool Improvements to Problem Spots

There is about 700 linear feet of rock-armoring that can be done in 35 muddy spots on existing trails (shown as blue diamond-shaped symbols on the following map). Many of these are dry in the summer, so they are a low priority now, but they could become worse over time. These can be done by volunteers over the course of a few years, prioritizing the most popular trails, like Gnomaste.

There is up to 850 linear feet of bench-cutting that could be done to widen steep and narrow sidehill trails. These sections should be bench-cut so that the tread is wide enough and level enough to prevent people from falling off the downhill edge of the trail. There are sections on the Goat Trail, Game Trail, and Upper Middle Outback where the trail is “creeping” downhill because riders’ tires are knocking the downhill edge further down the hillside. What is “wide enough” and “level enough” depends on the overall difficulty of the trail – for example, the Goat Trail is for advanced riders, so it doesn’t need to be more than 18 inches wide.

There is up to 1,000 linear feet of hand-building to make four minor re-routes. These are on Middle Outback (2 spots) and Frankenstein’s Folly (2 spots). These will close steep sections of trail that are eroding and replace them with more sustainable routes that will also improve the flow of the trails.

There are also puddles around the trail network that don’t need to be rock-armored, they just need to be drained by removing dirt on their downhill edge, with a tool like a grub-hoe. Similarly, there are hand-dug water bars on the trails that need to be occasionally maintained by removing silt with a grub-hoe.

Re-Routes

Most trails take a good route, so there are very few closures and re-routes recommended. The two trails with significant recommended re-routes are:

- Bandit – there are three sections of Bandit that take a bad route and should be relocated:
 - The “rut track” at the top is eroding and it uses the 7th hole tee box on the disc golf course as a jump. The woods to the north of this section would be a good place to have a few berms so that the trail can take a more sustainable route and avoid conflicts with the disc golf course.
 - The final drop on the north leg of Bandit dumps riders abruptly onto the newly-excavated ski trail. The run-in to the drop should be re-located to the north in a way that uses the terrain to naturally control riders speed as they approach the drop.

Following the drop, the trail should be bench cut through the woods to exit onto the ski trail south of its current exit – so that riders are going slower when they enter the ski trail.

- The south leg of Bandit is straight down a steep slope, exiting abruptly onto the ski trail just above the ski jump. This section of trail is eroding, has the potential for collisions between bikers and other trail users, and is not the most fun way to use the terrain. This section should be closed entirely, but a new expert-level trail nearby is proposed to fill the desire for this type of trail.
- Junji Shortcut – a 250-ft trail that takes a very steep descent down a slope and has a long unbridged wetland crossing. Re-route the steep section to take a sidehill descent with a less steep gradient, using a mini-excavator to make a hardened rock tread to mitigate groundwater seepage. Use the mini-excavator to install bridge abutments and set hardwood logs in place as bridge beams. This bridge would be longer (20-25') than commonly available pressure-treated lumber and there are useful trees on-site for the logs.

Mini-Excavator Improvements to Problem Spots

A total of 1,600 linear feet of mini-excavator improvements are recommended on existing trails in 6 locations (highlighted in bright green on the following map). These are locations where the trail goes through low or flat spots that get muddy and are too long for ground-bridges or rock-armoring to be practical.

- Two locations on Gnomaste, totalling 300 linear feet. The trail should be elevated to keep water off it, and rock-armor should be used for cross-drainage. These two sections can be accessed using an old skid trail off the nearby ski trail.
- 600 linear feet around the junction of Game Trail and Frankenstein's Folly. All three legs of this junction use old skid trails that are low and muddy. A mini-excavator can drain puddles in the trail where the old skid trails are "sunken" and elevate the trail through low flat sections.
- 250 linear feet where "Screaming Downhill" enters the newly-excavated ski trail. This was impacted by logging. An excavator smoothed out the skidder ruts and installed water bars, but this was done simply for erosion control, not with bikers in mind. Some rock armoring, debris cleanup, and a short 6-ft bridge over an intermittent stream should be done with a mini-excavator.
- 100 linear feet where the Middle Outback trail leaves the ski trail. A 6-ft bridge should be installed across the ditch, and a mini-excavator should be used to elevate and rock armor the trail on the other side of the ditch.
- 250 linear feet on Upper Middle Outback. Some of this is low and flat ground that should be elevated and rock-armored. Some of this is where the trail goes through a low spot where water pools – the trail should be shifted uphill to higher ground and a mini-excavator should be used to elevate and rock armor the trail.
- 100 linear feet where Middle Outback and Upper Middle Outback cross a stream. A mini-excavator should be used to build the rock abutments for this bridge and to elevate and

rock-armor the trail on the east side of the stream, where the ground is flat and sometimes muddy.

- 450 linear feet on Middle Back to re-align a steep section on a two-way trail, creating separate downhill and uphill lines. Use a combination of mini-excavator and rake-and-ride techniques to make a bench-cut that takes a less steep grade than the existing fall line trail – this bench-cut will be the climb and the “B-line” for descending. Use a mini-excavator to build a catch-berm at the bottom of a rock roller that will be the “A-line” on the descent.

Bridges

In total, there are 9 locations where a bridge is recommended (blue rectangles on the following map):

- 2 short (6-ft) bridges. These locations are where the trail crosses a ditch to get from a ski trail into the woods. While culverts or rock-armor are also options in situations like this, a short (6-ft long) bridge would be less of a maintenance liability than a culvert, and a rock-armored dip into and out of a steep-walled ditch would be a steep dip.
- 3 12-ft bridges spanning streams. These stream crossings are currently unbridged, but have some rock-armoring. They also have mud around the rock-armoring, which will get worse if the trails get more traffic, and this will impact these brooks.
- 1 long 20-ft bridge spanning a wetland on the Junji short-cut. This crossing is currently unbridged. The beams can be hardwood logs cut from trees on-site.
- 3 longer ground-bridges to get through long muddy sections where rock-armoring would be too much work and/or there are not enough useful rocks near the trail.

A NHDES Trails Notification permit should be obtained for 7 of these bridges – all except for the 25-ft and 45-ft ground bridges, which are not in wetlands, but are just on flat sections that get mud puddles.

Except for the log-beam bridge, it is recommended that pressure-treated wood be used for the support beams which should be at least 6-inches tall (2x6 or 4x6 on edge). Support beams should be set on rocks or on pressure-treated sills. Rough-sawn boards with a nominal thickness of 2-inches are recommended for the decking, which could be sourced locally or even from Oak Hill.

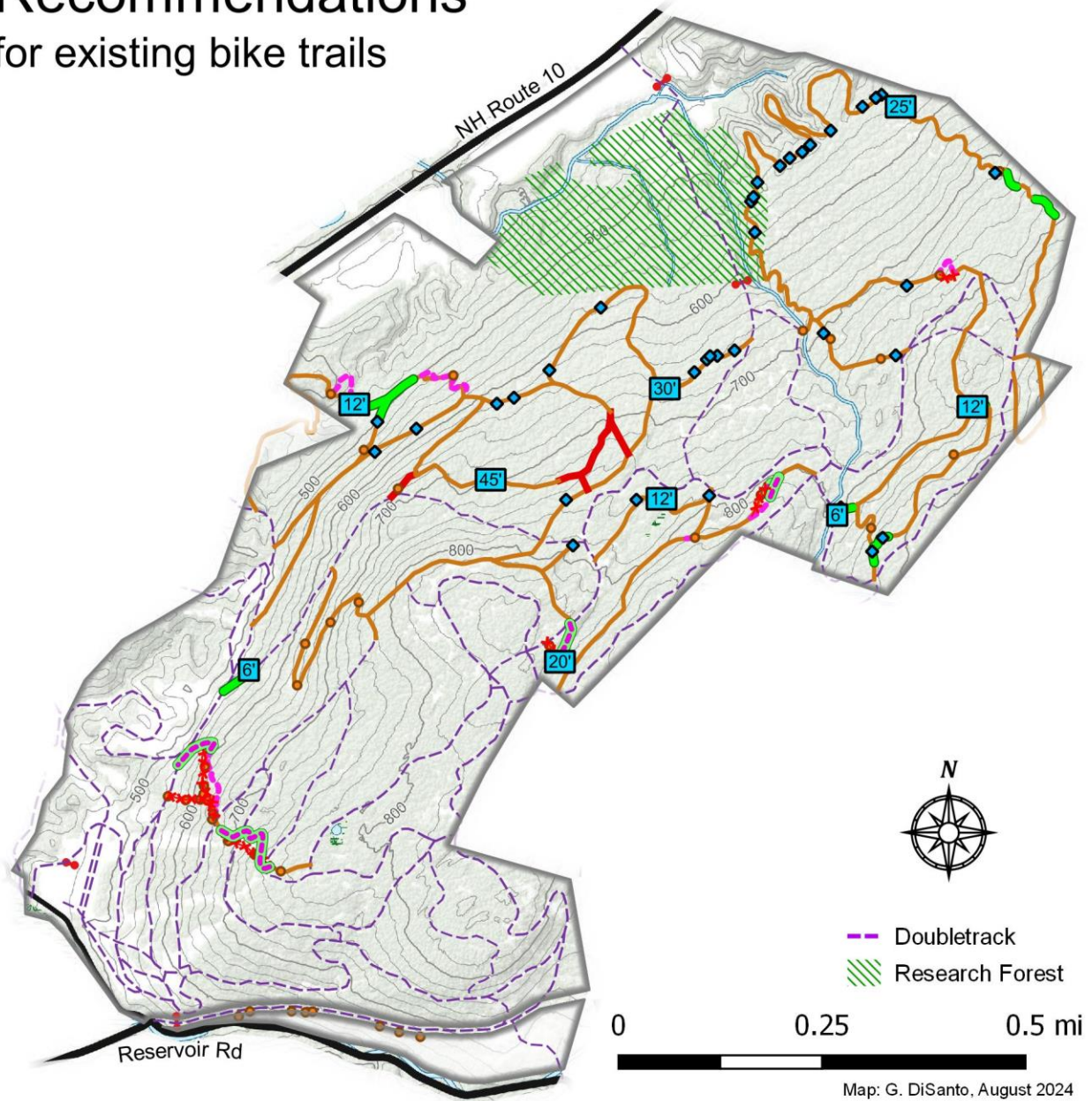
Some of these bridges are on trails that could be accessible to adaptive riders (see map on page 35 for the trails that could be accessible), so they should be at least 42-48” wide. The new bridges on inaccessible trails should still be at least 42” wide because many of them are either on high-speed locations, are elevated above a brook, or are in locations where riders are turning immediately before or after the bridges. Trails that are considered “inaccessible” may still be used by adaptive riders, as adaptive bike designs and riding levels evolve.



Above, left: Middle Outback leaves the ski trail and enters the woods by crossing a ditch. Use a mini-excavator to build the foundations for a 6-ft long bridge across the ditch, and to elevate and harden the next 100 feet of trail that is wet.

Right: Middle Outback and Upper Middle Outback have an unbridged stream crossing, with soft and wet conditions adjacent to the stream. Use a mini-excavator to build the foundation for a 12-ft long bridge, to clean up the blown-down trees, and harden the trail in the silty and seepy valley floor.

Recommendations for existing bike trails



Map: G. DiSanto, August 2024

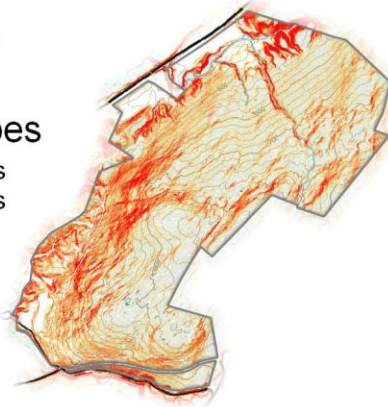
Recommended Actions for Existing Singletrack

- Keep this section of trail, make improvements to any problem spots
- Install New Bridge ... 170 linear feet (bridge lengths labelled on map)
- ◆ Rock armor on "keep" trails ... 700 linear ft
- Other problem spots on "keep" trails ... 1,850 ft of work with hand tools
- Mini-excavator improvements to problem spots on this section of trail ... 1,600 linear ft
- XXXXX Close this section and re-route
- - - Build re-route with hand-tools ... 1,600 linear ft
- - - Build re-route with mini-excavator ... 1,250 linear ft
- Close these short sections to simplify network when planned new connector trail is built ... 1,200 ft

Terrain Constraints

Steep Slopes

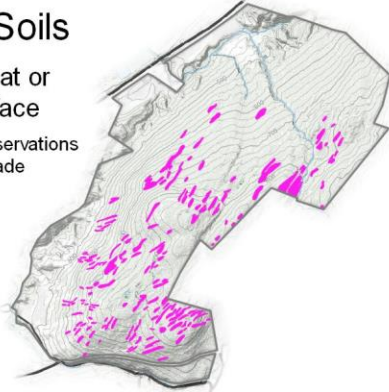
- 25% slopes
- 50% slopes



Shallow Soils

- Bedrock at or near surface

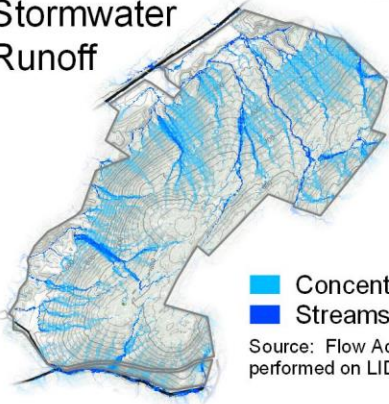
Source: Field observations and LIDAR hillshade



Stormwater Runoff

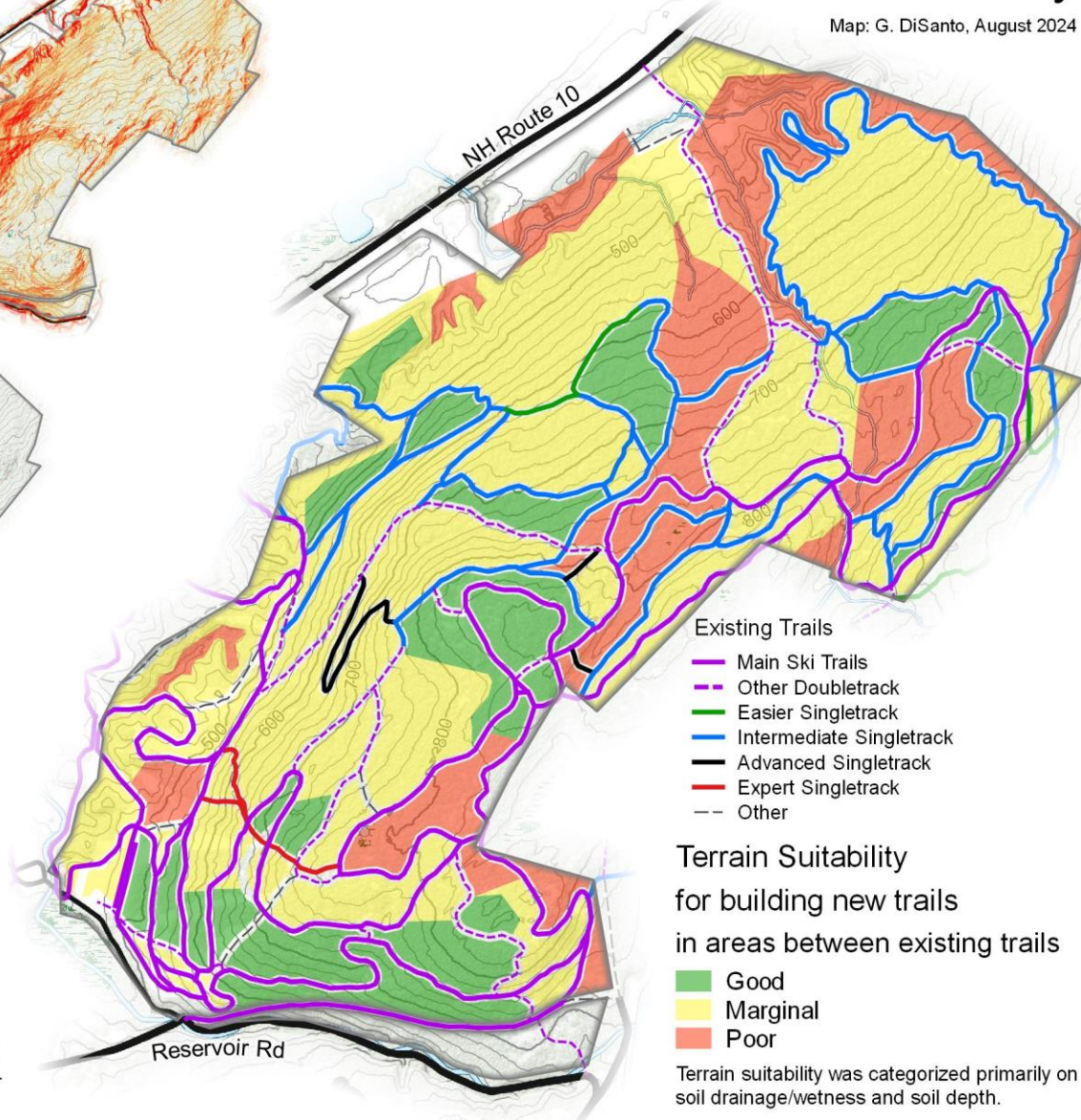
- Concentrated Runoff
- Streams

Source: Flow Accumulation model performed on LIDAR elevation data.



Terrain Suitability

Map: G. DiSanto, August 2024



- ### Existing Trails
- Main Ski Trails
 - - - Other Doubletrack
 - Easier Singletrack
 - Intermediate Singletrack
 - Advanced Singletrack
 - Expert Singletrack
 - - - Other

Terrain Suitability for building new trails in areas between existing trails

- Good
- Marginal
- Poor

Terrain suitability was categorized primarily on soil drainage/wetness and soil depth.

New Trails

Most of the terrain that is good for rake-and-ride trails already has trails. The area around Hunters Track, Fall Line, Up Through the Woods, Crystal Ridge has great slopes, great forests, and well-drained soils that allow for long sustained descents. The terrain around Junji, Middle Outback, and Upper Middle Outback forces trails to take rolling paths to stay on high-and-dry ground because there are low-lying wet areas scattered between bedrock outcrops. Gnomaste goes through a forest with more enriched soils that are moderately well-drained, on broad slopes without clear high-and-dry ridges.

Much of the “empty space” on the map has terrain that is too steep or too wet for the rake-and-ride style of trail. These areas could still be suitable for mountain bike trails, but a mini-excavator would be needed for sections or for entire trails. A mini-excavator would be useful to bench-cut sections where the sidehill is steep, to build banked turns where the trail needs some S-Turns to drop elevation on a steep hillside, and to install rock armoring in low spots. Some of the “empty space” on the map that appears to be useful for new connector trails is not suitable for new trails, even with a mini-excavator. For example, connecting the bottom of Gnomaste with the Hunters’ Track would be a logical way to improve the usability of the trail network. However, the terrain is so unsuitable for building that such a trail is not recommended.

The maps on the following pages show the five planned phases of new trails that are discussed in this section.

Phase 1 – Skills park, pump track, and a flow trail at the main parking lot

Phase 1 consists of a skills park, pump track, an aMTB accessible machine-built flow trail, and an aMTB accessible climbing trail connecting the parking lot to Old Wolfeboro Rd. This first phase will immediately add beginner-friendly terrain that is accessible from the main parking lot:

- A beginner skills area, with a lower section that has very easy features (Phase 1A) and an upper section with easy features that are slightly larger (Phase 1B).
- A pump track (1C) in the woods around the old stone fireplace, behind the ski groomer buildings.
- An 0.6-mile intermediate-level downhill flow trail that runs from the hill above Old Wolfeboro Rd down to the base of the ski hill (1D).
- A beginner-friendly and aMTB-accessible trail (1E) that connects directly from the parking area to Old Wolfeboro Rd, just above the gate, so that bikers do not need to ride down the paved road to get to Old Wolfeboro Rd, which is the main climbing trail to the top of the hill.



Above, left: Idea for a small jump line and mini flow trail (yellow lines) above the Nordic start/finish area (1A). A mini flow trail with a slight downhill pitch will have a series of rollers and berms that give riders a chance to practice these features near the parking area before they encounter them on the trails. There will also be a small jump line table-top jumps that have “A” and “B” take-off options, approximately 5-10 from lip-to-landing. See the “jumps” section of the glossary for more details and specifications. Riders can use the ski trail to return to the top of the skills park to do repeat laps (white line).

Above, right: Idea for a pump track (yellow line) around the old fireplace (orange outline) behind the ski groomer maintenance building . This wooded area should be thinned of undergrowth and hazard trees removed, leaving a canopy of healthy overstory trees for shade. Care would be taken to avoid any damage to the fireplace, as it will be the centerpiece of this pump track.

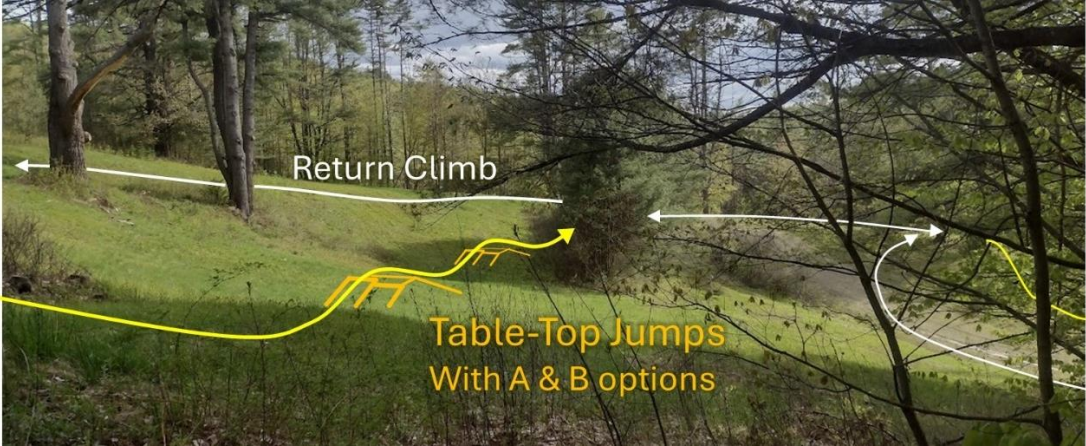


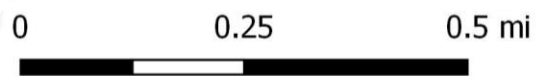
Photo above: Idea for the upper half of the beginner skills park (1B), with a small-medium jump line above the Nordic start/finish area. Table-top jumps will have “A” and “B” options, approximately 15-ft and 10-ft long from lip-to-landing. The slope below this (to the right) is where the smaller jumps and mini flow trail is planned.

Planned New Trails



- Existing Singletrack - Easier
- Existing Singletrack - Intermediate
- Existing Singletrack - Advanced
- Other Doubletrack
- Main Ski Trails
- ▨ Research Forest
- ▨ Gun Range Safety Zone

Trails labelled by the recommended phase and priority of construction (eg. 1A = recommended to be the first new trail built)



Map: G. DiSanto, August 2024

Planned New Trails (including "mini flow trails" in skills parks)

	Easier Singletrack - Machine-Built	29,000 linear ft
	Easier Singletrack - Hand-Built	3,300 linear ft
	Intermediate Singletrack - Machine-Built	3,000 linear ft
	Intermediate Singletrack - Hand-Built	1,600 linear ft
	Advanced Singletrack - Mixed Machine/Hand-Built ...	3,200 linear ft
	Advanced/Expert Singletrack - Hand-Built	7,900 linear ft
	Pump Tracks	600 linear ft

Phase 2 – Flow trails and a beginner loop around the old ski hill

- Re-route and improve “Bandit DH” (2A). This advanced trail will be different in character to the other trails in Phase 2, but it is recommended to be done in Phase 2, because it is problematic in its current state, and improving existing trails should be prioritized over building new trails. This will be a mix of hand-built and machine-built construction, and it is intended to be rideable by expert aMTB riders.
- 2.2 miles of beginner-friendly machine-built trails (2B-2E) that take a gradual route from the base of the ski hill to the top. This will be designed for two-way traffic and will allow beginners to make a big singletrack loop, something they currently cannot do at Oak Hill.
- A beginner (2F) downhill flow trail that descends from above Old Wolfeboro Rd to the top of the skills areas. The first 600 ft of 1D will be built as a beginner-friendly trail (the rest of 1D is intermediate-level), because 2F will split off from 1D at this point. Both 1D and 2F should be built to be aMTB-Blue accessible – the rolling terrain will provide some punchy climbs and some of the steep sidehill terrain adds an element of exposure, although the bench-cut sections of trails will be built at least 4-ft wide for safety.
- A beginner-friendly climbing trail (2G) that gets riders from the high-point of Old Wolfeboro Rd to the top of the hill, where they can access the flow trails.
- A beginner-friendly flow trail (2H) that descends 60 vertical feet from a Nordic trail (near the owl and bear carvings) to 2B. This creates an easily repeatable downhill trail in a fully visible area – great for camps and lessons.

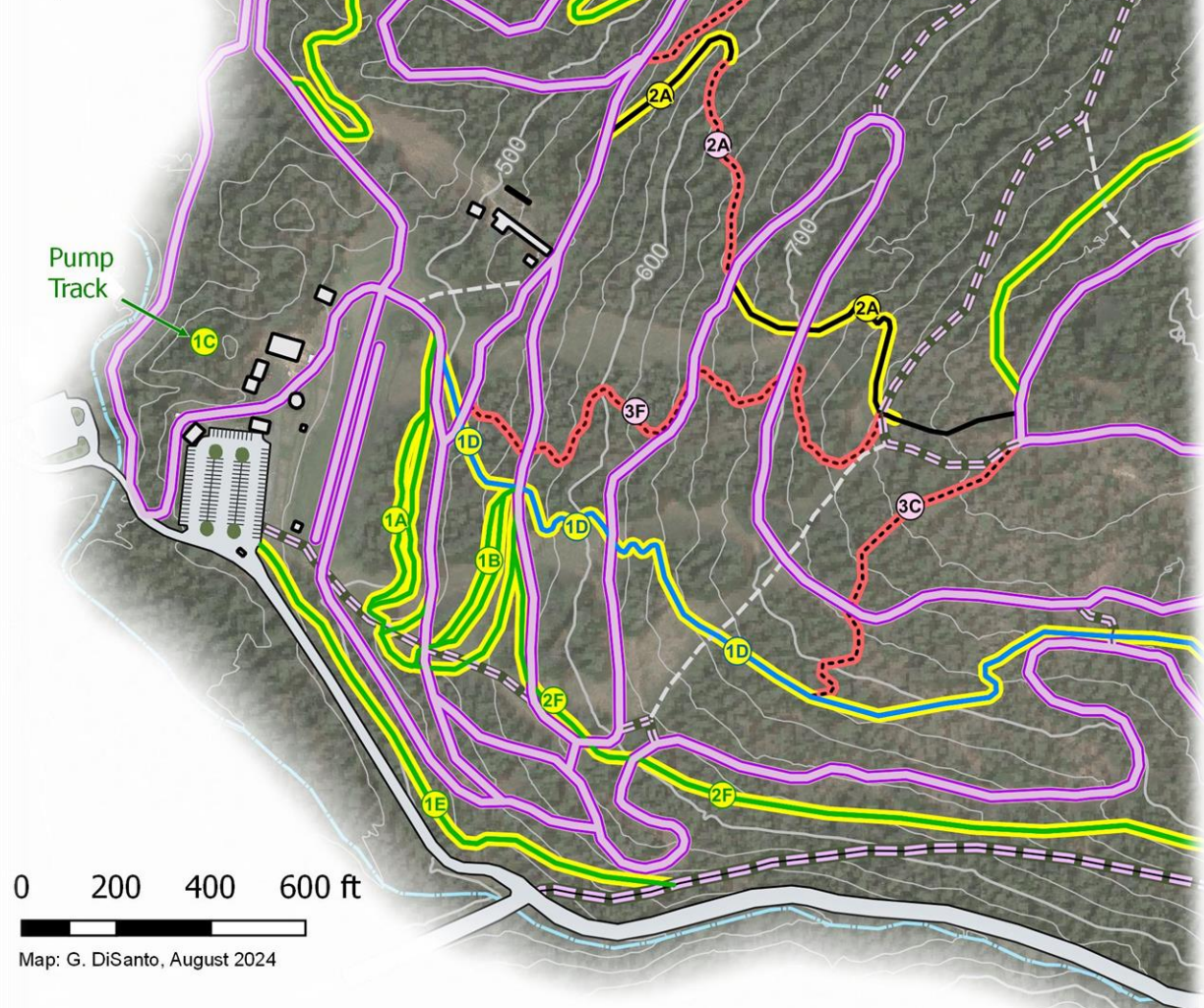


Left: Phase 2B wraps around the silt-sand terraces on the lower slopes of the ski network. Care should be taken not to alter the grade or drainage patterns where singletrack crosses ski trails. Trail will cross over snowmaking pipes and buried power.

Phase 3 – Hand-built trails on the old ski hill and an advanced flow trail

- Beginner-friendly hand-built trails in the gentle terrain at the top of the hill. A loop (3A) plays around in ledgy terrain and will have some rock armoring, rock rolls, and ground bridges so that beginners can gain confidence on technical features. The 3A loop is intended to be aMTB-Black-Diamond accessible, with adaptive riders needing support on some features. A trail (3B) will provide a beginner-friendly and aMTB-Green/Blue accessible rake-and-ride singletrack connection from the south end to the north end of the top of Oak Hill, to increase beginner-friendly loop options.
- Advanced hand-built trails (3C & 3D) that are mostly rake-and-ride. They will be rideable by intermediate-level riders, and a good stepping-stone to progress to more expert-level trails.
- Expert-level hand-built trails (3E & 3F) that are steeper than 3C & 3D. These will need more hand-digging than 3C and 3D; 3E will need a lot of catch-berms and catch-benches as it plays around with fall-line and sidehill terrain. 3F will need rock work and catch-berms to incorporate some rock outcrops into the trail.
- Advanced-level flow trail (3G) that is the only machine-built trail in Phase 3. This would have larger table-top jumps and features than the intermediate flow trail (1D), allowing riders to progress their skills to the next level in an accessible location on the ski hill.

Planned New Trails Ski Hill Area Detail



Map: G. DiSanto, August 2024

- | | |
|--|---|
| Potential New Trails (including "mini flow trails" in skills parks) | |
| | Easier Singletrack - Machine-Built |
| | Intermediate Singletrack - Machine-Built |
| | Advanced Singletrack - Mixed Machine/Hand-Built |
| | Advanced/Expert Singletrack - Hand-Built |
| | Existing Singletrack - Easier |
| | Existing Singletrack - Intermediate |
| | Existing Singletrack - Advanced |
| | Ski Trail |
| | Other Doubletrack |
| | 20-ft Contours |

Phase 4 – Fullington Field beginner trails and skills park

- A beginner-friendly two-way trail (4A) that connects Fullington Field with the rest of the trail network. This would use old skid trails through the study forest, to avoid minimize disturbance to the trees, all of which are inventoried and tagged for research. This would also be a good hiking alternative to the existing doubletrack that goes directly up the fall line from Fullington Field and is too steep for many bikers.
- A skills park with short “flow trails” that have rollers and table-top jumps (4B) on the hill above Fullington Field. Some wooden fencing and signage is recommended around the edge of this, due to its proximity to the entrance to the Dartmouth shooting range.
- A pump track in Fullington Field (4C). This could be asphalt-surfaced to reduce maintenance needs, because it is in an open area, exposed to the elements.
- A beginner-friendly and accessible downhill flow trail (4D) that provides an alternative to the descent on “Frankenstein’s Folly”.
- A beginner-friendly loop (4E) on the terraces below 2C, touring the old banks of Glacial Lake Hitchcock.



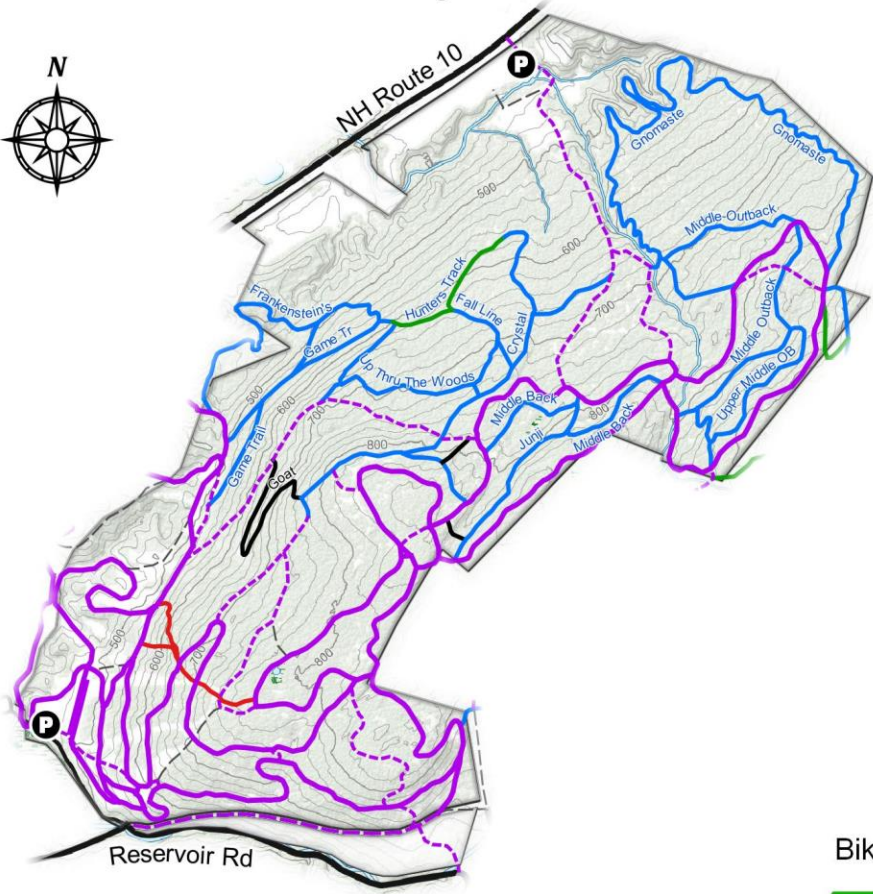
- Left: proposed site of the pump track, which could benefit from having an asphalt surface. Shade trees could be planted after construction to make it a more desirable place to spend time.
- Right: the slope above the Fullington Field access road could have two bench-cut trails running down it, with roller and small jumps. There is already an access road to the top of this slope. A soil berm could be constructed at the bottom of these trails to physically separate the skills area from the gravel access road.

Phase 5 – Short connector trails

- A short machine-built connector (5A) that relocates part of the “Middle Outback” loop off a wet section of doubletrack. This short connector will need some elevated turnpike sections with cross-drainage, as the sidehill has some groundwater seeps.
- A hand-built climbing trail (5B) that extends the Gnomaste climb further uphill. This will be a scenic section of trail along the brook, and will include a bridge across the brook.
- A mostly natural advanced downhill trail (5C) that creates another way to get to Middle Outback. The trail would sidewind across a ferny gully, using rock outcrops on either side. A mini-excavator would be used to harden and/or elevate the tread through the gully.
- A hand-built trail (5D) that connects Middle Outback directly to the top of Gnomaste and the northern Trescott access.

See page 46 for estimated costs of each phase and segment of new trail labelled on the map (1A-5D).

Current Trail System



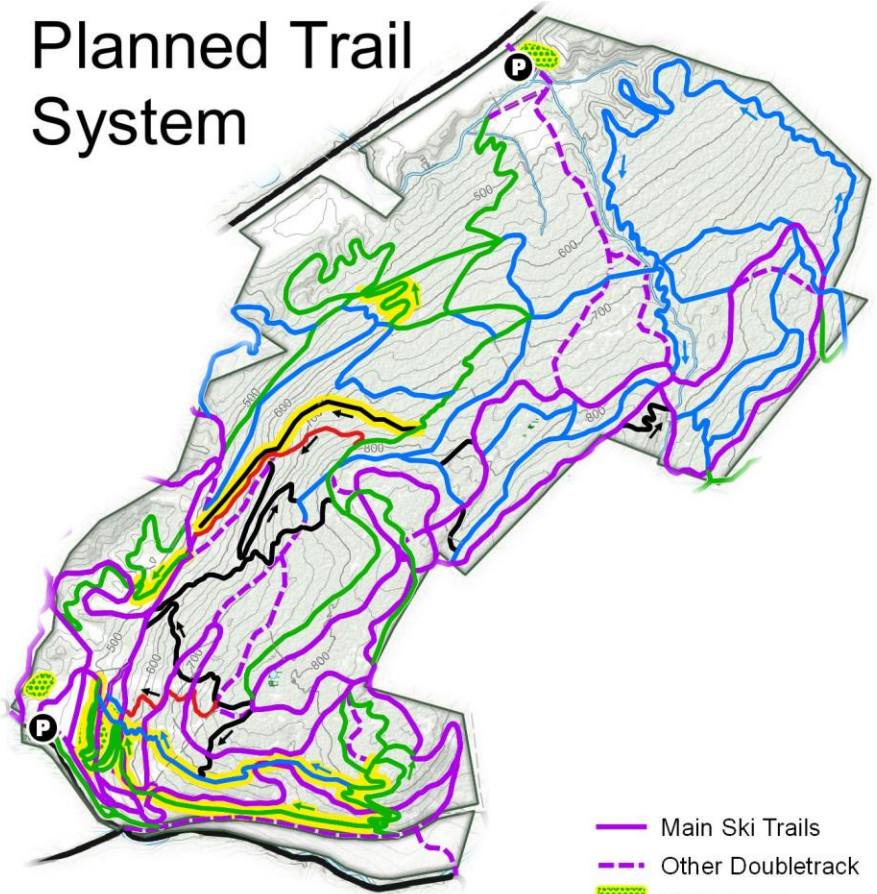
Bike Trails - Current

- Easier Singletrack 0.3 miles
- Intermediate Singletrack ... 5.7 miles
- Advanced Singletrack 0.4 miles
- Expert-Only Singletrack 0.4 miles

Total singletrack 6.8 miles

Map: G. DiSanto, August 2024

Planned Trail System



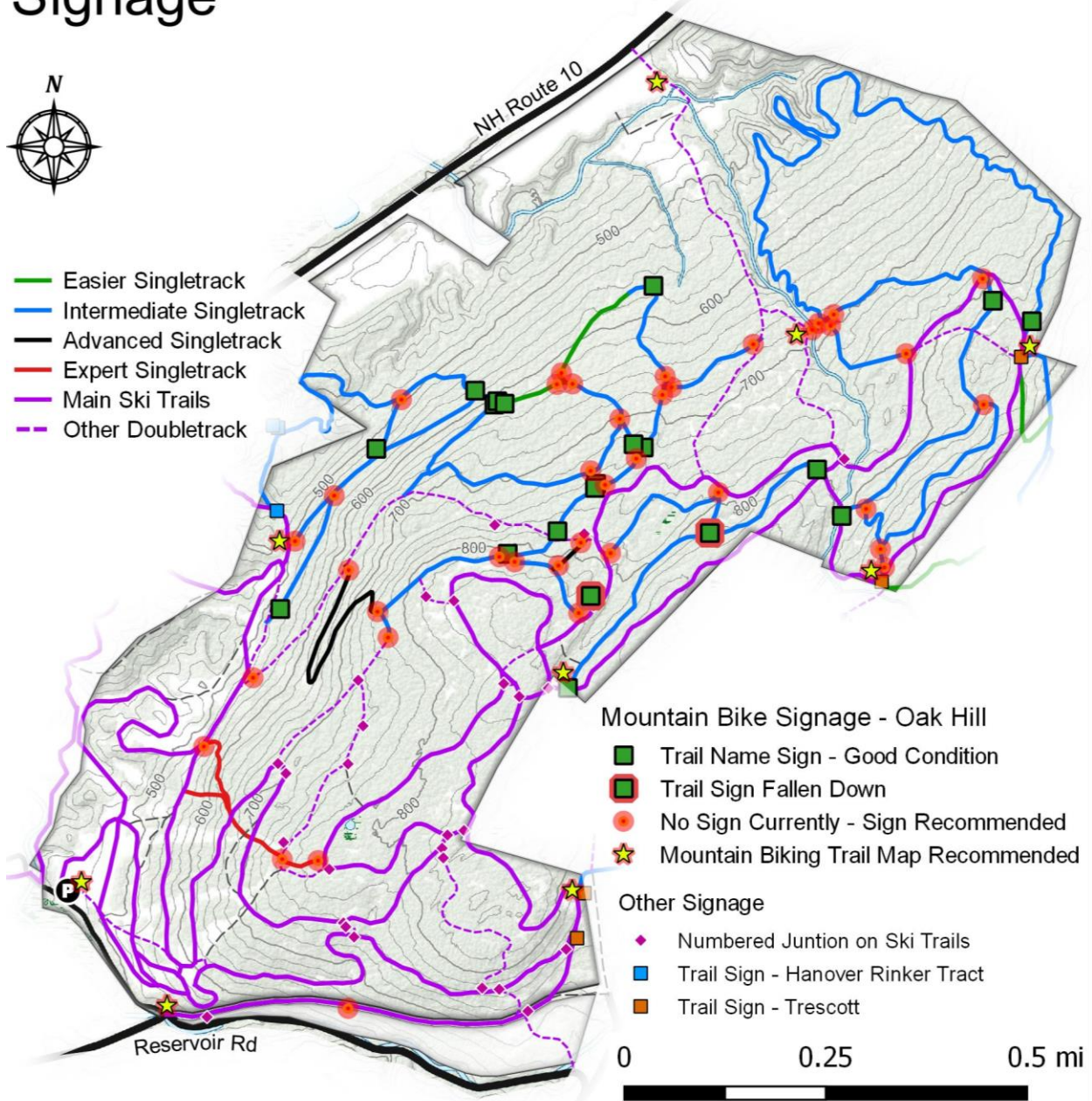
Bike Trails - After Implementing Plan

- Easier Singletrack (Two-Way or Climb) ... 5.4 miles
- Easier Downhill Flow Trail 1.4 miles
- Intermediate Singletrack (Natural) 5.7 miles
- Intermediate Downhill Flow Trail 0.5 miles
- Advanced Singletrack (Natural) 1.5 miles (1.2 mi. DH + 0.3 mi. climb)
- Advanced Downhill Flow Trail 0.4 miles
- Expert Singletrack 0.6 miles

Total singletrack 15.9 miles

- Main Ski Trails
- - - - Other Doubletrack
- ▨ Skills Areas
- One-Way Trail

Signage



There are trail name signs at many of the junctions on the Oak Hill bike trails. These signs are carved into a wood composite material with a router so that the trail name is recessed and has white letters on a green background. The benefits of these signs are that they are easy-to-read, use long-lasting materials, and are aesthetically-pleasing. The neighboring Trescott Trail also have signs with the names of bike trails, but with a different color-scheme. The current signage system at Oak Hill could be improved in five ways:

- 1) Add more signs. Many three-way junctions have only one or two trail segments signed, making the user guess about which trail is which.

- 2) Add signage for directional trails. Signs saying “Do Not Enter – Downhill Bike Traffic” should be installed at the bottom of downhill-only trails. Signs indicating “Uphill” could be added to the main climbing trails.
- 3) Mount the signs only to sturdy trees. Choosing trees with a diameter of at least 8 inches will reduce the risk of the tree being affected by the lag bolts and dying. Several trees with signs have fallen, because the trees chosen were not the healthiest or sturdiest trees to begin with. At the same time, avoid mounting them to very large, valuable, or notable trees. If no good trees are available, mount them to a pressure treated 4x4 post installed in the ground, but be sure to install it deep and compact the dirt as it is being backfilled, to prevent it from sagging.
- 4) Mount the signs within 5 feet of a junction, 4-5 feet above the ground. Since these signs are green, they are easily missed. Some signs are 10+ feet down the trail, and some are higher than the height people would expect. Finding the perfect tree right at the junction is not always possible, so it will be necessary to install some sign posts.
- 5) Add some maps at trailhead kiosks and major junctions.



Left-to-right, top row: A trail sign on an Oak Hill bike trail, a trail sign on a Trescott bike trail.
 Left-to-right, bottom row: a ski trail junction number with an old map on an Oak Hill ski trail, a trail sign on the Hanover Rinker Tract, and a ski trail map kiosk at Oak Hill.

With the planned new trails, there will need to be even more signage. In addition to the 20 existing singletrack trail name signs currently installed at Oak Hill, the following is a list of types and quantities of signage recommended:

- 40 additional trail name signs should be installed on the existing network.
- 90 trail name signs should be installed at junctions, after the planned new trails are built.
- 27 locations should have “Do Not Enter – Downhill Bike Traffic” signs installed, after the planned new trails are built.
- 5 locations where informational signs should be installed in the “start area” of planned new pump tracks and skills areas.
- At least 9 map kiosks at trailheads and major junctions.

Estimated costs of implementing these signage recommendations are:

- \$2,500 for design, materials, and wood-working labor to create the trail name signs and “One-Way Do Not Enter” signs.
- \$4,500 for the design and printing costs of kiosk maps and the informational pump track and skills area signage.
- \$1,000 for pressure-treated sign posts and mounting hardware to install this signage.
- \$5,000 in payroll and operating costs to have Oak Hill Outdoor Center staff install all of this signage throughout the network.

Total estimate: \$13,000 over several years, as the planned trails are built.

Adaptive Mountain Biking

Adaptive mountain bikes for riders with mobility challenges are becoming widespread, with the most common design being a bike with two front wheels, a hand-crank to pedal the bike forward, and sometimes an electric pedal-assist drive. Vermont Adaptive has been assessing trail systems in Vermont and assigning adaptive-specific Green/Blue/Black ratings to trails, along with descriptions of “assist needed” or “no assist needed”.

Trail features that require support, or limit adaptive bike accessibility, include:

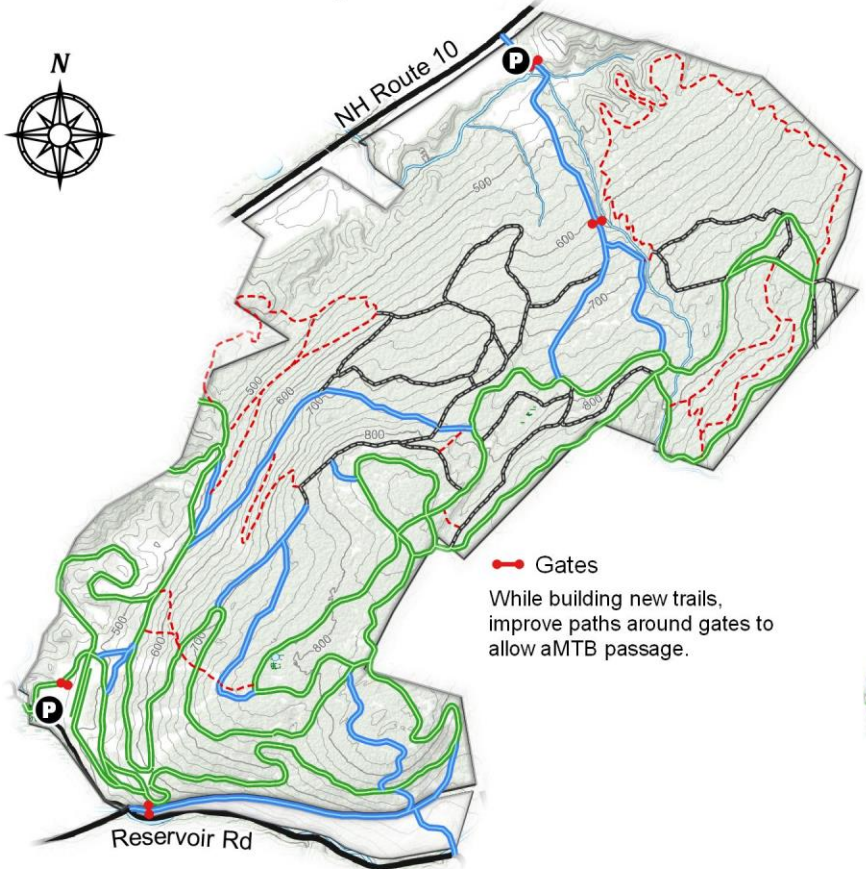
- Tight gaps between trees (40-42 inches)
- Narrow bridges (42-48 inches)
- Steep climbs with loose surface
- Steep sidehill slopes
- Narrow bench cuts (42-48 inches) on steep sidehill slopes
- Gap jumps or drops that require a biker to “pop their front wheel out” to level themselves in the air.



Currently at Oak Hill, much of the singletrack is difficult to access for adaptive riders, mostly due to the tight gaps between trees, narrow tread, steep sidehill, steep climbs, and narrow bridges. Many of these challenges are so widespread throughout the singletrack network that it is not recommended to retrofit all of these trails to be more adaptive. The doubletrack ski trails are accessible with little support needed, but there is an opportunity to create new singletrack at Oak Hill that is accessible to adaptive riders, so that they can mountain bike in the woods instead of on grassy ski trails.

Not all of the new planned trails will be accessible; some of the gravity trails on the steep hemlock slopes around the ski hill are not feasible options for accessible trails due to the gaps between large trees and the steep sidehill terrain. However, 85-90% of new trails, by length, would be accessible. This includes 7.8 miles of new singletrack rated Green or Blue for aMTB, none of which currently exists at Oak Hill. The map on the following page shows the current offering of aMTB at Oak Hill, and the proposed network trails. This is based on an interpretation of Vermont Adaptive’s rating system, and we hope to have adaptive-specific experts assess the trails this year.

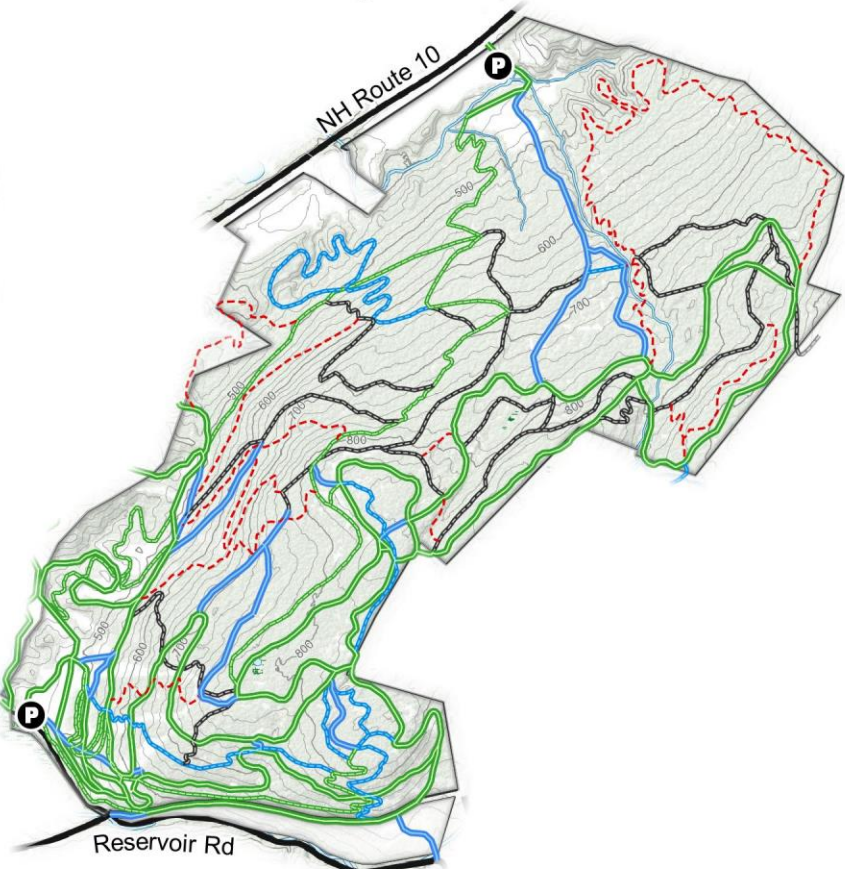
Accessibility - Current



- aMTB Green Circle - Doubletrack 7.1 miles (Support Recommended)
- aMTB Green Circle - Singletrack 0 miles (Support Recommended)
- aMTB Blue Square - Doubletrack 3.4 miles (Support Recommended)
- aMTB Blue Square - Singletrack 0 miles (Support Recommended)
- aMTB Black Diamond - Singletrack ... 2.9 miles (Assist Needed)
- - - Not Accessible 3.9 miles

Total Accessible Trails 13.4 miles

Accessibility - Planned



- aMTB Green Circle - Doubletrack 7.1 miles
- aMTB Green Circle - Singletrack 4.3 miles
- aMTB Blue Square - Doubletrack 3.4 miles
- aMTB Blue Square - Singletrack 2.7 miles
- aMTB Black Diamond - Singletrack ... 4.5 miles
- - - Not Accessible 4.4 miles

Total Accessible Trails 22.0 miles

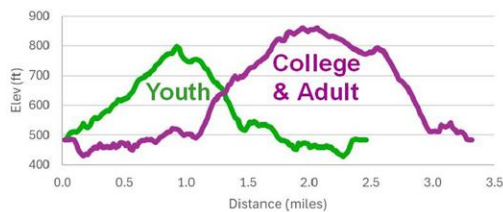
Potential Event & Race Courses

Cross-country courses:

Cross-country (XC) race courses have laps that should take 15-25 minutes, with a target race length of 45-90 minutes, depending on the category.

These are mass-start races, so it is important to include some doubletrack for passing opportunities, especially near the start/finish area and on climbs. Doubletrack should make up at least 5% of the race course, but not more than 50%. The following map shows a potential XC course:

Potential XC Courses



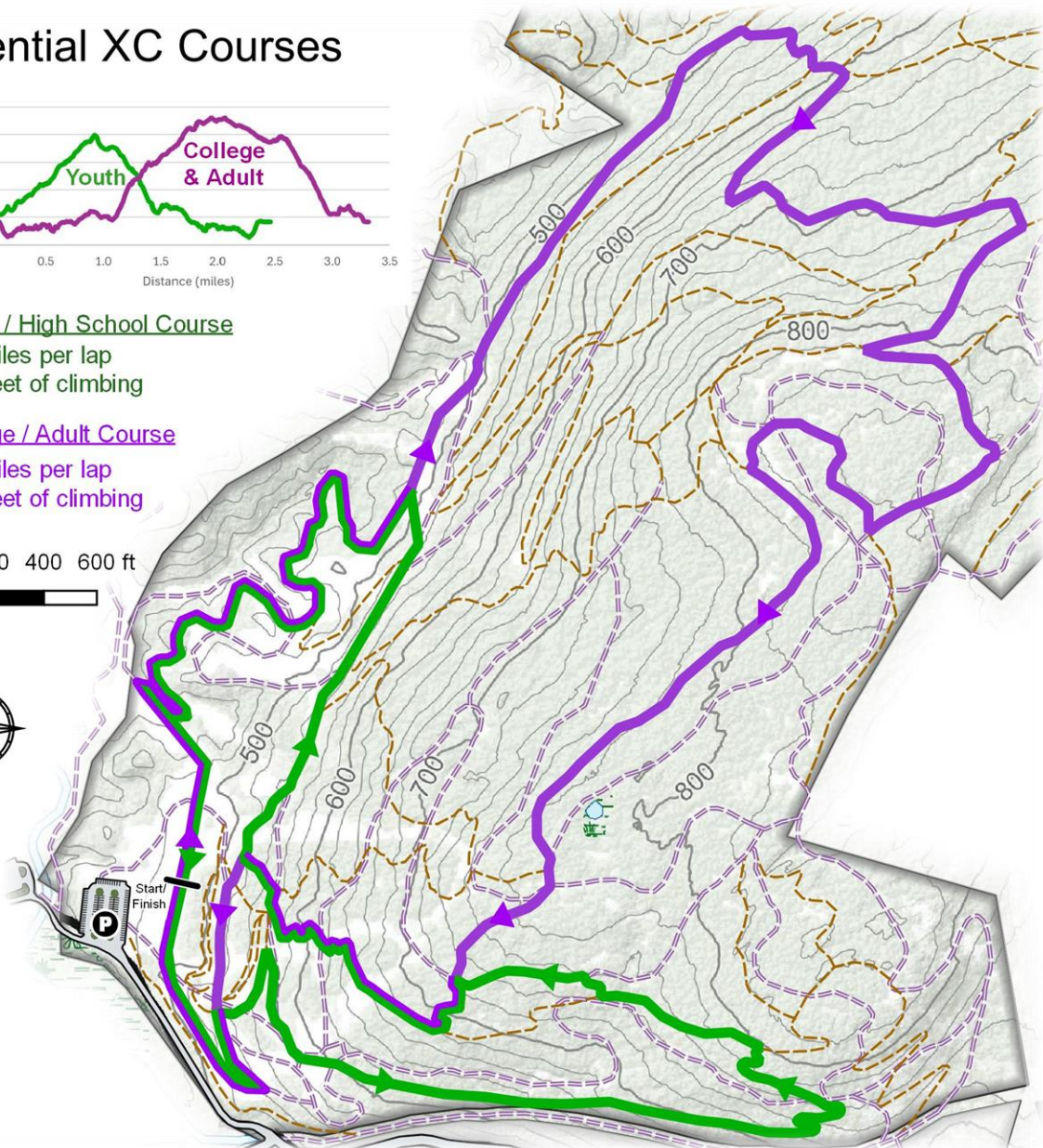
Youth / High School Course

2.5 miles per lap
405 feet of climbing

College / Adult Course

3.3 miles per lap
525 feet of climbing

0 200 400 600 ft



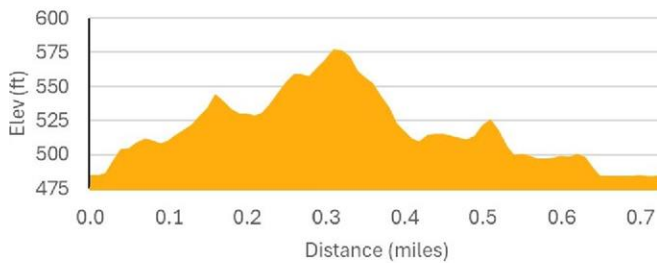
Short-track cross-country course:

Short track (STXC) courses have laps that should take 3-6 minutes for most racers. Different skill categories will do different numbers of laps, with a target race length of 20-35 minutes, depending on category.

These are mass-start races, so it is important to include doubletrack for passing opportunities, especially near the start/finish area and on climbs. Since the race is faster and shorter than cross-country races, doubletrack should make up a greater proportion of the course, typically 50%. The following map shows a potential STXC Course:

Potential STXC Course

0.7 miles per lap
110 feet of climbing



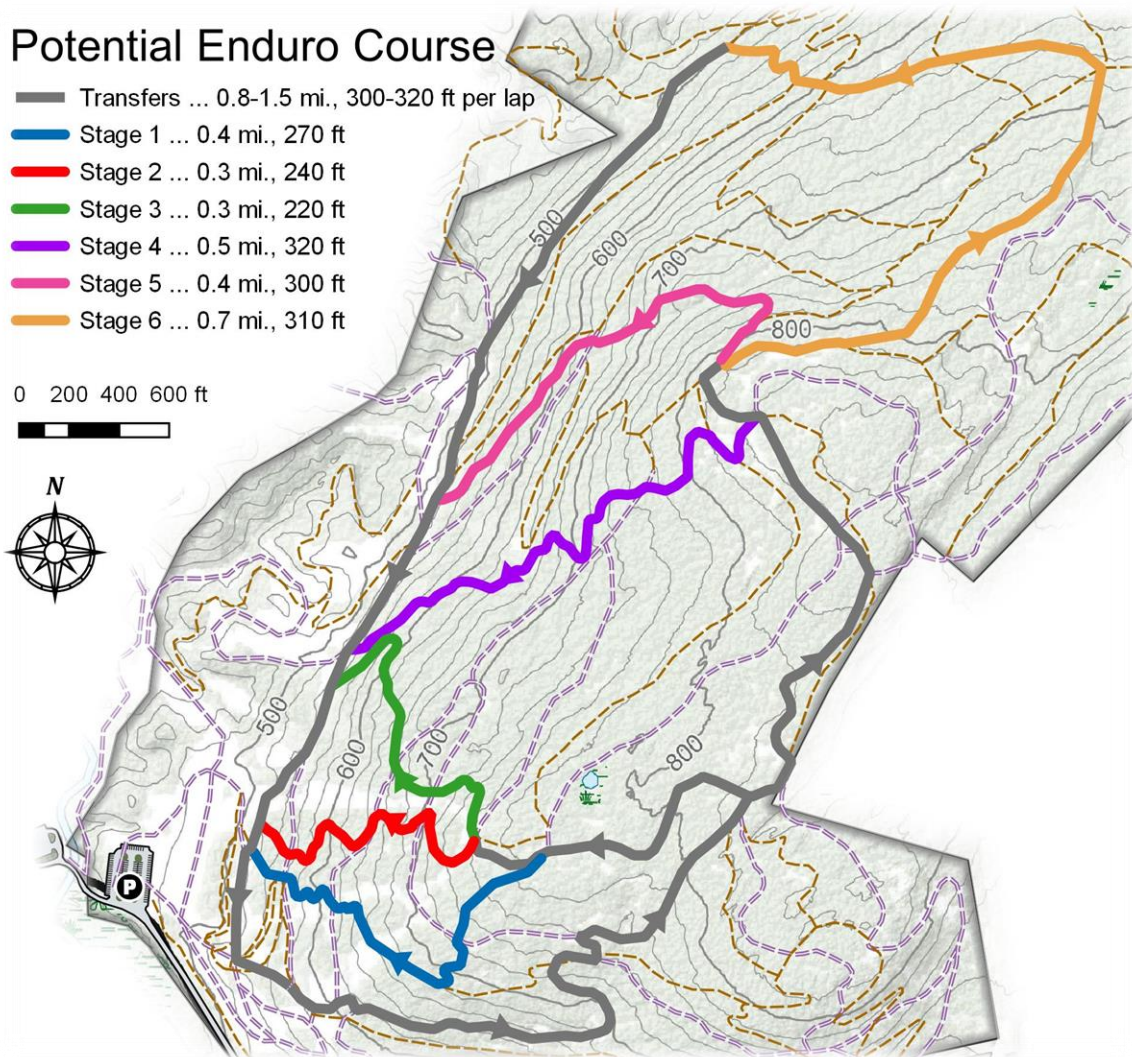
Cyclocross

Cyclocross is a discipline of biking that uses road-like bikes to race on grass and dirt surfaces, with short laps like Short Track XC racing. It is typically a late-fall and early-winter activity. Dartmouth Cycling Club hosted a cyclocross race around Storrs Pond, circa 2017. With the new ski trail improvements and parking areas, a course could potentially be sited at Oak Hill.

Enduro race course:

Enduro is a gravity event, with multiple downhill stages that are raced individually (not mass-start). A racer's cumulative time from all the downhill stages is their final time. The "transfer" climbs in between stages do not contribute to their final time, although there are often cut-off times to ensure that racers do not take unreasonable amounts of rest between downhill stages. These races are often timed with a chip-and-sensor system, since there are multiple start lines and multiple finish lines, instead of one start/finish area like in XC.

Downhill stages should consist of mostly technical terrain instead of "flow trails", because flow trails have features designed for a certain design speed, and racing would encourage riders to exceed that design speed. Typically, there are 4-6 downhill stages. On the regional racing circuit – the Eastern States Cup – downhill stages typically have at least 400 feet of vertical drop. Oak Hill does not have that much vertical drop, but it can host "mini-enduro" races for high school, college, or local races. The following map shows a potential "mini-enduro" race course with up to 6 stages, although coaches could choose to make it 2-5 stages depending on racers' abilities:



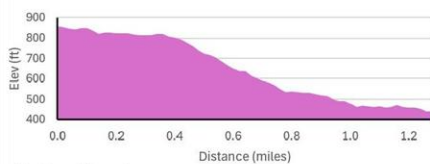
Downhill or Super-D course:

Downhill and Super-D are gravity races consisting of a single timed stage. Downhill courses are designed to have minimal or no pedalling. Super-D courses have pedally sections, but are mostly downhill.

Downhill races are usually held at venues with a chairlift or a vehicle shuttle, because racers use bikes that are optimized for downhill use instead of for pedalling. Oak Hill does not have a chairlift or the shuttling infrastructure that is expected at a regional race, and it does not have the vertical drop expected at a regional or college race. High School-affiliated racing does not usually include downhill races, but if the desire was there, a race could be held on one of the enduro stages from the previous map.

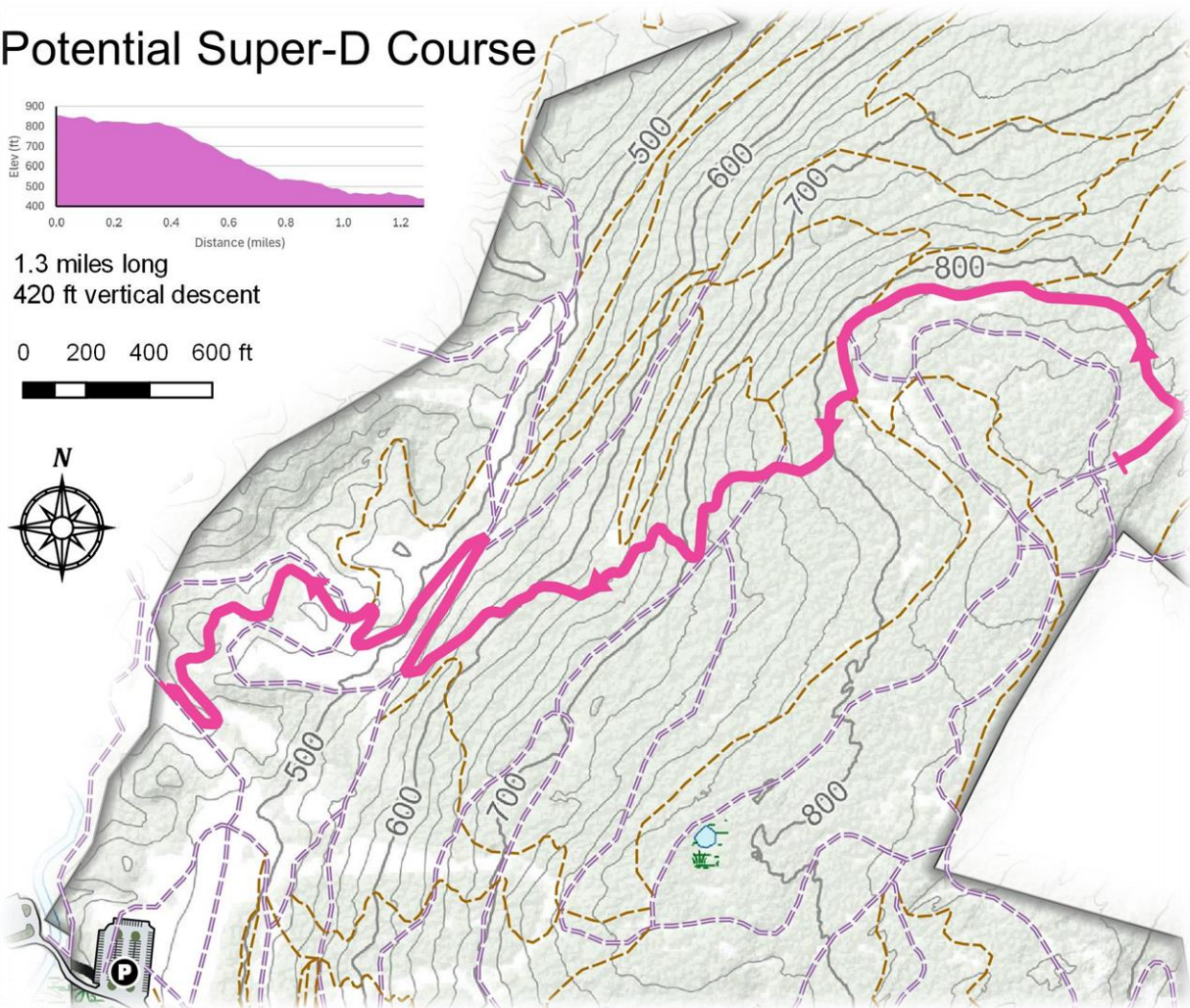
With the rising popularity of Enduro racing, Super-D racing's popularity has fallen, but it is still sometimes raced at the high school and collegiate level. In the era when Super-D was popular, races were often "mass-start", so they required some doubletrack sections for passing. Nowadays, it is more common for them to be individual timed races, so the course can be entirely singletrack. A Super-D race could be held on the course shown on the following map:

Potential Super-D Course



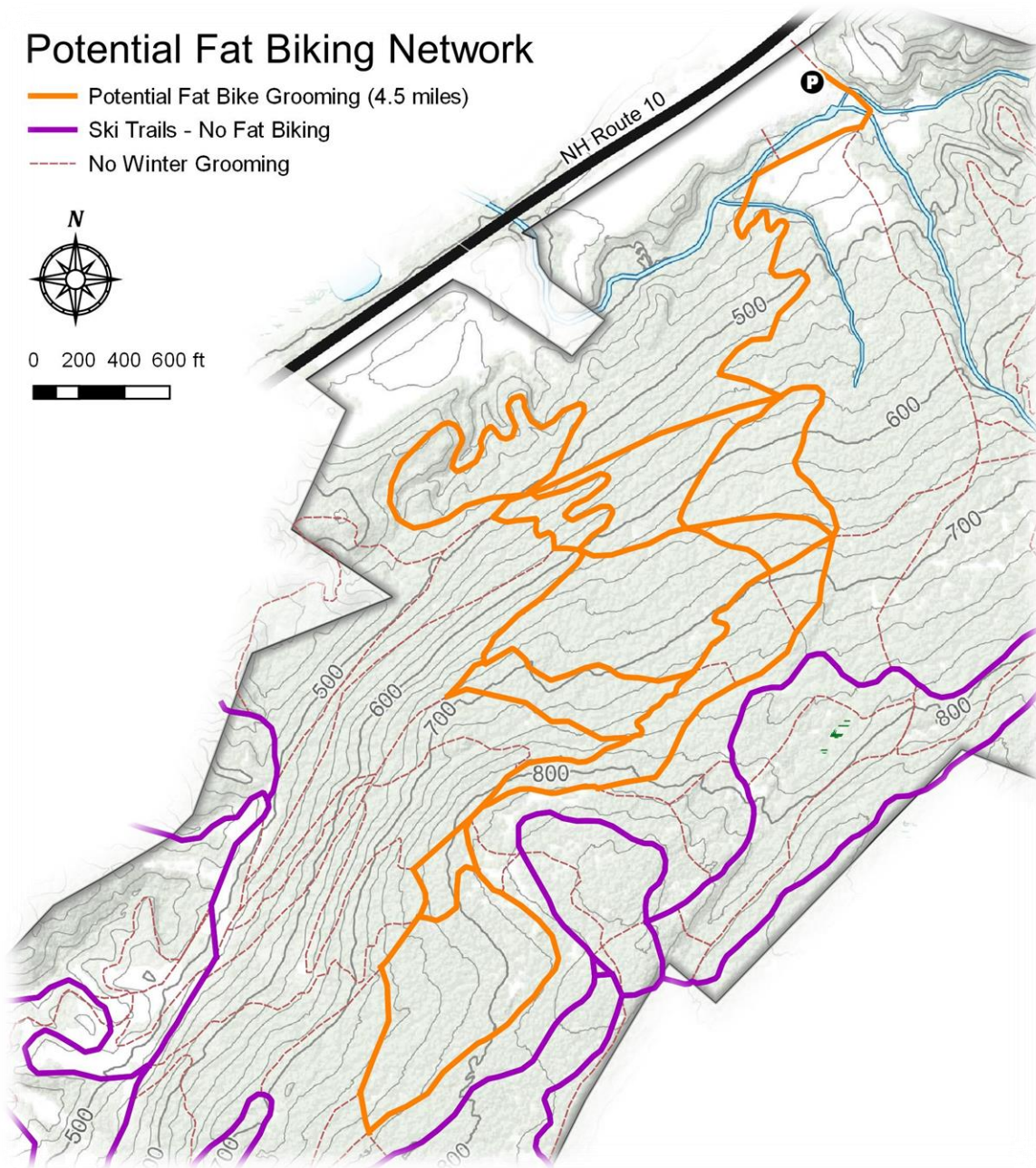
1.3 miles long
420 ft vertical descent

0 200 400 600 ft



Fat Biking

Some trail networks groom their mountain bike trails with “snow-dog” groomers, snowshoes, snowmobiles, Rokon motorcycles, and/or ATVs. It requires a great deal of labor, usually by volunteers, and conditions can be fickle. As soon as the temperature rises above freezing, or the strong sun hits the snow, fat bikes can sink into the surface and create ruts. Because of the potential rutting of the groomed snow, it is not recommended to allow fat bikes on the ski trails. The map below shows a 4.5 mile network of trails that could be groomed for fat biking, accessed from Fullington Field. The fat biking trails would not cross the groomed ski trails at all, so there is no reason a fat biker should wander onto the ski trails.



Trail Maintenance

Maintenance needs are different on “rake-and-ride” trails than on “flow trails”. On rake-and-ride trails, maintenance is typically limited to:

- Clearing blowdowns with chainsaws and handsaws – annual (early spring) and periodically (after a large storm).
- Clearing small branches and debris by walking the trails and throwing debris away from the trail by hand – annually (early spring) and periodically (after a large storm).
- Leaf-blowing or leaf-raking is optional.

On machine-built trails, all of the above maintenance tasks are needed, in addition to:

- Clearing small stones by walking the trails and throwing loose stones away from the trail by hand – annually (early spring). Frost heaving brings loose stones to the surface on trails that have been excavated, especially in the first year of a trail’s life. Some high-use trail systems, like bike parks with a chairlift, have workers use steel rakes to remove all loose rocks embedded in the trail every spring. This is overkill on free, pedal-accessed trails.
- Compacting loose dirt on banked turns and jump features – annually (early spring). The frost loosens dirt on features that are constructed above the prevailing grade of the ground, like banked turns (berms) and the lip of jumps. This is done by “tamping” the loose dirt with a tamper or the bottom of a McLeod, or “slapping” the dirt with the back of a shovel. These areas that need to be compacted often make up less than 1% of the trail’s surface area, but compacting them can be time-intensive.
- Removing leaves and debris from drainage ditches and from the mouths of culverts – every few years (late fall or early spring).
 - A steel rake, McLeod, or grub hoe can remove leaves and silt from the inlet and outlet mouths of culvert. If there is a drainage ditch leading to the culvert, debris should also be removed from the ditch for at least 10 feet uphill of the culvert.
 - If trails are leaf-blown, it is very important to not blow leaves into the ditches. In fact, the ditches and culverts should be leaf-blown, too, to prevent clogging.
 - Culverts that are at least 12” in diameter do not need annual clearing – every few years is fine. Culverts that are 6” in diameter are very susceptible to being plugged up by leaves and silt, rendering them useless. For this reason, culverts smaller than 12” should not be used, except where it is difficult to get enough dirt to adequately cover the culvert, such as areas where bedrock is near the surface.

The trail system at Oak Hill seems to get maintained adequately, because it is just low-maintenance “rake-and-ride” trails and there is only 7 miles of singletrack. If new trails are built, especially machine-built trails, the current model of maintenance will likely need to change. A few possible ways to handle the increased maintenance needs include:

- Assign maintenance responsibilities to the ski grooming staff and provide them with the tools and the payroll budget to accomplish this.

- Organize volunteer maintenance events on weekends in the early spring.
 - Many volunteers who attend annual maintenance events do not have the same skills and knowledge as the regular volunteers who maintain trail networks, so they are best suited for simple tasks like removing branches and stones from the trail. They should not be relied upon to use chainsaws. Tasks such as compacting berms and removing leaves and debris from culverts may seem simple, but not all volunteers will not have the strength or skills to do these tasks.
- Hire a youth conservation crew.
 - These crews often start in late-May or early-June, which is too late to be useful for annual early-spring tasks.
- Hire a trail-building contractor.
 - When drafting a contract for the construction of a machine-built trail, consider including a few days of inspection and follow-up maintenance for the following spring.
 - When the trail network is fully built-out, consider hiring a professional trail builder for a week or two every spring for tasks that cannot be done by volunteers or ski grooming staff.

Risk Management

New Hampshire's Landowner Liability Law (RSA 508:14) and Duty of Care Law (RSA 212:34) protect landowners from liability when someone gets hurt on their property, with a few exceptions:

- Charging a fee to enter the property to recreate. A contribution or other voluntary payment not required to be made to use such land shall not be considered a charge or fee
- *Maliciously* failing to warn against a dangerous condition.

RSA 212:34 clearly states that "outdoor recreational activities may be hazardous". Participants of outdoor recreation activities must assume the inherent risk and dangers they may face including variations in terrain on trails and paths such as rocks, stumps, equipment not in use, other objects, other people, and in snow or ice conditions.

If Oak Hill Outdoor Center decides to charge a fee for summer use, like they do for winter use, they will lose some protections under RSA 508:14. If a fee is charged, be sure that the membership fees are more than enough to cover the increased liability exposure and insurance premiums. Any outside organization that hold events on the property, such as races or fundraising rides, should be required by OHOC to carry their own liability insurance for the event.

Although mountain biking has some inherent risks, the best way to reduce the chances of serious accidents is through good trail design and construction. Most of the existing trails at Oak Hill have been built by non-professionals and while most are well-built from a safety viewpoint, the "Bandit" trail should be improved for safety. Any new trails built by non-professionals in the future should be built with the consultation of a professional mountain bike trail consultant. It is very important that any professional trail builders hired to work on the mountain bike trails have proven experience on *gravity-oriented, bike-specific* trails. There are many professional trail builders who do a great job building hiking trails, but an understanding of bike-specific trail geometry, speed, and momentum is critical to building a fun and safe mountain bike trail.

Timing, Cost Estimates, Contracting

Improvements on Existing Bike Trails

Cost estimates are divided by mini-excavator improvements, new bridges on existing trails, and hand tool improvements. Some bridges and some hand tool improvements could be done by skilled volunteers to offset some costs, but estimates are still provided for what it would cost for professionals to do this work.

Mini-excavator improvements

The following table provides cost estimates for re-routes and improvements to existing trails shown on the map on page 21. The re-route of the “Bandit DH” trail is not included in this estimate, but is included in Phase 1 of “New Trails” because its route will almost entirely change. Bridge materials and installation costs are included in five of these items.

Trail	Length (ft)	Cost Estimate
Gnomaste - elevate wet sections near top	300	\$3,600 - 4,800
Frankenstein's and Game Trail intersection (+ bridge)	750	\$8,500 - 11,500
Screaming DH / Goat - repair logging damage (+ bridge)	250	\$2,800 - 3,800
Middle Outback at ski trail ditch crossing (+ bridge)	100	\$2,300 - 2,700
Upper Middle Outback puddle	100	\$1,300 - 2,300
Middle / Upper Middle Outback stream crossing (+ bridge)	100	\$2,400 - 2,800
Total	1,600	\$20,900 - 25,900

Bridges on existing trails

Five of the bridges in the table below have had their material and installation costs included in the “mini-excavator improvements” table above. The other three are on existing trails no machine work is recommended, so the bridge foundations will be built by hand. The estimated costs below include materials, mobilizing the materials to the bridge site, constructing rock foundations and earthen approach ramps, and carpentry work. Some or all of this could be done by skilled volunteers to save money.

Trail	Length	Width	Cost Estimate
Screaming DH/Goat - crossing waterbar	6'	42"	*included above
Frankenstein's Folly - stream crossing	12'	42"	*included above
Middle Outback - crossing ski trail ditch	6'	48"	*included above
Middle / Upper Middle Outback - stream crossing	12'	48"	*included above
Junji shortcut – long spanning bridge with log beams	20-25'	42"	*included above
Gnomaste - ground bridge in muddy low spot	25'	42"	\$4,000 - 4,500
Middle Outback - 3-span bridge over braided stream	30'	42"	\$3,000 - 3,500
Up Through The Woods - 4-span ground bridge over seep	45'	42"	\$4,000 - 4,500
Total			\$11,000 - 12,500

Hand Tool Improvements

- 700 linear feet of rock work and hand tool work to harden, elevating, and/or drain 30 spots:
\$7,000 – 9,500 in professional labor*
 *Some or all of this could be offset with volunteer labor
- 1,600 linear feet of hand-building and/or bench cutting on seven segments of trails:
\$13,500 – 19,000 in professional labor*
 *Some or all of this could be offset with volunteer labor
- Draining puddles, clean out water bars and ditches in approximately spots – recommended to be done with volunteer labor.

New Trails

The following cost estimates are presented as a range and can be used for planning and fundraising purposes. For each trail, the Oak Hill Outdoor Center should get more than one estimate before hiring a contractor, which will help to refine these numbers. Also included in these tables are the trail’s code that is labelled on the maps of planned new trails on page 28, a description, the length in linear feet, the percentage of the trail that would be built using “Rake-and-Ride” / “Hand-Digging and Rock Work” / “Machine-Excavated”.

A trail building contractor could likely build 20,000 linear feet of trails per year, per machine-operator, if they are committed to only this project for a whole year. With 2-3 machine-operators and hand-crews working full-time on this Oak Hill project, it is possible to build this in one year. However, it is more reasonable to build this project over 2-4 years.

Phase 1 – Flow trails and a beginner loop around the ski hill

Trail		Length (ft)	R&R / Hand / Exc	Cost estimate
1A	Easier Skills Park (Lower)	1,300	0 / 0 / 100%	\$12,300 - 17,800
1B	Easier Skills Park (Upper)	1,350	0 / 0 / 100%	\$12,000 - 17,300
1C	Pump Track		0 / 0 / 100%	\$15,000 - 25,000
1D	Intermediate Flow Trail	3,300	0 / 0 / 100%	\$33,100 - 46,300
1E	Easier Climbing Trail	1,250	0 / 0 / 100%	\$10,000 - 14,400
Phase 1 Total		7,200 ft		\$82,400 - 120,800

Phase 2 – Machine-built beginner trails and skills park on the old ski hill

Trail		Length (ft)	R&R / Hand / Exc	Cost estimate
2A	Advanced Mixed Trail	1,500	20 / 25 / 55%	\$10,400 - 15,000
2B	Easier Machine-Built Singletrack	2,700	0 / 0 / 100%	\$22,000 - 31,800
2C	Easier Machine-Built Singletrack	2,950	0 / 0 / 100%	\$28,700 - 41,400
2D	Easier Machine-Built Singletrack	3,550	0 / 0 / 100%	\$34,600 - 48,500
2E	Easier Machine-Built Singletrack	2,100	0 / 0 / 100%	\$16,300 - 25,100
2F	Easier Flow Trail	3,800	0 / 0 / 100%	\$37,000 - 53,400
2G	Easier Climbing Trail	1,750	0 / 0 / 100%	\$16,900 - 24,400
2H	Easier Flow Trail	700	0 / 0 / 100%	\$5,700 - 8,300
Phase 2 Total		19,050 ft		\$171,600 - 247,900

Phase 3 – Hand-built trails on the old ski hill

Trail		Length (ft)	R&R / Hand / Exc	Cost estimate
3A	Easier Hand-Built Singletrack	1,500	50 / 40 / 10%	\$7,700 - 11,100
3B	Easier Hand-Built Singletrack	1,750	90 / 5 / 5%	\$5,600 - 8,100
3C	Advanced Hand-Built Descent	850	70 / 20 / 10%	\$3,400 - 5,000
3D	Advanced Hand-Built Descent	2,100	60 / 35 / 5%	\$9,500 - 13,800
3E	Expert Hand-Built Descent	1,850	50 / 50 / 0%	\$9,200 - 13,300
3F	Expert Hand-Built Descent	1,600	20 / 60 / 20%	\$9,800 - 14,200
3G	Advanced Flow Trail	2,200	0 / 0 / 100%	\$32,400 - 46,800
Phase 3 Total		11,850 ft		\$77,600 - 112,300

Phase 4 – Beginner trails and skills park in Fullington Field area

Trail		Length (ft)	R&R / Hand / Exc	Cost estimate
4A	Easier Machine-Built Singletrack	1,950	0 / 0 / 100%	\$19,100 - 27,700
4B	Easier Skills Park	850	0 / 0 / 100%	\$7,800 - 11,200
4C	Asphalt Pump Track		0 / 0 / 100%	\$40,000 - 60,000
4D	Easier Flow Trail	1,150	0 / 0 / 100%	\$10,000 - 14,500
4E	Easier Machine-Built Singletrack	2,900	0 / 0 / 100%	\$23,300 - 33,700
Phase 4 Total		6,850 ft		\$100,200 - 147,100

Phase 5 – Short connector trails

Trail		Length (ft)	R&R / Hand / Exc	Cost estimate
5A	Machine-Built Singletrack	300	0 / 0 / 100%	\$2,600 - 3,700
5B	Intermediate Hand-Built Singletrack	1,150	60 / 40 / 0%	\$5,200 - 7,600
5C	Advanced Descent	700	40 / 30 / 30%	\$4,100 - 5,900
5D	Intermediate Hand-Built Singletrack	450	60 / 40 / 0%	\$2,000 - 3,000
Phase 5 Total		2,600 ft		\$13,900 - 20,200

Signage

Total estimate: approximately **\$13,000** over several years, as the planned trails are built.

Maintenance

When the trail network is fully built-out, up to 120-200 staff hours of work is recommended each spring to inspect the trails, clear debris and blowdowns, re-surface and compact berms and jumps, and clear drainages. Throughout the summer and fall, weed-trimming, clearing blowdowns, and leaf-blowing(optional) could add up to another 50-80 staff hours. Volunteer efforts could help to reduce this cost.

Contracts for the new trails should include at least one day of follow-up inspections and assessments by the trail builder the following spring. Contracts for new trails should also include setting aside money for one week worth of intensive hand work or mini-excavator work per mile of new trail built, in case repairs or improvements are needed following an inspection.

Total

\$511,100 - \$728,200 for improvements, new trails, and signage.

\$8,500 - \$40,000 per year for maintenance and repairs, depending on how much new trail was built the year before and the severity of the weather in the past year.

Contracting

There are many qualified trail building contractors within a 1-1.5 hour radius of Oak Hill (the photos in Appendix E are all borrowed from some qualified mountain bike trail builders in NH and VT). Due to the great amount of work it would take to complete these planned trails, it is likely that Oak Hill Outdoor Center would contract with more than one builder per year, for more than one year.

OHOC's Board and/or staff have the organizational abilities to manage the hiring and supervision of these contractor(s), without hiring a construction or engineering firm as a general contractor. The contractor hired to build each trail is typically responsible for the final design; this plan will aid in communicating the desired characteristics and specifications of each trail to the contractor.

OHOC should try to get more than one estimate for each trail or phase, but scheduling availability and contractors' experience can be just as important as the bid price. Contractors that are invited to bid on a project should have mountain-bike specific trail building experience; there are different types of trails and features in this plan, and the builder for a project should have proven experience in that sub-category of mountain bike trail building (i.e. machine-built flow trail vs. pump track vs. hand-built gravity trail). They should also have experience building in the soils and terrain of northern New England, which have different drainage characteristics than other parts of the country.

Appendix A - Permitting

Typically, trail work that impacts streams and wetlands uses the NHDES Trails Notification process. This is a “Statutory Permit-By-Notification”, a simpler and cheaper process than a Minor or Major Standard Dredge-and-Fill permit. The review time for a Trails Notification is typically 30 days or less. The fee for a Trails Notification is \$25, although there may also be a \$25 fee to the NH Natural Heritage Bureau if there is a record of an endangered species nearby which requires consultation.

Work that requires a Trails Notification includes:

- Turnpiking (elevating) and ditching a trail through a wetland.
- Installing a boardwalk through a wetland.
- Installing a culvert in a stream, including intermittent streams.
- Installing a bridge over a stream, if any work will disturb soil or rocks in the streambank or streambed.

Work that may trigger a Minor Dredge & Fill permit:

- A wetland crossing (ditching, turnpiking, boardwalks) if the wetland crossing is **greater than 60 ft long**. All wetland crossings proposed in this plan are less than 60 ft long.
- A stream crossing (culvert or bridge that disturbs the streambanks or streambed) if the stream channel is **greater than 8 ft wide**. A bridge that completely spans the banks, with no work that disturbs the banks or streambed, is exempt.

Work that may trigger an Alteration of Terrain permit:

- Excavation that exceeds 100,000 square feet. This includes the cumulative impacts of multiple projects on the same property. If Oak Hill Outdoor Center has an ongoing Alteration of Terrain permit with NHDES for ski trail improvements, NHDES may see machine-built bike trails as part of the same Alteration of Terrain. Consult with the civil engineers or wetland scientists on the ski improvement project to determine if the proposed bike trails would need to be added to this existing Alteration of Terrain permit. In that case, the planned earth disturbance from the bike trails may need to be added to the grading and drainage plans filed with NHDES as part of that project.

Work that may trigger a Shoreland Permit from NH DES:

- None of this work will be within 250 ft of the Storrs Pond shoreline, so no Shoreland Permit will be needed.

Work that may require federal permits or an archeological review:

- None, unless federal grants are used to fund this trail work.

Work that will require permission from the Hanover Select Board:

- Any improvements or modifications to Old Wolfeboro Rd, a Class VI Highway, need permission from the Select Board. This section of road was discontinued “subject to gates and bars” by a Town Meeting vote in 1979. The Town-owned Right-of-Way is 3 rods (49.5 ft)

wide. Presumably the Right-of-Way would be approximately centered on the centerline of the trail, but that is unclear and no stone walls or monuments are observed that would define the edge of the Right-of-Way. The planned new climbing trails (1E, 2G on the map on page 25) would connect to Old Wolfeboro Rd, thus there would be some excavation in the Right-of-Way, which should require notifying the Town's Highway Supervisor.

Work that will require permission from neighbors:

- The planned new climbing trail from the main parking lot (1E) would involve some work above Storrs Pond Rd, on a thin strip of land owned by the Hanover Improvement Society between Storrs Pond Rd and the new ski trail.

Appendix B – Doubletrack & Ski Trails

The ski trails are mowed in the summer and are well-used by walkers, runners, gravel bikers, and mountain bikers. In addition to the groomed ski trails, there are other doubletrack trails throughout Oak Hill that receive varying amounts of use and maintenance.

While this trails plan focuses on the singletrack mountain bike trails, all of the doubletrack trails were assessed for improvements that could be made to make summer uses more enjoyable.

Common issues that could be improved were:

- Failing culverts,
- Mud puddles in low spots
- Soft conditions where groundwater is seeping into the trail

The map on the following page shows the location of these problem spots. Recommended improvements to fix these problems include:

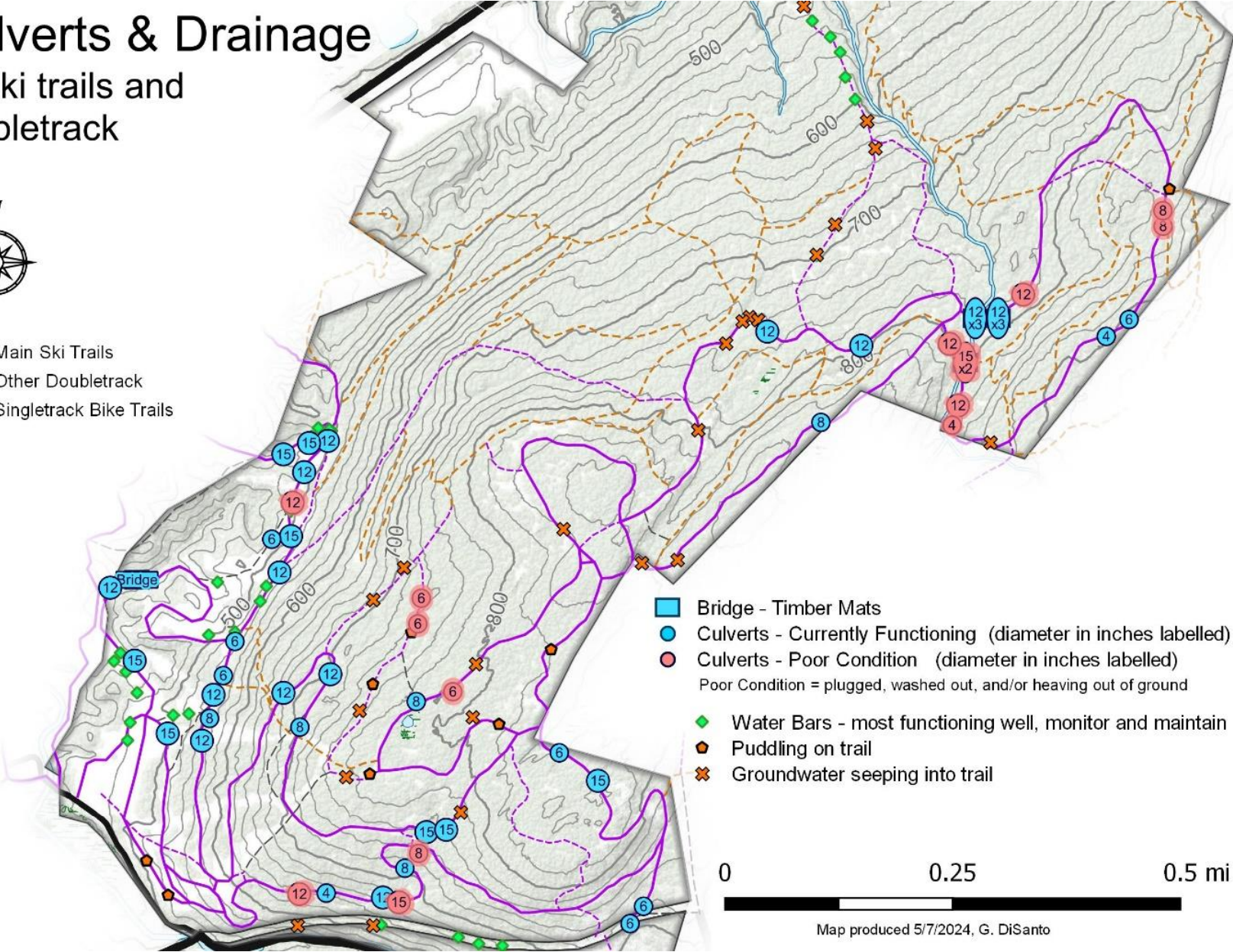
- Replacing plugged culverts and washed-out culverts with a larger diameter culvert, to reduce the likelihood of plugging or washing out again.
- Covering heaving culverts with a layer of geofabric and then covering with more dirt. There should be at least 12” of dirt over the top of a culvert (or more if the native soil has a lot of clay, which is expansive and prone to heaving).
- Regrading low spots so that they are outsloped, so that puddling water can drain off the trail.
- Improving or extending ditches to keep groundwater from seeping into the trail.

Culverts & Drainage

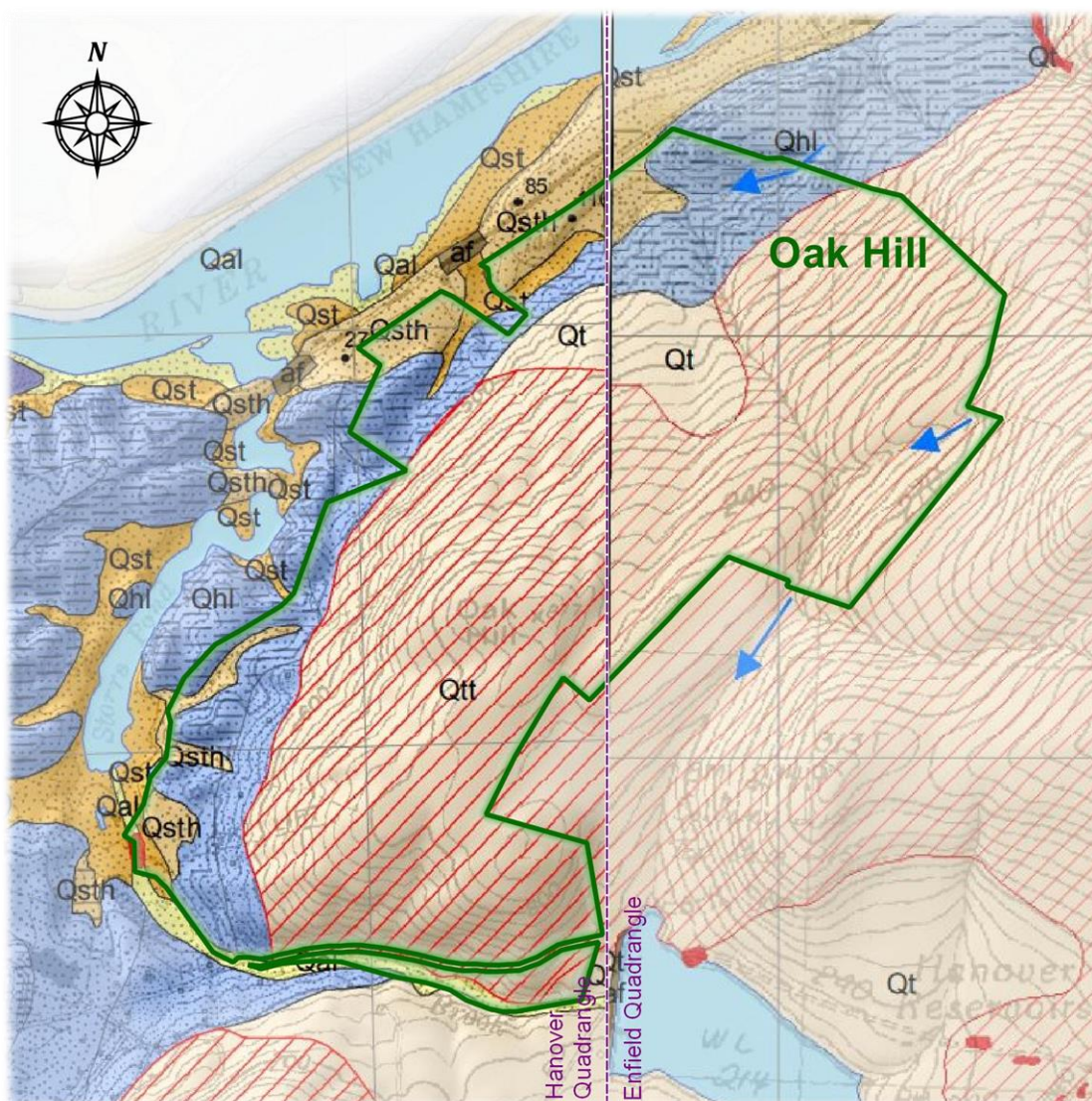
on ski trails and doubletrack












- Main Ski Trails
- Other Doubletrack
- Singletrack Bike Trails



Appendix C – Soil & Geology Maps



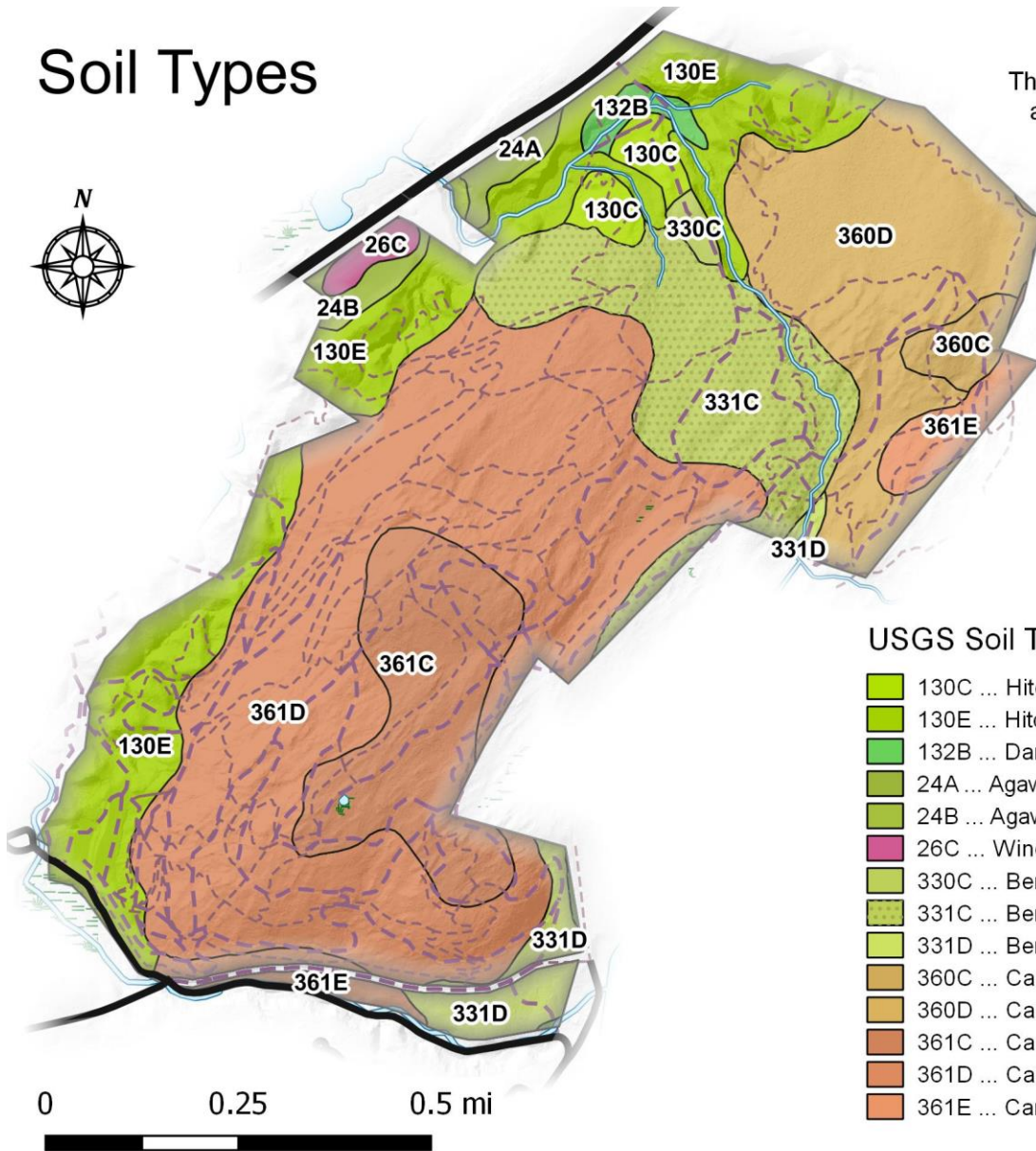
Surficial Geology

-  **Qt - Till**
Nonsorted to poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders; a predominately sandy diamicton containing some gravel. Thickness varies and is generally less than 20 ft thick, but is thicker under drumlins and streamlined hills.
-  **Qtt - Thin till**
Depth to bedrock generally 10 ft or less.
-  **Qal - Alluvium**
Sand, silt, gravel, and muck in flood plains along present-day rivers and streams.
-  **Qst - Stream terrace deposits**
Sand, silt, gravel, and occasional muck on terraces cut into glacial deposits in major stream valleys.
-  **QstH - High-level stream terrace deposits**
Sand, silt, gravel, and occasional muck on terraces cut into glacial deposits in major stream valleys.
-  **Qhl - Lake bottom and nearshore deposits**
Sand, gravel, silt, and clay deposited by glacial melt water in contact with or beyond adjacent ice as near-shore and bottom-set beds of Glacial Lake Hitchcock.
-  **Bedrock Exposure**
-  **Meltwater Channel**
-  **Glacial Striations**

Data and descriptions comes from the New Hampshire Geological Survey's Surficial Geologic Maps of the Hanover and Enfield 7.5' Quadrangles, 2010



Soil Types



The US Geological Survey's soil types were developed at a landscape scale (1:24,000) and are not intended to be precise enough for trail planning.

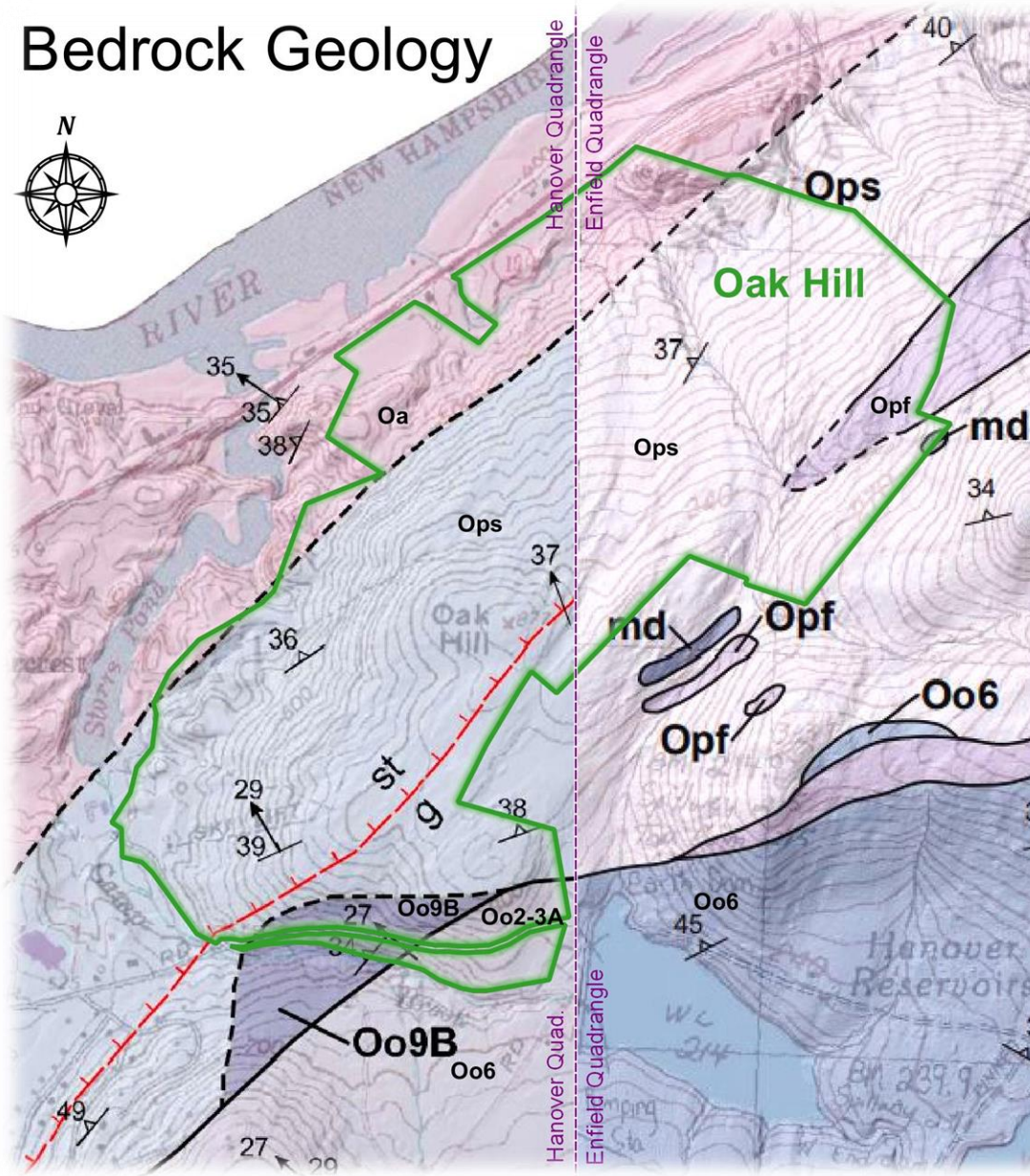
This map is still a useful tool for understanding the terrain at Oak Hill. The lower terraces are composed of silt deposited on the banks of glacial Lake Hitchcock and make for smooth trails. The large drainage above Fullington field has deposits of silt, but is stonier than the lower terraces. The upland area on Oak Hill is composed of glacial till with bedrock outcrops.

- - Doubletrack
- - - Singletrack (existing + planned)

USGS Soil Types

- 130C ... Hitchcock silt loam, 8-15% slopes
- 130E ... Hitchcock silt loam, 15-60% slopes
- 132B ... Dartmouth silt loam, 0-3% slopes
- 24A ... Agawam fine sandy loam, 0-3% slopes
- 24B ... Agawam fine sandy loam, 3-8% slopes
- 26C ... Windsor loamy fine sand, 8-15% slopes, excessively drained
- 330C ... Bernardston silt loam, 8-15% slopes
- 331C ... Bernardston silt loam, 8-15% slopes, very stony
- 331D ... Bernardston silt loam, 15-25% slopes
- 360C ... Cardigan-Kearsarge complex, 8-15% slopes
- 360D ... Cardigan-Kearsarge complex, 15-25% slopes
- 361C ... Cardigan-Kearsarge-Rock outcrop complex, 8-15% slopes
- 361D ... Cardigan-Kearsarge-Rock outcrop complex, 15-25% slopes
- 361E ... Cardigan-Kearsarge-Rock outcrop complex, 25-60% slopes

Bedrock Geology



- Contact (Certain)
- - - Contact (Inferred)
- - - Mineral Isograd (Inferred)

Intrusive and Fault Rocks

md Metadiabase sills and dikes (unknown age)
Fine- to medium-grained hornblende gneiss.
Extent limited to outcrops.

Oo9B Amphibolite
Amphibolite, likely metagabbro, crops out as sills.
The massive, blocky- and brown-weathering rock seems to be intercalated with quartz diorite.

Ordovician Oliverian Plutonic Rocks

Oo1b Granite (Ordovician)
The granite in the center of the Lebanon Dome is a pinkish gray, medium-grained, weakly to non-foliated biotite granite, which has been quarried for dimensional stone.

Oo6 (Hanover) Quartz Diorite

Oo6 (Enfield)

Metasedimentary and Metavolcanic Rocks

Ops (Hanover) Sulfidic schist member
Schists in the Partridge formation are rusty-weathering, black to dark gray, graphitic and sulfidic fine- to coarse-grained schist. They are coarser away from the Lebanon Dome, for example on the west slopes of Oak Hill.

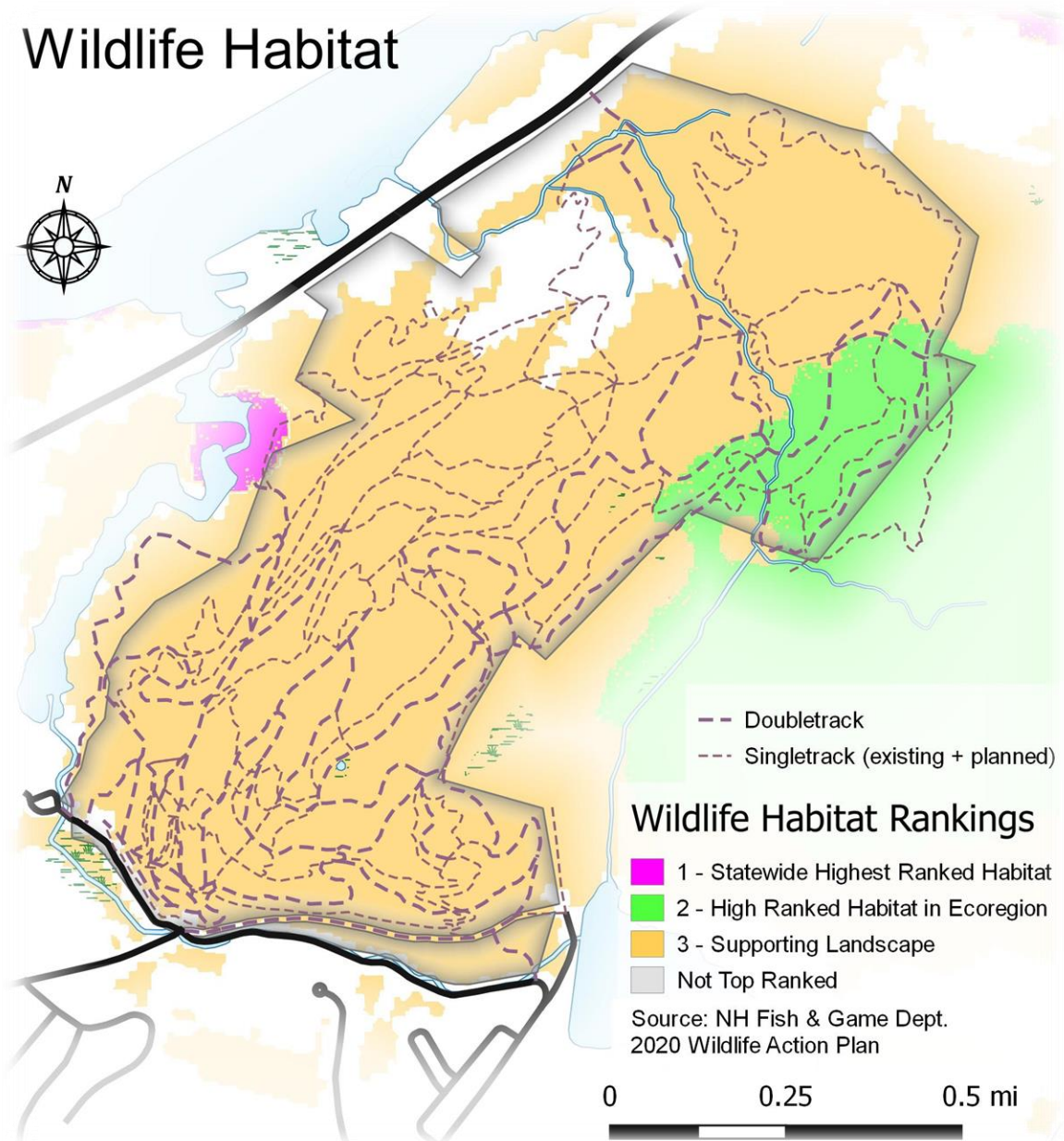
Opf Felsic volcanics member
Felsic metavolcanics of the Partridge Formation range from rusty weathering, light gray fine-grained sulfidic felsite to rusty, medium-grained biotite feldspar-studded gneiss.

Oa Ammonoosuc Volcanics undifferentiated (Ordovician)
Range from dark green-black fine- to medium-grained hornblende gneisses to black and white metavolcanics with distinct alternating hornblende-rich and feldspathic layers.

Data and descriptions comes from the New Hampshire Geological Survey's Bedrock Geologic Maps of the Hanover and Enfield 7.5' Quadrangles, 2016.

Appendix D – Wildlife & Ecological Resources

Wildlife Habitat

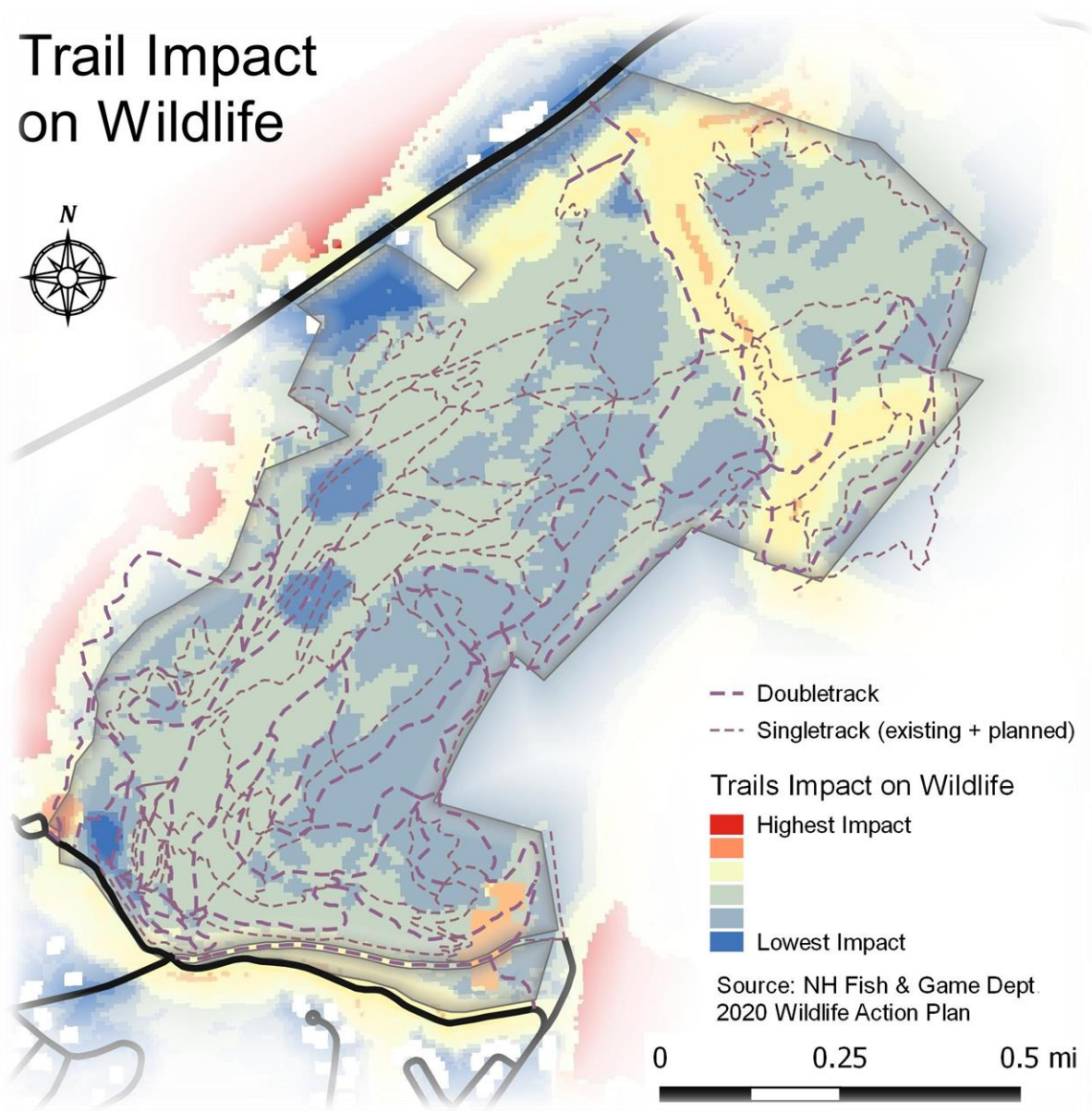


This map from NH Fish & Game’s Wildlife Action Plan ... “shows where the wildlife habitat is in the best relative condition in New Hampshire, particularly for Species of Greatest Conservation Need. The analysis used a series of data on species locations, landscape setting and human influences that affect the ability of habitats to be used by wildlife.”

www.wildlife.nh.gov/wildlife-and-habitat/nh-wildlife-action-plan/habitat-ecological-condition

Most of Oak Hill is ranked in the 3rd Tier – Supporting Landscapes, and this is where nearly all of the planned new trails will be. There is 0.1 mile of planned new trails in 2nd Tier Habitat and no new trails planned in the 1st Tier – Statewide Highest Ranked Habitats.

Trail Impact on Wildlife



New Hampshire Fish & Game’s “Trail Locator Tool” encourages trail planners to “follow the blue” to avoid locating trails in areas that have a high impact on wildlife. While this resource is based on a statewide model and is not ground-truthed at the individual-property-level, it provides a set of guiding principles that are useful to trail planners:

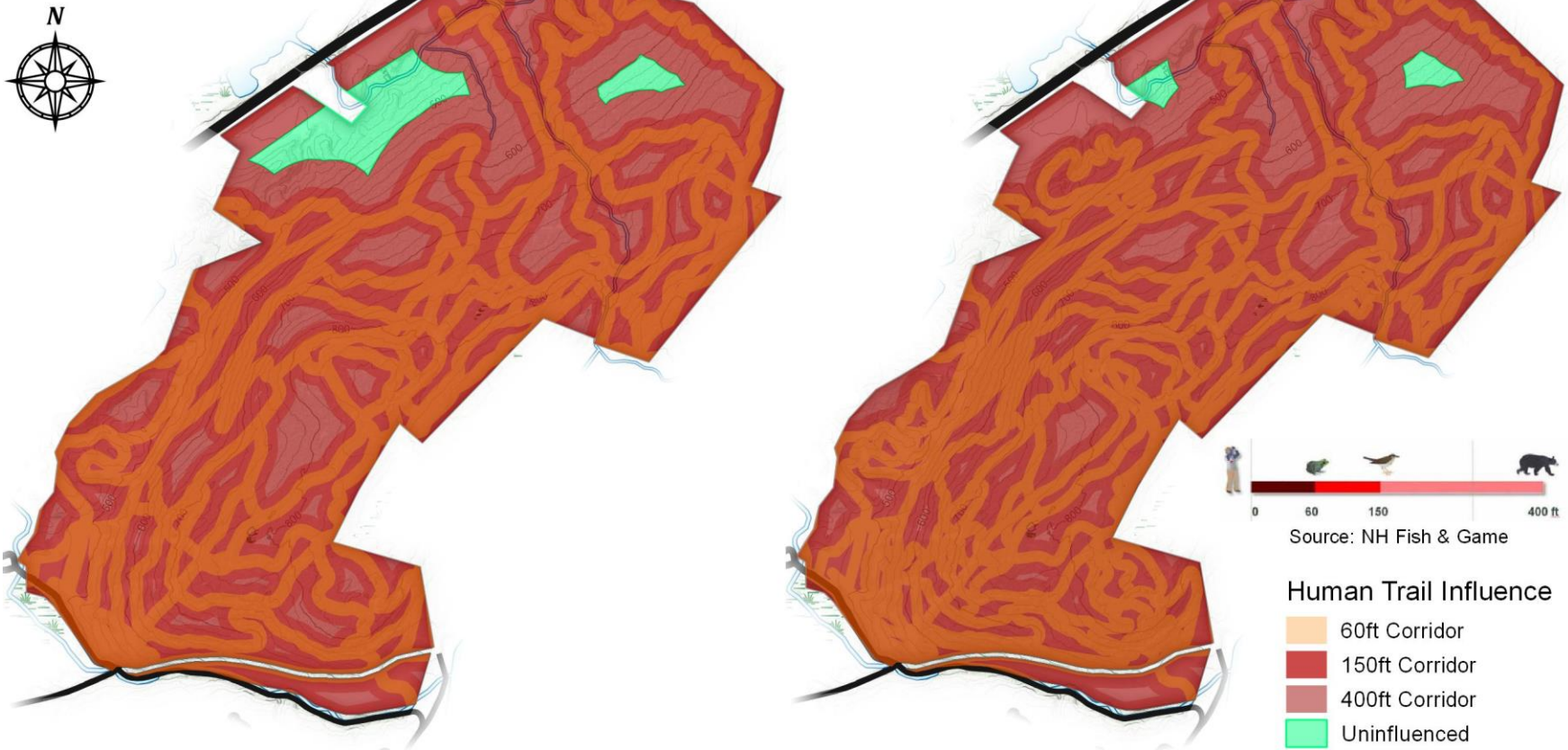
- Avoid special habitat types and known locations of rare species
- Route trails along habitat edges
- Route trails away from wet areas and avoid steep slopes

The existing trails at Oak Hill mostly avoid these high impact areas, as Oak Hill is mostly in the “blue”. A few existing trails go through “orange” areas, but no new trails are planned in these areas.

Wildlife - Corridors of Human Influence

Existing

Planned



“In New Hampshire, a trail’s corridor of influence on wildlife is about 400 feet in each direction” ([NH Fish & Game’s “Planning Trails for People & Wildlife” resource](#)). At Oak Hill, over 95% of the land is already influenced by human recreation, due to the high density of existing trails. Functionally, this property is already being managed as a recreation area, not a wildlife preserve. Adding to the dense network of trails here has less of an impact on regional wildlife than if you added new trails in a wilder area.

Appendix E – Mountain Bike Trail Glossary

There are a lot of trail-building terms used in this plan, which are explained below, with photos to illustrate trail building techniques and design specifications. The mountain bike community has a great deal of jargon, slang, and terminology; this glossary may not make a regular person fluent in the dialect of mountain bikers, but hopefully it makes the jargon more understandable.

Rake-and-Ride and Hand-Built Trails

Trails that are built with hand tools have a more natural feel than machine-built trails. They are cheaper and faster to build, if the route they take does not require a lot of digging or rock work. These trails' surface conditions are a result of what the natural terrain gives you – they can be smooth and “loamy” (top left photo below), rooty (top right), or rocky (bottom left). Some commonly used hand tools for building bike trails are shown in the bottom right.



Machine-Built Trail

Mini-excavators are a great tool for building “flow” trails, or for building any dirt-surfaced trail through a section of terrain that is too difficult to build with hand tools. Sections that need to be “bench cut”, “turnpiked”, or “rock-armored” require the trail builder to move dirt and rocks. Short sections like this can be done with hand tools, but if there are extensive sections like this, a mini-excavator is the most efficient way to build a trail. Bike-specific features like banked turns (“berms”) and jumps also require a lot of digging, which could be done by hand, but is more efficient to do with a mini-excavator.



For simple trails that need some bench cutting and berms, mini-excavators from 1.5 tons (left) to 4 tons (right) are a good size. Mid-sized excavators up to 15 tons can be more efficient at building tabletop jumps that need a lot of dirt moved, but they also need a wider corridor cleared through the woods. Skid steers are often used alongside excavators for pump tracks and skills parks. Walk-behind plate compactors are often used to finish pump tracks, skills parks, and flow trails.

Berms

Banked turns, a.k.a. “berms”, provide support as bikers lean into a turn. This helps riders preserve momentum and speed and they are most common on “flow” trails. To maximize fun and safety, it is important that they have a consistent arc and a well-compacted top. Berms can help riders to turn 90° corners (below, left), 45° pocket turns (right, berm in the foreground), or make full 180° switchbacks (right, berm in the background).



Bench Cut

A section of trail that is cut into a hillside so that the tread is more level than the prevailing slope. The tread should still be outsloped at a 2-5% grade to shed water, except where the tread needs to be insloped to support riders who are leaning into a turn. On beginner-friendly and accessible trails, the tread should be at least 4 feet wide.

The “backslope” above the bench cut should be graded so that the soil is no steeper than 1:1 – a common mistake is leaving a vertical “wall” which erodes and also reduces the usable width of the tread. The downhill edge of the trail should be well-compacted so that bike tires that wander onto the edge do not “wash-out”. On advanced and expert-level hand-built trails, the tread can be much narrower than 4 feet, as long as it is appropriately wide for the trail’s speed and exposure, and the downhill edge is supportive. Rock can be used to build a bench cut where the soil is shallow to bedrock (photo below, right).



Catch-Berm and Catch-Bench

Not every trail needs a full-sized berm – off camber turns on rake-and-ride trails can be a fun challenge. However, when a trail transitions from a steep fall-line to a sidehill, bikers’ tires need some support to turn against the off-camber ground. A 90° turn can be built at the bottom of the fall-line section to provide this support (bottom left) or a simple bench cut could provide enough support (bottom right).



Rock-armor

Rock armoring is a good technique to harden the trail where it goes through a dip in the terrain (top row of photos). Water that concentrates in the low spot on the trail can cause dirt to become soft and muddy, even if the trail is built with an outslope, but a trail surface made with rocks won't become soft. Large rocks should be used and they should be set so that they don't become dislodged when bikers ride over them. Rock work can also be used to build features like a banked turn (bottom left photo) or at the interface of dirt and ledge (bottom right photo).



Bridges

For bridged stream crossings, the bridge should use minimum 6” tall beams, pressure-treated, no more than 12” on center, with pressure-treated sills resting on rocks for support and rot-resistance (photo below, left). To cross sections of ground that are sometimes muddy, a long “ground-bridge” (photo below, right) can be a better solution than building an elevated earthen “turnpike” or a long section of rock armoring, especially on hand-built trails.

When crossing a wet area, ground bridges should have their sills (cross-beams) resting on dry ground, preferably rock, and not resting in a jurisdictional wetland. No such wetland crossings are planned at Oak Hill. For all bridges, the higher its deck is elevated above the ground, the less humid its environment will be, which slows decay and reduces slick surface conditions.

Decking should be 4 feet wide on planned accessible trails. Decking should be done with 2x6 or 2x8 boards, which can be pressure-treated for a long life-span. Rough-sawn pressure-treated lumber is harder to find than planed pressure-treated lumber, but can be used to provide better grip in wet conditions. Rough-sawn untreated hardwood can also be used for decking, which could be sourced from oaks or maples at Oak Hill. Untreated softwood lumber is less resistant to decay, so if it is used in bridge decking, expect to replace broken or rotten boards before the pressure-treated beams fail.



G. DiSanto



Green Woodlands: B. Moody, N. Wildermann

Elevated Tread and Turnpiking

To build a trail through flat, low areas that are not well-drained, the trail should be elevated to keep water off it. This will effectively create a ditch, with a concentrated flow of water that needs to either be shed into the woods with a “turn-off” or cross-drained across the trail via a culvert, bridge, or rock-armored dip.

Culverts require maintenance to keep their inlets and outlets free of debris and vegetation, so their use should be minimized as much as possible. To drain small areas that can puddle, like the inside of a berm, a minimum 8-inch diameter culvert should be used. To drain short ditch lines, a minimum 12-inch diameter culvert should be used, and areas with a larger catchment area should have a minimum 15-inch diameter culvert.

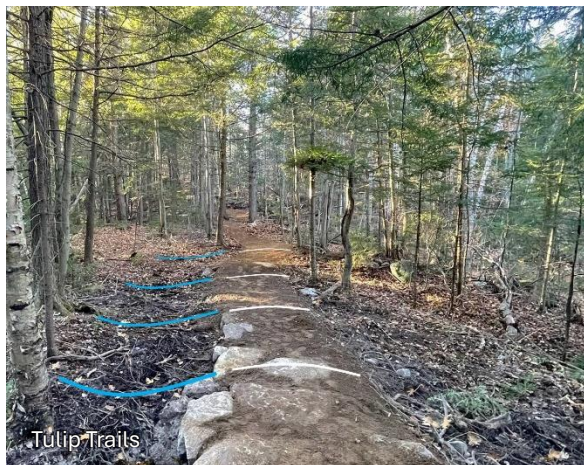


Table-Top Jumps

Oak Hill currently has no tabletop jumps; it only has a few rogue hand-built step-downs and gap jumps. The planned tabletop jumps will all be built in either the skills areas near the parking lot or on the “flow trails” on the old ski hill. Building these in accessible locations near the roads and ski trails will make them easier to maintain. They will also be more visible and accessible, so they will be easy to do repeat laps and will be good places for groups of riders to learn and teach each other to jump. Tabletops with 2 or more take-off ramps (photo below, left) are good for skills parks, while tabletops with one take-off are most common on flow trails (right).

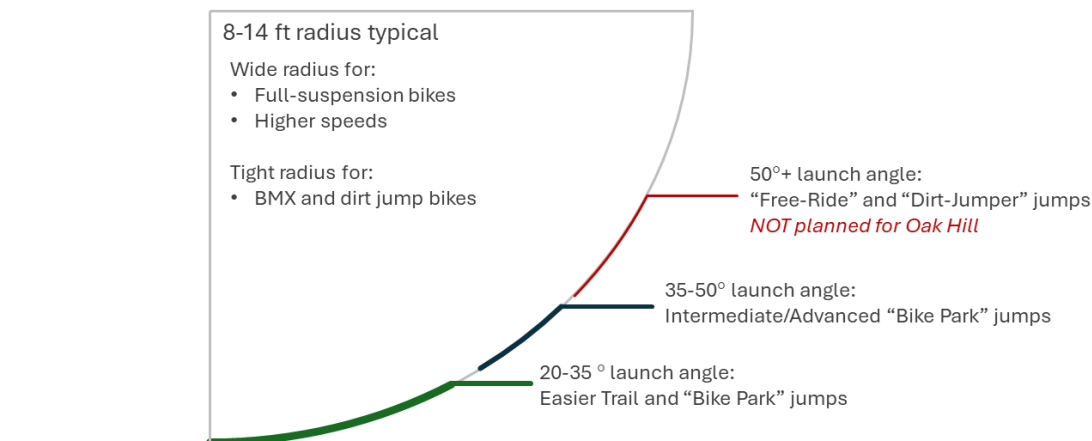


G. DiSanto



Green Woodlands, Builder: B. Moody

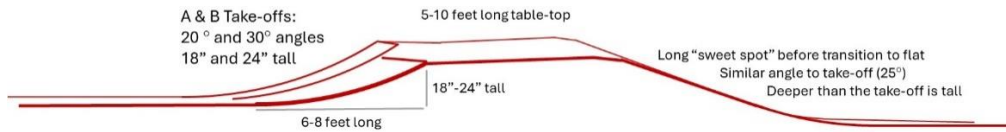
Jumps are popular and memorable features on a trail network, so it is very important to design, build, and maintain them well. There are many variables to consider: take-off angle, take-off ramp radius, tabletop length, tabletop width, and landing depth. Generally, the landing “lip” is roughly the same elevation as the take-off lip, so the tabletop is level. The diagrams below, and on the following page, illustrate these variables and their correlation with design speed and the difficulty rating of a trail.



The designs below illustrate jump sizes that are planned for Oak Hill. The “easier” jump lines are planned for the beginner-friendly skills park and flow trails, while the medium-sized jump lines are planned for the intermediate section of the skills park and the flow trails. The bigger jumps shown below may be built on the advanced flow trail that uses part of the existing “screaming downhill” trail. On the flow trails, multiple take-offs are not necessary for all jumps, because that would require wide tabletops that are not recommended for a forested setting.

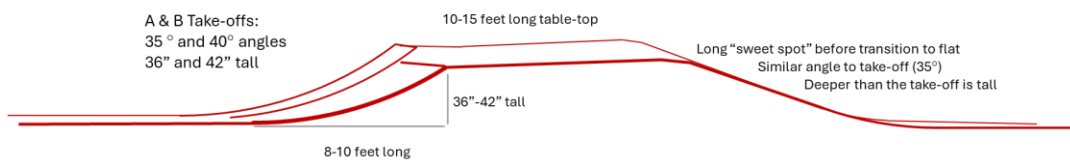
Easier Jump Line

Table-top jump designs



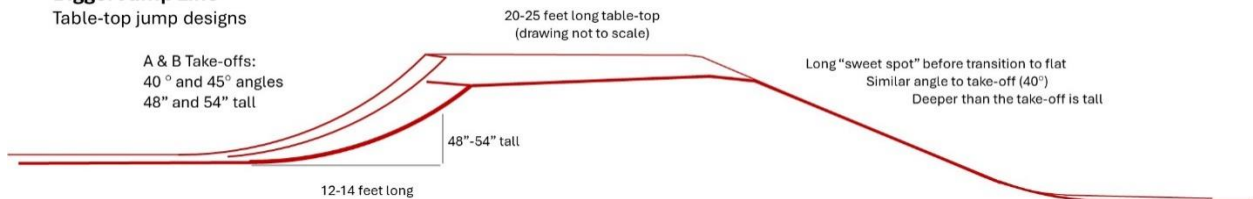
Medium-Sized Jump Line

Table-top jump designs



Bigger Jump Line

Table-top jump designs



“Step-up” jumps can be a variation on the table-top jump. They have a landing lip that is higher than the take-off lip and are often built when a section of trail goes up a short rise. Riders with speed can catch air to the landing, but riders without enough speed can simply roll over the top (photo below, left). The rider shown in the photo below (right) is airing to the landing of a table-top jump, but the jump is rollable at slower speeds and there is no dangerous gap.



Drops and Step-Downs

Drops and step-downs are features that allow riders to catch air, without hitting a ramp that shoots them upwards, like a jump. Drops are features where a rider must push their front wheel out to keep their bike level until their rear wheel is clear of the drop. Drops are sometimes naturally occurring rock drops and they are also sometimes built out of wood (but wood drops are not recommended at Oak Hill to reduce maintenance liability). Some naturally occurring rock drops may be built on the planned trails at Oak Hill and they will all have ways to avoid “mandatory air”, like the drop in the photo below (left).

Step-downs are jumps with a very mellow launch angle (often $<20^\circ$) where the landing is at a lower elevation than the take-off. These can sometimes be “gap jumps,” but are often “rollable” if riders decide at the last second not to jump. The step-down take-off shown in the photo below (right) is rollable and has a go-around path.



Rollers

Rollers are rounded mounds and dips that a rider can “pump” over using their upper body to gain momentum without pedalling. Rollers are fun and they are also a good way for riders to gauge their speed before a jump or berm. Their spacing (frequency), length, and height (amplitude) should be a function of the design speed of a section of trail. Tight rollers can help riders gain speed as they drop in to a jump line (below, left) and long mellow rollers can make a trail interesting and flowy on long bench cuts (right), while also acting as grade reversals to shed stormwater off the trail.



Rock Rolls, Slabs, and Wall-Rides

Rock features are fun challenges that make use of the rugged terrain that we have here. Rock rolls (photo below, left) are drops that don't require you to catch air, but they may need warning signage above them so that riders know to slow down before rolling over the convex edge. Slabs (middle) are long sections of exposed bedrock, which don't need warning signage if they are fully visible as riders approach them. Wall-rides (right) can be ridden like banked turns, and they should have a dirt option below them for riders who don't have enough speed to properly ride the rock.



UVMBA, Landmark Trails



Green Woodlands, Builder: C. Tulip



Green Woodlands, Builder: J. Sanborn

Pump Tracks

Pump tracks are series of rollers and berms that riders can do laps around by “pumping” the bike instead of pedalling. They are commonly built near trailhead areas, so that they can be used to warm-up before a ride or to keep bikers occupied while they wait for riding partners to arrive. They are very popular with families, children, and riders of all abilities to develop technique and fitness.

Locating pump tracks in flat, open areas near a trailhead makes their construction easier and cheaper. However, being in a treeless environment creates challenging surface conditions. The exposure to the elements (rain, sun, frost pockets, shadeless heat) creates loose and dusty conditions. A clay surface holds together better than sandy soils, but it may still need to be re-compacted every spring if it is too exposed to the elements. Many trail organizations are opting for asphalt-surfaced pump tracks, which is recommended for the planned pump track at Fullington Field, due to its exposure. The planned pump track around the old fireplace near the Oak Hill parking area is recommended to be a clay surface, because it will be under a tree canopy.



Tulip Trails, Six Rivers NEMBA



Highland Trails LLC, Southwick School