5.0 Significant Environmental Impacts Associated with Renovate®

As a manufactured chemical that is released into the environment, triclopyr, the main component of Renovate®, has been extensively evaluated for non-desired impacts in terrestrial and aquatic ecosystems. Much of this testing and evaluation has been reviewed as a facet of the NYS registration process, which resulted in the registration of Garlon 3A® in New York to control woody plants and broadleaf weeds in selected terrestrial areas.

The following section discusses the potential impacts from the use of Renovate® in the waters of New York State.

5.1 Direct and Indirect Impacts to Non-target Species

Renovate® 3 is formulated as a selective aquatic herbicide for use in the management of unwanted aquatic macrophytes. The main component of Renovate® 3, triclopyr, has been evaluated during the registration process to determine potential adverse effects to non-target species. Direct impacts evaluated include toxicity, chronic changes in behavior or physiology, genetic defects or changes in breeding success or breeding rates for many test organisms. Indirect effects resulting from aquatic plant management may include changes in population size, changes in community structure or changes in ecosystem function. Both direct and indirect impacts can be evaluated at all stages of the life cycle of the non-target organism; though generally, the most sensitive stage of the organism (the young) is the period during which the organism is at greatest risk.

It should be noted that indirect impacts are often positive. For example, by controlling an exotic weed with Renovate® 3, the lake manager can facilitate the restoration of the native plant community. These desired changes in the community structure could be construed as a positive "impact". Additionally, the balance of potential impacts must be considered in relation to the potential impacts from the uncontrolled presence of an exotic nuisance weed in an aquatic environment. The prevention of long-term impacts caused by unwanted aquatic plants may offset a potential short-term impact of the management program.

The direct toxicity of triclopyr-based herbicides to fish and wildlife has been assessed using a variety of acute and chronic laboratory toxicity tests. As supported by extensive toxicological tests conducted during the product development and registration process, triclopyr is reported to be “slightly toxic” to “practically non-toxic” based on the USEPA’s ecotoxicological categories (Table 5-1).

The following sections summarize the potential impacts from the use of Renovate® 3 in the waters of New York State. The majority of the toxicological information was obtained from the USEPA’s *Reregistration Eligibility Decision (RED) for Triclopyr* (USEPA, 1998) and SePRO’s *Technical Bulletin for Renovate®* (SePRO, 2004). Supplemental information was also available in the Washington State’s Department of Ecology *Supplemental Environment Impact Statement Assessments of Aquatic Herbicides* (WDOE, 2001). Table 5-2 summarizes the toxicity data presented in the federal label as presented by the recent SePRO technical bulletin for a number of non-target organisms.

Table 5-1 USEPA Ecotoxicological Categories for Mammals, Birds, and Aquatic Organisms

Acute Oral Toxicity in Mammals (mg/Kg body wt)	Toxicity in Birds		Acute Toxicity in Fish and Invertebrates (mg/L test solution)	Toxicity Ranking
	Acute Oral (mg/Kg body weight)	Dietary (mg/Kg feed)		
<10	<10	<50	<0.1	Very Highly Toxic
10-50	10-50	50-500	0.1-1.0	Highly Toxic
>50-100	>50-500	>50-1000	>1-10	Moderately Toxic
>500-2000	>500-2000	>1000-5000	>10-100	Slightly Toxic
>2000	>2000	>5000	>100	Practically Non-Toxic

Source: Elizabeth Zucker, 1985. Hazard Evaluation Division, Standard Evaluation Procedure, and Acute Toxicity Test for Freshwater Fish. PB86-129277. EPA-540/9-85-006

5.1.1 Macrophytes and Aquatic Plant Communities

Table 2-1 and Section 2.4 discuss those aquatic plants considered to be sensitive to Renovate® 3. Impacts to non-target macrophytes will be dependent on the sensitivity of that macrophyte to Renovate® 3 at the application rate utilized, the time of year of application, and the use rate.

The loss of non-target plants within the aquatic plant community could alter the quality of functions that the vegetative community serves in the aquatic ecosystem. Loss of certain species from the community could alter the available habitat for fish species. The thinning of the macrophyte community could reduce the amount of refuge available to prey species and enhance the success of predators such as smallmouth bass. Such changes could benefit the fishery by altering the size distribution of the fishery (Andrews, 1989). Lillie and Budd (1992) and Pullman (1993) suggest that in plant communities where Eurasian watermilfoil is in its pioneer stage of invasion or in heterogeneous communities where watermilfoil is a component, habitat functions and values of this plant are considered to be comparable with native plant species. Therefore, the control of Eurasian watermilfoil in such communities could positively or negatively impact the associated fish community by temporarily reducing needed cover, shelter and food sources. However, it should be recognized that, once established, Eurasian watermilfoil is opportunistic and aggressive and demonstrates an ability to grow faster than, and displace, native plants (Pullman, 1993; Madsen et al., 1991b). The value of the fishery will then be degraded by loss of plant diversity resulting from excessive Eurasian watermilfoil growth.

According to the Washington State SEIS (WDOE, 2001), target macrophytes like watermilfoil and purple loosestrife will show damage within one to four weeks of application. The biomass of the target species is often reduced by more than 98% after treatment with triclopyr TEA and does not re-grow significantly for one year or more after treatment. Non-target species that were in low numbers and biomass prior to treatment increased in numbers and biomass to four times the levels found in the control. However, while numbers and biomass of the native species may decrease shortly (i.e., 1 to 12 weeks), after treatment of full label dosage, they often compete more effectively and dominate the water column by the end of the season and for a year or more after treatment (Getsinger et al, 1997; Gardner and Grue, 1996; Netherland and Getsinger; 1993 and Petty et al, 1998). Application at lower dosages (0.5 to 1.5 ppm ae) led to either a slight increase or unchanged status for native plants in 7 of 9 test plots (Poovey et al., 2004). Species which increased slightly or remained the same following treatment included bladderwort (*Utricularia vulgaris*), wild celery (*Vallisneria americana*), stargrass (*Zosterella* dubia), naiad (*Najas guadalupensis*), and water marigold (*Megalondonta beckii*). Note that the last two species are on the NYSDEC Protected Plant List (Young, 2004). One species that declined was northern milfoil (*M. sibericum*), a close taxonomic representative of Eurasian watermilfoil.

Table 5-2 Summary of Selected Triclopyr Toxicity

	Study	Organism	Results	Comments
Mammalian Studies [1,2]				
Acute	Oral LD50	Male rat	2,574 mg/kg	Practically non-toxic
	Eye irritation	Rabbit	Corrosive	Severe eye irritant
	Dermal LD50	Rabbit	>2,000 mg/kg	Practically non-toxic
Subchronic	Oral (90 days) NOEL	Mouse	20 mg/kg/day	No effects at this level
	Oral (90 days) NOEL	Rat	30 mg/kg/day	No effects at this level
	Oral (6 months) NOEL	Dog	2.5 mg/kg/day	No effects at this level
Chronic	Oral (22 month) NOEL	Mouse	5.3 mg/kg/day	Not oncogenic
	Oral (2 year) NOEL	Rat	3 mg/kg/day	Not oncogenic
Freshwater Organism Studies [1]				
Fish 96 hour LC50		Bluegill	891 mg/L	Practically non-toxic
Fish 96 hour LC50		Rainbow trout	552 mg/L	Practically non-toxic
Fish 96 hour LC50		Fathead minnow	44 mg/L	Slightly toxic
Non-target Insect		*Daphnia magna*	248 mg/L	No effect on number and size
Avian Studies [1]				
Avian 8 day LC50		Mallard Duck	>10,000 ppm	Practically non-toxic
Avian 8 day LC50		Bobwhite Quail	2,935 ppm	Practically non-toxic
Marine Organism Studies [1]				
Mollusc 96 hour EC50		Eastern oyster	58 mg/L	Slightly toxic
Vertebrate 96 hour LC50		Tidewater silverside	130 mg/L	Practically non-toxic
Invertebrate 96 hour LC50		Grass shrimp	326 mg/L	Practically non-toxic
Algae 120 hour EC50		*Skeletonema costatum*	11 mg/L	Slightly toxic

[1] – Studies conducted with triclopyr TEA unless otherwise noted.

[2] – Subchronic and chronic mammalian studies conducted with triclopyr acid.

Data obtained from SePRO's Technical Bulletin for Renovate® (SePRO, 2004)

As part of the product registration process, aquatic plant testing was required because aerial application and outdoor non-residential use may expose non-target aquatic plants to triclopyr. The results presented in the RED (USEPA, 1998) indicate that exposure levels of 8.80 or greater ppm active ingredient (a.i.) triclopyr TEA may cause detrimental effects to the growth and reproduction of vascular aquatic plant species.

5.1.2 Algal and Planktonic Species

Toxicity testing presented in the RED indicate that algae may be affected from exposure levels of greater than 5.9 ppm a.i. triclopyr TEA or 32.45 ppm a.i. of triclopyr acid (USEPA, 1998). The SePRO technical bulletin presented a 120 hour EC50 of 11 ppm of triclopyr TEA for *Skeletonema costatum* (SePRO, 2004). In ponds treated with triclopyr TEA for the control of Eurasian watermilfoil, the more sensitive blue-green algae forms may have been adversely impacted. However, healthy and diverse populations of algae remained in both treated and untreated ponds. The green algae dominated the water column with *Spirogyra, Cladophora*, *Mougeotia, Volvox, Closterium* and *Scenedesmus* being dominant (WDOE, 2001). The macroalgae (charophytes) also appeared to be unaffected by treatment with triclopyr TEA (Petty et al, 1998).

5.1.3 Fish, Shellfish, and Aquatic Macroinvertebrates

The RED presented acute LC50s for freshwater fish ranging from 240 ppm for the rainbow trout (*Oncorhynchus mykiss*) to 947 for the fathead minnow (*Pimephales promelas*). These result indicate that triclopyr TEA is "practically non-toxic" to freshwater fish on an acute basis (USEPA, 1998). Data presented in the SePRO technical bulletin results in a similar conclusion with acute LC50s ranging from 44 ppm for the fathead minnow ("slightly toxic") to 891 ppm for the bluegill ("practically non-toxic") (Mayes et al., 1984; Woodburn et al, 1993; SePRO, 2004).

Freshwater fish early life cycle testing indicated that triclopyr TEA may affect fish at levels greater than 104 ppm, based on a reduction in fish length (USEPA, 1998).

Freshwater invertebrate testing with the water flea (*Daphnia magna*) indicated that triclopyr TEA is "practically non-toxic" to aquatic invertebrates (LC50 or EC50 of 1,496 ppm) on an acute basis (USEPA, 1998). Data presented in the SePRO technical bulletin results indicates that no acute impacts to *D. magna* were observed at 248 ppm (SePRO, 2004). Life cycle testing indicated that the level of triclopyr TEA above 80.7 ppm may have an adverse effect on *D. magna* reproduction (USEPA, 1998).

Marine species were also included in the suite of registration tests conducted for triclopyr. Acute toxicity testing results indicated that triclopyr TEA is "slightly toxic" to "practically non-toxic" to estuarine/marine invertebrates and "practically non-toxic" to estuarine/marine fish. The lowest EC50 was 58 ppm for the Eastern oyster (*Crassostrea virginica*) based on shell deposition (USEPA, 1998; SePRO, 2004).

5.1.4 Birds

The toxic effects of triclopyr on birds have been investigated in a small number of studies conducted by the Dow Chemical Company and other investigators. These results, presented in the RED (e.g., mallard duck LD50 of 2,055 mg/kg), indicate that triclopyr TEA is considered "practically non-toxic" to avian species on an acute oral basis (USEPA, 1998).

The results of sub-acute dietary tests with the mallard duck and the bobwhite quail indicate that that triclopyr TEA is also "practically non-toxic" to avian species on a sub-acute dietary basis. The LC50s for sub-acute avian dietary assays ranged from 5,401 ppm to >10,000 ppm (USEPA, 1989). Avian LC50s presented in the SePRO Technical Bulletin for Renovate® (SePRO, 2004) ranged from 2,935 ppm for the bobwhite quail to >10,000 ppm for the mallard duck. These values are also within the "practically non-toxic" category.

Chronic avian reproduction studies were required for triclopyr registration because birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season, and the pesticide is stable in the environment to the extent that potentially toxic amounts may persist in animal feed (USEPA, 1998). The avian toxicity discussion in the RED (USEPA, 1998) indicated that an avian reproduction study was not needed for triclopyr BEE and TEA. Therefore, testing for potential reproductive effects was only conducted with the triclopyr acid and not the TEA formulation. Based on this testing, reproduction of birds may be affected at levels greater than 100 ppm triclopyr acid (NOEC level for mallard duck study; USEPA, 1998).

Water fowl are likely to be the most highly exposed bird species, given that they potentially swim, drink and feed on lakes and ponds proposed for treatment with Renovate® 3. However, several factors are likely to mitigate this potential risk since (1) available toxicity values indicate that triclopyr is relatively non-toxic to avian species; (2) the nominal maximum exposure concentration in water is ~2.5 mg/L triclopyr as per maximum application rates; (3) the non-bioaccumulative properties of triclopyr and its metabolites; and (4) the environmental fate characteristics of triclopyr TEA and triclopyr acid demonstrate that they are short-lived in the aquatic environment (see Section 4.7). Overall, it would appear that there are negligible risks to avian species, including those whose diet might consist of aquatic vegetation treated with triclopyr.

5.1.5 Mammals

USEPA (1989) indicated that all three forms of triclopyr (triclopyr acid, TEA, and BEE) were considered bioequivalent with regard to toxicity to mammals. Mammalian acute and chronic testing was conducted with the triclopyr acid and not the TEA formulation. Acute oral rat data for triclopyr acid indicates an LD50 value of 729 and 630 mg/kg in male and female rats, respectively. This data indicates that triclopyr acid is "slightly toxic" to mammals (WDOE, 2001; USEPA, 1998). Data presented in the SePRO Technical Bulletin for Renovate® (SePRO, 2004) presents an oral LD50 of 2,574 mg/kg for male rats. This result indicates triclopyr acid is "practically non-toxic" to mammals on an acute oral basis.

Sub-chronic and chronic mammalian studies were conducted with triclopyr acid, but not with the TEA formulation. A 90 day sub-chronic oral exposure assay found no effects in mice at 20 mg/kg/day triclopyr acid and no effects in rats at 30 mg/kg/day triclopyr acid (SePRO, 2004). A 6-month oral exposure assay with dogs found no effects at 2.5 mg/kg/day triclopyr acid (SePRO, 2004).

Chronic mammalian toxicity data presented in the SePRO Technical Bulletin for Renovate® (SePRO, 2004) indicates that triclopyr acid is not oncogenic. This is based on a 22 month oral dosing rat study with a NOEL of 5.3 mg/kg/day and a 2 year study with a NOEL of 3 mg/kg/day (SePRO, 2004).

A two-generation rat reproduction study was performed using triclopyr acid. The reproductive/systemic NOEL for the rat reproduction study was found to be 25 mg/kg/day based on decreased litter size, decreased body weight and weight gain, and decreased survival of the F1 and F2 litters at the next highest dose level (250 mg/kg/day) (USEPA, 1998).

5.1.6 Reptiles and Amphibians

Limited information was identified on the effects of triclopyr TEA on reptiles or amphibians. The USEPA ECOTOX electronic database was reviewed (11/6/06) resulting in identified information (13 records) for two studies conducted with (3,5,6-trichloro-2-pyridyloxy)acetic acid. However, only two endpoints were recorded (ten records recorded no response (NR) as the endpoint). One study (Nishiuchi, 1989) identified a 48 hour LC50 of >100 mg/L for the frog (*Rana brevipoda porosa)*. Another study (Berrill,et al., 1994) reported 100% mortality values (identified as NR-LETH in the database) between 2.4 and 4.8 mg/L at 48 hours for the bullfrog (*Rana catesbeiana*) and the green frog (*Rana clamitans*). These results indicate a wide range of potential amphibian responses.

Garlon 3A (triclopyr TEA) and Garlon 4 (triclopyr BEE) have been specifically tested for malformations in the frog embryo teratogenesis assay (Perkins et al. 2000). In the Frog Embryo Teratogenesis Assay-Xenopus (FETAX) test, frog (*Xenopus laevis*) embryos were exposed to the test solution in petri dishes for 96-hours. Garlon 3A had an LC50 of 162.5 mg/L and Garlon 4 had an LC50 of 9.3 mg/L. These results indicate that triclopyr TEA is within the "practically non-toxic" ecotoxicity category for *X. laevis*. Field observations in one study indicated that *Rana pipiens* adults and tadpoles remained common 11 weeks after treatment of the Columbia, MO pond site at rates of 2.5 ppm ae (Petty et al, 1998).

5.1.7 Federal and State Listed Rare, Threatened, and Endangered Species

Of the many rare plant species that are native to New York State (see Appendix B for full list of NYSDEC Protected Plants), only six are listed as threatened or endangered under the Endangered Species Act of 1973. These federally-protected plants are an important piece of New York's natural heritage and biodiversity. They are given legal protection in order to ensure the continued survival of the species. These species are not considered to be aquatic plants and it is unlikely that they would come in contact with Renovate® 3 applied as directed on the product label.

However for application in the aquatic environment, there are a number of potentially relevant New York State-protected plant species including endangered, threatened and rare categories (Young, 2004). For purposes of the SEIS, a sub-listing of the aquatic macrophytes (i.e., floating-leaved and submerged plants) was developed for consideration of potential impacts and is presented in Table 5-4. This list was adapted from the New York Natural Heritage Program Protected Plant List and identifies protected plants (endangered, threatened, rare) belonging primarily to the floating-leaved and submerged plant community. These would be the species of interest relevant for applications to treat submerged plants such as Eurasian watermilfoil.

Inspection of this list indicates that with the exception of the native milfoils (*M. alterniflorum, farwellii, pinnatum*), no adverse impacts are predicted at typical label application rates. Prior work has indicated that triclopyr does not adverse impact the monocotyledonous pondweeds (*Potamogeton* spp.) bladderworts (*Utricularia* spp.), and naiads (*Najas* spp.) which often constitute the desirable macrophytes in terms of growth structure and habitat formation (Mattson et al., 2004).

For applications for control of purple loosestrife, a potentially much greater number of species may be present in the shoreline and riparian zones. For verification of the status of the much more numerous emergent and semi-aquatic plant species refer to the source document (Young, 2004). As with any herbicide application, whether aquatic or terrestrial in nature, the proponent should contact the New York State Natural Heritage Program to ascertain whether any State-listed protected plants are potentially present in treatment areas and, if present, provide adequate protection and mitigation.

Table 5-3 Federally Listed Threatened or Endangered Plant Species Found in New York State [1]

Name and Federal Status	Description
Northern wild monk's-hood (*Aconitum noveboracense*) Threatened	An herbaceous perennial with distinctive blue, hood-shaped flowers. The plants range from one to four feet in height, with wide, toothed leaves. They prefer to occupy cool sites such as stream sides or shaded cliff sides.
Sandplain gerardia (*Agalinis acuta*) Endangered	A small annual plant with delicate pink blossoms. Six of the twelve known natural populations in the world can be found in coastal grassland areas on Long Island.
Seabeach amaranth (*Amaranthus pumilus*) Threatened	An annual plant with reddish stems and small, rounded leaves. For years it was thought to be extirpated from New York State, until it was found again in 1990. It is found along sandy beaches of the Atlantic coast, where it grows on the shifting sands between dunes and the high tide mark.
Hart's-tongue fern (*Asplenium scolopendrium var americanum*) Threatened	A member of the spleenwort genus with large lanceolate to strap-shaped fronds. Over 90% of the U.S. population of this fern is found in Central New York, where it requires moist, sheltered locations and lime-rich soils.
Floating pennywort (*Hydrocotyle ranunculoides*) Endangered	A small stoloniferous perennial aquatic plant, with floating and emergent leaves. Propagates by rooting at nodes, stem fragments, seed. Found throughout most of eastern and southeastern United States except New England (i.e., northern limit in New York); also Pacific coast.
Leedy's roseroot (*Sedum integrifolium ssp. leedyi*) Threatened	A perennial with waxy, succulent leaves. The flowers are small and densely arranged, with four or five petals, and vary in color from dark red to orange or yellow. It grows on a few cliffs only in New York and Minnesota. This sub-species has probably always been rare, because of its very specific habitat requirements.
Houghton's goldenrod (*Solidago houghtonii*) Threatened	Grows only in the wetlands along the Great Lakes shoreline. It is a perennial with an upright stem and many yellow flower heads, which are arranged in somewhat flat-topped clusters. The leaves are narrow and grouped toward the base of the plant. There are many other goldenrods found in New York, some of which are similar-looking. One way to differentiate Houghton's goldenrod is by confirming the presence of tiny hairs on the flower stalks within the flower cluster.

[1] Information obtained from NYSDEC Endangered Plant Species in New York website http://www.dec.state.ny.us/website/dlf/privland/forprot/endspec/

Table 5-4 New York State Protected Aquatic Macrophytes [1]

Endangered Status	
Callitriche hermaphroditica	Autumn Water-Starwort
Hydrocotyle ranunculoides	Floating Pennywort
Hydrocoyle verticillata	Water-Pennywort
Lemna perpusilla	Minute Duckweed
Lemna valdiviana	Pale Duckweed
Myriophyllum pinnatum	Green Parrot's-Feather
Najas guadalupensis var. *muenscheri*	Muenscher's Naiad
Najas guadalupensis var. *olivacea*	Southern Naiad
Najas marina	Holly-Leaved Naiad
Potamogeton diversifolius	Water-Thread Pondweed
Potamogeton filiformis var.*alpinus*	Slender Pondweed
Potamogeton filiformis var.*occidentalis*	Sheathed Pondweed
Potamogeton ogdenii	Ogden's Pondweed
Potamogeton strictifolius	Straight-Leaf Pondweed
Sagittaria teres	Quill-Leaf Arrowhead
Utricularia inflate	Large Floating Bladderwort
Threatened Status	
Certatophyllum echinatum	Prickly Hornwort
Megalodonta (Bidens) beckii var. *beckii*	Water-Marigold
Myriophyllum alterniflorum	Water Milfoil
Myriophyllum farwellii	Farwell's Water Milfoil
Neobeckia (Rorippa) *aquatica*	Lake-Cress
Podostemum ceratophyllum	Riverweed
Potamogeton alpinus	Northern Pondweed
Potamogeton confervoides	Algae-Like Pondweed
Potamogeton hillii	Hill's Pondweed
Potamogeton pulcher	Spotted Pondweed
Proserpinaca pectinata	Combed-Leaved Mermaid Weed
Sagittaria calycina var. *spongiosa*	Spongy Arrowhead
Utricularia juncea	Rush Bladderwort
Utricularia minor	Lesser Bladderwort
Utricularia radiate	Small Floating Bladderwort
Utricularia striata	Bladderwort
Rare Status	
Isoetes (macrospore) *lacustris*	Large-Spored Quillwort

1 - This list was adapted from the New York Natural Heritage Program Protected Plant List and identifies protected plants belonging primarily to the floating-leaved and submerged plant community. For verification of the status of the much more numerous emergent and semi-aquatic plant species refer to the source document (Young, 2004).

5.2 Potential for Impact of Treated Plant Biomass on Water Quality

Reductions in dissolved oxygen (DO) may be caused by a number of natural events, such as a die-off of the microscopic green plants (phytoplankton) in the pond, or overturns in which oxygen deficient water from the deeper levels of the pond mixes with water in the upper levels and rapid decaying of dead macrophytes. One indirect effect of the use of any “fast acting” and non-selective effective aquatic herbicide is the creation of dead and decaying macrophyte biomass following application. Plants may begin to sink from the lake surface in 1 to 7 days and death of the plant is typically complete in 1 to 3 weeks. This organic material that sinks to the bottom, is subject to bacterial and fungal breakdown, and results in consumption of DO. If the oxygen demand is sufficiently large, a localized DO deficit may occur at the point of treatment that could result in the loss of sensitive fish or invertebrates. Based on the conditions (water temperature, wind/wave conditions, stratified state), these short-term effects may be severe.

If organic biomass is transported internally within the waterbody and enters the hypolimnion of a stratified lake, the severity and duration of hypolimnetic oxygen deficits could be increased. In addition to the lowered DO, water quality may also be affected by the release of nutrients from the dead and decaying macrophyte, with subsequent uptake by phytoplankton. This may lead to an algal bloom and decreased water transparency. Based on the relatively rapid uptake and response to target macrophytes to treatment by Renovate® 3 this release of nutrients could be phased over days to weeks. In the long-term, overall water quality should not be significantly affected since the organic material within the target macrophytes is subject to annual senescence and decay even in the absence of the herbicide.

Petty et al. (1998) reported that dense Eurasian watermilfoil stands in study plots suppressed DO levels in bottom waters by inhibiting circulation and exchange of surface waters, and by contributing greatly to oxygen-consuming respiration processes. Once the Eurasian watermilfoil was removed (2.5 ppm triclopyr applications to 16 acre plots), DO levels rebounded. In both treatment plots (targeting 2.5 ppm), DO levels increased within 1 week post-treatment in the lower half of the water column. When conducting entire littoral zone specific treatments, a significant decline in DO is greatly minimized, since even though the target plant is selectively controlled, the ambient DO is sustained from advective diffusion from untreated deeper waters and through photosynthesis by algae and macrophyte species not affected by triclopyr (Eichler, 2006)

Mitigation of the potential water quality impacts posed by the generation of large amounts of biodegradable biomass may be achieved by limiting the total amount of area treated to less than one half of the total water area. In addition, phasing the timing of treatments and/or providing adjacent untreated areas to act as temporary refugia for aquatic organisms should be incorporated as part of a site-specific IAVMP. In addition, the diversity and coverage of the plant community within the treatment area and susceptibility of select plant species should also be evaluated, as those species not impacted by a treatment (i.e. naiads, coontail, water celery, *Chara*) in many situations would allow adequate DO levels to be sustained following a Renovate® 3 treatment.

5.3 Impact of Residence Time of Renovate® 3 in the Water Column

Renovate® 3 is designed to remain in the water column long enough to produce its effects and then degrade and dissipate. There is no need to retain elevated dose concentrations in the water column for extended periods of time (days to weeks) or periodically reapply to “bump up” concentrations which may be required for other aquatic herbicides (e.g., fluridone). As discussed in the previous sections, Renovate® 3 is a relatively fast acting (effects observed within days to weeks) systemic herbicide that degrades with an average half-life in the laboratory of <1 to 3.5 days in the water column (see Section 4.7.3 for details). Field studies in geographically diverse locations (i.e., CA, GA, MN, MO, TX, WA) have shown triclopyr and its major breakdown products (i.e., TCP and TMP metabolites) dissipated from water with half-lives ranging from 5.9 to 7.5 (mean of 6.5 days) and 4.0 to 10 days (mean of 6.1 days), respectively (Petty et al., 2003). Therefore, it is not anticipated that an extended residence time in the water column would be a significant factor or would cause secondary potential impacts.

5.4 Recolonization of Non-target Plants after Control of Target Plants is Achieved

Following application of Renovate® 3, rapid recolonization and/or increase of pre-application cover of the bottom areas by non-susceptible native plants is expected. By selective removal and decrease of biomass of Eurasian watermilfoil, local native plants will likely experience an increase in light availability (particularly lower in the plant canopy) and available physical habitat, thus facilitating growth. Increases in submerged native pondweeds, bladderwort (*Utricularia vulgaris*), wild celery (*Vallisneria americana*), stargrass (*Zosterella dubia*), naiad (*Najas guadalupensis*), and water marigold (*Megalondonta beckii*), were noted in test plots given applications of 0.5 to 1.5 ppm ae in Minnesota ponds (Poovey et al., 2004). Important floating-leaved target species (e.g., *Nuphar, Nymphaea*) are susceptible when treated by direct foliar spray but they are largely unaffected by sub-surface application of Renovate® 3, therefore treatment for Eurasian watermilfoil should not decrease their abundance nor diminish their presence for fishery habitat. Release of nutrients following decay and breakdown of the milfoil could increase concentrations in the local environment, with potential uptake and growth by phytoplankton, periphyton, or benthic macroalgae (*Chara, Nitella*).

Overall, the colonization of native species expected after control of target nuisance plants is achieved should be rapid and effective. The relative success of the short-term expansion of the native plant community will be dependent on the percent reduction of the nuisance species, which is a function of the application dosage, contact period, size of application, and seasonal timing of application. The longevity of the increased native plant success will depend on the long-term suppression of the nuisance species through application of a successful IAVMP. Substantial removal of standing Eurasian watermilfoil shoots and reduced frequency of the plant can be obtained in the same season as the treatment, but complete kill of rootcrowns may not occur due to dosage or exposure limitations. Without further treatment recovery of milfoil to nuisance levels can occur within the next growing season (Poovey et al., 2004).

5.5 Impacts on Coastal Resource

At the present time, application of Renovate® 3 is expected to be limited to largely freshwater settings and is not currently intended for use in the marine environment (label indicates not to apply to saltwater bays or estuaries). However, potential downstream migration of the product from application areas into estuarine or marine environments is possible. As noted in Section 5.1.3, the use of Renovate® 3 at the recommended application rates has very little potential to result in an adverse impact to marine species. The likelihood of any affect is also small due to the short half-life of the product and the potential for significant dilution in estuarine and marine environments due to waves, tidal action, etc.

If the use of Renovate® 3 is proposed to be located within the NYS Coastal Zone and is determined to require federal licensing, permitting, or approval, or involves federal funding, then the action would be subject to the NYS Coastal Zone Management Program (19 NYCRR Section 600). This determination would be required during the preparation of an individual permit application.