

INDIGENOUS PLANT SPECIES FOR FUNCTIONAL AND ORNAMENTAL
PLANTING IN INDUSTRIAL AGGREGATE MINES¹

by

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Abstract. Quarry and sand and gravel pit operators are interested in improving the visual image of their mining operations. Often the tree and shrub species they select for landscape improvements are ornamental landscape plant species that are not indigenous species. The plant species are selected because of the species real or perceived ornamental and functional characteristics. The vegetation at selected limestone quarries and sand and gravel pits in Iowa and north-central Missouri was analyzed by field observation as to effectiveness ornamentally and functionally. Information on the planting of ornamental plants, ie: species, when planted, survival rate, replanting, etc., was obtained where possible. The effectiveness of the vegetation in terms of function, ie: ornamental, visual screen, etc. was determined. The findings are that some plants with strong ornamental characteristics and values may have poor functional characteristics and low survival rates and low growth rates. It is not always clear if a plant species was selected for its ornamental or functional values. Introduced species often require intensive maintenance. Some native pioneer species can do very well functionally and esthetically on these sites. In summary, native pioneer species can be the source of plant materials which are ecologically and visually compatible while serving functional needs, yet they are readily available, inexpensive, hardy under a wide range of conditions, and require relatively low energy and management inputs. A list of tree species which are indigenous to most of Iowa and appropriate to a mine environment is included as an aid to mine operators in selecting appropriate plant species.

Introduction

Aggregate mine operators are becoming increasingly aware of the importance of their operations and industry projecting a positive public image. There is an increasing need for operators to obtain a variety of approvals and permits ranging from water discharge permits to conditional use permits under the zoning ordinance and reclamation plans. A significant part of the public image or perception of a mine operation is the visual image of the mine and related facilities. In the effort to improve the visual

image of the mine site and related facilities, some mine operators embark on programs of improved housekeeping, signage and specific landscape improvements such as lawns, decorative fences, plantings, berms, etc.

Decorative and ornamental landscape plantings and lawns often dominate the operator's response to the perceived need to 'landscape' and beautify the operating sites. Most of these ornamental plantings are at or near the mine entrance and along public roads leading to the entrance. Ornamental landscape plantings are also sometimes located within the site itself. These interior plantings can be located in a variety of locations and related to such site elements as: flagpoles, scale house, overlooks, buildings, etc.

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During site visits to rural Iowa aggregate mine sites, it was noted that:

1. Non-indigenous, non-native, ornamental landscape plantings were at times very conspicuous in the rural landscape because of the form and foliage of the plant

- species and the location of the plantings.
2. Often the ornamental landscape plants were not thriving, some had low survival rates, some were mechanically damaged by operations, and some were improperly planted.
 3. Operators themselves indicated that they had problems with some deciduous and evergreen plantings having low survival rates and having to be replaced.
 4. Some plantings and plant species were inappropriate for apparent functional landscape purposes such as visual screening due to the use of inappropriate plant species, plant spacings and planting schemes and/or locations.
 5. Volunteers of indigenous and native species, usually pioneer plants, were thriving on the mine sites and had potential uses for ornamental, design or engineering purposes.

The above observations led to the decision to survey more closely selected aggregate mine sites to document to what degree the preliminary observations were correct. The mine site plantings were looked at in terms of:

1. Purpose of the plantings.
2. Appropriateness of the purpose.
3. Appropriateness of plant species for the purpose.
4. Appropriateness of the plant species for the environmental conditions.

The objective of this study is to identify problems with landscape plantings, and plant species selected, on aggregate mine sites that could be more appropriately solved with indigenous plant species. Problems would be identified, and a suggested methodology for the development of appropriate alternative solutions. Emphasis and focus was on the selection and use of native plant species indigenous to the entire state of Iowa. The purpose in selecting only native and indigenous plants appropriate across the entire state of Iowa was to determine if a small, useful palette of relatively hardy and functional tree species could be developed for use by aggregate mine operators throughout Iowa.

Method

Over 20 aggregate mine operations of two different operators were surveyed. The two different operators of these sites have over 60 aggregate mine sites in Iowa. Four of the rural aggregate mines were studied in greater detail and documented with photographs. Three were limestone quarries and one was a sand and gravel pit. Locations ranged from south central Iowa to central east Iowa.

Landscape plantings at the mine sites were categorized as to their perceived purpose; ornamental, engineering or design function. An ornamental function could be more appropriately be a category under the design functions, but for purposes of this study it was left as a separate function. The ornamental function is assigned to those plantings which are perceived to be used primarily for decorative enhancement. Some of the design functions that can be assigned to plants are below:

DESIGN FUNCTIONS FOR PLANTINGS (Robinette 1972)

- Spatial Definition
- Spatial Articulation
- Contrast
- Focus
- Accent
- Complement
- Visual Screening
- View Enframing
- Vista Creation

There are also engineering functions that can be assigned to plants. Some of these engineering functions are below:

ENGINEERING FUNCTIONS FOR PLANTINGS (Robinette 1972)

- Wind/Water Erosion Control
- Sedimentation Control
- Dust Control
- Acoustical Control
- Light (glare and reflection) Control
- Climate Control
- Snow Drift Control

There was particular attention paid to group plantings. Group plantings were more apt to have been conceived of as having design or engineering functions rather than a strictly ornamental or decorative function. Examples of ornamental plantings on the mine sites were included. See Fig. 1 for a sample of the Landscape Planting Survey Sheet developed for this study. The plantings and species were then evaluated as to the appropriateness of the species selected for the particular site environmental conditions and function. The parameters used to judge the planting and plant species were:

1. Climate
2. Micro-climate/Exposure
3. Operations
4. Soils
5. Function (Design/Engineering)
6. Management Practices

The parameters were viewed with the idea of limiting factors. That is 1) what environmental, including site and operation, characteristics limits the selection and use of plant species, and 2) what limits of a specific plant species must be considered if that species is to be used on aggregate mine sites in Iowa.

From the analysis of plant species limitations imposed by: 1) the location, 2) the function, and 3) the plant species, possible alternatives are proposed. The purpose is to develop a methodology for the selection of plant species, particularly indigenous species, for design and engineering functions on aggregate mine sites in Iowa that could be useful to the aggregate mine operators.

LANDSCAPE PLANTING SURVEY SHEET

SITE NO. _____ PLANTING: _____
 MINE SITE NAME: _____
 LOCATION ON SITE: _____
 BY: _____ DATE: _____

1. PRIMARY PLANT(S) (Common and Botanical Name):
 Common: _____ Common: _____
 Botanical: _____ Botanical: _____

2. DESIGN FUNCTION: _____

3. ENGINEERING FUNCTION: _____

4. PHYSICAL CONDITION: _____

5. PLANTING DATA: _____

6. ENVIRONMENTAL/MANAGEMENT CONDITIONS: Site Plant

1) Climate: _____
 2) Exposure, Microclimate: _____
 3) Soils, Etc: _____
 4) Operations, Etc. _____
 5) Management Practices: _____

7. COMMENTS/CONCLUSIONS:

Figure 1. Sample of Landscape Planting Survey Sheet used for landscape planting survey of aggregate mines.

Mine #1

The White Pines shown in Figure 1 and 2 provide virtually no visual screening because of their size and spacing (20'± o.c.). They have no other apparent purpose other than decorative ornamental. They appear in the rural landscape as individual evergreen trees in contrast to the agricultural fields and riparian and upland deciduous trees. Some of the trees have been



Figure 2. One of the White Pines in a row between stockpiles and split rail fence along county road. Note the gravel from the stockpile.

removed and some are severely damaged with broken branches and trunk. In general, these trees are not robust and are a visual contrasting element in the rural, agricultural landscape.

Of 13 pine trees, 3 had been cut off at the ground, 4 have severe mechanical damage (stockpiling operations?) and the remainder lack vitality. The area the trees were planted in has not been mined and the limestone is 24" to 36" below the surface. The trees are very exposed to winds, etc. These white pines have very limited ornamental and/or functional value due to their condition, size, spacing, location and the site environmental conditions.



Figure 3. Row of White Pines between stockpiles and split rail fence along county road. Note the edge of the gravel stockpile between the pines.



Figure 4. One of the Arborvitae planted in a row on both sides of an 'overlook' of the quarry operation. The foliage is brown and dead.

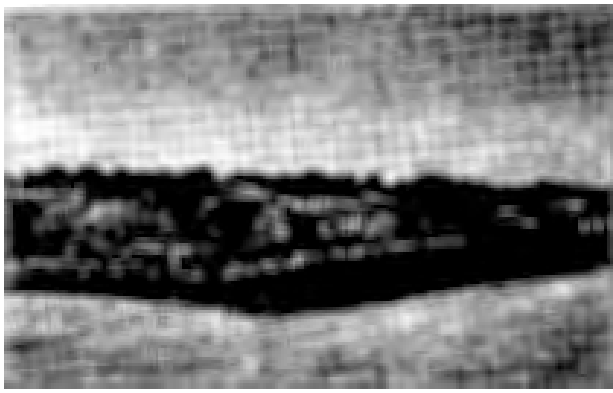
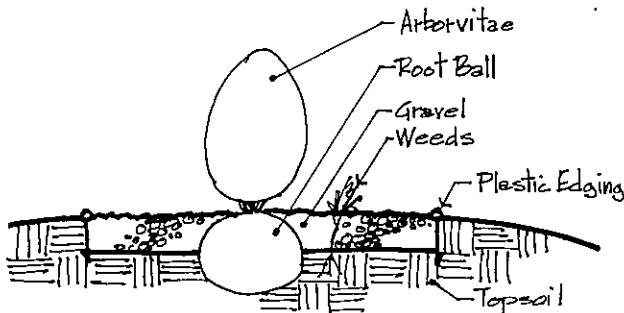
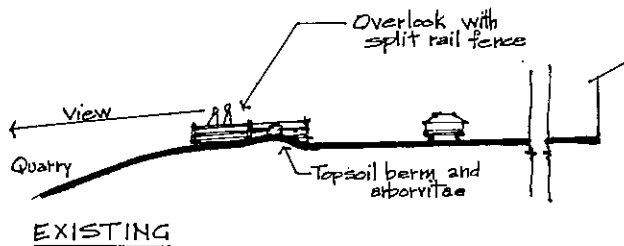


Figure 5. Row of Arborvitae planted on both sides of the 'overlook' which is enclosed by split rail fence on far left of photograph. Note the potential exposure to wind and sun.

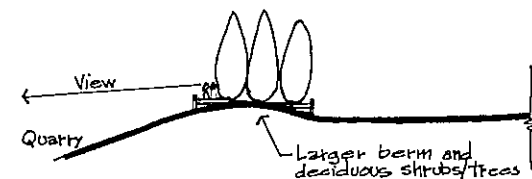


No Scale

Figure 6. Cross-section of Arborvitae in gravel bed. Note that the top portion of the root ball is in gravel and not soil. Also, weeds growing up thru the gravel will be a continual maintenance problem.



EXISTING



ALTERNATIVE

Figure 7. Sections of overlook showing existing (top) and alternative (bottom).

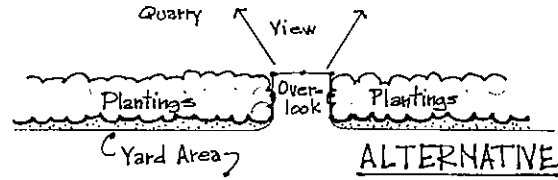
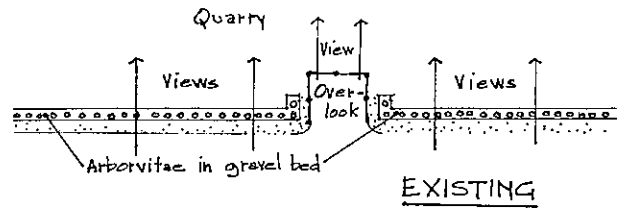


Figure 8. Plan views of overlook showing existing and alternative plantings for sections in Figure 7.

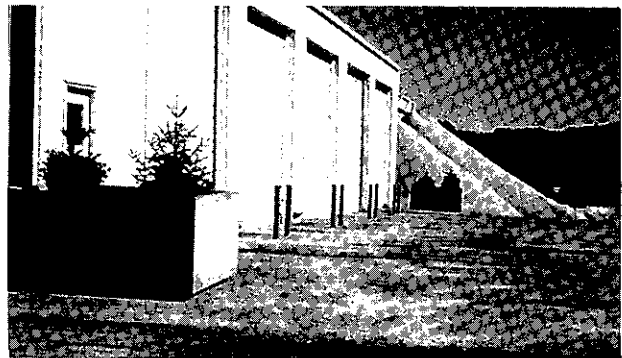


Figure 9. Plantings of Black Hills Spruce in containers at a maintenance shop.

Mine #2

This sand and gravel pit operation is on leased rural agricultural land that is bounded by an interstate, a paved county road, a gravel county road and a river. The site is within the floodplain. It is a new operation and is scheduled to be in production this spring. Part of the permitting requirements were that the operations remain 200' to 500' from the boundaries. Visual screening was also required on three sides; the Interstate, paved county road and the river. The visual screens have been planted with the plant species shown below and were inspected November 1985.

<u>Location of Visual Screen Planting</u>	<u>Initial Planting</u>	<u>Second Year Planting</u>
1. 500' from county road	Seedlings Pinus sylvestris, banksiana and strobus	18" Pinus strobus
2. Adjacent to interstate	Seedlings (same as above)	
3. Adjacent to river on topsoil berm	Seedlings Hybrid Poplars	Seedlings Pinus banksiana

The first year plantings did not do well and had very low survival rates according to the operator. The same was true for the mixed pine seedlings planted in the open corn field. Both of these plantings were replanted. The mixed pine seedlings along the interstate had higher survival rates, but would have competition from the weeds which grew to a height of 3+ feet.

Visual Screen #1 (500' from County Road). The mixed pine seedlings had been replaced by 18"± White Pines (*Pinus strobus*). The planting location is very exposed, particularly in the winter, and the topsoil is deep, but heavy. It is thought that the environmental conditions of exposure to harsh winter winds, summer heat and the heavy, flood plain soils was too severe for the seedlings. The planting was done by untrained personnel, but nothing of the planting technique is known.



Figure 10. Double row of White pines (20' ± o.c.) planted as a visual screen 500' from paved county road.

It should be noted that White Pine are the 18" White Pines are planted 20'± on center in two offset rows. It will be some time before this planting will be an effective visual screen to only the very most northeastern corner of Iowa. There is a large stand of White Pines on an uplands area overlooking the site. But it would appear that this site is very difficult for white pines because of the soils and exposure to direct sun and prevailing dry winds, especially in winter. White Pines prefer a regime of a high degree of available soil moisture, reduced evaporation stress, and stable temperature near the ground.

Alternative. An alternative is to use the stripped topsoil and overburden and create an earth berm for potentially better drainage. Deciduous plantings appropriate to the environmental conditions, and the operators needs, could be planted to visually screen the operations. The earth berm creates north and south facing slopes and thereby creates different micro-climates. For example, a berm with a southerly facing slope and a northerly facing slope of 20 degrees each would have 106% and 81% solar radiation absorption of level soil at the 42nd parallel north on June 21. (Bailey 1974). The micro-climate created on the north-facing slope of

the berm, and reinforced by deciduous plantings on the south facing slope, could improve the survival rates of White Pines if they were planted on the north slope.

Visual Screen #2 (Adjacent to Interstate). Most of the mixed pine seedlings in this planting have survived the first year. They are more protected from direct exposure to direct sun and prevailing dry winds because they have the raised interstate embankment adjacent on the west and heavy woods on the north. The profuse and vigorous weeds would compete with the seedlings for sunlight, water and nutrients, but they could provide protection from the sun and wind.

Alternative. The use of an earth berm could again improve drainage and enhance the visual screening. gain, use of native deciduous plants could be used to provide sufficient visual screening.



Figure 11. Scotch Pine seedling planted along Interstate as visual screen.

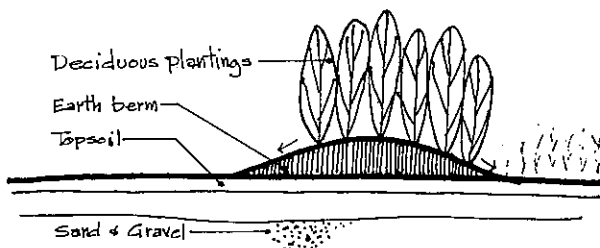


Figure 12. Alternative planting on berm for improved visual screen and soil drainage.

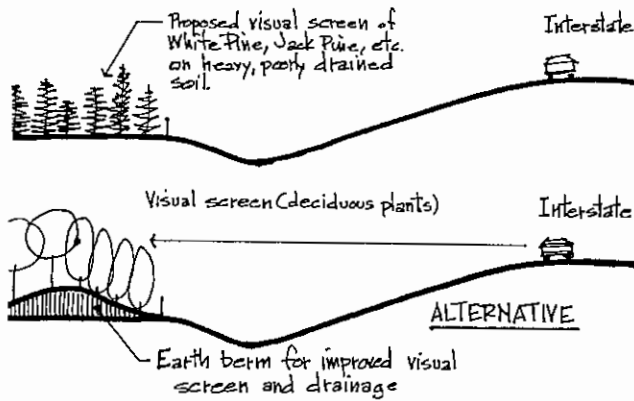


Figure 13. Existing and Alternative cross-section for visual screen.

Visual Screen #3. The mining permit required a visual screen composed of an earth berm 15' high planted with trees within 200' of the river. The operator planted hybrid Poplar seedlings, but they were replaced at the end of the first year with Jack Pine (*pinus banksiana*) due to the low survival rate of the Poplars. It is not known why the poplars failed, except that they received no care and it was a dry summer. The current planting is two rows of Jack Pine planted every 15'± at the top of the two side slopes.

Alternative. The existing floodplain vegetation should be used as a guide for plant specie selection. There are many Box Elder (*Acer negundo*) growing on this site and on an adjacent sand and gravel operation where it used effectively as a visual screen in conjunction with an earth berm. The use of a Box Elder and other native, riparian deciduous trees is appropriate in terms of the environmental conditions and the desire to visually screen the operations from views across the river. The deciduous plants would visually blend in better with the existing vegetation than evergreen trees.



Figure 14. Jack Pine Planted on Berm Near River



Figure 15. Earth Berm from across the River.

Mine #3

This mine is isolated on a county road in a rural agricultural landscape. The landscape improvements at the entrance consist of mowed lawn, split-rail wood fence, two crushed limestone beds contained by railroad ties or timbers, and small yews as shown in Figures 16 and 17. The 3 yews in Figure 17 are not doing well. A close inspection disclosed that the root ball of the yews had been set on top of the existing grade and the crushed stone used for 'backfilling' around the ball. See Figure 18.

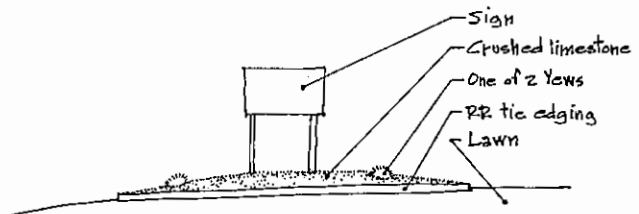


Figure 16. Existing entrance sign and landscape elements with two yew shrubs in a crushed limestone bed contained by railroad ties.



Figure 17. Decorative landscape treatment of entrance with 3 small evergreen yews, a large stone in crushed limestone with timber border, in conjunction with split rail fence.

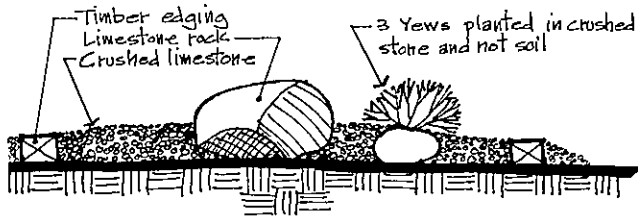


Figure 18. Section through decorative landscape treatment shown in Figure 16. Not that the yews were 'planted' in the crushed stone.

The methods of construction of the 'gravel' beds and planting, along with the necessity of mowing grass, mean that this will be a costly landscape improvement to maintain. The only purpose of the landscape elements used appears to be ornamental. These landscape elements create significant visual contrast with the surrounding rural landscape because of their form scale and color. The landscape development does not visually blend the quarry site into the surrounding rural, agricultural landscape, but does just the opposite. Maintaining a large area of mowed lawn creates a continual maintenance problem and cost.

Figure 19 indicates that the volunteer Box Elder can be a partial but effective screen. It also illustrates the effectiveness of earth berms or mounds in visually screening much of the yard and stockpile.



Figure 19. View from road west of entrance. Note effectiveness of even partial screening. Horizontal dashed lines indicate the visual screening provided by 4' and 6' earth berms.

Alternative. The lawn area should be decreased in area and it should be less intensely manicured. Mowings should occur less often and in keeping with the frequency of the county road mowings. As much area as possible should be planted 'out' with native deciduous plants to blend in with the surrounding rural landscape and decrease maintenance costs. There is no need for

crushed limestone beds edged with railroad ties. These landscape elements will be nothing but continual maintenance problems in the future and should be removed. In general, clean up and simplify the landscape treatment of the road frontage to blend in better with the surrounding landscape and decrease maintenance costs. Additional visual screening of the operations could be provided in Figure 19 by creating earth berms with overburden and additional deciduous plantings.

Mine #4

Mine #4 has a hedge composed of a single row of Tartarian Honeysuckle planted 30" ± on center as shown in Figure 21. These honeysuckle are doing well and have been sheared off at a height of 3' ±. There are also Black Hills Spruce (15"-18") planted at 15' ± o.c. adjacent to the hedge (on the south side). These spruce are doing poorly. Most of them have many branches which have lost all of their leaves. None of the spruce have a saucer formed of earth or mulch. Figure 20 shows other spruce planted singularly in a straight line 15' ± o.c. These spruce appear to have been mechanically damaged by the mowing equipment. No saucer, mulch or stakes have been utilized.



Figure 20. Individual Black Hills Spruce planted between county road and quarry. All show signs of severe stress.

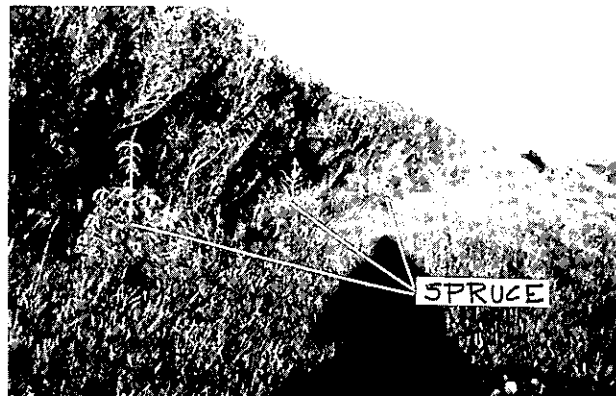


Figure 21. Black Hills Spruce planted at base of Tartarian Honeysuckle hedge along right-of-way live between road and quarry.

CHARACTERISTICS

PLANT SPECIES	SHAPE			PREFERRED HABITAT	SOIL CHARACTERISTICS				FLOOD TOLERANCE			GROWTH RATE/LONGEVITY			AVAILABILITY REMARKS
	FORM	HEIGHT	SPREAD		PREFERRED SOIL		DRAINAGE	MOISTURE	TOLERANCE	RATE	LONGEVITY	LONGEVITY	REMARKS		
					WET	UPLAND								WET	
ACER NEGUNDO BOXELDER	•	-	-	•	•	•	•	•	•	•	•	•	•	PIONEER SPECIES	
ACER SACCHARINUM SILVER MAPLE	•	-	-	•	•	•	•	•	•	•	•	•	•	READILY AVAILABLE	
AQUILARIA COMMON HACKBERRY	•	-	-	•	•	•	•	•	•	•	•	•	•	READILY AVAILABLE	
FRAXINUS FRAXINUS GREEN ASH	•	-	-	•	•	•	•	•	•	•	•	•	•	READILY AVAILABLE	
GLADSTONIA TRILOBATA HONEYLOCUST	•	-	-	•	•	•	•	•	•	•	•	•	•	READILY AVAILABLE	
JUGLANS NIGRA BLACK WALNUT	•	-	-	•	•	•	•	•	•	•	•	•	•	LIMITED AVAILABILITY	
JUNIPERUS VIRGINIANA EASTERN RED CEDAR	•	-	-	•	•	•	•	•	•	•	•	•	•	PIONEER SPECIES	
POPULUS DELTOIDES COTTONWOOD	•	-	-	•	•	•	•	•	•	•	•	•	•	LIMITED AVAILABILITY	
PRUNUS AMERICANA AMERICAN PLUM	•	-	-	•	•	•	•	•	•	•	•	•	•	LIMITED AVAILABILITY	
PRUNUS VIRGINIANA COMMON CHOCCHERRY	•	-	-	•	•	•	•	•	•	•	•	•	•	LIMITED AVAILABILITY	
RHUS GLABRA SMOOTH SUMAC	•	-	-	•	•	•	•	•	•	•	•	•	•	READILY AVAILABLE	
SALIX AMYGDALOIDES PEACHLEAF WILLOW	•	-	-	•	•	•	•	•	•	•	•	•	•	UNAVAILABLE	
SALIX NIGRA BLACK WILLOW	•	-	-	•	•	•	•	•	•	•	•	•	•	LIMITED AVAILABILITY	

Figure 22. Indigenous tree species suitable for aggregate mine sites throughout Iowa. From Hinners (1986).

The use of Spruce is completely inappropriate because they will never provide a visual screen, will be a significant contrast to the surrounding landscape and are in a very difficult environmental condition. The clipped hedge is also visually intrusive and does not provide complete visual screening of the operation.

Indigenous Trees

A list of 13 tree species indigenous to all of Iowa is in Fig. 22. These species range over a preferred habitat from floodplain to upland. Box Elder, Poplars, and Red Cedars along with some Silver Maple, Green Ash and Smooth Sumac are often found on the mine sites. See Figure 22.

This list is not meant to be all inclusive, but is to be used as a starting point in the selection of trees species for aggregate mine sites. The species should have good survivability, be readily available, including on the mine sites itself. Work in the future could lead to a more extensive list of plant species suitable for aggregate mine sites in Iowa. Included would be shrubs and plant species both indigenous and naturalized to the entire state of Iowa. Of particular interest would those species which would have high survival rates on exposed sites subject to severe environmental and/or operational conditions with a minimum of maintenance. Plant species characteristics such as form, preferred habitat, soil preference, flood tolerance and growth rate are shown in Figure 22.

Recommendations

To achieve a more effective use of landscape elements in projecting a positive visual image of aggregate mine sites, the following recommendations are made.

1. The operator must determine what the goals are. Examples of some of these are:
 - a. Mitigation of the visual impacts of the operations.
 - b. Beautification by the use of ornamental plantings and other landscape elements.
 - c. Allowing controlled views and/or vistas of the operations.
 - d. Complete screening of the operations.
 - e. Partial screening of the operation
 - f. Visual compatibility within the surrounding landscape.
 - g. Level of maintenance activity/cost desired

To achieve more visually compatible and cost effective landscape development of the mine sites more use should be made of:

1. Native, indigenous plant species.
2. Earth shaping and forming.
3. More naturalistic plantings.
4. Native/natural grasses and ground covers.

The above would decrease the use of out of scale or visually contrasting landscape elements. In selecting plant species and determining planting design and location, the following format is recommended.

1. Determine the purpose of the planting, that is what problem(s) is to be solved.
2. Determine the environmental conditions (soil, wind, exposure, moisture, operations, etc.) the plants are going to be subjected to.
3. Select the plant species that best solve the problem and are appropriate to the environmental conditions.
4. Determine what alternative landscape elements (plantings, earth forms, fencing, etc.) can provide solutions to the problem.
5. Select the most cost effective landscape element or combination of elements that is in keeping with the operator's goals.

Conclusions

The conclusions of the study are:

1. Landscape elements are being used to project a positive visual image.
2. These landscape elements are too often being used in an ineffective or counter productive manner because they are:
 - a. Not viewed as part of the total landscape both on and off the mine site.
 - b. Out of scale and/or character to the industrial mine site and the surrounding rural agricultural landscape.
 - c. Used primarily for their perceived ornamental values which are more appropriate to decorative function in residential landscapes.
 - d. Introducing visually contrasting elements into the existing rural landscape.
 - e. Used in environmental settings that exceed the limitations of the plant species selected.

Too many of these ornamental plant species and landscape elements are not cost effective because they:

- a. Can have high initial planting or construction costs because of their ornamental nature.
- b. Can have very low survival rates because of environmental conditions.
- c. Are often functionally inappropriate or ineffective.
- d. Can have high maintenance costs.

In summary, this survey of the use of plantings and plant species four rural Iowa aggregate mines has indicated that plants are selected too often for their perceived ornamental value and with too little regard to their functional purpose and environmental limitations. There is a bias towards evergreen plant species, yet Red Cedar is the only indigenous evergreen tree in the geographical area where these mines are located. The results are low survival rates and functionally ineffective plants and plantings which translates into low cost effectiveness.

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